# Fenland District Council
# Cambridgeshire County Council
## March Area Transport Study

**Local Model Validation Report**
11 March 2011

Plan Design Enable

# Notice

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## March Area Transport Study

The market town of March is the second largest settlement in Fenland District.  The aim of the March Area Transport Study is to build and interpret a transport model that can provide forecasts for the future land use planning March and its surrounding area.

This document is the Local Model Validation Report.

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## Glossary of Abbreviations Used in this Report

| | |
|---|---|
| Automatic Traffic Count | ATC |
| Cambridgeshire County Council | CCC |
| COst Benefit Analysis | COBA |
| Department for Transport | DfT |
| Design Manual for Roads and Bridges | DMRB |
| Employers' Business | EB |
| Fenland District Council | FDC |
| Home-Based Education | HBEd |
| Home-Based Work | HBW |
| Inter Peak | IP |
| Geoffrey E Havers | GEH |
| Graphical Information System | GIS |
| Journey To Work | JTW |
| Light Goods Vehicle | LGV |
| Local Model Validation Report | LMVR |
| March Area Transport Study | MATS |
| Manual Classified Count | MCC |
| Manual Classified Turning Count | MCTC |
| Matrix Estimation by Maximum Entropy | ME2 |
| Ordnance Survey | OS |
| Ordnance Survey Grid Reference | OSGR |
| Origin Based Assignment | OBA |
| Other Goods Vehicle Class 1 (Medium Goods Vehicle) | OGV1 |
| Other Goods Vehicle Class 2 (Heavy Goods Vehicle) | OGV2 |
| Other Trip Purpose | OTP |
| Passenger Car Unit | PCU |
| Pence per Kilometre | PPK |
| Pence per Minute | PPM |
| Roadside Interview | RSI |
| Simulation and Assignment of Traffic in Urban Road Networks | SATURN |
| User Class | UC |
| Value of Time | VOT |
| Vehicle Operating Cost | VOC |
| Vehicle Per Hour | vph |
| Web Transport Analysis Guidance | WebTAG |
| Wisbech Area Transport Study | WATS |
| Work To Home | WTH |

## Glossary of Technical Terms

| | |
|---|---|
| Furness Process | This is a process used to distribute trips within a matrix. Given a starting point (often a logit distribution function) and a set of target trip ends, the Furness process distributes the trips so that the matrix origin and destination totals match the target trip ends. |
| ME2 (Matrix Estimation from Maximum Entropy) | This is a process that is used to estimate trip matrices from traffic counts such that the modelled link flows match the observed data more closely. This allows for errors within the matrix building process and the inherent inaccuracy of synthetic data, allowing the output assignment to match local conditions more accurately. |
| SATASS/SATSIM (assignment) Loop | This is the iterative loop that the model assignment procedure undertakes. The SATASS process takes the flows from the demand matrices, and assigns these to the network in such a way that it believes will satisfy the Wardrop Equilibrium Assignment. SATSIM then takes these assigned flows, and simulates these flows onto the network, passing back the flow-delay curves for each node to the SATASS program. This in turn adjusts its assignment of flows to the network based upon the flow-delay information that it has received from the SATSIM program, and passes a new set of link flows over to SATSIM. This loop is repeated until the model converges, whereby the change in link flows between each loop has reached a specified threshold. |
| SATME2 | This is a program that is used in conjunction with SATPIJA to estimate trip matrices from observed traffic counts (SATURN 77777 Card). It is based on the modelling procedure ME2.<br><br>SATME2 essentially tries to improve the fit between modelled and observed flows by selectively factoring individual cells of the input trip matrix (prior). |
| SATPIJA | This program is run as part of the Matrix Estimation process, and produces a file that contains the proportion of trips between each origin and destination that uses the counted link. |
| SATURN 77777 Card | The 77777 card is the section of the network file which includes the observed traffic counts that are used within the Matrix Estimation element of the network calibration. |
| Select Link Analysis | An analysis procedure within SATURN that provides origin/destination information for all trips along a selected link. This is useful for understanding the type of trips (e.g. local or external) that uses a specific link and for demonstrating the traffic patterns on specific links within the network. |
| Wardrop Equilibrium Assignment | The assignment procedure used within SATURN for this model. Traffic arranges itself in congested networks such that:<br>• no individual trip maker can reduce his/her path costs by switching routes;<br>• the costs of travel on all used routes between each origin/destination pair have equal and minimum costs while all unused routes have greater or equal costs. |

# 1. Introduction

This document is the Local Model Validation Report. It represents the culmination of the base year MATS SATURN highway model development, and hence is the basis for future modelling work in March.

# Introduction

## Background

1.1. Atkins Transport Planning was commissioned by Cambridgeshire County Council (CCC) and Fenland District Council (FDC) in July 2010 to undertake a transport study and produce a transport model for the market town of March.

1.2. The March Area Transport Study (MATS) sets out to review existing transport problems and issues and will examine a range of proposed measures and policies to improve the current transport system as well as meet the demand expected from future growth in the study area.

1.3. The MATS SATURN highway model has been validated to represent existing traffic conditions, and it forms the basis for future modelling work in March.

## Scope and Structure of this Report

1.4. This document is the Local Model Validation Report (LMVR) and it provides details on the development of the base year MATS SATURN highway model. It outlines the methodology and traffic data used to develop the model network and demand matrices, and provides detailed model calibration and validation statistics.

1.5. The report is arranged in nine chapters and two appendices, following this introduction:

- Chapter 2 gives an overview of the modelling framework;
- Chapter 3 describes all of the data that was used during the development and validation of the model;
- Chapter 4 details the general parameters that were used within the model;
- Chapter 5 sets out the development of the model network;
- Chapter 6 describes the development of the model demand matrices;
- Chapter 7 describes the model calibration and validation procedures;
- Chapter 8 provides the model calibration and validation results;
- Chapter 9 draws together the conclusions of the model calibration and validation exercise;
- Appendix A gives detailed tables and graphs of the validation results; and
- Appendix B includes network and sector plots of the model.

# 2. Overview of Modelling Framework

This chapter provides information on coverage of the MATS SATURN highway model and the zoning and sectoring systems.

# Overview of Modelling Framework

## WebTAG

2.1. The MATS model has been built following the Web Transport Analysis Guidance (WebTAG). This is the web-based guidance set out by the Department for Transport (DfT) on how to conduct transport studies, and provides guidance on how to conduct modelling and appraisal for highway and public transport schemes.

## The Study Area

2.2. The study area comprises the market town of March, the principal roads of A141, B1101 and B1099. The study area extends to the A141/A605 junction in the north and the A141/A1093 junction in the south.

2.3. The extent of the study area is shown in Figure 2.1. The blue links in Figure 2.1, which are the simulation links, highlight the study area. A larger version of Figure 2.1 can also be found in Appendix B which provides a more detailed network structure for March.

## MATS Zones and Sectors

2.4. A zone plan for this study has been devised to give a fine level of detail in March, growing coarser further away from the town, ultimately covering the whole of England, Scotland and Wales in 87 zones. Zone boundaries are based on existing divisions such as output area, ward, parish district and county boundaries. On several occasions, however, it was necessary to split an output area to reflect physical barriers such as the river, in accordance with DfT guidance on zone designation. The resulting zone plan is shown in Figure 2.2 and Figure 2.3.

2.5. The zone plan has been aggregated into eight sectors. The sectoring system is used as a means of keeping track of the basic movements around the model, and for basic trip distribution checks within the model. Table 2.1 lists the sectors and the number of zones within each sector, and Figure 2.4 shows the sector plan.

**Table 2.1 – MATS Sectors**

| Sector ID | Description | Number of Zones |
|---|---|---|
| 1 | March North | 13 |
| 2 | March East | 19 |
| 3 | March West | 17 |
| 4 | Fenland North | 10 |
| 5 | Fenland East | 2 |
| 6 | Fenland South | 7 |
| 7 | Rest of Cambridgeshire and Peterborough | 8 |
| 8 | Rest of Country | 11 |
| Total | | 87 |

## Modelling Software

2.6. The MATS highway model was built and run using the SATURN software suite (**S**imulation and **A**ssignment of **T**raffic to **U**rban **R**oad **N**etworks), version 10.9.17.

## Modelled Base Year and Time Periods

2.7. The base year for the MATS SATURN highway model is 2010. Three time periods have been modelled:

- AM peak (0800-0900);
- Inter peak (Average hour between 1000-1600); and
- PM peak (1700-1800).

**Figure 2.1 – MATS Network/Study Area**

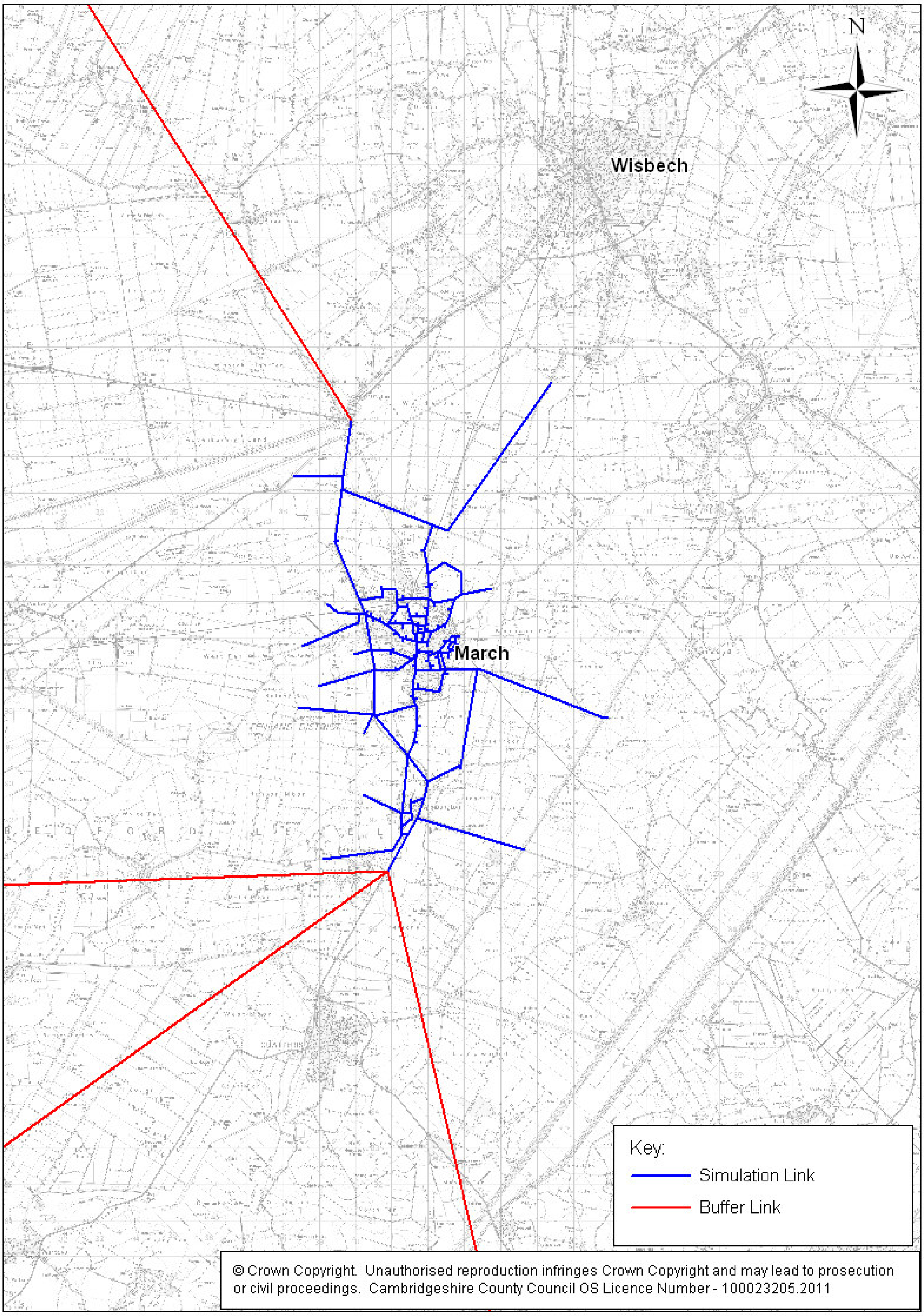


Figure 2.2 – MATS Zone Plan (Overview)

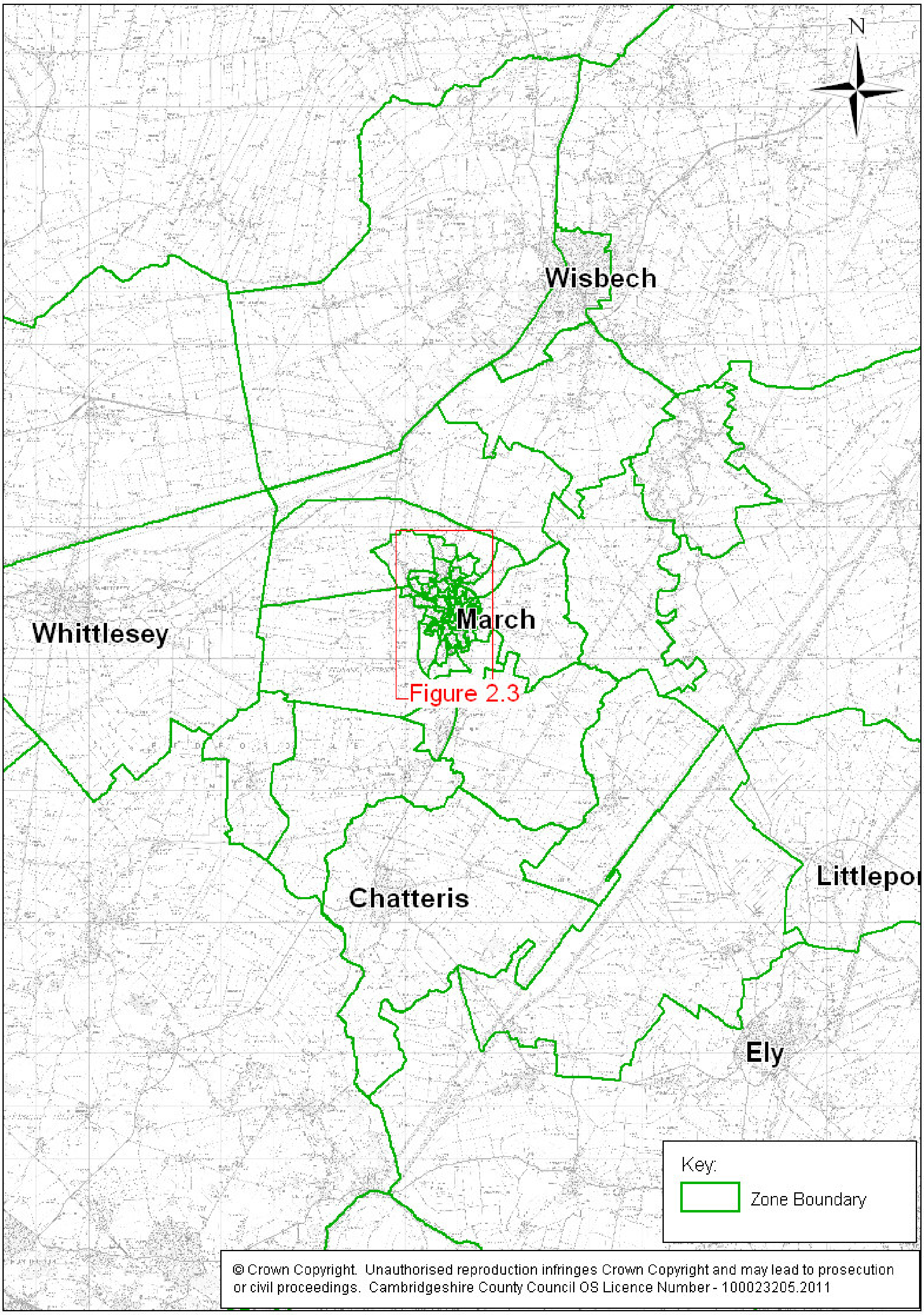


Figure 2.3 – MATS Zone Plan (March)

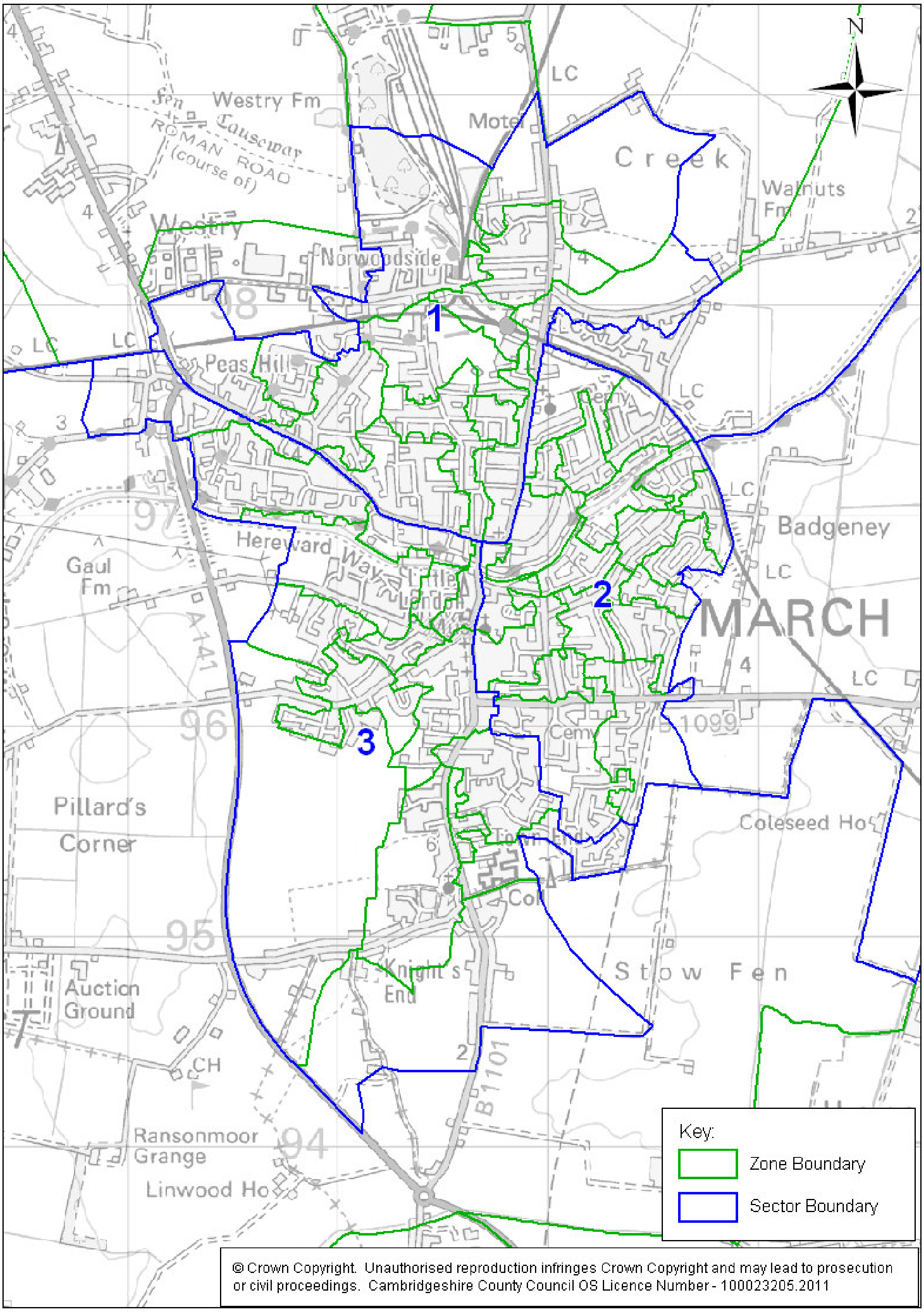
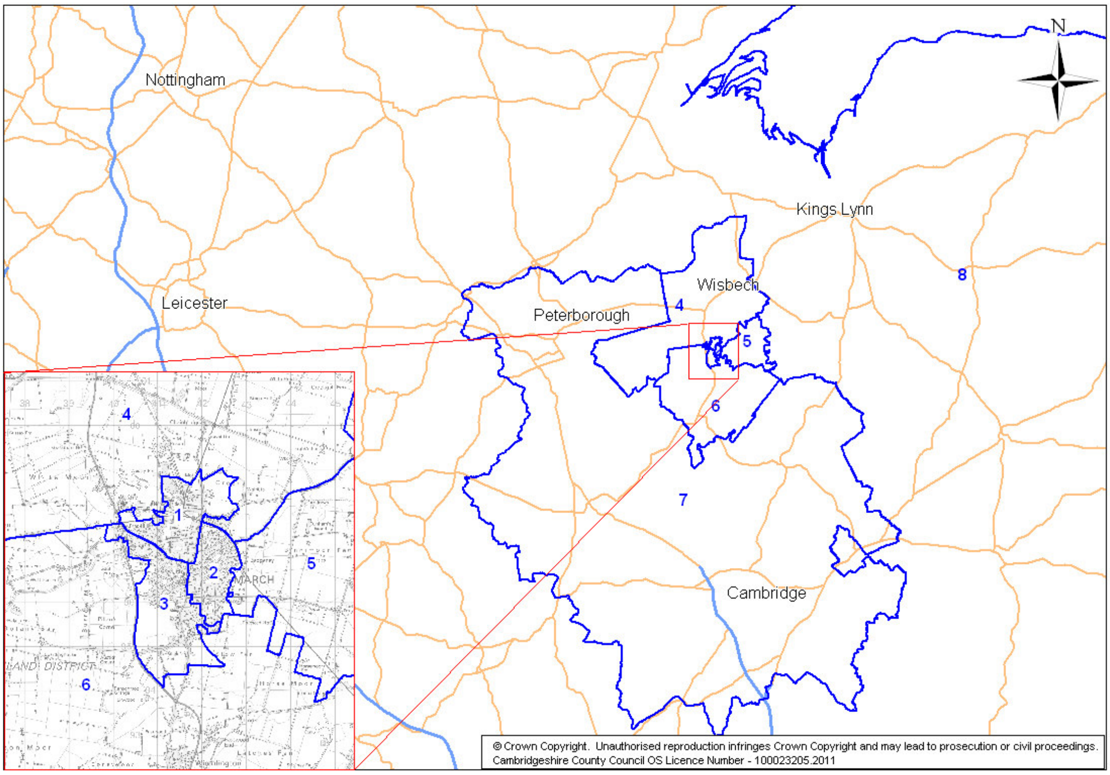


**Figure 2.4 – MATS Sector System**




See Appendix B for a larger figure of the MATS Sector System.

# 3. Data Sources

A variety of traffic data was identified and collected to enable the most accurate understanding of the trip pattern in and around the MATS study area.

# Data Sources

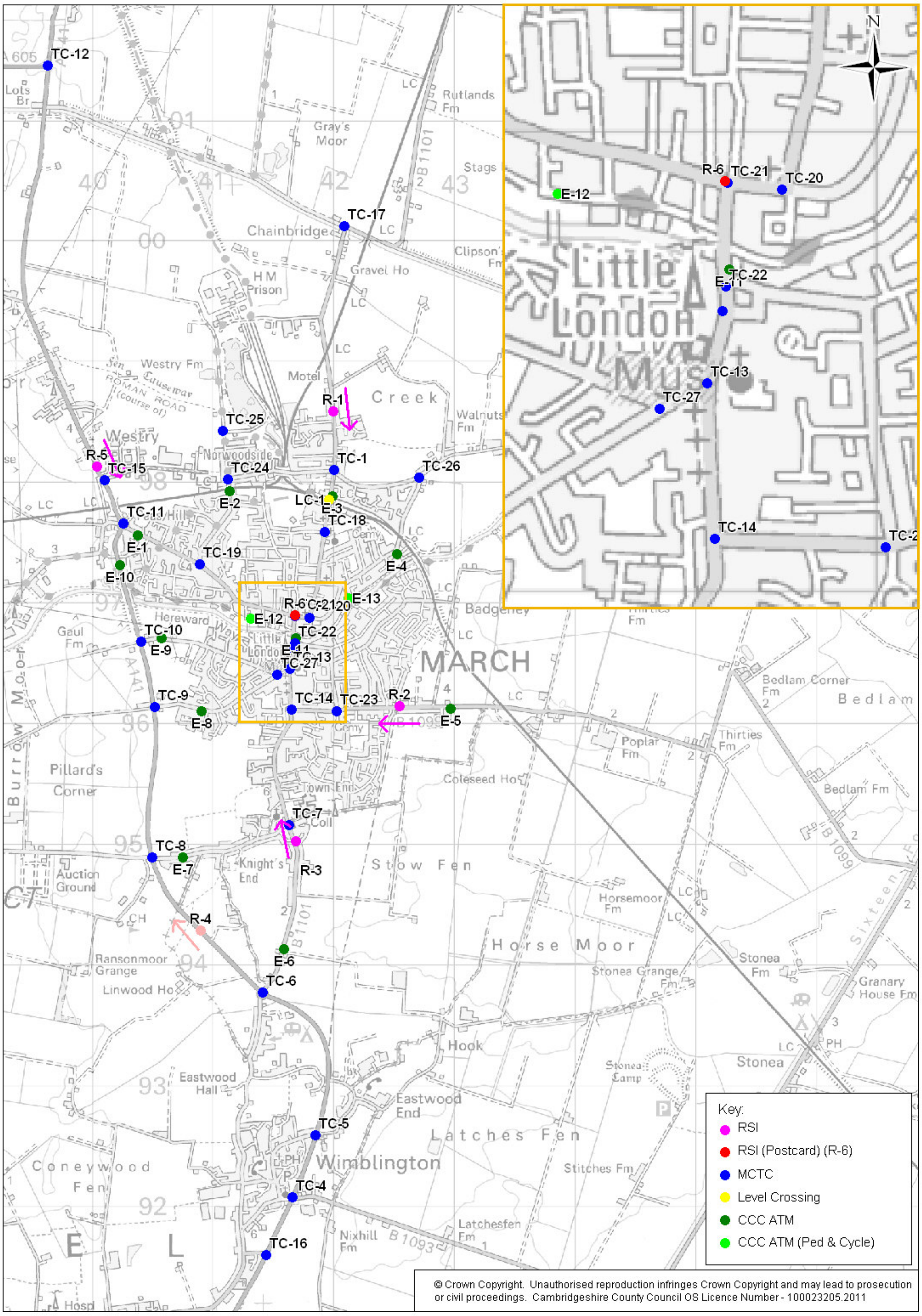
3.1. A variety of traffic data have been identified and collected to provide information on the traffic movements in and around March. Existing data including CCC's annual town monitoring traffic survey data have been collated and processed, whilst additional data including roadside interview (RSI) data and manual classified turning counts (MCTCs) were collected to complement the available traffic datasets.

3.2. A complete list of the data that has been collected is presented below; further discussion on the use of the data can be found in the rest of this report. Full details of the surveys and a summary of data have been presented in the MATS Data Collection Report.

- RSI survey data (with associated manual classified count (MCC) and automatic traffic count (ATC) survey data);
- MCTC survey data for key junctions within the study area;
- CCC's annual town monitoring traffic survey data which provides MCC data for the local road network;
- Journey time survey data;
- Queue length survey data
- Level crossing survey data;
- Traffic signal data;
- Bus route and timetable information;
- Highway network inventory;
- 2001 Journey to Work (JTW) National Census data;
- CCC education trip data; and
- TrafficMaster data.

3.3. Figure 3.1 shows the locations of the traffic count surveys. It should be noted that Site R-4 was originally identified as a RSI site, however a suitable and safe stretch of the A141 for the RSI site was not available and the RSI could not be undertaken. Only the MCC survey and the two-week continuous ATC survey were undertaken for this site.

**Figure 3.1 – All Count Data**



## Roadside Interview Survey Data

3.4. Five RSI surveys, including Site R-6 postcard site, were undertaken in October 2010. These surveys provide 12-hour origin/destination interview data, along with bi-direction MCC data on the survey day. Two-week bi-directional ATC data were also collected at each RSI site to provide continuous traffic flow profile.

3.5. This data enables interview direction and (by transposition) non-interview direction demand matrices to be compiled for all RSI sites.

## Traffic Count Data

3.6. 25 junctions in and around March were selected for MCTC surveys; and CCC's annual town monitoring surveys provides MCC data for 11 road links within the MATS study area. This traffic count data does not directly form part of the demand matrices, but it is used in the calibration and validation stages of the model building.

## Journey Time Survey Data

3.7. Journey time surveys for four routes were carried out across the study area. The detailed journey time data is key to understanding present conditions and is integral to the development and validation of the highway model.

## Queue Length Survey Data

3.8. The queue length data was undertaken for seven key junctions within the study area. The data is used in the model calibration stage to ensure junction delay within the model is representative.

## Level Crossing Survey Data

3.9. The duration of level crossing barrier closures, the queue length on the approaches to the barrier and MCC data for the March Station Road level crossing were collected to allow the impact of the level crossing on the highway network to be modelled accurately. The level crossing barrier closure duration data is used in the network coding stage, whilst the queue length and MCC data is used in the model calibration and validation stages.

## CCC Education Trip Data

3.10. 2010 education trip data was provided by CCC, which gives journey to school data for all state funded primary and secondary schools in Cambridgeshire. Eight schools have been identified within the study area; seven of which are primary schools, and one is secondary school. All movements to the schools in March have been isolated and kept as well as movements for pupils who live in March but go to school elsewhere.

3.11. The education trip data is provided by mode, and all car trips have been extracted for the highway model. The education trip data has been used to estimate the internal trip movements within March, alongside the synthetic demand data.

## 2001 Journey to Work National Census Data

3.12. An origin/destination matrix based on the 2001 JTW Census data was produced to assist the infilling of the traffic movements that are not, fully or partially, captured by the RSI (e.g. internal movements within March).

3.13. A database of the JTW trips between all output areas within England and Wales by mode from the 2001 Census has been made available for this study. The bullet points below list the modes that are included in the 2001 Census database. For the MATS JTW Census matrix, car driver trips were taken as equivalent to vehicle trips, and were the only mode from the JTW Census Data that was used.

- Work From Home;
- Underground;
- Train;
- Bus;
- Taxi;
- Car Driver;
- Car Passenger;
- Motorcycle;
- Pedal Cycle;
- Walk; and
- Other.

3.14. Graphical Information System (GIS) software (MapInfo) was used to identify the 2001 Census zones, known as output areas, which are within each individual MATS model zones, and a correspondence list between the MATS zones and output areas were produced.

3.15. By setting up Microsoft Access Queries with the 2001 Census data and the zone correspondence list produced from MapInfo, a 2001 JTW Census matrix based on the MATS zone plan was generated.

3.16. This JTW Census matrix is one of the basic inputs for the matrix building process (synthetic component) and is discussed in detail in Chapter 6.

## Highway Network Inventory

3.17. Highway network information, such as the road structure and junction layouts, was collected from different sources, such as Ordnance Survey (OS) mapping, aerial and street-view photography. This information forms the basis for the SATURN highway network coding.

3.18. Other network attributes, such as weight restrictions and traffic calming measures, were also collected from existing data sources (e.g. CCC website) and site visits. The impacts of these attributes were considered during the network calibration stage and incorporated into the model where appropriate.

## TrafficMaster Data

3.19. The TrafficMaster data provides observed speed data for September 2008 to July 2009 for the AM and PM peaks, covering the urban area of March and the main approach routes to March, consistent with the traffic model coverage. This data was used to assist the calibration and validation of the model, and ensuring the modelled link speeds are representative.

## Bus Route and Timetable Information

3.20. Bus route and timetable information was downloaded from the CCC website and relevant bus operators' website. The bus routes and service frequencies (i.e. buses per hour), calculated from the timetables, were coded into the model.

## Signal Timing Data

3.21. Signal staging, phasing and timing data was obtained from CCC to allow the accurate representation of all signalised junctions (including pedestrian crossings) within the model.

# 4. Highway Model – General Parameters

This chapter outlines the general model parameters, including PCU factors and time and distance costs, used.

# Highway Model – General Parameters

4.1. This chapter gives all the general parameters that have been used throughout the MATS SATURN highway model, including a detailed derivation of the time and distance costs.

## SATURN Version and Parameters

4.2. Version 10.9.17 of SATURN software suite has been used for the MATS highway modelling. The Origin Based Assignment (OBA) procedure has been utilised, with stringent convergence criteria based Flow Change Stability.

4.3. Flow Change Stability 'P' is the measure of convergence of assignment simulation loops. It is the percentage of links where assigned flows change by less than 5% between successive assignment simulation loops. Design Manual for Roads and Bridges (DMRB) (Volume 12 Section 2 Part 1 Traffic Appraisal in Urban Areas) states that assignment model iterations should continue until at least four successive values of 'P' in excess of 90% have been obtained.

4.4. For the MATS model, more stringent convergence criteria than the DMRB guidance have been used. Emerging guidance from the SATURN developers suggest that a more stringent convergence of the Flow Change Stability would be advantageous, with a 'P' value of 99% or more for four consecutive iterations. The MATS model has been set to achieve 'P' value of 99% for five consecutive iterations, as the size of the MATS model is relatively small and it should achieve this more stringent convergence criteria.

## Passenger Car Unit Factors

4.5. Standard factors to convert each vehicle type into Passenger Car Units (PCUs) have been taken from *Transport in the Urban Environment* (Institution of Highways and Transportation, 1997). These are:

- Motorcycle = 0.4 PCU;
- Car or Light Goods Vehicle (LGV) = 1.0 PCU;
- Other Goods Vehicle Class 1 (OGV1) = 1.5 PCU;
- Other Goods Vehicle Class 2 (OGV2) = 2.3 PCU; and
- Bus or coach = 2.0 PCU.

## Modelled Base Year and Time Periods

4.6. The base year for the MATS SATURN highway model is 2010.

4.7. Three time periods have been chosen for the MATS SATURN highway model, as defined below:

- AM peak hour (0800-0900);
- Average inter peak hour (average of 1000-1600); and
- PM peak hour (1700-1800).

4.8. The above modelled time periods have been used because traffic data analysis shows that 0800 to 0900 and 1700 to 1800 are the busiest hours within the study area. For the inter peak (1000-1600), the traffic flow is reasonably consistent throughout the period therefore average inter peak values were used. (See the MATS Data Collection Report for traffic flow profile analysis)

4.9. For all traffic counts, the single hour data have been extracted and calculated based on the time periods described above.

4.10. However, to improve the accuracy of the RSI that is input into the model, interviews have been 'funnelled'. The funnelling process ensures that the greatest amount of RSI survey data is used within the building of the matrices.

4.11. The funnelling process takes into account the interview data over the whole time period and concentrates it to the MCC count of the peak 1-hour modelled period. The funnelling process provides a wider range of observed origin/destination data and allows all RSI data to be used. For each time period, this occurs as shown below:

- AM peak period (0700-1000) interviews are scaled to the count between 0800 and 0900;
- Inter peak period (1000-1600) interviews are scaled to the average hourly count between 1000 and 1600; and
- PM peak period (1600-1900) interviews are scaled to the count between 1700 and 1800.

4.12. Taking the AM peak period as an example, all interviews that were conducted between 0700 and 1000 are used to produce the origin/destination movements for the AM peak hour by scaling to the traffic count of the 0800 to 0900 peak hour.

## User Classes

4.13. The MATS SATURN highway model comprises six user classes:

- User Class 1 (UC1) – Light Vehicles[1], Home-Based Work (HBW) purpose;
- User Class 2 (UC2) – Light Vehicles, Home-Based Education (HBEd) purpose;
- User Class 3 (UC3) – Light Vehicles, Employers' Business (EB) purpose;
- User Class 4 (UC4) – Light Vehicles , Other Trip Purpose (OTP);
- User Class 5 (UC5) – OGV1, all purposes; and
- User Class 6 (UC6) – OGV2, all purposes.

## Time and Distance Costs

4.14. Two important parameters that are input to SATURN models are Pence per Minute (PPM) and Pence per Kilometre (PPK) values. These represent the travellers' valuation of the time and distance of each journey, and the ratio between the two. The interaction of these parameters has significant effect on route choice. If time is highly valued but distance is not, then the quickest route will be chosen no matter how far it is; conversely, if distance is highly valued but time is not, the shortest route would be chosen no matter how slow it is. Generally, the route choice is a balance between the relative importance of time and distance to the traveller.

### Value of Time Costs: Pence per Minute

4.15. The PPM model parameter was calculated based on time costs from WebTAG Unit 3.5.6D (dated March 2010). All references to WebTAG in the following paragraphs refer to WebTAG Unit 3.5.6D.

4.16. WebTAG Table 1 provides the latest Values of Working Time per person, recommended by the DfT, expressed in 2002 values and prices in pounds per hour. These values are given in Table 4.1. These have been applied to the EB trips purpose for cars and LGV (i.e. UC3), and to OGV1 and OGV2 (i.e. UC5 and UC6).

**Table 4.1 – 2002 Values of Working Time per Person (2002 prices, £/hour)**

| Vehicle Occupant | Resource Cost | Perceived Cost | Market Price |
|---|---|---|---|
| Car driver | 21.86 | 21.86 | 26.43 |
| Car passenger | 15.66 | 15.66 | 18.94 |
| LGV (driver or passenger) | 8.42 | 8.42 | 10.18 |
| OGV1/OGV2 (driver or passenger) | 8.42 | 8.42 | 10.18 |

[1] Light Vehicles include Cars, LGVs and Motorcycles.

4.17. WebTAG Table 2 provides the latest Values of Non-Working Time per person, expressed in 2002 values and prices in pounds per hour. These values are given in Table 4.2. 'Commuting' values have been applied to HBW (i.e. UC1) and HBEd (i.e. UC2) trip purposes; 'other' values have been applied to the other trip purposes (i.e. UC4).

**Table 4.2 – 2002 Values of Non-Working Time per Person (2002 prices, £/hour)**

| Purpose | Resource Cost | Perceived Cost | Market Price |
|---|---|---|---|
| Commuting | 4.17 | 5.04 | 5.04 |
| Other | 3.68 | 4.46 | 4.46 |

4.18. Vehicle occupancies (Table 4.3), proportion of travel for each purpose (Table 4.4) and proportions of vehicles making up each user class (Table 4.5) have all been calculated from the 2010 RSI data that was collected in March for this study.

4.19. As an additional data check, vehicle occupancy values from WebTAG Table 4 and Table 5 (Weekday values included in Table 4.3 below) were compared to the local observed values from the 2010 RSI data. All observed vehicle occupancy compares well to the WebTAG values, except for OGV1 which the observed value is significantly higher than the WebTAG in the PM peak. Sensitivity test, using the WebTAG vehicle occupancy of 1.00 for OGV1 was undertaken. The results show that the differences between the models are negligible, and the observed OGV1 occupancy was used in the final MATS models.

**Table 4.3 – Vehicle Occupancy per Trip (including driver)**

| Vehicle Type / Journey Purpose | 2010 RSI Data | | | WebTAG Weekday Ave (2000) |
|---|---|---|---|---|
| | AM | IP | PM | |
| Car / HBW (UC1) | 1.10 | 1.11 | 1.14 | 1.15 |
| Car / HBEd (UC2) | 2.10 | 1.52 | 1.92 | - |
| Car / EB (UC3) | 1.16 | 1.13 | 1.27 | 1.21 |
| Car / OTP (UC4) | 1.47 | 1.48 | 1.52 | 1.72 |
| LGV / HBW (UC1) | 1.06 | 1.32 | 1.23 | 1.46 |
| LGV / HBEd (UC2) | 2.00 | - | 1.00 | - |
| LGV / EB (UC3) | 1.21 | 1.23 | 1.13 | 1.20 |
| LGV / OTP (UC4) | 1.32 | 1.39 | 1.50 | 1.46 |
| OGV1 / Work (UC5) | 1.27 | 1.17 | 1.50 | 1.00 |
| OGV2 / Work (UC6) | 1.00 | 1.00 | 1.00 | 1.00 |

**Table 4.4 – Proportion of Vehicles Travelling for Each Purpose (2010)**

| Vehicle Type / Journey Purpose | AM | IP | PM |
|---|---|---|---|
| Car / HBW (UC1) | 46% | 19% | 40% |
| Car / HBEd (UC2) | 4% | 2% | 4% |
| Car / EB (UC3) | 11% | 11% | 7% |
| Car / OTP (UC4) | 39% | 68% | 49% |
| **Car / All Purposes (UC1 to UC4)** | **100%** | **100%** | **100%** |
| LGV / HBW (UC1) | 40% | 22% | 33% |
| LGV / HBEd (UC2) | 1% | 0% | 1% |
| LGV / EB (UC3) | 39% | 54% | 23% |
| LGV / OTP (UC4) | 20% | 24% | 43% |
| **LGV / All Purposes (UC1 to UC4)** | **100%** | **100%** | **100%** |
| OGV1 / Work (UC5) | 100% | 100% | 100% |
| OGV2 / Work (UC6) | 100% | 100% | 100% |

**Table 4.5 – Proportion of Vehicle Types in Each User Class (2010)**

| User Class | Vehicle Type | AM | IP | PM |
|---|---|---|---|---|
| UC1 | Car | 86% | 87% | 92% |
| | LGV | 14% | 13% | 8% |
| UC2 | Car | 97% | 100% | 97% |
| | LGV | 3% | 0% | 3% |
| UC3 | Car | 60% | 61% | 72% |
| | LGV | 40% | 39% | 28% |
| UC4 | Car | 92% | 96% | 91% |
| | LGV | 8% | 4% | 9% |
| UC5 | OGV1 | 100% | 100% | 100% |
| UC6 | OGV2 | 100% | 100% | 100% |

4.20. The 2002 value of time costs for each vehicle type and journey purposes (car, LGV, OGV1 and OGV2; HBW, HBEd, EB and OTP) were combined in the relevant proportions of occupancy (Table 4.3) and purpose (Table 4.4) to derive the values of time cost in 2002 values (at 2002 prices), given in Table 4.6.

**Table 4.6 – 2002 Perceived Values of Time per Vehicle (2002 prices, £/hour)**

| Vehicle Type | Journey Purpose | AM | IP | PM |
|---|---|---|---|---|
| Car | HBW | 5.57 | 5.60 | 5.74 |
| | HBEd | 10.60 | 7.65 | 9.66 |
| | EB | 24.29 | 23.82 | 26.04 |
| | OTP | 6.56 | 6.62 | 6.78 |
| LGV | HBW | 5.33 | 6.64 | 6.18 |
| | HBEd | 10.08 | - | 5.04 |
| | EB | 10.15 | 10.34 | 9.54 |
| | OTP | 5.87 | 6.22 | 6.69 |
| OGV1 | Work | 10.72 | 9.82 | 12.63 |
| OGV2 | Work | 8.42 | 8.42 | 8.42 |

4.21. WebTAG Table 3 provides the forecast growth in the values of time for 2002 onwards, which have been used to calculate growth factors from 2002 to 2010. These figures are shown in Table 4.7.

**Table 4.7 – Forecast Growth in the Working and Non-Working Values of Time**

| Year | GDP Growth (%pa) | Population Growth (%pa) | Work VOT Growth (%pa) | Non-Work VOT Growth (%pa) |
|---|---|---|---|---|
| 2002-2003 | 2.81 | 0.36 | 2.44 | 1.95 |
| 2003-2004 | 2.95 | 0.39 | 2.55 | 2.04 |
| 2004-2005 | 2.17 | 0.49 | 1.67 | 1.34 |
| 2005-2006 | 2.85 | 0.66 | 2.18 | 1.74 |
| 2006-2007 | 2.56 | 0.58 | 1.97 | 1.57 |
| 2007-2008 | 0.55 | 0.64 | -0.09 | -0.07 |
| 2008-2009 | -4.75 | 0.67 | -5.38 | -4.31 |
| 2009-2010 | 1.25 | 0.73 | 0.52 | 0.41 |
| **2002-2010** | **-** | **-** | **1.058** | **0.146** |

4.22. The 2002 values of time (Table 4.6) were combined with the 2002 to 2010 factor (Table 4.7) to give the 2010 values of time, at 2002 prices in pounds per hour (Table 4.8).

**Table 4.8 – 2010 Perceived Values of Time per Vehicle (2002 prices, £/hour)**

| Vehicle Type | Journey Purpose | AM | IP | PM |
|---|---|---|---|---|
| Car | HBW | 5.82 | 5.86 | 6.01 |
| | HBEd | 11.08 | 8.01 | 10.10 |
| | EB | 25.69 | 25.19 | 27.53 |
| | OTP | 6.87 | 6.93 | 7.09 |
| LGV | HBW | 5.57 | 6.94 | 6.47 |
| | HBEd | 10.54 | n/a | 5.27 |
| | EB | 10.74 | 10.93 | 10.09 |
| | OTP | 6.14 | 6.51 | 7.00 |
| OGV1 | Work | 11.00 | 10.39 | 13.36 |
| OGV2 | Work | 8.90 | 8.90 | 8.90 |

4.23. The 2010 values of time were converted from vehicle type to user classes using the proportions given in Table 4.5. The PPM parameter was established by converting these values of time in pounds per hour to pence per minute. The values used within the base year MATS SATURN highway model are shown in Table 4.9.

**Table 4.9 – 2010 Values of Time (PPM) Used in the Base Year MATS SATURN Models (2002 prices)**

| User Class | Value of Time | AM | IP | PM |
|---|---|---|---|---|
| UC1 | £/hour | 5.79 | 6.00 | 6.05 |
| | PPM | 9.65 | 10.00 | 10.08 |
| UC2 | £/hour | 11.07 | 8.01 | 9.97 |
| | PPM | 18.45 | 13.34 | 16.62 |
| UC3 | £/hour | 19.72 | 19.62 | 22.72 |
| | PPM | 32.87 | 32.70 | 37.87 |
| UC4 | £/hour | 6.81 | 6.91 | 7.08 |
| | PPM | 11.34 | 11.51 | 11.80 |
| UC5 | £/hour | 11.33 | 10.39 | 13.36 |
| | PPM | 18.89 | 17.31 | 22.26 |
| UC6 | £/hour | 8.90 | 8.90 | 8.90 |
| | PPM | 14.84 | 14.84 | 14.84 |

## Distance Costs: Pence per Kilometre

4.24. The PPK value (also known as Vehicle Operation Cost (VOC)) is partially based on speed with the model. These speeds were obtained in two stages: for initial calculations, the observed speed data from TrafficMaster data (2008/2009) was used to generate initial values of PPM and PPK which were fed into the model to give better estimates of the average speeds in the network; these speeds were then fed back into the PPK calculations to give the final PPM and PPK values for the model. These speeds were 64, 69 and 62 kph for the AM, inter and PM peak models respectively.

4.25. WebTAG 3.5.6D gives details on the calculations required to produce the VOC, which are composed of a fuel element and non-fuel element.

## Fuel Element

4.26. WebTAG Table 10 gives the values of the four parameters that are used to calculate fuel consumption. The parameters are expressed in average 2002 values and prices and these have been reproduced in Table 4.10 below.

**Table 4.10 – 2002 Fuel VOC Formulae Parameter Values (2002 prices, litres/kilometre)**

| Vehicle Category | Parameters | | | |
|---|---|---|---|---|
| | a | b | c | d |
| Average Car | 0.9574479 | 0.04782644 | -0.00012946 | 2.53734E-06 |
| Average LGV | 1.162824392 | 0.061032451 | -0.00049695 | 8.63611E-06 |
| OGV1 | 1.564481329 | 0.260097879 | -0.00378306 | 3.24446E-05 |
| OGV2 | 3.613294863 | 0.42026914 | -0.00494704 | 3.82806E-05 |

4.27. These parameters, along with the average speed ($v$) for each time period, are used to calculate the fuel consumption for each model using the following formula. The results are shown in Table 4.11.

$$L = (a + bv + cv^2 + dv^3)/v$$

$Where:$

$L = fuel\ consumption, expressed\ in\ litres\ per\ kilometre;$

$v = average\ speed\ in\ kilometres\ per\ hour; and$

$a, b, c, d\ are\ parameters\ defined\ for\ each\ vehicle\ category.$

**Table 4.11 – 2002 Fuel Consumption Values (2002 prices, litres/kilometre)**

| Vehicle Category | AM Ave Speed (kph) | AM Fuel Consumption (litre/km) | IP Ave Speed (kph) | IP Fuel Consumption (litre/km) | PM Ave Speed (kph) | PM Fuel Consumption (litre/km) |
|---|---|---|---|---|---|---|
| Average Car | 63.72 | 0.065 | 68.72 | 0.065 | 61.86 | 0.065 |
| Average LGV | 63.72 | 0.083 | 68.72 | 0.085 | 61.86 | 0.082 |
| OGV1 | 63.72 | 0.175 | 68.72 | 0.176 | 61.86 | 0.176 |
| OGV2 | 63.72 | 0.317 | 68.72 | 0.314 | 61.86 | 0.319 |

4.28. In order to factor these 2002 fuel efficiency values to 2010 levels, WebTAG Table 13 was used (reproduced in Table 4.12).

**Table 4.12 – Vehicle Fuel Efficiency Improvements**

| Year | Change in Vehicle Efficiency (%pa) | | | |
|---|---|---|---|---|
| | Average Car | Average LGV | OGV1 | OGV2 |
| 2002-2003 | -0.79 | 0.64 | 0.46 | -0.17 |
| 2003-2004 | -0.83 | -1.42 | 0 | 0 |
| 2004-2005 | -1.04 | -1.78 | 0 | 0 |
| 2005-2006 | -1.02 | -1.49 | -1.23 | -1.23 |
| 2006-2007 | -0.44 | -1.49 | -1.23 | -1.23 |
| 2007-2008 | -1.06 | -1.49 | -1.23 | -1.23 |
| 2008-2010 | -1.11 | -1.49 | -1.23 | -1.23 |
| **2002-2010** | **0.9283** | **0.9040** | **0.9443** | **0.9384** |

4.29. Multiplying these factors (Table 4.12) by the 2002 fuel consumption values (Table 4.11) gives the 2010 fuel consumption values which is provided in Table 4.13.

**Table 4.13 – 2010 Fuel Consumption Values (litres/kilometre)**

| Vehicle Category | AM | IP | PM |
|---|---|---|---|
| Average Car | 0.060 | 0.060 | 0.060 |
| Average LGV | 0.075 | 0.076 | 0.074 |
| OGV1 | 0.166 | 0.166 | 0.166 |
| OGV2 | 0.298 | 0.294 | 0.299 |

4.30. WebTAG Table 11 gives the 2008 resource costs for fuel and WebTAG Table 14 gives the forecast growth for future years. These have been combined to give the 2010 fuel costs, in 2002 prices, shown in Table 4.14 below.

**Table 4.14 – 2010 Fuel Costs (2002 prices, pence/litre)**

| Vehicle Category | Fuel | Duty (2010) | Tax | Pence/litre |
|---|---|---|---|---|
| Car (work) | 32.18 | 48.00 | - | 80.18 |
| Car (non-work) | 32.18 | 48.00 | 17.50 | 94.21 |
| LGV (work) | 33.91 | 48.00 | - | 81.91 |
| LGV (non-work) | 33.91 | 48.00 | 17.50 | 96.24 |
| OGV1 | 34.03 | 48.00 | - | 82.03 |
| OGV2 | 34.03 | 48.00 | - | 82.03 |

4.31. These fuel costs (Table 4.14) can be multiplied by the 2010 fuel consumption values (Table 4.13) to produce the fuel element of the VOC, which is provided in Table 4.15 below.

**Table 4.15 – 2010 Fuel Element of VOC (2002 prices, pence/kilometre)**

| Vehicle Category | AM litre/km | AM pence/km | IP litre/km | IP pence/km | PM litre/km | PM pence/km |
|---|---|---|---|---|---|---|
| Car (work) | 0.060 | 4.831 | 0.060 | 4.827 | 0.060 | 4.839 |
| Car (non-work) | 0.060 | 5.677 | 0.060 | 5.671 | 0.060 | 5.685 |
| LGV (work) | 0.075 | 6.122 | 0.076 | 6.263 | 0.074 | 6.081 |
| LGV (non-work) | 0.075 | 7.193 | 0.076 | 7.359 | 0.074 | 7.146 |
| OGV1 | 0.166 | 13.582 | 0.166 | 13.643 | 0.166 | 13.597 |
| OGV2 | 0.298 | 24.416 | 0.294 | 24.146 | 0.299 | 24.568 |

## Non-Fuel Element

4.32. WebTAG Paragraph 1.3.16 gives a formula for calculating the non-fuel element of VOC (in pence per kilometre), which includes expenses such as oil, tyres, maintenance and depreciation for all vehicles, along with a vehicle capital saving for vehicles in working time only. The formula is:

$$C = a1 + \frac{b1}{v}$$

$Where:$

$C = cost\ in\ pence\ per\ kilometre\ travelled;$

$v = average\ link\ speed\ in\ kilometres\ per\ hour;$

4.33. WebTAG Table 15 gives the values of parameters $a1$ and $b1$ for input to the above formula, reproduced in Table 4.16.

**Table 4.16 – Non-Fuel Element Formula Parameter Values**

| Vehicle Category | Parameter Values | |
|---|---|---|
| | $a1$ (pence/km) | $b1$ (pence/km) |
| Car (work) | 4.069 | 111.391 |
| Car (non-work) | 3.151 | - |
| LGV (work) | 5.910 | 38.603 |
| LGV (non-work) | 5.910 | - |
| OGV1 | 5.501 | 216.165 |
| OGV2 | 10.702 | 416.672 |

4.34. Using the average speed ($v$) for each time period, the non-fuel element of the VOC can be calculated (Table 4.17).

**Table 4.17 – Non-Fuel Element of VOC (2002 prices, pence/kilometre)**

| Vehicle Category | AM Ave Speed (kph) | AM Non-Fuel VOC (pence/km) | IP Ave Speed (kph) | IP Non-Fuel VOC (pence/km) | PM Ave Speed (kph) | PM Non-Fuel VOC (pence/km) |
|---|---|---|---|---|---|---|
| Car (work) | 63.72 | 5.82 | 68.72 | 5.69 | 61.86 | 5.87 |
| Car (non-work) | 63.72 | 3.15 | 68.72 | 3.15 | 61.86 | 3.15 |
| LGV (work) | 63.72 | 6.52 | 68.72 | 6.47 | 61.86 | 6.53 |
| LGV (non-work) | 63.72 | 5.91 | 68.72 | 5.91 | 61.86 | 5.91 |
| OGV1 | 63.72 | 8.89 | 68.72 | 8.65 | 61.86 | 9.00 |
| OGV2 | 63.72 | 17.24 | 68.72 | 16.77 | 61.86 | 17.44 |

## Total Vehicle Operating Cost

4.35. The fuel and non-fuel elements of VOC are summed to give the total VOC for each vehicle category for each time period, shown in Table 4.18.

**Table 4.18 – Total VOC for Each Vehicle Category (2002 prices, pence/kilometre)**

| Vehicle Category | AM | | | IP | | | PM | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fuel VOC | Non-Fuel VOC | Total VOC | Fuel VOC | Non-Fuel VOC | Total VOC | Fuel VOC | Non-Fuel VOC | Total VOC |
| Car (work) | 4.83 | 5.82 | 10.65 | 4.83 | 5.69 | 10.52 | 4.84 | 5.87 | 10.71 |
| Car (non-work) | 5.68 | 3.15 | 8.83 | 5.67 | 3.15 | 8.82 | 5.69 | 3.15 | 8.84 |
| LGV (work) | 6.12 | 6.52 | 12.64 | 6.26 | 6.47 | 12.73 | 6.08 | 6.53 | 12.62 |
| LGV (non-work) | 7.19 | 5.91 | 13.10 | 7.36 | 5.91 | 13.27 | 7.15 | 5.91 | 13.06 |
| OGV1 | 13.58 | 8.89 | 22.48 | 13.64 | 8.65 | 22.29 | 13.60 | 9.00 | 22.59 |
| OGV2 | 24.42 | 17.24 | 41.66 | 24.15 | 16.77 | 40.91 | 24.57 | 17.44 | 42.01 |

4.36. Using the proportions of vehicles given in Table 4.5, the PPK values for each user class can be derived – these are shown in Table 4.19.

**Table 4.19 – 2010 Vehicle Operating Costs (PPK) Used in the Base Year MATS SATURN Models (2002 prices)**

| User Class | AM | IP | PM |
|---|---|---|---|
| UC1 | 9.41 | 9.40 | 9.19 |
| UC2 | 8.96 | 8.82 | 8.95 |
| UC3 | 11.44 | 11.38 | 11.23 |
| UC4 | 9.18 | 9.02 | 9.22 |
| UC5 | 22.48 | 22.29 | 22.59 |
| UC6 | 41.66 | 40.91 | 42.01 |

### PPM and PPK Parameters: Final Values

4.37. When input in to the SATURN models, the PPM and PPK values are given as a ratio, rather than absolute values. The final parameters for the AM, inter and PM peak base year MATS SATURN highway models are given in Table 4.20, Table 4.21 and Table 4.22 respectively.

**Table 4.20 – AM Peak PPM and PPK Parameters**

| User Class | Absolute Values (2002 prices) | | Model Parameters | |
|---|---|---|---|---|
| | PPM | PPK | PPM = 1 | PPK = |
| UC1 | 9.65 | 9.41 | 1.00 | 0.97 |
| UC2 | 18.45 | 8.96 | 1.00 | 0.49 |
| UC3 | 32.87 | 11.44 | 1.00 | 0.35 |
| UC4 | 11.34 | 9.18 | 1.00 | 0.81 |
| UC5 | 18.89 | 22.48 | 1.00 | 1.19 |
| UC6 | 14.84 | 41.66 | 1.00 | 2.81 |

**Table 4.21 – Inter Peak PPM and PPK Parameters**

| User Class | Absolute Values (2002 prices) | | Model Parameters | |
|---|---|---|---|---|
| | PPM | PPK | PPM = 1 | PPK = |
| UC1 | 10.00 | 9.40 | 1.00 | 0.94 |
| UC2 | 13.34 | 8.82 | 1.00 | 0.66 |
| UC3 | 32.70 | 11.38 | 1.00 | 0.35 |
| UC4 | 11.51 | 9.02 | 1.00 | 0.78 |
| UC5 | 17.31 | 22.29 | 1.00 | 1.29 |
| UC6 | 14.84 | 40.91 | 1.00 | 2.76 |

**Table 4.22 – PM Peak PPM and PPK Parameters**

| User Class | Absolute Values (2002 prices) | | Model Parameters | |
|---|---|---|---|---|
| | PPM | PPK | PPM = 1 | PPK = |
| UC1 | 10.08 | 9.19 | 1.00 | 0.91 |
| UC2 | 16.62 | 8.95 | 1.00 | 0.54 |
| UC3 | 37.87 | 11.23 | 1.00 | 0.30 |
| UC4 | 11.80 | 9.22 | 1.00 | 0.78 |
| UC5 | 22.26 | 22.59 | 1.00 | 1.01 |
| UC6 | 14.84 | 42.01 | 1.00 | 2.83 |

# 5. Highway Model – Network Development

The network coding for the MATS SATURN highway model has been carried in line with the SATURN manual and DMRB guidance. Key network characteristics are discussed in this chapter.

# Highway Model – Network Development

## Network Coverage

5.1. The network covers all key links within the study area, with a greater emphasis on the centre of March. The model stretches from the A141/A605 junction in the north to the A141/B1093 junction in the south; and from the level crossing on the B1099 in the east to Doddington in the west.

## Network Coding

5.2. The network coding has been carried out in line with the SATURN manual and the DMRB guidance. Network calibration and alterations were coded in stages so that any modelling errors could easily be traced and amended.

### Links

5.3. The core area of the network is coded in simulation with buffer links connecting to external zones. Figure 2.1 shows the MATS network link structure and coverage, and the simulation links are shown in blue and buffer links are shown in red.

5.4. For all urban zone connectors, 'stub' zone connectors have been used. A stub zone connector is a single point of connection from a zone to the network. This method has been used as it will most accurately represent the loading points of traffic onto the highway network when considering the size of the MATS zones in the urban area. The capacities of the 'stubs' are unrestricted to ensure the demand to/from the zones can successfully enter the traffic network. For all non-urban zone connectors, they have been connected to the appropriate routes to the MATS network. Figure 5.1 shows all urban zone connectors that have been coded as 'stubs'.

5.5. All network links have been checked to ensure link attributes, such as link distance and speed, are consistent along a road and in both directions. Figure 5.2 shows the core network by coded link speed. It should be noted that in some cases, the coded link speed might be different to the speed limit as the coded link speed takes into account other link attributes, such as road conditions.

5.6. Crow-fly and coded link distance comparison was undertaken to ensure all coded link distance are reasonable and appropriate. For all simulation links within the network, the coded distances are either equal to or longer than the crow-fly distances as expected. Figure 5.3 shows the percentage difference between the coded distance and crow-fly distance for all simulation links.

5.7. For majority of the simulation links, the coded distances are very similar to the crow-fly distances. For a few of the longer links toward the edge of the network, such as B1099 Upwell Road from Cavalry Drive to Sixteen Foot Bank, the coded distances are significantly longer than the crow-fly distances (approximately 30%) due to the curves and alignments of the road.

5.8. Buffer links have not been included in the crow-fly versus coded link distance check as to keep the network concise, the node positions for the buffer network are generally not geographically representative and the coded distances for buffer links are generally much greater than the crow-fly distances.

**Figure 5.1 – Urban Zone Connecting Stubs**

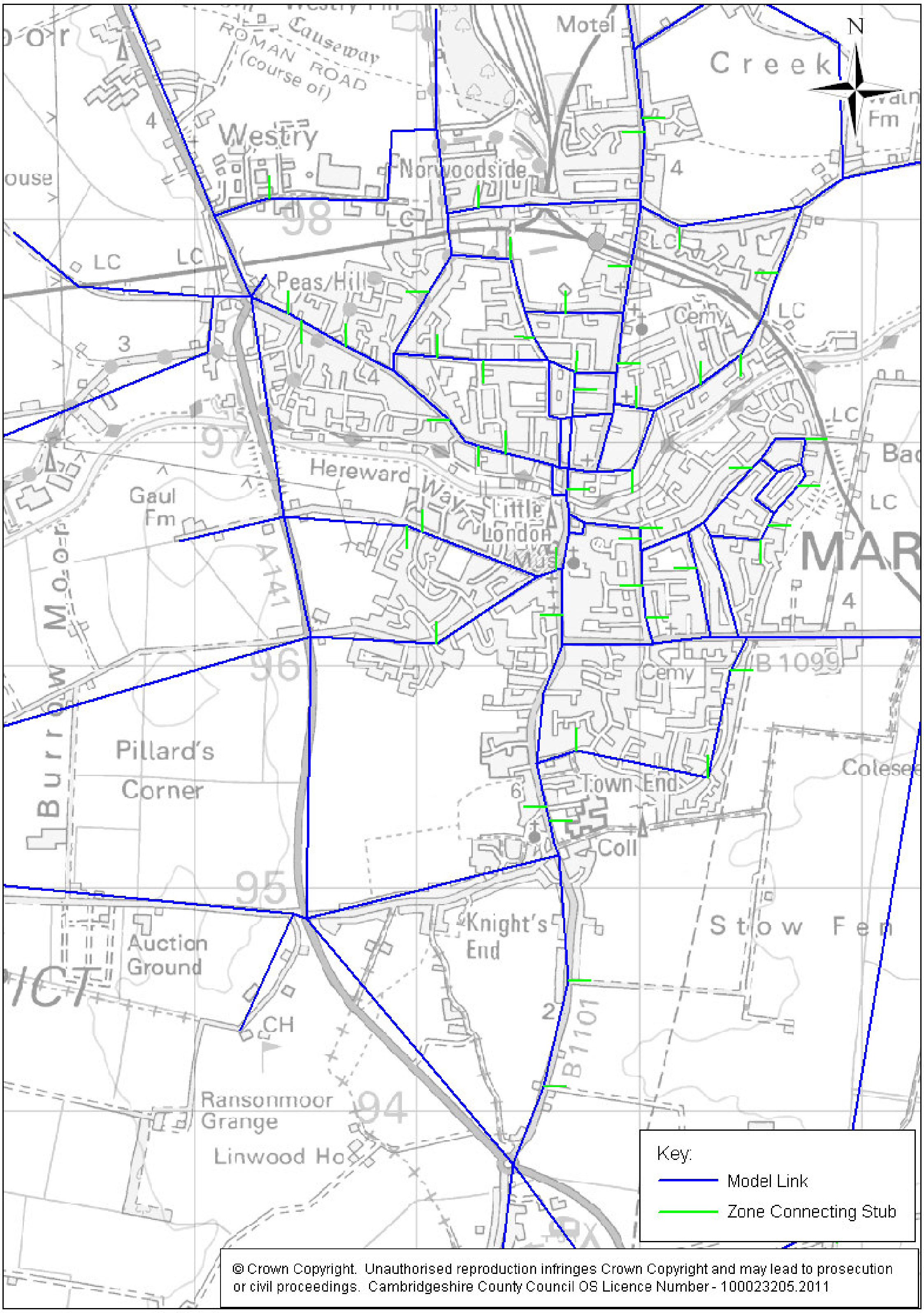


**Figure 5.2 – Link Speeds**

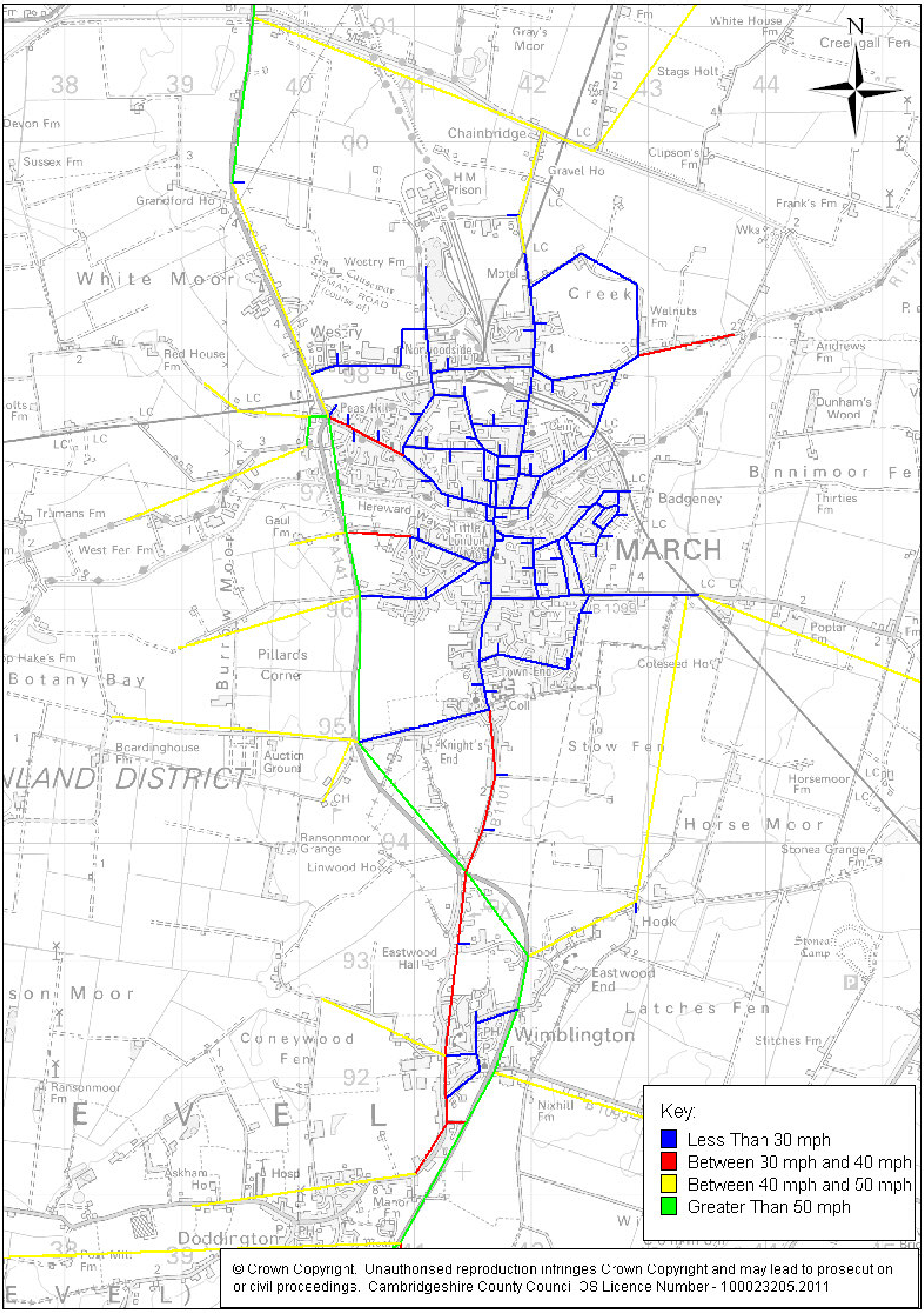
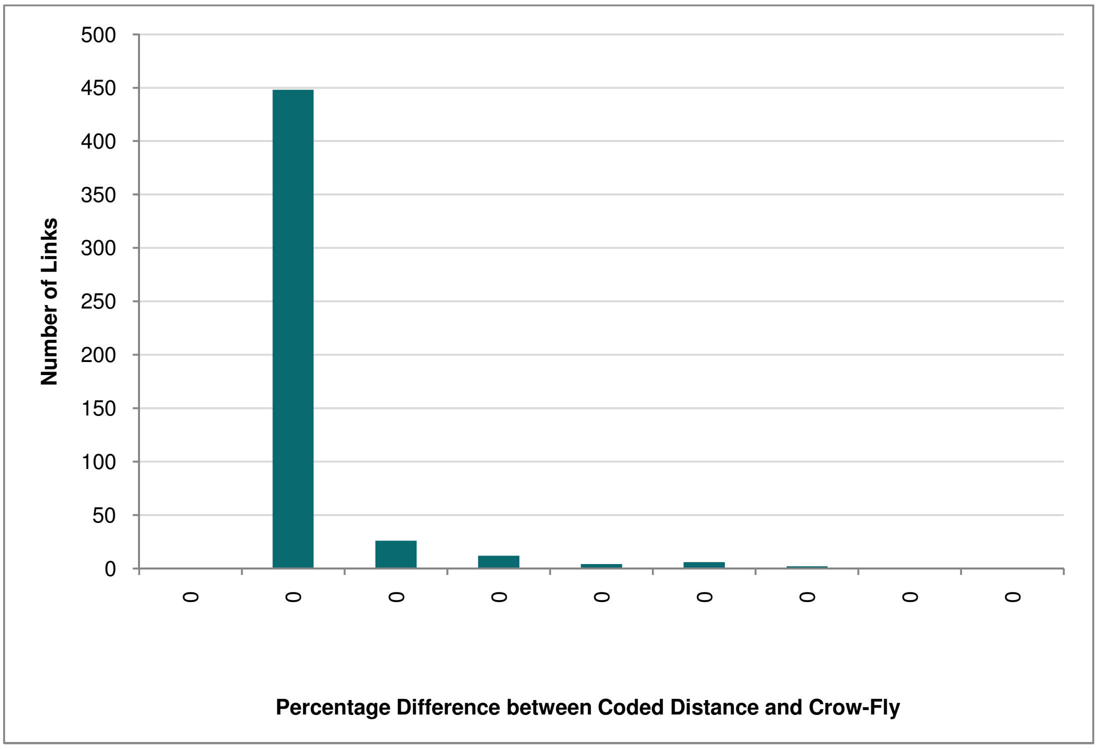


**Figure 5.3 – Percentage Difference between Coded and Crow-Fly Link Distances**




## Nodes

5.9. For the simulation network, maps, aerial and street-view photographs have been used to assist the junction coding process.

5.10. For all mini-roundabouts, node type 2 (roundabout with U-turns banned) has been used and a low circulatory time has been set; and for all other roundabouts, node type 5 (roundabout with U-turns permitted) has been used with a longer circulatory time. Traffic signals and signalised pedestrian crossings have been coded as signalised nodes. Timings for all signals modelled were provided by CCC.

5.11. Level crossings have been coded as link penalties. Level crossings generally have long green time and cycle time, and coding it as traffic signals can often cause assignment errors. The link penalties for all modelled level crossings have been calculated based on the 2010 observed barrier closure times for the B1101 Station Road level crossing.

5.12. The number of level crossing closures and the average length of barrier down-time per closure within each peak hour were obtained from the observed data for B1101 Station Road. It is important to note that a vehicle can arrive at the level crossing at any point during the closure (i.e. Some vehicles experience the full delay of the closure whereas some vehicles may experience minimal delay if they arrive just as the barriers are lifting). To account for this within the model, level crossing observations undertaken for previous projects have shown that the average delay experience by each vehicle is approximately half of the closure time. Based on this information, the average penalty for each vehicle passing the level crossing within the modelled hour is calculated as follow:

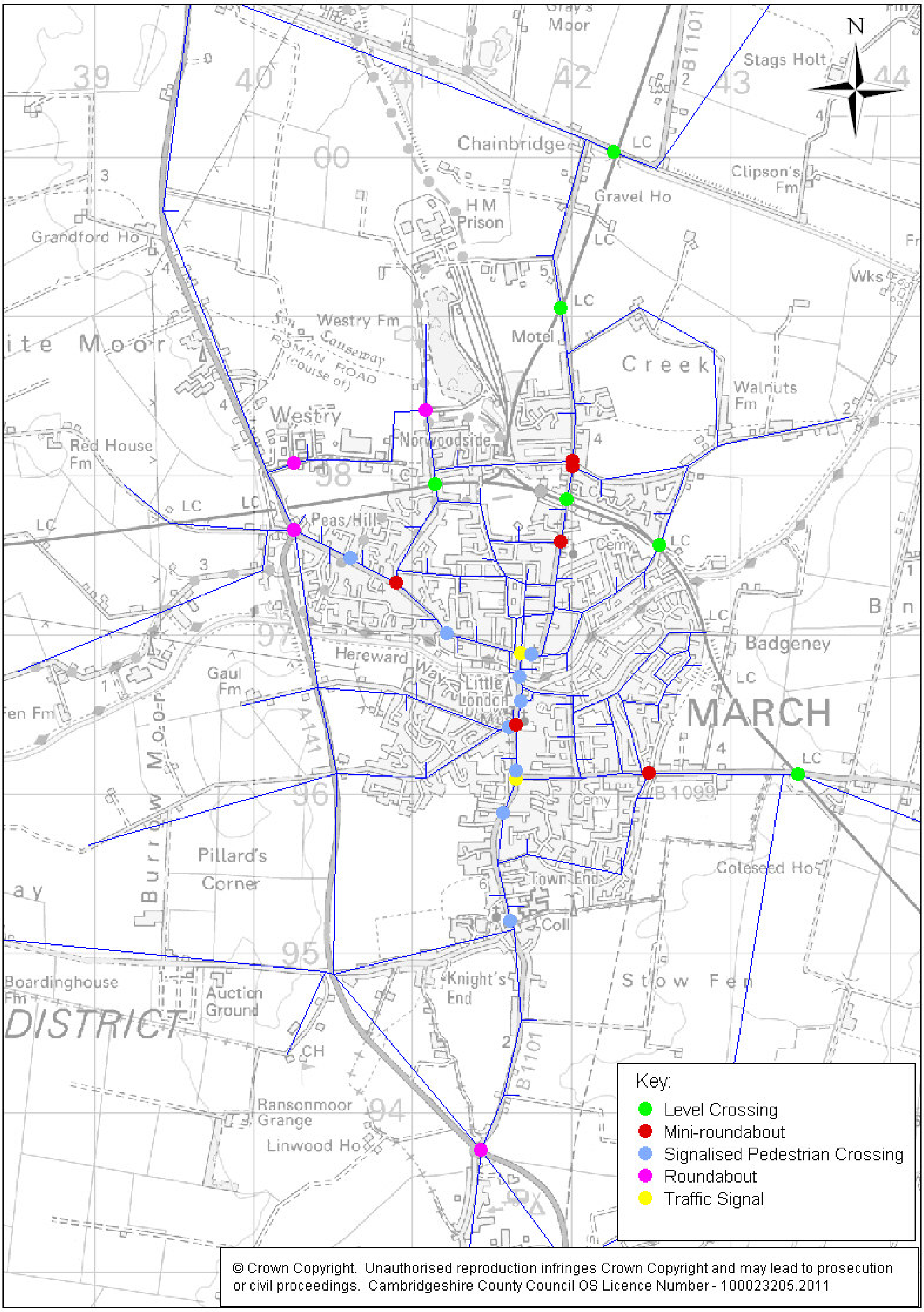
$$Level\ Crossing\ Link\ Penalty\ (s) = \frac{\left(\frac{Total\ Level\ Crossing\ Closure\ Time\ (s)}{Number\ of\ Closures}\right)}{2} \times \frac{Total\ Level\ Crossing\ Closure\ Time\ (s)}{3600}$$

5.13. Types of level crossings were also considered as part of link penalty calculation. Different types of level crossing barriers have different safety margins. For example, automatic barrier generally have shorter closure time than manual barrier for the same train due to safety. This was taken into account when calculating the link penalties for all modelled level crossings.

5.14. All other junctions have been coded as priority junctions with give-way markers on the appropriate arms.

5.15. Figure 5.4 highlights all roundabout, level crossing and signalised junction nodes for the simulation network. Although the level crossings between March and Wisbech have been highlighted in Figure 5.4 for completeness, it has been noted that this railway line is currently not in operation, and no penalties have been applied to these level crossings.

**Figure 5.4 – Types of Junctions**



## Speed Flow Curves

5.16. Speed flow curves are used within the model to reflect capacity constraint on links due to flow volume. This is achieved by applying a speed flow relationship which represents decreases in link speeds with flow increases, with the characteristics of the road determining the nature of this relationship. Speed flow curves have been assigned to all rural links with link distance greater than 200m as delays for these links tend to be dictated by conditions on the link itself as opposed to junction properties.

5.17. Speed flow curves are not assigned to urban or short (i.e. < 200m) links because the main cause of delay for these network links is junction delay, not link delay, and therefore it is not appropriate to apply speed flow curves to these links.

5.18. COBA speed flow curves have been used for this study. Figure 5.5 highlights the links with speed flow curves; and Table 5.1 lists the COBA speed flow curves used and shows how they differ for rural, suburban and urban roads.

**Table 5.1 – Speed Flow Curve Classification**

| S0 (kph) | S1 (kph) | S2 (kph) | F (PCU/hour /lane) | C (PCU/hour /lane) | N | Description |
|---|---|---|---|---|---|---|
| Rural | | | | | | |
| 116.0 | 109.5 | 45 | 1,200 | 2,520 | 3.81 | 3 or 4 Lane Motorway (Dual Carriageway) |
| 112.0 | 105.5 | 45 | 1,200 | 2,430 | 3.85 | 2 Lane Motorway (Dual Carriageway) |
| 108.5 | 102.5 | 45 | 1,080 | 2,260 | 3.66 | Dual Carriageway 3 Lane All Purpose Road |
| 104.5 | 98.5 | 45 | 1,080 | 2,180 | 3.68 | Dual Carriageway 2 Lane All Purpose Road |
| 91.0 | 71.5 | 45 | 1,100 | 1,860 | 2.24 | Good Quality Single Carriageway 10 Metre Width |
| 84.0 | 64.5 | 45 | 1,100 | 1,660 | 2.13 | Typical Quality Single Carriageway 10 Metre Width |
| 87.0 | 71.5 | 45 | 880 | 1,640 | 2.16 | Typical Quality Single Carriageway 7.3 Metre Width |
| 78.0 | 63.5 | 45 | 850 | 1,380 | 2.07 | Typical Quality Single Carriageway 7.0 Metre Width |
| 67.0 | 53.5 | 45 | 770 | 1,010 | 1.79 | Bad Quality Single Carriageway 6.5 Metre Width |
| Suburban | | | | | | |
| 78.0 | 66.0 | 35 | 1,050 | 1,730 | 3.29 | Dual Carriageway With Low Development |
| 71.0 | 45.0 | 35 | 1,050 | 1,270 | 2.04 | Dual Carriageway With Typical Development |
| 58.0 | 46.5 | 35 | 250 | 500 | 1.40 | Dual Carriageway With Heavy Development |
| 68.0 | 56.0 | 35 | 1,050 | 1,730 | 3.74 | Single Carriageway With Low Development |
| 61.0 | 35.0 | 35 | 1,050 | 1,270 | 2.32 | Single Carriageway With Typical Development |
| 45.0 | 36.5 | 35 | 250 | 500 | 1.55 | Single Carriageway With Heavy Development |
| Urban | | | | | | |
| 54.0 | 39.5 | 25 | 490 | 980 | 1.67 | Good Quality Non-central Area With 50% Development |
| 48.5 | 36.8 | 25 | 390 | 780 | 1.56 | Typical Quality Non-central Area With 50% Development |
| 44.5 | 34.8 | 25 | 325 | 650 | 1.48 | Non-central Area With 100% Development |
| 37.0 | 26.0 | 15 | 370 | 740 | 1.83 | Central Area, Average of 2 Junctions per km |
| 34.0 | 24.5 | 15 | 315 | 630 | 1.73 | Central Area, Average of 4.5 Junctions per km |
| 28.5 | 21.8 | 15 | 225 | 450 | 1.55 | Central Area, Average of 9 Junctions per km |
| Small Town | | | | | | |
| 65.5 | 57.0 | 30 | 700 | 1,300 | 3.00 | Typical Road with 35% Development |
| 56.5 | 48.0 | 30 | 700 | 1,300 | 3.39 | Typical Road with 60% Development |
| 46.5 | 38.0 | 30 | 700 | 1,300 | 2.45 | Typical Road with 90% Development |

S0 = free flow speed; S1 = 'intermediate' break point speed; S2 = speed at capacity; F = maximum flow at which the free flow conditions hold; C = link capacity; N = N factor

**Figure 5.5 – Links with Speed Flow Curves**

## Bus Routes

5.19. A full review of the base year bus provision was carried out and all bus routes that operated within, or passed through March in October 2010 were coded into the highway model. The bullet points below list the bus routes that have been included. Details of the exact routes and bus frequencies can be found within the MATS Data Collection Report.

- 33: Peterborough – Whittlesey – March;
- 46: Kings Lynn – Wisbech – March;
- 56: Wisbech – March – Benwick Or Manea;
- 380: Wisbech – Friday Bridge – March;
- X9: Littleport – Ely – Cambridge; and
- 010: Kings Lynn – London Victoria

# 6. Model Development – Matrix Development

Full process of generating model demand matrices for the base year MATS SATURN highway models is discussed in this chapter.

# Model Development – Matrix Development

6.1. This chapter gives details on the full process of generating model demand matrices for the base year MATS SATURN highway models.

## Building the Observed Matrices

6.2. Observed demand matrices were built using only the data collected in the RSI surveys. As discussed previously in this report, the RSI survey data provides origin/destination information for the strategic movements within the study area. The exact process used to generate the observed matrices from this data is summarised below.

### Data Cleaning and Geo-coding

6.3. Raw RSI survey data is supplied as a simple table for each survey site with columns containing the following information:

- The time at which the vehicle passed through the RSI site;
- Vehicle type (Car/LGV/OGV1/OGV2/Motorcycle);
- Vehicle occupancy;
- The address, postcode, OSGR and purpose of the origin;
- The address, postcode, OSGR and purpose of the destination; and
- The location of the car park in March if applicable.

6.4. This data was plotted using GIS software to enable illogical trip movements to be removed. This was achieved by plotting each origin and destination point (joined by a line) for each RSI site, and analysing the visual output in detail to ascertain whether or not each trip would logically have passed through that survey site. A route planner was used to check any alternative routes, as this enables time and distance comparisons of different routes between any given start and end points.

6.5. After the data had been cleaned of illogical trip movements, each origin and destination was assigned to a zone in the model according to the geographical location of its postcode using GIS software. In the case where car park data was provided, the location of vehicle destination (i.e. the car park) would overwrite the ultimate trip destination postcode.

6.6. Individual site matrices were then produced and assigned to the model network and the model assignments were checked visually to ensure the cleaned data only contain logical movements.

## Purpose Identification

6.7. The survey data was collected with an origin and destination purpose; however, for the Car and LGV trips, the matrices only require one purpose per trip. The RSI purposes are shown in Table 6.1; and the modelled purposes are HBW, HBEd, EB and OTP (as defined previously in Paragraph 4.13). The conversions shown in Table 6.2 allow a single purpose to be assigned to each trip.

**Table 6.1 – RSI Origin/Destination Purpose Definitions**

| Code | Description |
|---|---|
| 1 | Home |
| 2 | Tourism |
| 3 | Work |
| 4 | Employers' Business |
| 5 | Education |
| 6 | Shopping |
| 7 | Personal Business |
| 8 | Visit Friends/Family |
| 9 | Recreation/Leisure |

**Table 6.2 – Conversion to Trip Purposes**

| | | Destination Purpose | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Origin Purpose | 1 | OTP | OTP | HBW | EB | HBEd | OTP | OTP | OTP | OTP |
| | 2 | OTP | OTP | OTP | EB | OTP | OTP | OTP | OTP | OTP |
| | 3 | HBW | OTP | EB | EB | OTP | OTP | OTP | OTP | OTP |
| | 4 | EB | EB | EB | EB | EB | EB | EB | EB | EB |
| | 5 | HBEd | OTP | OTP | EB | OTP | OTP | OTP | OTP | OTP |
| | 6 | OTP | OTP | OTP | EB | OTP | OTP | OTP | OTP | OTP |
| | 7 | OTP | OTP | OTP | EB | OTP | OTP | OTP | OTP | OTP |
| | 8 | OTP | OTP | OTP | EB | OTP | OTP | OTP | OTP | OTP |
| | 9 | OTP | OTP | OTP | EB | OTP | OTP | OTP | OTP | OTP |

## Transposition

6.8. The RSI data provides observed matrices for the interview direction for all individual RSI sites, and by transposition, non-interview direction matrices can be generated from interview direction matrices, providing bi-directional observed matrices for all RSI sites.

6.9. In this process, for all user classes except UC4 (OTP), the AM matrices were transposed to provide non-interview direction information for the PM peak; and vice versa for the AM peak non-interview direction. For UC4, OTP trips, transposed matrices from the same time period were used for both AM and PM peak as in most cases, the outgoing and return journeys for OTP trips are made within the time period. For the inter peak, the non-interview direction matrices were taken from the same periods for all user classes. Table 6.3 shows the sources of the non-interview direction matrices.

Table 6.3 – Sources of Non-Interview Direction Matrices

| User Class | AM | IP | PM |
|---|---|---|---|
| UC1 HBW | $PM^T$ | $IP^T$ | $AM^T$ |
| UC2 HBEd | $PM^T$ | $IP^T$ | $AM^T$ |
| UC3 EB | $PM^T$ | $IP^T$ | $AM^T$ |
| UC4 OTP | $AM^T$ | $IP^T$ | $PM^T$ |
| OGV1 | $PM^T$ | $IP^T$ | $AM^T$ |
| OGV2 | $PM^T$ | $IP^T$ | $AM^T$ |

$AM^T$ = Transposition of AM; $IP^T$ – Transposition of IP; $PM^T$ = Transposition of PM

## Factoring – RSI Survey Data

6.10. Since the RSI surveys only interview a subset of the traffic passing through each site, it is necessary to expand the number of interviews to the observed traffic flow at each site.

6.11. As discussed in Chapter 4 of this report, the interview data was 'funnelled', so the MCC and ATC data reference below are single-hour counts, whereas the 'No. of interviews' are collected over a greater length of time.

6.12. Firstly, a factor, $F_1$, was calculated for each time period for each vehicle type at each site, according to the interview direction MCC data that has been recorded during the RSI surveys. This factor was equal to

$$F_1 = \frac{MCC}{No.of\ Interviews}$$

6.13. A second factor, $F_2$, was then calculated for each modelled hour at each site to scale the MCC data to the average ATC value for the same direction. This was undertaken because flow profile analysis of the ATC data shows that the flow level of the MCC survey day (which was undertaken on the same day as the RSI survey) was generally lower than average. This might be expected due to the additional delay caused by the RSI surveys. Therefore an adjustment factor, $F_2$, was applied to ensure the correct level of traffic flow was modelled. For more information on the ATC adjustment factors, see Chapter 3 of the MATS Data Collection Report.

$$F_1 = \frac{ATC}{MCC}$$

6.14. Finally these two factors, $F_1$ and $F_2$, were combined into a single interview direction expansion factor, $F$, which was applied to each survey record to scale the interviews up to the average observed hourly traffic flow by vehicle type.

$$F = F_1 \times F_2$$

6.15. At the same time, non-interview direction factors were calculated for the transposed matrices. This was calculated in the same way as the interview direction factors, except that each MCC and ATC data was replaced with the equivalent count in the opposite direction and the number of interviews replaced with the number of transposed interviews.

### Matrix Squaring

6.16. At the end of the above processes, the RSI data is still in table format but with additional columns containing the following information:

- Origin Zone;
- Destination Zone;
- User Class (Trip Purpose);
- Time Period; and
- Expansion Factor.

6.17. In order to use this information in the MATS SATURN model, the data has to be in the form of a square matrix. This is achieved by using a spreadsheet Pivot Table with origin zones as row headings, destination zones as column headings and a sum of expansion factors (in PCU) as the data.

6.18. This process was undertaken by user class and time period, and different matrices were produced for the interview and non-interview direction. Using the process described above, 252 matrices were created (3 Time Periods x 7 RSI Surveyed Arms (i.e. Site R-1, R-2, R-3, R-5, R-6A, R-6B & R-6C) x 2 Directions x 6 User Classes).

### Seasonality

6.19. DMRB (Volume 13 Section 1 Part 4 Traffic Flow Input to COBA) states that *April, May, June September and October (excluding periods affected by bank holidays)* are neutral months. Traffic surveys undertaken in neutral months are considered to be more reliable, and in general, the traffic data used for the development of a traffic model should be based on neutral month data. If data outside of the neutral months is to be used, seasonality factors should be applied to the traffic data to ensure the traffic data used is representative of average weekday conditions.

6.20. Table 6.4 lists all the survey dates of all the traffic survey data that was used for this study. All surveys undertaken as part of the 2010 March Data Collection programme were undertaken in October 2010, a neutral month, therefore no seasonality adjustment was required. The data from the 2010 March Data Collection programme was used for the MATS model demand development process as well as model calibration and validation.

6.21. Additional survey data from the CCC annual town monitoring programme was also used, mostly as an additional check for the traffic flow around the model network. All surveys were undertaken in October 2010, except two (i.e. E-10 & E-11) which were undertaken on 2$^{nd}$ November 2010. Traffic flow level checks were undertaken for Site E-10 and E-11, and the results show that the data from these two sites are consistent with other adjacent traffic survey sites undertaken in October 2010. Therefore seasonality adjustment was not required for all CCC annual town monitoring sites.

**Table 6.4 – Traffic Count Survey Dates**

| | Site ID | Location | Count Type | 2010 Survey Dates | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 12Oct (Tue) | 14Oct (Thu) | 19Oct (Tue) | 21Oct (Thu) | 2Nov (Tue) |
| CCC Annual Town Monitoring | E-1 | Wisbech Rd | MCC | | | ✓ | | |
| | E-2 | Norwood Rd | MCC | | | ✓ | | |
| | E-3 | Elm Rd | MCC | | | ✓ | | |
| | E-4 | Creek Rd | MCC | | | ✓ | | |
| | E-5 | Upwell Rd | MCC | | | ✓ | | |
| | E-6 | Wimblington Rd | MCC | | | ✓ | | |
| | E-7 | Knights End Rd | MCC | | | ✓ | | |
| | E-8 | Burrowmoor Rd | MCC | | | ✓ | | |
| | E-9 | Gaul Rd | MCC | | | ✓ | | |
| | E-10 | A141 March Bypass | MCC | | | | | ✓ |
| | E-11 | Town Bridge | MCC | | | | | ✓ |
| 2010 March Data Collection | R-1* | B1101 Elm Rd | RSI & MCC | ✓ | | | | |
| | R-2* | B1099 Upwell Rd | RSI & MCC | | | ✓ | | |
| | R-3* | B1101 Wimblington Rd | RSI & MCC | | | ✓ | | |
| | R-4** | A141 Isle of Ely Way | MCC | | | | ✓ | |
| | R-5* | A141 Wisbech Rd | RSI & MCC | ✓ | | | | |
| | TC-1 | B1101 Elm Rd/Estover Rd/Norwood Rd | MCTC | | | | ✓ | |
| | TC-4 | A141/Manea Rd | MCTC | | | | ✓ | |
| | TC-5 | A141/King St | MCTC | | | | ✓ | |
| | TC-6 | A141/B1101 Wimblington Rd | MCTC | | ✓ | | | |
| | TC-7 | B1101 Wimblington Rd/Jobs Ln | MCTC | | | | ✓ | |
| | TC-8 | A141/Knights End Rd | MCTC | | ✓ | | | |
| | TC-9 | A141/Burrowmoor Rd | MCTC | | | | ✓ | |
| | TC-10 | A141/Gaul Rd | MCTC | | | | ✓ | |
| | TC-11 | A141/B1099 Wisbech Rd | MCTC | | ✓ | | | |
| | TC-12 | A141/A605 | MCTC | | | | ✓ | |
| | TC-13 | B1101 High St/Burrowmoor Rd | MCTC | | | | ✓ | |
| | TC-14 | B1101 High St/St Peters Rd | MCTC | | ✓ | | | |
| | TC-15 | A141/Hostmoor Ave | MCTC | | | | ✓ | |
| | TC-16 | A141/B1093 Doddington Rd | MCTC | | | | ✓ | |
| | TC-17 | B1101 Elm Rd/Twenty Foot Rd | MCTC | | | | ✓ | |
| | TC-18 | B1101 Station Rd/County Rd | MCTC | | ✓ | | | |
| | TC-19 | B1099 Wisbech Rd/Norwood Rd | MCTC | | ✓ | | | |
| | TC-20 | B1101 Station Rd/Creek Rd | MCTC | | | | ✓ | |
| | TC-21 | B1101 Station Rd/B1101 Broad St/B1099 Dartford Rd | MCTC | | | | ✓ | |
| | TC-22 | B1101 High St/Elwyn Rd/Market Pl | MCTC | | | | ✓ | |
| | TC-23 | B1099 Upwell Rd/Elwyn Rd | MCTC | | | | ✓ | |
| | TC-24 | Hundreds Rd/Norwood Rd | MCTC | | | | ✓ | |
| | TC-25 | Hundreds Rd/Melbourne Ave | MCTC | | | | ✓ | |
| | TC-26 | Estover Rd/Creek Rd | MCTC | | | | ✓ | |
| | TC-27 | Burrowmoor Rd/Gaul Rd | MCTC | | | | ✓ | |
| | LC-1 | B1101 Station Rd level crossing | MCC | | ✓ | | | |

*ATC was also undertaken at Site R-1 to Site R-5 between Monday 11th to Sunday 24th October 2010. **RSI was not undertaken at Site R-4 due to site restriction and safety.

### Compiling the Site Matrices

6.22. As discussed in Paragraph 6.18, 252 matrices were created. To compile these individual matrices into full site matrices, a batch file was used which carried out the following steps:

- For each time period and user class, add together the interview and non-interview direction matrices.
- For each RSI site, stack the six user classes to produce a single observed matrix by site and time period.
- 21 bi-directional site matrices, by time period and by RSI site, were created at the end of this process.

### Removal of Double Counting

6.23. Due to the locations of the RSI sites, some movements would have been accounted for in two (or more) site matrices. For example, trips between Wisbech to March City Road car park would have travelled through RSI Site R-5 (or Site R-1) and Site R-6. The interviews at each RSI site have been factored up to the number of vehicles counted passing through that site and such that, trips such as the one described above would replicate each other and therefore be double-counted in the demand matrices.

6.24. It should also be noted that due to the way in which the transposed components of the matrices were created, all trips that pass through more than one RSI site (regardless of the direction of travel) would have been double counted.

6.25. The barrier method of removing double counting has been employed for the MATS model. This means that, for each origin/destination zone pair, the number of RSI sites that a trip would have passed through was counted. This information is used to build up a ‘double counting’ mask matrix which contains one for any movement passes through zero or one RSI sites, two for any movements that pass through two RSI sites, three for any movements that pass through three RSI sites and so on.

### Compiling the Full Observed Matrices

6.26. Finally to compile the full observed matrices, all site matrices were added by time period and then divided by the ‘double counting’ mask matrix to remove double counting.

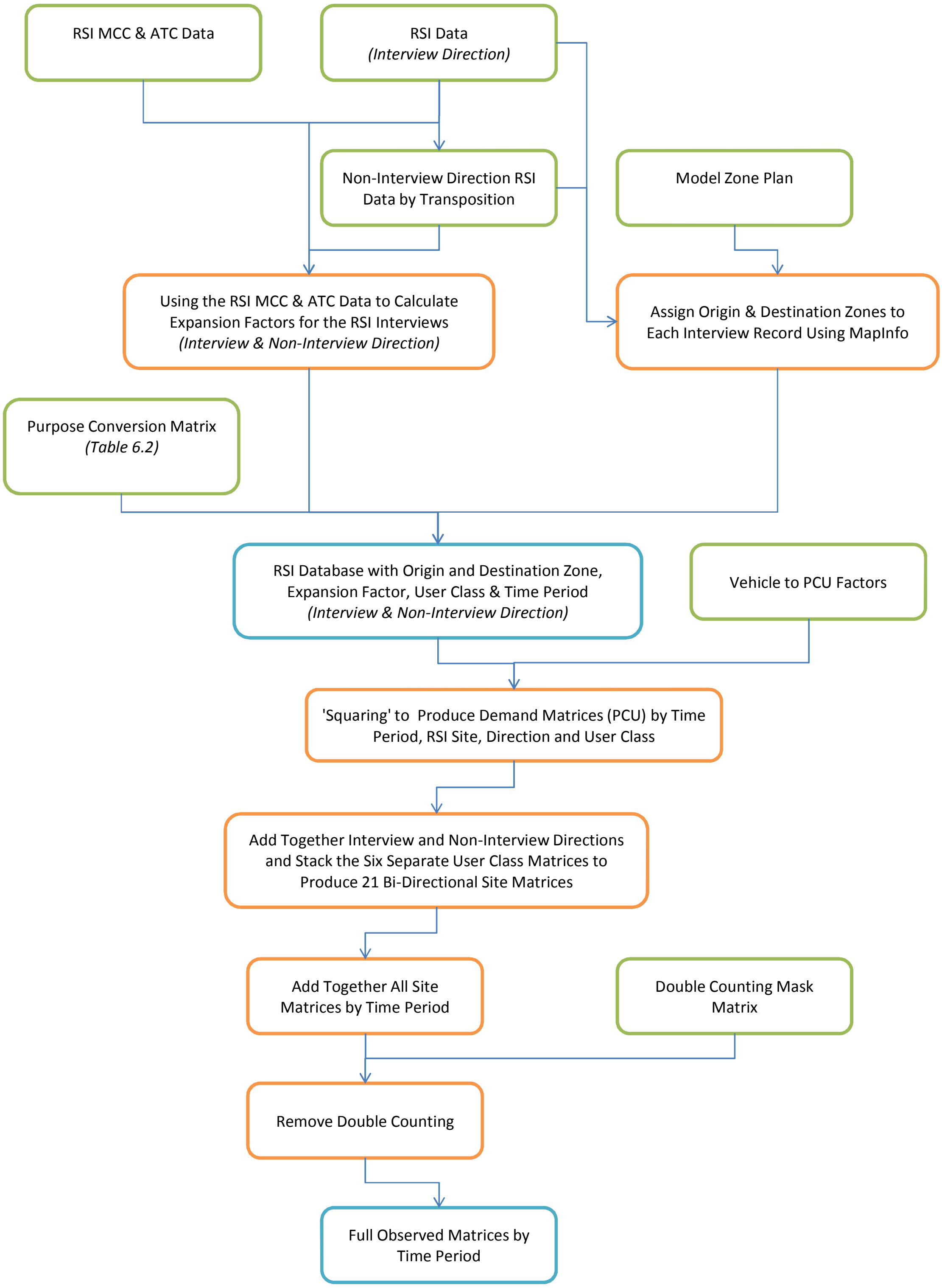
6.27. Figure 6.1 below is a flow chart summarising the key steps for compiling the full observed matrices.

6.28. Table 6.5 below shows the matrix totals before and after double counting has been removed by time period. All intra-zonal trips (i.e. Zone 101 to Zone 101) have also been removed as a final step to produce the full observed matrices as these trips would not enter the traffic model and have been removed for tidiness.

**Table 6.5 – Matrix Totals (Full Observed)**

| | AM | IP | PM |
|---|---|---|---|
| Before Double Counting Removal | 5,536 | 4,758 | 6,331 |
| After Double Counting Removal | 3,879 | 3,203 | 4,291 |
| % Reduction after Double Counting Removal | 30% | 33% | 32% |
| After Intra-zonal Trip Removal | 3,879 | 3,194 | 4,291 |

**Figure 6.1 – Observed Matrix Building Process**



## Building the Synthetic Matrices

6.29. Although the RSI data, which was used to create the full observed matrices, provides demand data for many of the traffic movements within the study area, there are movements within the MATS model which would not have been captured by the RSI surveys. For example, from Wimblington to Hostmoor Avenue Industrial Estate, and from March railway station to Mill View retail area.

6.30. To create complete demand matrices for all movements within the MATS model, a synthetic component of the demand matrices was required for the partially observed and unobserved movements in the matrix. The basis of the synthetic data for this study is the 2001 JTW National Census Data for all user classes, except UC2 (HBEd) for which the CCC education trip data was used.

6.31. The process used to create the synthetic matrices for all user classes, except UC2 (HBEd) was as follows:

*Processing the 2001 JTW Census Data*

1) As discussed in Paragraph 3.14 to 3.16, a 2001 JTW Census matrix based on the MATS zone plan was generated using GIS software and Microsoft Access Queries.
2) The JTW matrix was factored from 2001 to 2010 using the traffic flow data from the 2001 and 2010 Traffic Monitoring Report for Cambridgeshire (Table 6.6).

**Table 6.6 – 2001 to 2010 Factor (March Annual Town Monitoring Report)**

| | Total Vehicles entering/leaving March |
|---|---|
| 2001 | 32,063 |
| 2010 | 33,654 |
| 2001 to 2010 Factor | 1.0496 |

3) The 2010 JTW matrix was transposed to create the 2010 work to home (WTH) matrix.
4) The 2010 JTW and WTH matrices were divided from all day into the modelled time periods based on the proportions calculated from the RSI data. Table 6.7 below shows the proportion of JTW and WTH trips for each modelled time period.

**Table 6.7 – Proportion of JTW and WTH Trips**

| | AM | IP | PM |
|---|---|---|---|
| Journey to Work | 20% | 5% | 3% |
| Work to Home | 2% | 4% | 22% |

5) The JTW and WTH matrices (per time period) were added together to produce the full bi-directional infill data for journeys to and from work (i.e. trip purpose definition equivalent to MATS UC1 (HBW) (see Table 6.2)).

*Creating Infill Data for Other User Classes*

6) Percentages were calculated that describe each of the other user classes as proportion of HBW, using the observed data for each time period (Table 6.8).

Table 6.8 – Other User Class as Proportion of HBW

| | AM | IP | PM |
|---|---|---|---|
| UC1 HBW | 100% | 100% | 100% |
| UC2 HBEd* | - | - | - |
| UC3 EB | 33% | 83% | 22% |
| UC4 OTP | 80% | 321% | 122% |
| UC5 OGV1 | 6% | 15% | 3% |
| UC6 OGV2 | 8% | 26% | 7% |

*The synthetic element of UC2 (HBEd) trips are based on CCC Education Trip Data (See Paragraph 6.37 to Paragraph 6.40)

7) The HBW Census matrices were multiplied by the above factors to create a starting point for the synthetic matrices for each user class.

*Identifying all partially observed and unobserved movements*

8) To ensure that the traffic movements that are observed by the RSI surveys would not be over-written by the synthetic data, a mask matrix was produced and applied to each of the infill data matrices created at the end of Step 7.

*Gravity Models and Logit Functions*

9) After stripping out the data that had already been fully observed, the differences between the infill data matrices and the corresponding observed matrices were calculated for all partially observed and unobserved movements to identify the 'missing' trips.

10) The row and column totals were calculated for the above difference matrices – these provide the total number of trips to and from each zone, known as trip ends, to be synthesised for each time period and user class.

11) From the RSI data, the observed trip length distributions were calculated for each time period and user class. Each distribution was plotted on a graph.

12) A logit function was generated to replicate the trip length distribution for each time period and user class (see Paragraph 6.32 to Paragraph 6.36 below for details on the gravity model and logit function). Each logit function was calibrated by changing the values of the coefficients until the graph of the function matched the observed trip length distribution as closely as possible.

13) From the MATS SATURN models for each time period (assigned with the observed matrices), a distance skim (a matrix containing the distances between every origin and destination in the network) was taken, to create a matrix of the average observed distance between each origin/destination zone pair.

14) Using the logit functions (Step 12), distance skims (Step 13) and observed movement mask (Step 8), for each time period and user class, a matrix of the distribution of all partially observed and unobserved trip movements was generated.

15) Feed the trip ends and the trip distribution matrices into a Furness process, to distribute the required trip ends according to the calculated distribution, creating synthetic matrices of the partially observed and unobserved movements.

## Gravity Models and Logit Functions

6.32. A gravity model can be used to describe the propensity of a journey to be made between an origin and a destination, based on the costs associated with the travel between these locations. These costs could, for example, be based on time, distance or a combination of the two.

6.33. Gravity models attempt to describe a trip distribution based on very limited data – they do not provide an accurate trip matrix, but the information can be used to inform a prior matrix that provides a good starting point for the Matrix Estimation process that takes observed traffic counts into account.

6.34. For this study, a gravity model has been developed for each user class based on distance costs. A profile of the length of car trips in the study area was ascertained from the RSI data, and this was used to inform the gravity model. In this case, the gravity model used the following logit function:

$$F(C_{ij}) = C_{ij}^{X_1} \exp(X_2 C_{ij})$$

$Where:$

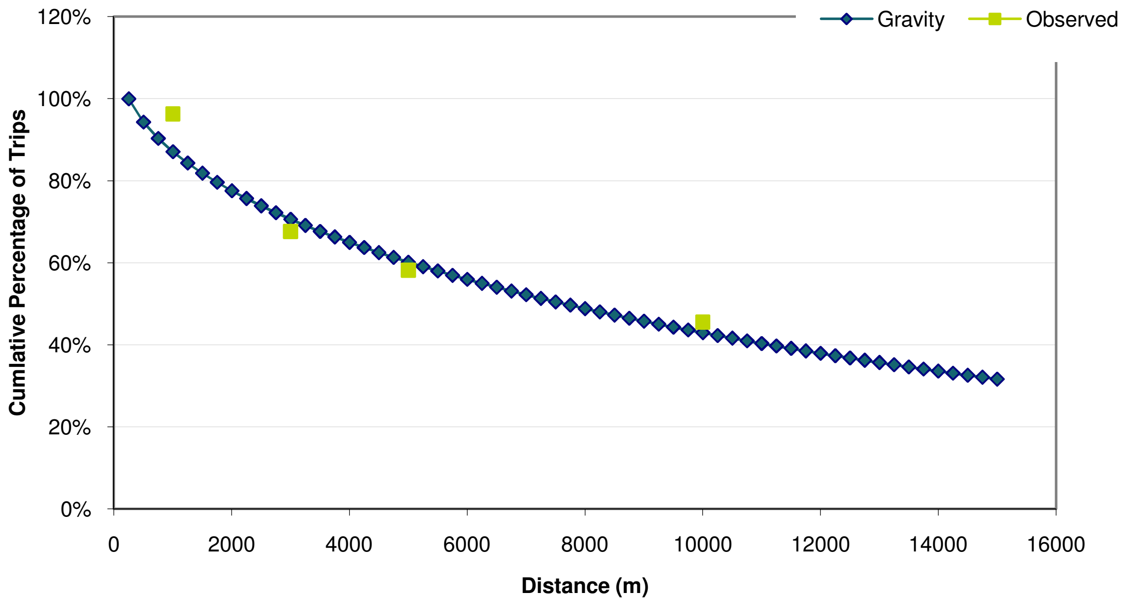
$F(C_{ij}) = cost\ deterrence\ for\ zone\ i\ to\ zone\ j;$

$C_{ij} = distance\ cost\ for\ zone\ i\ to\ zone\ j;\ and$

$X_1 and\ X_2 = coefficients\ to\ be\ calibrated.$

6.35. Logit functions were developed by user class and time periods, and an example of the calibrated logit function for UC1 (HBW) for the AM peak is shown in Figure 6.2.

**Figure 6.2 – Calibration of the Logit Function for AM Peak UC1 (HBW)**




6.36. Figure 6.2 shows that 100% of the UC1 (HBW) trips are greater than 0km (as expected); approximately 80% of trips are greater than 2km; approximately 60% of the trips are greater than 5km and so on.

## User Class 2 HBEd Trips

6.37. 2010 education trip data (by MATS zones) was provided by CCC, which gives home to school journey data for all state funded schools in March, and also for pupils who live in March but go to school outside of March. The data was provided by mode, and all trips by car have been extracted and used for infilling.

6.38. To divide the education trip data into the modelled time periods, proportion of home to school and school to home trips was calculated from the RSI data. Table 6.9 below shows the proportion of home to school and school to home trips for each modelled time period.

**Table 6.9 – Proportion of Home to School and School to Home Trips**

| | AM | IP | PM |
|---|---|---|---|
| Home to School | 70% | - | - |
| School to Home | - | 6% | 28% |

6.39. By multiplying the full home to school and school to home (by transposition) matrices to the proportions shown in Table 6.9, matrices by time period were created, and finally, adding the two outbound and return matrices together, the full bi-directional synthetic data for UC2 (HBEd) was created.

6.40. Similar to the other user classes, only partially observed and unobserved movements would be infilled with this synthetic data.

## OGV1 and OGV2 Trip Infilling

6.41. As discussed in Chapter 3 of the MATS Data Collection Report, there is a lack of interview data for OGV1 and OGV2 for RSI Site R-5 and Site R-6. Although the process discussed above provides synthetic data for OGV1 and OGV2, it is believed that the OGV1 and OGV2 interview data from the Wisbech Area Transport Study (WATS) which has also been made available for this study is likely to provide more accurate origin/destination data for these two user classes.

6.42. This is due to the fact that the greater number of samples from the Wisbech data is more likely to accurately represent the full pattern on HGV movements at these locations. A small sample rate can lead to a 'lumpy' distribution, whereby the numbers of trips counted at the ATC sites adjacent to the RSI sites are distributed over only a few origin/destination pairs. By using the Wisbech data that had a higher sample rate, it was possible to gain a more accurate representation of the origin/destination movements in the area.

6.43. Similar to the RSI data for this study, the origin and destination data taken from WATS has been put into MATS zone, and the interviews that are expected to pass through the MATS study area have been extracted. Due to the locations of the WATS RSI sites, only the trips that use the A141 were deemed to be appropriate to be used for this study.

6.44. To factor the WATS interview data (i.e. 2008) to MATS flow level (i.e. 2010), the turning count for A141/A605 (TC-12) was used to calculate the expansion factors. As it was deemed that the synthetic data created from the WATS RSI data is likely to be more accurate than the gravity models, for all origin/destination zone pairs that WATS RSI surveys captured, the synthetic data were replaced with the WATS data.

## Compiling the Synthetic Matrices

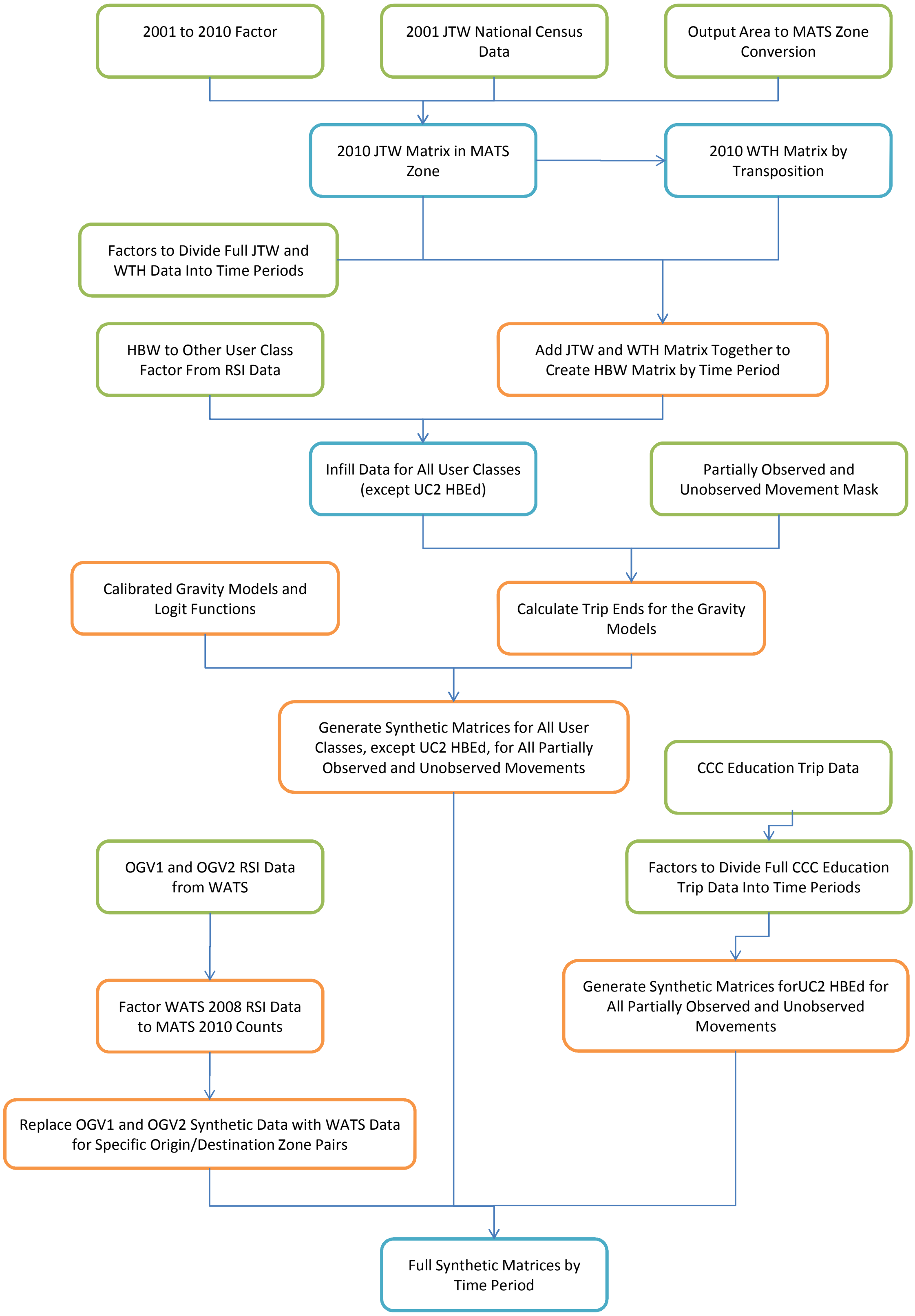
6.45. Paragraph 6.29 to Paragraph 6.44 above describes the process used to create the synthetic matrices. Figure 6.3 below is a flow chart summarising the key steps for compiling the full synthetic matrices.

6.46. Table 6.10 below shows the matrix totals after each of the key synthetic matrix development processes. The data is presented by user class to clearly show the impact of each step.

**Table 6.10 – Matrix Totals (Full Synthetic)**

| | Synthetic Data from the Gravity Models | | | After Infilling with CCC Education Trip Data | | | After Infilling with WATS Data | | |
|---|---|---|---|---|---|---|---|---|---|
| | AM | IP | PM | AM | IP | PM | AM | IP | PM |
| UC1 HBW | 505 | 204 | 586 | 505 | 204 | 586 | 505 | 204 | 586 |
| UC2 HBEd | - | - | - | 338 | 28 | 133 | 338 | 28 | 133 |
| UC3 EB | 179 | 177 | 135 | 179 | 177 | 135 | 179 | 177 | 135 |
| UC4 OTP | 413 | 628 | 740 | 413 | 628 | 740 | 416 | 628 | 740 |
| UC5 OGV1 | 86 | 84 | 51 | 86 | 84 | 51 | 159 | 151 | 63 |
| UC6 OGV2 | 72 | 89 | 68 | 72 | 89 | 68 | 225 | 280 | 207 |
| TOTAL | 1,255 | 1,182 | 1,580 | 1,593 | 1,210 | 1,713 | 1,822 | 1,468 | 1,864 |

**Figure 6.3 – Synthetic Matrix Build Process**



## Compiling the Full Prior Matrices

6.47. The paragraphs above describe the steps that were taken to generate the observed and synthetic matrices for each user class and time period. As has been noted, these matrices have been created in such a way that the observed matrices contain only the observed movements and a portion of the partially observed movements, and the synthetic matrices contain only the unobserved movements and the other portion of the partially observed movements. Therefore these two components can simply be added together to produce the final full prior matrices.

6.48. Table 6.11 below shows the matrix totals for the prior matrices and the proportion of the observed and synthetic components, and Table 6.12 to Table 6.14 shows the proportion of the observed component of the prior matrices by the MATS sector system (See Appendix B for sector plan). The composition of observed and synthetic data of the prior matrices is generally consistent for all three modelled time periods, suggesting that the demand matrix development process adopted is robust. The percentage of synthetic data within the matrix is also comparable to the WATS model, which comprised of 31%, 30% and 29% synthetic trips for the AM, Inter and PM peak periods respectively.

**Table 6.11 – Matrix Totals (Prior)**

| | AM | IP | PM |
|---|---|---|---|
| Observed | 3,879 (68%) | 3,194 (69%) | 4,291 (70%) |
| Synthetic | 1,822 (32%) | 1,468 (31%) | 1,864 (30%) |
| Prior Matrix | 5,701 (100%) | 4,662 (100%) | 6,155 (100%) |

6.49. Table 6.12 to Table 6.14 shows that a high proportion of the trips from external areas (i.e. Sector 4 to Sector 8) to March (i.e. Sector 1 to Sector 3) are made up of observed data. For the March internal to internal movements (i.e. movements between Sector 1, 2 and 3) and external to external movements (i.e. movements between Sector 4, 5, 6, 7 and 8), a larger proportion of the trips were synthesised. Due to the location of the RSI survey sites, this combination of observed and synthetic data is reasonable and the prior matrices are considered to be acceptable.

6.50. Select Link Analysis for all RSI links were also undertaken to ensure that the traffic flows for these links remain fairly consistent between the prior and post ME2 assignments. Table 6.15 shows the results from the Select Link Analysis. All flow data is presented as 2-way combined flow, for Site R-6, the total junction arrive flow is presented rather than individual entry arms.

6.51. Table 6.15 shows that for all RSI sites with 2-way flow less than 1,000 PCU (i.e. Site R-1, R-2 & R-3), the flow difference between the prior and post ME2 assignment is less than 50 PCU for all RSI sites and time periods.

6.52. For RSI sites with higher flow (greater than 1,000 PCU) (i.e. Site R-3 & R-5), the absolute flow difference between the prior and post ME2 assignment is greater, as might be expected, but the percentage differences remain reasonably low, between 2% and 7% for all time periods.

Table 6.12 – Sector to Sector Analysis: Proportion of Observed Data (AM)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 17% | 82% | 91% | 82% | 100% | 82% | 89% | 79% | 72% |
| 2 | 74% | 51% | 35% | 93% | 100% | 88% | 96% | 98% | 75% |
| 3 | 72% | 51% | 22% | 70% | 100% | 55% | 49% | 43% | 51% |
| 4 | 91% | 97% | 95% | 34% | 100% | 89% | 86% | 64% | 73% |
| 5 | 98% | 100% | 99% | 100% | 0% | 54% | 100% | 100% | 87% |
| 6 | 90% | 92% | 73% | 58% | 74% | 2% | 38% | 77% | 63% |
| 7 | 95% | 95% | 72% | 61% | 100% | 39% | 100% | 100% | 78% |
| 8 | 95% | 97% | 89% | 42% | 100% | 36% | 100% | 100% | 68% |
| Total | 74% | 75% | 64% | 59% | 96% | 56% | 77% | 74% | 68% |

Table 6.13 – Sector to Sector Analysis: Proportion of Observed Data (IP)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 27% | 86% | 83% | 82% | 99% | 84% | 86% | 84% | 78% |
| 2 | 86% | 66% | 73% | 74% | 100% | 94% | 92% | 95% | 82% |
| 3 | 84% | 71% | 32% | 77% | 99% | 66% | 53% | 79% | 66% |
| 4 | 82% | 79% | 77% | 46% | 100% | 77% | 70% | 28% | 63% |
| 5 | 99% | 100% | 99% | 100% | 100% | 71% | 100% | 100% | 92% |
| 6 | 85% | 94% | 68% | 75% | 72% | 0% | 31% | 24% | 59% |
| 7 | 87% | 93% | 56% | 69% | 100% | 33% | 100% | 100% | 72% |
| 8 | 82% | 95% | 80% | 28% | 100% | 22% | 100% | 100% | 61% |
| Total | 78% | 82% | 67% | 62% | 93% | 58% | 71% | 62% | 69% |

Table 6.14 – Sector to Sector Analysis: Proportion of Observed Data (PM)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 13% | 82% | 80% | 90% | 96% | 88% | 95% | 96% | 78% |
| 2 | 86% | 72% | 60% | 97% | 100% | 94% | 97% | 99% | 84% |
| 3 | 90% | 49% | 38% | 91% | 100% | 72% | 70% | 90% | 69% |
| 4 | 83% | 93% | 67% | 27% | 100% | 55% | 55% | 47% | 57% |
| 5 | 100% | 100% | 100% | 100% | 0% | 69% | 100% | 100% | 95% |
| 6 | 76% | 87% | 50% | 85% | 37% | 1% | 52% | 35% | 54% |
| 7 | 87% | 97% | 45% | 81% | 100% | 45% | 100% | 100% | 74% |
| 8 | 89% | 99% | 58% | 55% | 100% | 54% | 100% | 100% | 77% |
| Total | 77% | 83% | 57% | 66% | 86% | 61% | 76% | 73% | 70% |

Table 6.15 – Select Link Analysis

| | RSI Site | Prior | Post ME2 | Diff | % Diff |
|---|---|---|---|---|---|
| AM | R-1 | 442 | 460 | 17 | 3.9% |
| | R-2 | 197 | 212 | 15 | 7.5% |
| | R-3 | 942 | 918 | -24 | -2.6% |
| | R-5 | 1,796 | 1,683 | -113 | -6.3% |
| | R-6 | 1,266 | 1,299 | 33 | 2.6% |
| IP | R-1 | 291 | 319 | 27 | 9.4% |
| | R-2 | 196 | 225 | 30 | 15.1% |
| | R-3 | 806 | 788 | -18 | -2.3% |
| | R-5 | 1,481 | 1,412 | -69 | -4.7% |
| | R-6 | 1,148 | 1,211 | 63 | 5.5% |
| PM | R-1 | 495 | 516 | 21 | 4.3% |
| | R-2 | 219 | 262 | 44 | 20.0% |
| | R-3 | 969 | 980 | 11 | 1.1% |
| | R-5 | 1,855 | 1,754 | -101 | -5.4% |
| | R-6 | 1,448 | 1,506 | 58 | 4.0% |

6.53.

# 7. Highway Model – Calibration and Validation Procedures

This chapter outlines the procedures and the acceptability guidelines for the highway model.

# Highway Model – Calibration and Validation Procedures

7.1. Model calibration refers to the process of adjusting and confirming values of the various parameters in the network, and correcting origin/destination movements in the trip matrices, as necessary to improve the performance for the model. This is achieved by making use of the various data collected during the study.

7.2. Model validation seeks to demonstrate that the calibrated model correctly reproduces observed conditions when applied in the base year situation. Ideally, it should make use of the data which is not used directly in the model calibration.

## Data Utilised

7.3. During the calibration and validation of the model, the following data sources were used:

- RSI MCC survey data;
- MCTC survey data;
- Journey time survey data;
- Queue length survey data
- TrafficMaster speed data;
- CCC traffic signal data; and
- Highway network inventory surveys.

## Calibration Counts and Matrix Estimation

7.4. All counts that had not been designated as validation counts were used within the Matrix Estimation by Maximum Entropy (ME2) process to calibrate the model, by inclusion in the SATURN 77777 card. These counts are shown below in Table 7.1, with the location of these counts shown in Figure 7.1.

**Table 7.1 – MATS Calibration Counts**

| Site ID | Location | Count Type | Date | Source |
|---|---|---|---|---|
| E-2 | Norwood Road | MCC | 19/10/2010 | CCC Annual Town Monitoring |
| E-3 | Elm Road | MCC | 19/10/2010 | CCC Annual Town Monitoring |
| E-4 | Creek Road | MCC | 19/10/2010 | CCC Annual Town Monitoring |
| R-4 | A141 Isle of Ely Way | RSI MCC (factored) | 21/10/2010 | SkyHigh 2010 |
| TC-1 | B1101 Elm Road/Estover Road/Norwood Road | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-4 | A141/Manea Road | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-5 | A141/King Street | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-6 | A141/B1101 Wimblington Road | MCTC | 14/10/2010 | SkyHigh 2010 |
| TC-7 | B1101 Wimblington Road/Jobs Lane | MCTC | 21/10/2010 | SkyHigh 2010 |

| Site ID | Location | Count Type | Date | Source |
|---|---|---|---|---|
| TC-9 | A141/Burrowmoor Road | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-10 | A141/Gaul Road | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-11 | A141/B1099 Wisbech Road | MCTC | 14/10/2010 | SkyHigh 2010 |
| TC-12 | A141/A605 | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-14 | B1101 High Street/St Peters road | MCTC | 14/10/2010 | SkyHigh 2010 |
| TC-15 | A141/Hostmoor Avenue | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-16 | A141/B1093 Doddington Road | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-17 | B1101 Elm Road/Twenty Foot Road | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-18 | B1101 Station Road/County Road | MCTC | 14/10/2010 | SkyHigh 2010 |
| TC-19 | B1099 Wisbech Road/Norwood Road | MCTC | 14/10/2010 | SkyHigh 2010 |
| TC-20 | B1101 Station Road/Creek Road | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-22 | B1101 High Street/Elwyn Road/Market Place | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-25 | Hundreds Road/Melbourne Avenue | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-27 | Burrowmoor Road/Gaul Road | MCTC | 21/10/2010 | SkyHigh 2010 |

## Assignment Parameters

7.5. Model assignments were carried out using the Origin Based Assignment (OBA) procedure. The OBA procedure provides the most accurate solutions for the Wardrop User Equilibrium, which is used to govern the assignment of traffic to the network. It seeks to minimise the generalised cost along each path for each trip, where generalised cost can be defined as below:

$$\text{Generalised cost} = \beta \times \text{time} + \alpha \times \text{distance}$$

7.6. Further details of these parameters can be found in Chapter 4.

7.7. One distinct advantage of the OBA procedure is a reduced amount of model noise, enabling greater detail to be sought in comparing small changes to either the network or demand.

## Model Convergence Guidelines

7.8. The following guidance was applied to the convergence of the model.

7.9. The DMRB (Volume 12 Section 2 Part 1 Traffic Appraisal in Urban Areas) defines 'Gap' as the measure of convergence between the final SATASS/SATSIM loop. It is the difference between costs on the assigned routes and those along the minimum cost routes, as a percentage of the cost routes.

7.10. In addition to this, DMRB advice recommends the following criteria for Wardrop User Equilibrium assignment to ensure a satisfactory model convergence:

- Delta' is the measure of convergence of the final assignment to ensure that the alternative routes used in the assignment process do not differ significantly from the final minimum cost. It is the difference between costs on the various multiple assigned routes and those along the final minimum cost routes, as a percentage of the minimum cost routes. Its value should be less than 1%.
- Flow Change Stability (P) is the measure of convergence of assignment-simulation loops. It is the percentage of links where assigned flows change by less than 5% between successive assignment simulation loops. Assignment model iterations should continue until at least four successive values of 'P' greater than 90% have been obtained.
- 'Gap' is the measure of convergence between the final SATASS/SATSIM loop. It is the difference between costs on the assigned routes and those along the minimum cost routes, as a percentage of the cost routes. A value of less than 0.25% is recommended.

7.11. Emerging guidance from the SATURN developers suggests that a more stringent convergence of the Flow Change Stability would be advantageous, with a 'P' value of 99% or more for four consecutive iterations. As such, the MATS model has been set to adhere to this stringent criterion, which should easily be met for a model of this size.

## Calibration Procedure

7.12. The calibration procedure involved a number of tasks, all of which were designed to ensure that the model adequately reproduces observed traffic flows and travel times in the study area. These tasks included:

- The verification of speed flow curves in the model to represent the operation conditions of the road network;
- Checking junction capacities and gap acceptance values to represent typical operating conditions;
- Ensuring that the traffic counts used within the model are valid and do not conflict with adjacent counts, and are representative of normal traffic conditions;
- Correlating the observed delay and congestion points with the modelled;
- Use of Matrix Estimation process (ME2) to best 'fit' the prior demand matrices to observed traffic flows on the study area cordon and observed links and turning flows within the study area.

### Speed Flow Curves

7.13. In SATURN, delays and queues in the simulation network occur at junctions. Speed flow curves can also be allocated to simulation links in order to represent delays due to road conditions. Speed flow curves within simulation network have only been applied to non-urban links outside the built up area where junction capacity and delay are not the dominant capacity determinant. In the buffer network, delays and queues result only from speed flow curves assigned to the links. The speed flow curves that have been used in this model are presented in Table 5.1.

## Model Validation

7.14. During the latter stages of the model development, validation checks were also incorporated into the processing of the model output data. This primarily consisted of comparing observed and assigned link flows, and journey times along the specified routes. The validation comparison criteria used the guidelines as set out in the DMRB.

### Assignment Acceptability Guidelines

7.15. The traffic flow assignment acceptability guidelines are set out in the DMRB. These are reproduced in Table 7.2.

7.16. The observed flow and screenline flow criteria in Table 7.2 related to total flows, i.e. all vehicles, and should not be used when comparing partial link flows, e.g. by vehicle classification.

**Table 7.2 – DMRB Assignment Acceptability Guidelines**

| Criteria Measures | Acceptability Guideline |
|---|---|
| *Assigned hourly flows compared with observed flows* | |
| Individual flows within 100 vehicles per hour (vph) for flows <700 vph | At least 85% of cases |
| Individual flows within 15% for flows 700-2,700 vph | At least 85% of cases |
| Individual flows within 400 vph flow flows >2,700 vph | At least 85% of cases |
| Total Screenline flows (normally >5 links) to be within 5% | All (or nearly all) screenlines |
| GEH Statistic: Individual flows GEH < 5 | At least 85% of cases |
| GEH Statistic: Screenline totals GEH < 4 | All (or nearly all) screenlines |
| *Modelled journey times compared with observed journey times* | |
| Total journey times within 15% (or 1-minute if higher) | At least 85% of routes |

### The GEH Statistic

7.17. The GEH (Geoffrey E Havers) Statistic included in Table 7.2 above is a generally accepted value used as an indicator of 'goodness of fit', i.e. the extent to which modelled flows match corresponding observed values. The GEH Statistic is a form of chi-square statistic. It is described in the DMRB (Volume 12 Section 2 Part 1 Traffic Appraisal in Urban Areas). It is defined as:

$$GEH = \sqrt{\frac{(M-C)^2}{{}^1\!/_2\,(M+C)}}$$

$Where:$

$M = modelled\ flow; and$

$C = observed\ flow\ (or\ count).$

7.18. Based on the DMRB guidance, a GEH value of less than 5 indicates a satisfactory fit between independent observed counts and modelled flows. For screenlines or other combinations of links, a GEH value of 4 or less per screenline is required in all or nearly all cases.

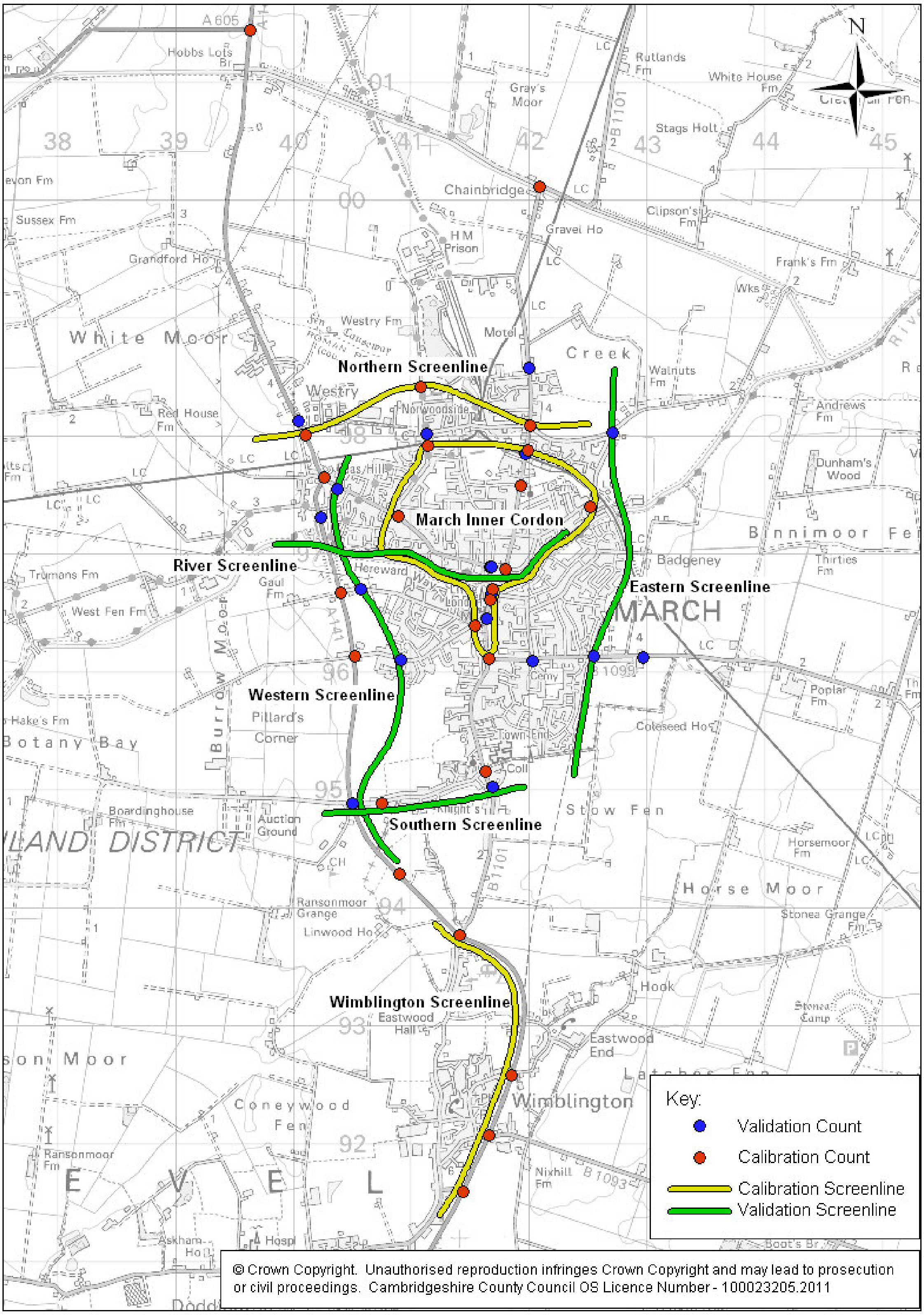
## Validation Count List

7.19. A set of counts were used as an independent validation check of the model. These counts did not form part of the SATURN 77777 card. Table 7.3 lists the validation counts and Figure 7.1 shows the validation count locations.

**Table 7.3 – MATS Validation Counts**

| Site ID | Location | Count Type | Date | Source |
|---|---|---|---|---|
| E-1 | Wisbech Rd | MCC | 19/10/2010 | CCC Annual Town Monitoring |
| E-5 | Upwell Rd | MCC | 19/10/2010 | CCC Annual Town Monitoring |
| E-7 | Knights End Rd | MCC | 19/10/2010 | CCC Annual Town Monitoring |
| E-8 | Burrowmoor Rd | MCC | 19/10/2010 | CCC Annual Town Monitoring |
| E-9 | Gaul Rd | MCC | 19/10/2010 | CCC Annual Town Monitoring |
| E-10 | A141 March Bypass | MCC | 19/10/2010 | CCC Annual Town Monitoring |
| E-11 | Town Bridge | MCC | 19/10/2010 | CCC Annual Town Monitoring |
| R-1 | B1101 Elm Rd | RSI MCC (factored) | 12/10/2010 | SkyHigh 2010 |
| R-2 | B1099 Upwell Rd | RSI MCC (factored) | 19/10/2010 | SkyHigh 2010 |
| R-3 | B1101 Wimblington Rd | RSI MCC (factored) | 19/10/2010 | SkyHigh 2010 |
| R-5 | A141 Wisbech Rd | RSI MCC (factored) | 12/10/2010 | SkyHigh 2010 |
| TC-8 | A141/Knights End Rd | MCTC | 14/10/2010 | SkyHigh 2010 |
| TC-13 | B1101 High St/Burrowmoor Rd | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-21 | B1101 Broad St/B1099 Dartford Rd/B1101 Station Rd | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-22 | B1101 High St/Elwyn Rd/Market Pl | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-23 | B1099 Upwell Rd/Elwyn Rd | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-24 | Hundreds Rd/Norwood Rd | MCTC | 21/10/2010 | SkyHigh 2010 |
| TC-26 | Estover Rd/Creek Rd | MCTC | 21/10/2010 | SkyHigh 2010 |
| LC-1 | B1101 Station Rd Level Crossing | LC MCC | 14/10/2010 | SkyHigh 2010 |

**Figure 7.1 – MATS Screenline, Calibration and Validation Count Locations**



## Analysis of Journey Time Survey Data

7.20. A series of journey time surveys were undertaken for this study, as described in Chapter 3. Table 7.4 below highlights the number of observed runs that were used to obtain the average journey time. Surveys that were undertaken between 0730 and 0930 were used for the AM peak hour, between 1000 and 1600 were used for the Inter peak hour, and between 1630 and 1830 were used for the PM peak hour. Anomalous results were removed along with any data that was recorded outside these time frames.

**Table 7.4 – Number of Journey Times Used**

| Journey Time Route | AM | IP | PM |
|---|---|---|---|
| Pink Route NB | 5 | 10 | 5 |
| Pink Route SB | 5 | 10 | 5 |
| Blue Route EB | 5 | 10 | 5 |
| Blue Route WB | 4 | 10 | 5 |
| Green Route NB | 7 | 15 | 7 |
| Green Route SB | 7 | 15 | 7 |
| Red Route NB | 4 | 10 | 5 |
| Red Route SB | 4 | 10 | 5 |

7.21. In addition to the routes above, a further route was created by combining data for the Blue, Green and Red routes between St Peters Road and Dartford Road. This enabled a much more thorough check on the journey time of this section of road to be performed to ensure greater accuracy on this particular link within the town centre. The table below highlights the number of runs used for the additional black route.

**Table 7.5 – Number of Journey Times Used – Additional Black Route**

| Journey Time Route | AM | IP | PM |
|---|---|---|---|
| Black Route NB | 16 | 35 | 17 |
| Black Route SB | 16 | 35 | 17 |

7.22. It is important to check the data and discard anomalous runs, as these can have a significant effect on the calculated average value, as demonstrated in Figure 7.2, showing data from the Red Route NB for the AM peak hour. Run 4 from the first graph was deemed anomalous, since the delay shown here was not observed at any of the other survey runs throughout the day. This anomaly could be due to an error in the data recording, or a specific set of traffic conditions that are not representative of the average conditions being modelled.

7.23. Once the anomalous run has been removed from the calculations, the average journey time changes from 12 minutes and 20 seconds to 11 minutes and 17 seconds, and the reduced variability can be seen across the data.

**Figure 7.2 – Red Route NB AM Peak Hour Journey Time Including Anomalous Data**

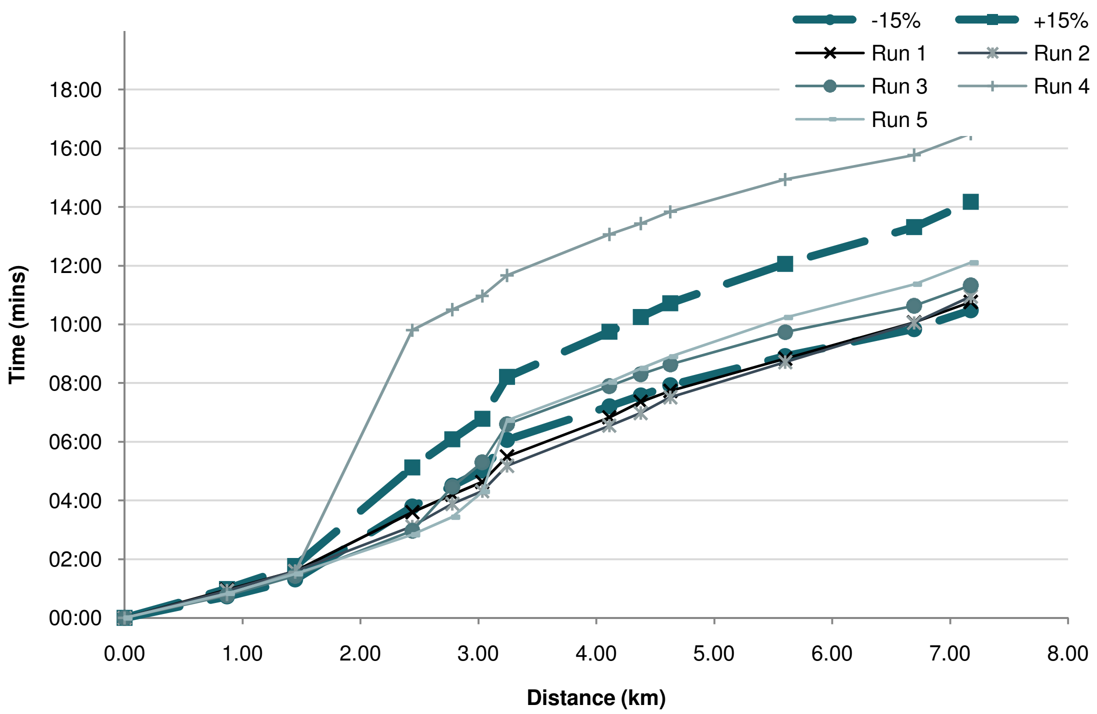
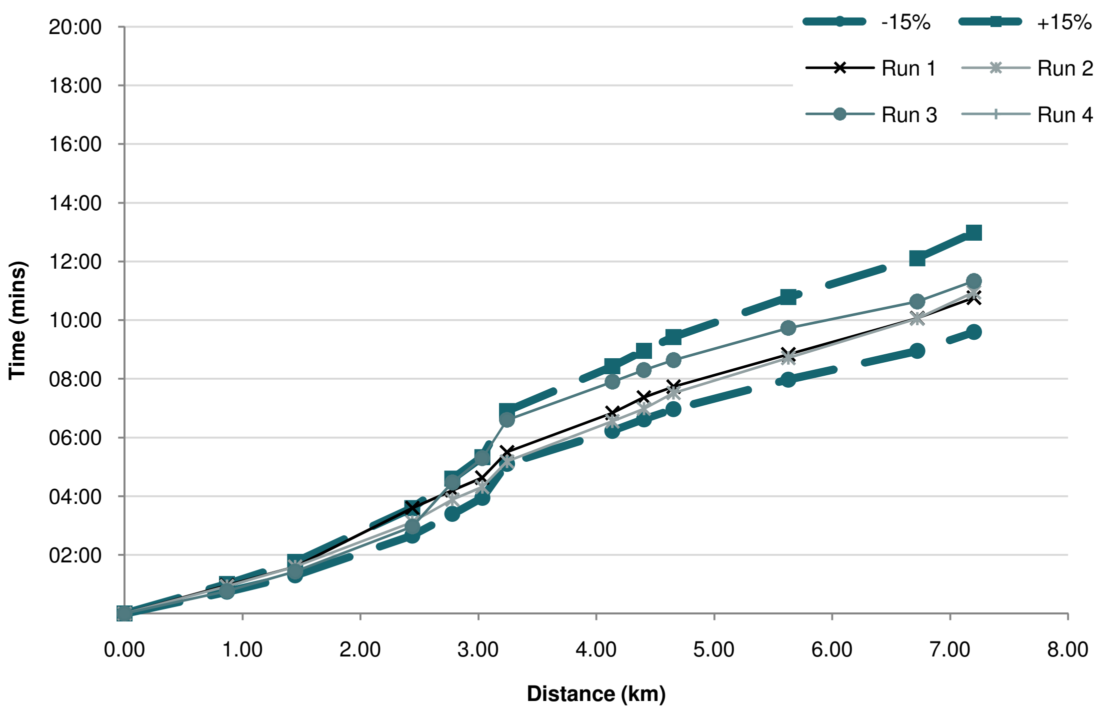



**Figure 7.3 – Red Route NB AM Peak Hour Journey Time with Anomalous Data Removed**



# 8. Highway Model – Calibration and Validation Results

The performance of base year MATS SATURN highway model has been assessed against a number of benchmarks to ensure it provides a satisfactory replication of existing traffic conditions.

# Highway Model – Calibration and Validation Results

8.1. This chapter presents the results of the calibration and validation exercises undertaken for each of the three modelled time periods: AM, inter and PM peak. The performance of each time period has been assessed against a number of benchmarks.

## Prior Assignment Summary

8.2. Initial assignments of the matrices were undertaken without running the ME2 process. Basic assignment information such as trip length distribution and matrix totals were collected from the prior assignments for comparison against post ME2 assignments.

8.3. A comparison of the matrix totals for the prior and post ME2 assignment will indicate the impact of the calibration traffic counts on the matrices and the assignment; and the trip length distributions for the prior and post ME2 assignments were checked to ensure the proportion of trips in each distance band remains fairly stable between the prior and final matrices.

8.4. A check against the DMRB Assignment Acceptability Guidelines for the prior assignment was also undertaken. This indicated that 93%, 96% and 97% of validation counts pass DMRB flow criteria in the AM, inter and PM peak hours respectively, while 75%, 72% and 74%of validation counts have a GEH of less than 5. In terms of journey time routes, 100% of the AM peak, 100% of the Inter peak and 100% of the PM peak journey time routes pass the DMRB validation criteria.

8.5. It should be noted that it is not a requirement for the prior assignment to meet the DMRB acceptability guidelines, but these figures have been included here for reference only.

## Post ME2 Assignment Summary

8.6. Chapter 6 of this report describes the process of building the prior matrices, from observed and synthetic data. Whilst every effort has been made to ensure these are as accurate as possible, it is acknowledged that the observed data was not available to inform all movements, and the synthetic data is only an 'initial estimate'. Therefore, the ME2 procedure has been used within SATURN to better inform the synthetic component of the demand matrices, using count data as a basis.

8.7. The SATURN Matrix Estimation process has been set up to complete four iterations of the SATPIJA, SATME2 and assignment loop. Within each iteration, SATPIJA and SATME2 are run on each vehicle type separately. To facilitate this, the count data has been split into the relevant vehicle types, namely light vehicles (i.e. Cars & LGV), OGV1 and OGV2.

### Observed and Assigned Traffic Flow Comparisons

8.8. The final validated assignment was compared against observed traffic flows at all sites along the five screenlines, one cordon and six additional count sites that did not form part of either a screenline or cordon.

8.9. A summary of the outputs for the screenlines and cordon (Table 8.1 to Table 8.6) are presented below, and full details of these and the six additional sites can be found within Appendix A.

8.10. A check against the DMRB Acceptability Guidelines indicate that in the final validation assignments, out of all validation counts from the screenlines, cordon, and six additional sites, all three modelled time periods exceeded the criteria of 85% of counts having a GEH of less than 5, and 85% of counts passing the DMRB flow criteria.

8.11. Within the AM peak model, 97% of counts have a GEH of less than 5 and 87% of counts pass the DMRB flow criteria.

8.12. Within the Inter peak model, 97% of counts have a GEH of less than 5 and 86% of counts pass the DMRB flow criteria.

8.13. Within the PM peak model, 100% of counts have a GEH of less than 5 and 88% of counts pass the DMRB flow criteria.

**Table 8.1 – AM Peak Final Assignment Screenline and Cordon Summary**

| Screenline | | Total Screenline Flow from Count Data | Assigned Modelled Flow | Diff | %Diff | GEH | DMRB Flow | DMRB GEH |
|---|---|---|---|---|---|---|---|---|
| Validation | Eastern Screenline | 355 | 347 | 8 | 2% | 0.4 | ✓ | ✓ |
| | Southern Screenline | 2162 | 2231 | -69 | -3% | 1.5 | ✓ | ✓ |
| | Western Screenline | 1614 | 1621 | -7 | 0% | 0.2 | ✓ | ✓ |
| | River Screenline | 2842 | 2787 | 55 | 2% | 1.0 | ✓ | ✓ |
| Calibration | Northern Screenline | 2362 | 2402 | -40 | -2% | 0.8 | ✓ | ✓ |
| | March Inner Cordon | 4015 | 3976 | 39 | 1% | 0.6 | ✓ | ✓ |
| | Wimblington Screenline | 717 | 696 | 21 | 3% | 0.8 | ✓ | ✓ |

**Table 8.2 – AM Peak Count Validation Summary**

| Number of Validation Counts | Number Passing DMRB Flow | % Passing | Number Passing DMRB GEH | % Passing | DMRB Flow | DMRB GEH |
|---|---|---|---|---|---|---|
| 69 | 67 | 97% | 60 | 87% | ✓ | ✓ |

**Table 8.3 – Inter Peak Final Assignment Screenline and Cordon Summary**

| Screenline | | Total Screenline Flow from Count Data | Assigned Modelled Flow | Diff | %Diff | GEH | DMRB Flow | DMRB GEH |
|---|---|---|---|---|---|---|---|---|
| Validation | Eastern Screenline | 327 | 358 | -32 | -10% | 1.7 | × | ✓ |
| | Southern Screenline | 1690 | 1837 | -147 | -9% | 3.5 | × | ✓ |
| | Western Screenline | 1228 | 1187 | 40 | 3% | 1.2 | ✓ | ✓ |
| | River Screenline | 2362 | 2363 | -1 | 0% | 0.0 | ✓ | ✓ |
| Calibration | Northern Screenline | 1804 | 1994 | -190 | -11% | 4.4 | × | × |
| | March Inner Cordon | 3520 | 3368 | 152 | 4% | 2.6 | ✓ | ✓ |
| | Wimblington Screenline | 654 | 634 | 19 | 3% | 0.8 | ✓ | ✓ |

**Table 8.4 – Inter Peak Count Validation Summary**

| Number of Validation Counts | Number Passing DMRB Flow | % Passing | Number Passing DMRB GEH | % Passing | DMRB Flow | DMRB GEH |
|---|---|---|---|---|---|---|
| 69 | 67 | 97% | 60 | 87% | ✓ | ✓ |

**Table 8.5 – PM Peak Final Assignment Screenline and Cordon Summary**

| Screenline | | Total Screenline Flow from Count Data | Assigned Modelled Flow | Diff | %Diff | GEH | DMRB Flow | DMRB GEH |
|---|---|---|---|---|---|---|---|---|
| Validation | Eastern Screenline | 419 | 416 | 4 | 1% | 0.2 | ✓ | ✓ |
| | Southern Screenline | 2415 | 2426 | -11 | 0% | 0.2 | ✓ | ✓ |
| | Western Screenline | 1546 | 1559 | -13 | -1% | 0.3 | ✓ | ✓ |
| | River Screenline | 2985 | 3077 | -92 | -3% | 1.7 | ✓ | ✓ |
| Calibration | Northern Screenline | 2405 | 2424 | -19 | -1% | 0.4 | ✓ | ✓ |
| | March Inner Cordon | 4207 | 4219 | -12 | 0% | 0.2 | ✓ | ✓ |
| | Wimblington Screenline | 845 | 823 | 22 | 3% | 0.8 | ✓ | ✓ |

**Table 8.6 – PM Peak Count Validation Summary**

| Number of Validation Counts | Number Passing DMRB Flow | % Passing | Number Passing DMRB GEH | % Passing | DMRB Flow | DMRB GEH |
|---|---|---|---|---|---|---|
| 69 | 69 | 100% | 60 | 87% | ✓ | ✓ |

8.14. Figure 8.1 to Figure 8.3 shows the ‘goodness of fit’, using GEH values, between the observed and modelled flow data in graphical format for the AM, inter and PM peak model respectively.

**Figure 8.1 – Count Calibration/Validation Overview (AM)**

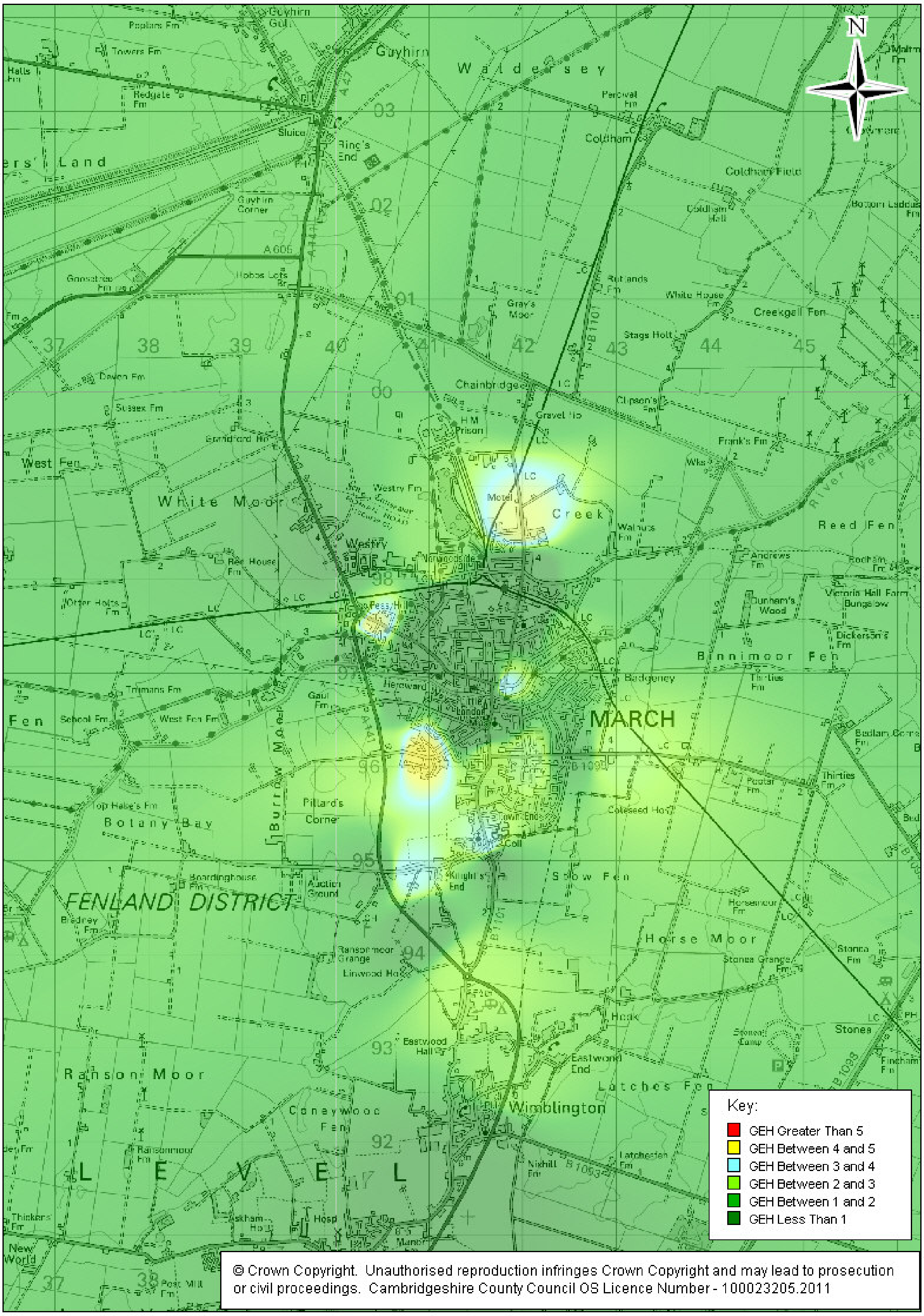


**Figure 8.2 – Count Calibration/Validation Overview (IP)**

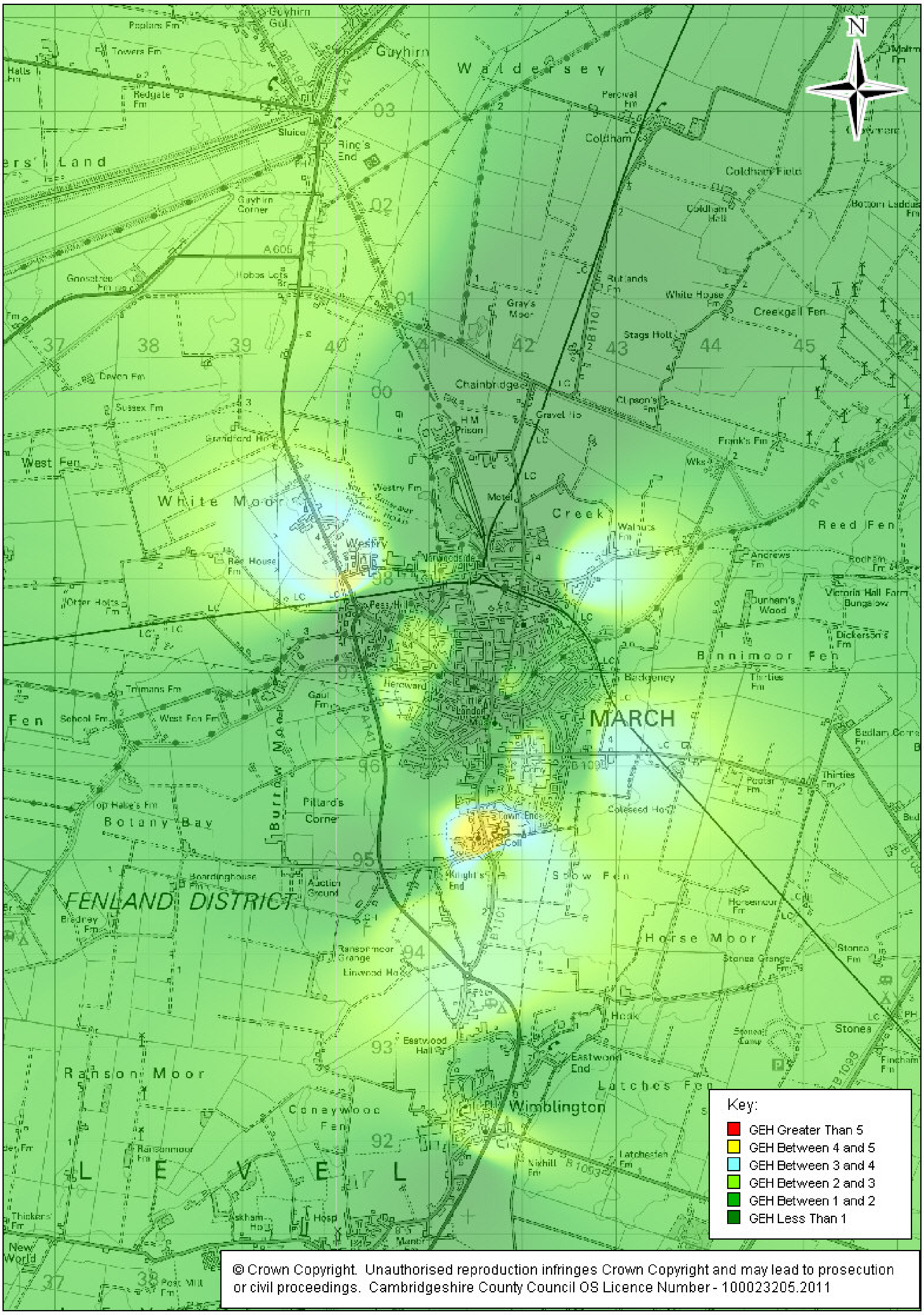
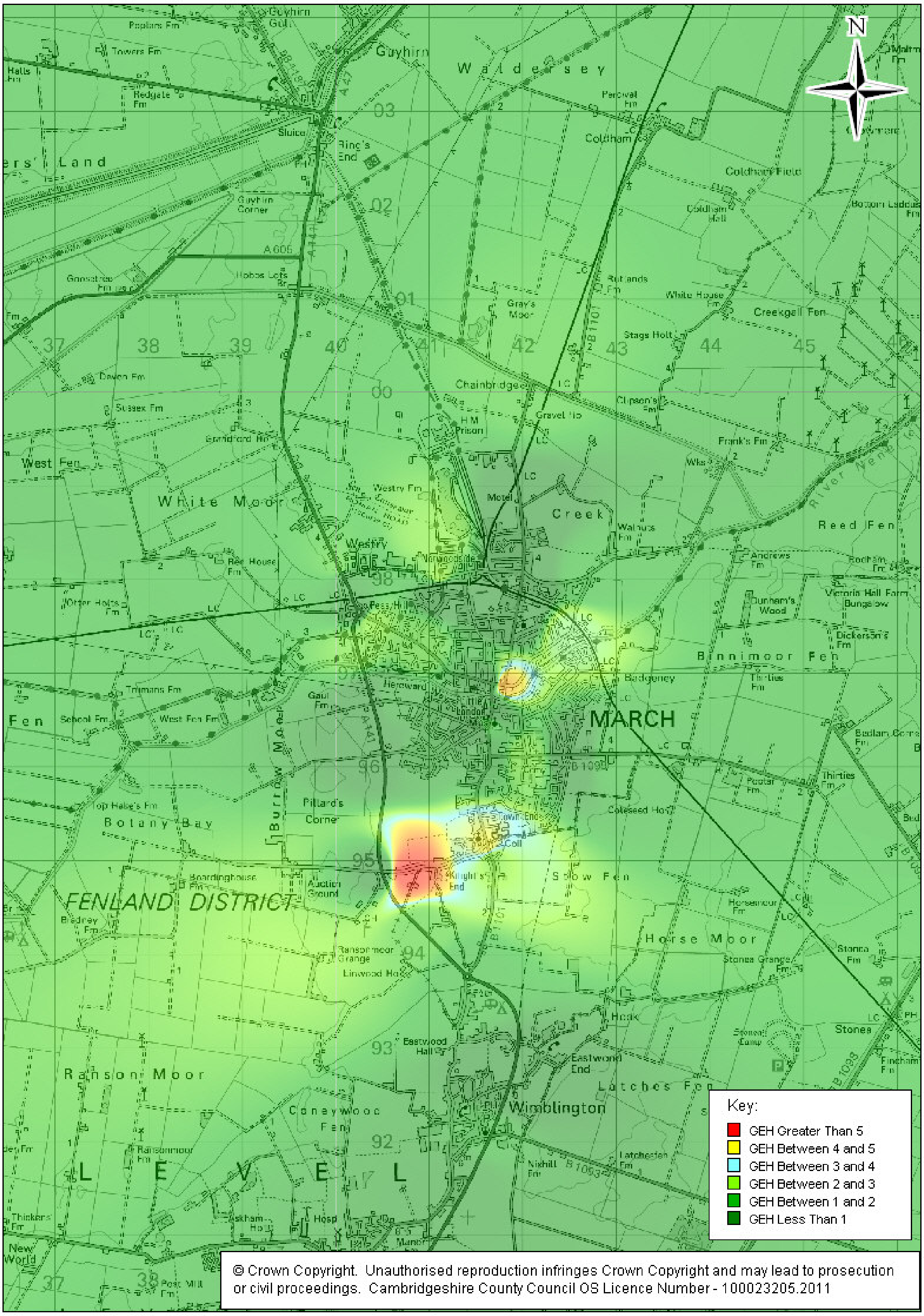


**Figure 8.3 – Count Calibration/Validation Overview (PM)**



## Journey Time Comparisons

8.15. A graphical summary of the overall modelled and observed journey time comparison for each route in the AM peak along with indicators of a 15% error bar is shown in Figure 8.4. Figure 8.5 shows a summary of the Inter peak journey times, while Figure 8.6 shows the same summary for the PM peak. Detailed comparisons between the observed and modelled journey times for all three time periods against the upper and lower 95% confidence intervals of the observed times are produced within Appendix A.

8.16. The results in Table 8.7 to Table 8.9 show that the modelled journey times in all three time periods meet with the DMRB validation criteria in all cases. The criterion is for the difference between the modelled and the mean observed journey times to be less than 15% or 1 minute.

**Figure 8.4 – AM Peak Final Assignment Journey Time Summary**

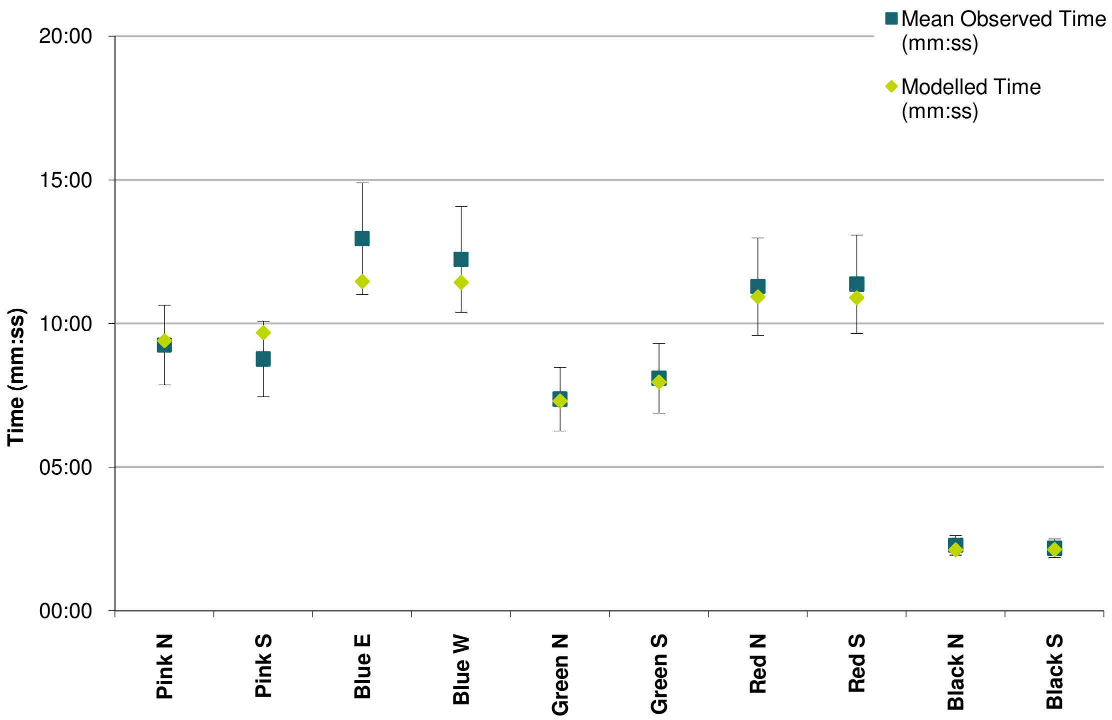



**Table 8.7 – AM Peak Final Assignment Journey Time Summary**

| Route | Mean Observed Time (hh:mm:ss) | Modelled Time (hh:mm:ss) | Diff (hh:mm:ss) | % Diff | DMRB Criteria |
|---|---|---|---|---|---|
| Pink Route NB | 00:09:15 | 00:09:24 | 00:00:09 | 2% | ✓ |
| Pink Route SB | 00:08:46 | 00:09:41 | 00:00:55 | 9% | ✓ |
| Blue Route EB | 00:12:57 | 00:11:28 | 00:01:29 | -13% | ✓ |
| Blue Route WB | 00:12:14 | 00:11:26 | 00:00:48 | -7% | ✓ |
| Green Route NB | 00:07:22 | 00:07:18 | 00:00:04 | -1% | ✓ |
| Green Route SB | 00:08:06 | 00:07:58 | 00:00:08 | -2% | ✓ |
| Red Route NB | 00:11:17 | 00:10:56 | 00:00:21 | -3% | ✓ |
| Red Route SB | 00:11:22 | 00:10:54 | 00:00:28 | -4% | ✓ |
| Black Route NB | 00:02:17 | 00:02:07 | 00:00:10 | -8% | ✓ |
| Black Route SB | 00:02:11 | 00:02:08 | 00:00:03 | -2% | ✓ |

**Figure 8.5 – Inter Peak Final Assignment Journey Time Summary**

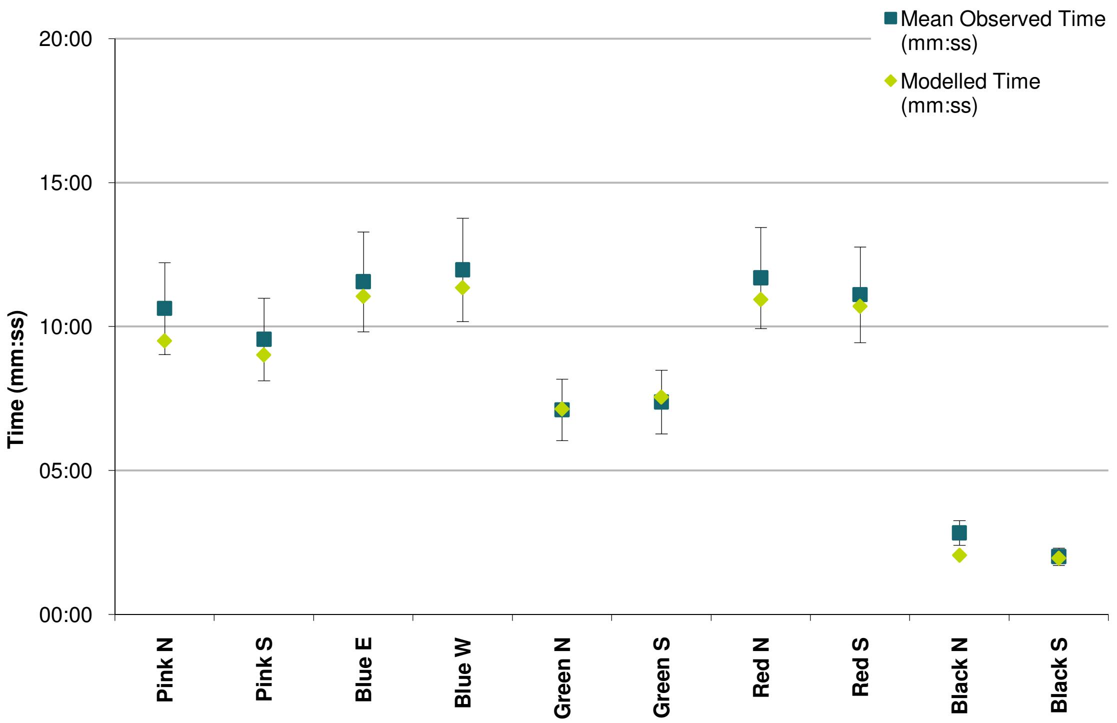



**Table 8.8 – Inter Peak Final Assignment Journey Time Summary**

| Route | Mean Observed Time (hh:mm:ss) | Modelled Time (hh:mm:ss) | Diff (hh:mm:ss) | % Diff | DMRB Criteria |
|---|---|---|---|---|---|
| Pink Route NB | 00:10:38 | 00:09:30 | 00:01:08 | -12% | ✓ |
| Pink Route SB | 00:09:33 | 00:09:01 | 00:00:32 | -6% | ✓ |
| Blue Route EB | 00:11:34 | 00:11:03 | 00:00:31 | -5% | ✓ |
| Blue Route WB | 00:11:58 | 00:11:21 | 00:00:37 | -5% | ✓ |
| Green Route NB | 00:07:06 | 00:07:08 | 00:00:02 | 0% | ✓ |
| Green Route SB | 00:07:23 | 00:07:33 | 00:00:11 | 2% | ✓ |
| Red Route NB | 00:11:41 | 00:10:56 | 00:00:45 | -7% | ✓ |
| Red Route SB | 00:11:07 | 00:10:42 | 00:00:25 | -4% | ✓ |
| Black Route NB | 00:02:50 | 00:02:03 | 00:00:47 | -38% | ✓ |
| Black Route SB | 00:02:01 | 00:01:57 | 00:00:04 | -3% | ✓ |

**Figure 8.6 – PM Peak Final Assignment Journey Time Summary**

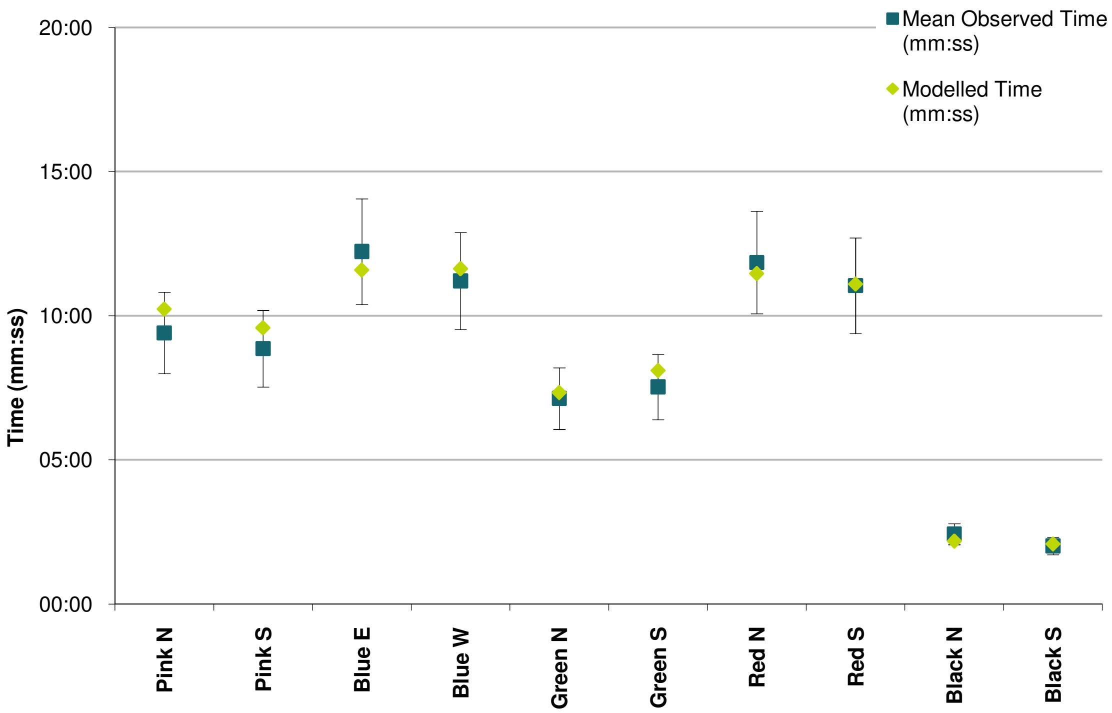



**Table 8.9 – PM Peak Final Assignment Journey Time Summary**

| Route | Mean Observed Time (hh:mm:ss) | Modelled Time (hh:mm:ss) | Diff (hh:mm:ss) | % Diff | DMRB Criteria |
|---|---|---|---|---|---|
| Pink Route NB | 00:09:24 | 00:10:14 | 00:00:50 | 8% | ✓ |
| Pink Route SB | 00:08:52 | 00:09:35 | 00:00:43 | 8% | ✓ |
| Blue Route EB | 00:12:14 | 00:11:35 | 00:00:39 | -6% | ✓ |
| Blue Route WB | 00:11:12 | 00:11:38 | 00:00:26 | 4% | ✓ |
| Green Route NB | 00:07:08 | 00:07:20 | 00:00:12 | 3% | ✓ |
| Green Route SB | 00:07:32 | 00:08:06 | 00:00:34 | 7% | ✓ |
| Red Route NB | 00:11:51 | 00:11:28 | 00:00:23 | -3% | ✓ |
| Red Route SB | 00:11:03 | 00:11:06 | 00:00:03 | 0% | ✓ |
| Black Route NB | 00:02:26 | 00:02:11 | 00:00:15 | -11% | ✓ |
| Black Route SB | 00:02:01 | 00:02:05 | 00:00:04 | 3% | ✓ |

## Prior and Post ME2 Matrix Comparisons

8.17. At the end of the Matrix Estimation process, the prior and post ME2 matrices have been compared. Table 8.10 below shows the change in total matrix size between the prior and post ME2 matrices and Table 8.11 to Table **8.13** show the matrix change at the MATS 8 sector level for all modelled time periods.

8.18. Table 8.11 to Table **8.13** show that the most significant sector to sector movement change due to the ME2 process are generally intra-sectoral movements (i.e. Sector 1 to Sector 1 & Sector 4 to Sector 4). The demand data for these movements are generally synthesised, therefore it is expected the ME2 process would adjusted these movements.

8.19. For movements between the external areas (i.e. Sector 4 to Sector 8) and March (i.e. Sector 1 to Sector 3), the demand data have remained reasonably consistent between the prior and post ME2 matrices as these movements have mostly been captured by the RSI surveys. It should be noted that part of Sector 4 to March movements were unobserved, namely Hostmoor Avenue Industrial Estate and Whitemoor Prison to/from March Town Centre, therefore the prior and post ME2 matrix differences between Sector 4 and March are generally greater than the other external sectors to/from March movements.

**Table 8.10 – Prior and Post ME2 Matrix Total Comparison**

| Time Period | Prior Matrix Total | Post ME2 Matrix Total | Difference |
|---|---|---|---|
| AM | 5,701 | 6,420 | 719 (13%) |
| IP | 4,662 | 5,306 | 644 (14%) |
| PM | 6,155 | 6,912 | 758 (12%) |

Table 8.11 – Prior and Post ME2 Sector Matrix Difference (AM)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total |
|---|---|---|---|---|---|---|---|---|---|
| **1** | 139 | 6 | 85 | 57 | 0 | 13 | -4 | -7 | **289** |
| **2** | 41 | -1 | 64 | 28 | 0 | -23 | 2 | 0 | **111** |
| **3** | 40 | 2 | 156 | 80 | 0 | 4 | -60 | -57 | **166** |
| **4** | 21 | -1 | 7 | 186 | 0 | 77 | 23 | 6 | **318** |
| **5** | 0 | 0 | 0 | 0 | 0 | -7 | 0 | 0 | **-8** |
| **6** | 30 | -9 | -2 | 25 | -2 | -3 | -44 | -28 | **-33** |
| **7** | -2 | 1 | -6 | -16 | 0 | 7 | 0 | 0 | **-16** |
| **8** | -2 | 0 | -2 | -39 | 0 | -65 | 0 | 0 | **-108** |
| **Total** | **267** | **-2** | **302** | **321** | **-2** | **3** | **-83** | **-87** | **719** |

Table 8.12 – Prior and Post ME2 Sector Matrix Difference (IP)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total |
|---|---|---|---|---|---|---|---|---|---|
| **1** | 95 | 57 | 44 | 108 | 0 | 8 | -12 | -11 | **290** |
| **2** | 54 | 2 | 48 | 0 | 0 | -13 | -1 | -1 | **90** |
| **3** | 31 | 21 | 33 | 32 | 0 | 51 | -40 | -14 | **113** |
| **4** | 108 | -1 | 25 | 77 | 0 | 77 | -11 | -13 | **262** |
| **5** | 0 | 0 | 0 | 0 | 0 | -3 | 0 | 0 | **-4** |
| **6** | 1 | -13 | 35 | 91 | -3 | 3 | -14 | -48 | **51** |
| **7** | -11 | -1 | -38 | -13 | 0 | -5 | 0 | 0 | **-69** |
| **8** | -9 | -1 | -16 | -17 | 0 | -47 | 0 | 0 | **-90** |
| **Total** | **268** | **64** | **132** | **278** | **-4** | **71** | **-78** | **-87** | **644** |

Table 8.13 – Prior and Post ME2 Sector Matrix Difference (PM)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total |
|---|---|---|---|---|---|---|---|---|---|
| **1** | 62 | 6 | 63 | 27 | 0 | 4 | -3 | -2 | **156** |
| **2** | 27 | 0 | 44 | 9 | 0 | -12 | 1 | -1 | **68** |
| **3** | 9 | 46 | 9 | 17 | 1 | 35 | -22 | -9 | **85** |
| **4** | 102 | 7 | 47 | 189 | 0 | 137 | -34 | -38 | **410** |
| **5** | 0 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | **-1** |
| **6** | -7 | -1 | 38 | 98 | -6 | 6 | -24 | -47 | **58** |
| **7** | -6 | -2 | -29 | 62 | 0 | -34 | 0 | 0 | **-9** |
| **8** | -5 | -1 | -25 | 20 | 0 | 2 | 0 | 0 | **-10** |
| **Total** | **182** | **55** | **147** | **421** | **-5** | **137** | **-83** | **-96** | **758** |

## Trip Length Distribution

8.20. The figures below show the change in the trip length distribution between the Prior and Post ME2 assignments.

8.21. These graphs indicate that the proportion of trips in each distance band remains very stable between the prior and final matrix in all three time periods. There is a correlation of 98% in the AM peak, 97% in the Inter peak, and 98% in the PM peak.

**Figure 8.7 – AM Peak Trip Length Distribution Changes**

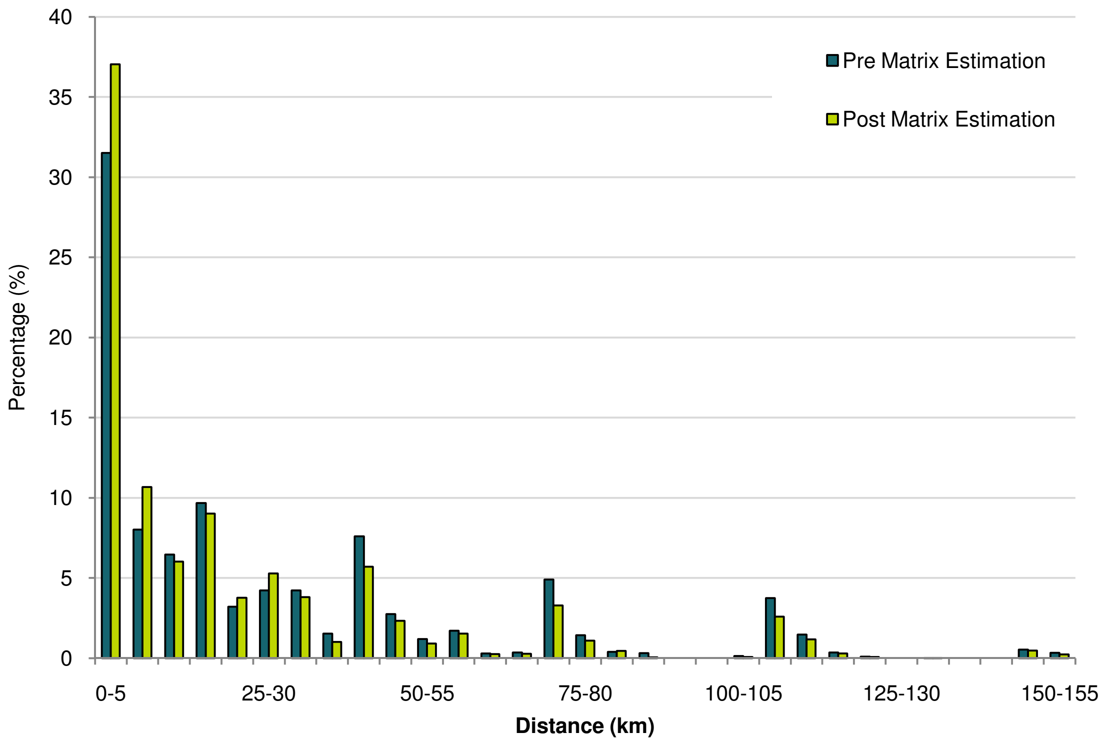



**Figure 8.8 – Inter Peak Trip Length Distribution Changes**

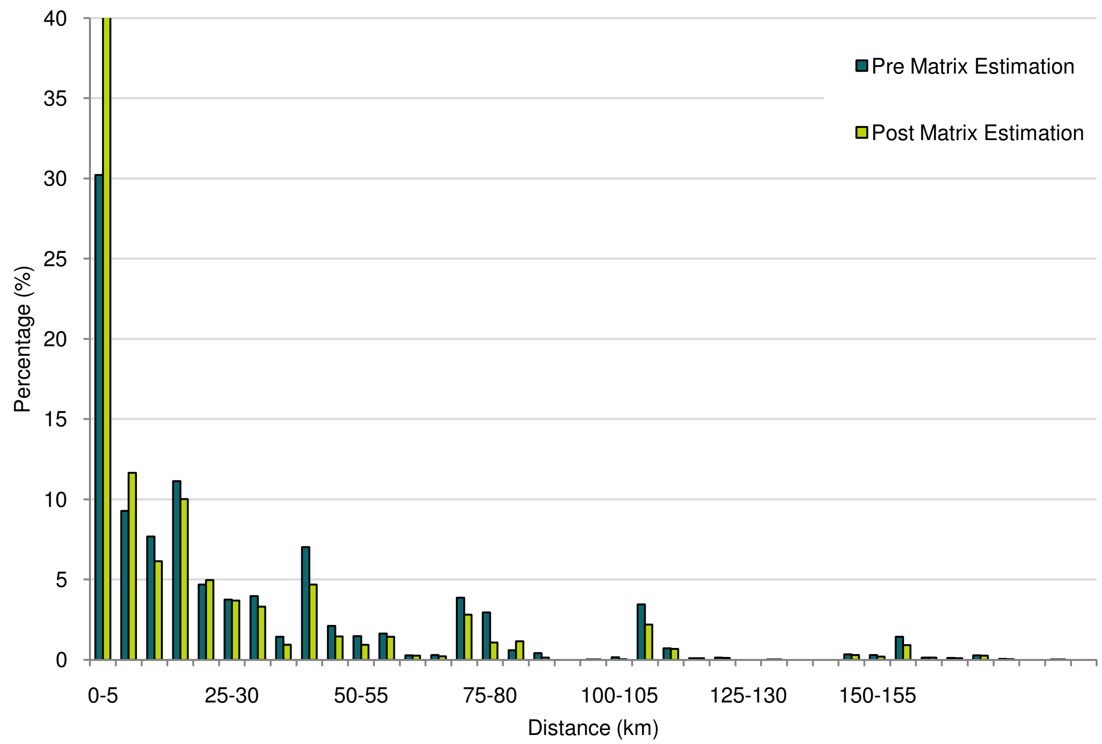
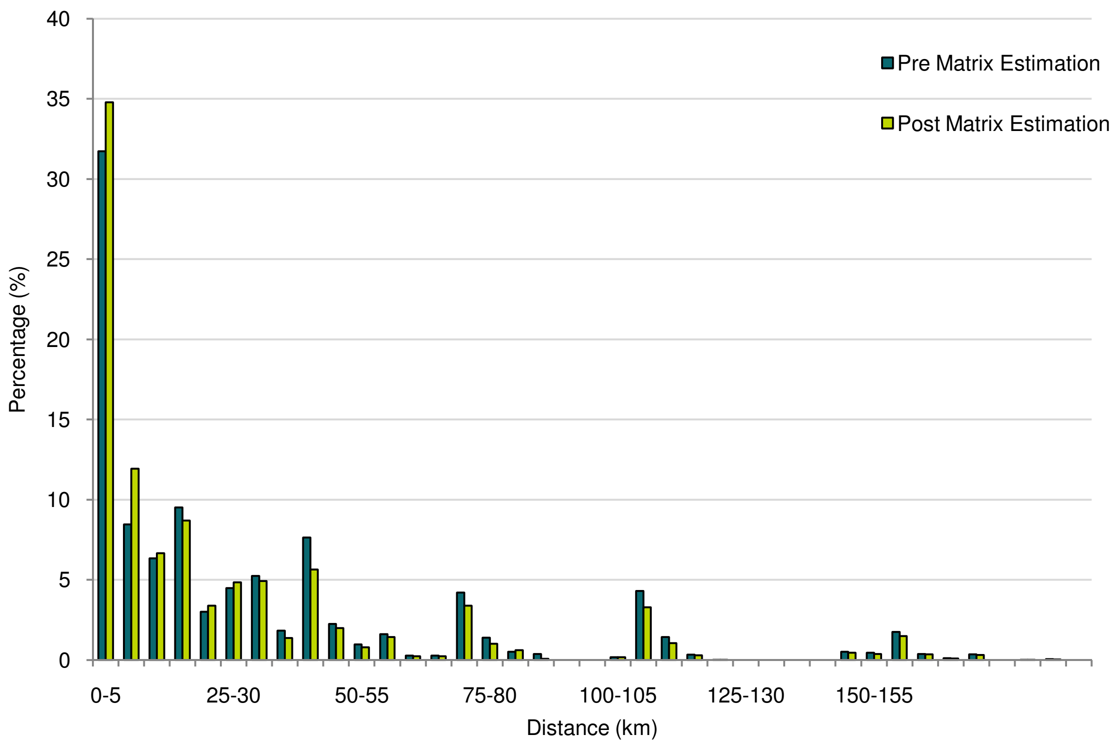


Figure 8.9 – PM Peak Trip Length Distribution Changes




## Model Convergence

8.22. The following tables show the convergence criteria for the final five loops of the convergence process, monitoring all of the criteria mentioned in paragraphs 7.8 to 7.11.

Table 8.14 – AM Peak Model Convergence Criteria

| Loop | Gap (%) | Delta (%/Number of Loops) | Flow Change Stability (%) |
|---|---|---|---|
| 8 | 0.00008 | 0.000 / 7 | 99.3 |
| 9 | 0.00004 | 0.000 / 7 | 99.3 |
| 10 | 0.00003 | 0.000 / 7 | 99.4 |
| 11 | 0.00001 | 0.000 / 7 | 99.8 |
| 12 | 0.00003 | 0.000 / 7 | 99.7 |

Table 8.15 – Inter Peak Model Convergence Criteria

| Loop | Gap (%) | Delta (%/Number of Loops) | Flow Change Stability (%) |
|---|---|---|---|
| 4 | 0.00044 | 0.000 / 7 | 98.8 |
| 5 | 0.00024 | 0.000 / 7 | 99.6 |
| 6 | 0.00014 | 0.000 / 7 | 99.6 |
| 7 | 0.00013 | 0.000 / 7 | 99.6 |
| 8 | 0.00013 | 0.000 / 7 | 99.6 |

**Table 8.16 – PM Peak Model Convergence Criteria**

| Loop | Gap (%) | Delta (%/Number of Loops) | Flow Change Stability (%) |
|---|---|---|---|
| 8 | 0.0015 | 0.000 / 7 | 98.8 |
| 9 | 0.00035 | 0.000 / 7 | 99.0 |
| 10 | 0.00020 | 0.000 / 7 | 99.8 |
| 11 | 0.00017 | 0.000 / 7 | 99.7 |
| 12 | 0.00013 | 0.000 / 7 | 99.9 |

8.23. The tables above show that the models meet all of the required DMRB convergence criteria, as well as the emerging guidance regarding more stringent flow change stability.

# 9. Conclusions

The March Area Transport Model validates well compared against defined criteria, producing a robust model from which accurate forecasts of March and the surrounding area can be made.

# Conclusions

## Results Summary

9.1. The overall objective has been to build a 2010 March Area Transport SATURN Model. It is intended that the base models produced by this exercise are then used to forecast local traffic flows in March and the immediate surrounding area.

### Flow Calibration and Validation

9.2. It can be seen from the previously presented data that the model validates within the requirements of the DMRB criteria, both in terms of screenlines and individual traffic counts.

### Journey Time Validation

9.3. The data within this report demonstrates that the MATS model has a very good level of validation for the journey times along the selected routes, with all journey time routes across all three time periods conforming to the DMRB validation criteria.

### Model Convergence

9.4. The performance of the model in terms of convergence falls within the criteria specified within the DMRB guidance. The model also performs well enough to meet the recommendations of the emerging guidance on Flow Change Stability from the SATURN developers.

## Suitability of the MATS Base Model

9.5. The indicators of model performance set out within this report demonstrate that the MATS model is capable of a good representation of the 2010 base year traffic levels and patterns. Modelled flows at individual locations and across screenline boundaries match closely to the corresponding observed traffic levels. Modelled journey times also demonstrate a very clear match to the observed situation.

9.6. The results of this calibration and validation exercise for each of the time periods indicate a good correlation between the observed and modelled data throughout the study area. As such, these models represent a robust basis from which to forecast local traffic flows and assess transport impacts of proposed developments within March.

9.7. When considering using the MATS base models for assessing transport impacts of future developments, it should be noted that the models were constructed using traffic data with the greater density of information within March (as shown in Figure 3.1). The model validates well throughout the study area, however there is a lower density of traffic count information for areas outside of March (i.e. Wimblington). This means that for assessing development areas outside of March, further local calibration and validation may be required to enable a robust assessment to be undertaken.

# A. Detailed Validation Results

## AM Peak Hour

### Screenline Results

Table A.1 – AM Peak Screenline Results

| Description | Observed Flow | Modelled Flow | Diff | % Diff | GEH | DMRB Flow | DMRB GEH |
|---|---|---|---|---|---|---|---|
| **Northern Screenline (Calibration)** | | | | | | | |
| TC-15.1 A141/Hostmoor Avenue (N to E) | 144 | 122 | 22 | 16% | 1.95 | ✓ | ✓ |
| TC-15.2 A141/Hostmoor Avenue (N to S) | 695 | 723 | -28 | -4% | 1.05 | ✓ | ✓ |
| TC-15.4 A141/Hostmoor Avenue (S to N) | 760 | 799 | -39 | -5% | 1.39 | ✓ | ✓ |
| TC-25.1 Hundreds Road/Melbourne Avenue (N to S) | 5 | 0 | 5 | 100% | 3.16 | ✓ | ✓ |
| TC-25.2 Hundreds Road/Melbourne Avenue (N to W) | 9 | 2 | 8 | 80% | 3.16 | ✓ | ✓ |
| TC-25.4 Hundreds Road/Melbourne Avenue (S to N) | 9 | 0 | 9 | 100% | 4.24 | ✓ | ✓ |
| TC-25.5 Hundreds Road/Melbourne Avenue (W to N) | 8 | 17 | -8 | -105% | 2.41 | ✓ | ✓ |
| TC-1.1 B1101 Elm Road/Estover Road/Norwood Road (N to S & E) | 303 | 311 | -8 | -3% | 0.48 | ✓ | ✓ |
| TC-1.2 B1101 Elm Road/Estover Road/Norwood Road (N to W) | 93 | 93 | 0 | 0% | 0.00 | ✓ | ✓ |
| TC-1.4 B1101 Elm Road/Estover Road/Norwood Road (E to W & N) | 54 | 54 | 0 | 0% | 0.03 | ✓ | ✓ |
| TC-1.5 B1101 Elm Road/Estover Road/Norwood Road (S to W & N) | 217 | 217 | 0 | 0% | 0.02 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-1.7 B1101 Elm Road/Estover Road/Norwood Road (W to N) | 65 | 65 | 0 | 0% | 0.00 | ✓ | ✓ |
| **Screenline Total** | **2362** | **2402** | **-40** | **-2%** | **0.82** | ✓ | ✓ |
| | | | | | | | |
| **Eastern Screenline (Validation)** | | | | | | | |
| R-2.1 RSI B1099 Upwell Road (WB) | 94 | 102 | -8 | -9% | 0.84 | ✓ | ✓ |
| R-2.2 RSI MCC SkyHigh 2010 B1099 Upwell Road (EB) | 133 | 110 | 23 | 17% | 2.10 | ✓ | ✓ |
| TC-26.1 Estover Road/Creek Road (E to S) | 2 | 13 | -11 | -569% | 4.10 | ✓ | ✓ |
| TC-26.2 Estover Road/Creek Road (E to W) | 16 | 26 | -10 | -64% | 2.24 | ✓ | ✓ |
| TC-26.3 Estover Road/Creek Road (S to W) | 29 | 29 | -1 | -2% | 0.11 | ✓ | ✓ |
| TC-26.4 Estover Road/Creek Road (S to E) | 3 | 12 | -9 | -288% | 3.19 | ✓ | ✓ |
| TC-26.5 Estover Road/Creek Road (W to E) | 6 | 7 | -1 | -15% | 0.36 | ✓ | ✓ |
| TC-26.6 Estover Road/Creek Road (W to S) | 22 | 9 | 13 | 59% | 3.26 | ✓ | ✓ |
| **Screenline Total** | **355** | **347** | **8** | **2%** | **0.43** | ✓ | ✓ |
| | | | | | | | |
| **Southern Screenline (Validation)** | | | | | | | |
| R-3.1 B1101 Wimblington Road (NB) | 457 | 467 | -9 | -2% | 0.44 | ✓ | ✓ |
| R-3.2 B1101 Wimblington Road (SB) | 419 | 449 | -30 | -7% | 1.44 | ✓ | ✓ |
| TC-8.1 A141/Knights End Road (S to W) | 16 | 3 | 13 | 79% | 4.11 | ✓ | ✓ |
| TC-8.2 A141/Knights End Road (S to N) | 616 | 671 | -55 | -9% | 2.17 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-8.3 A141/Knights End Road (S to E) | 2 | 0 | 2 | 100% | 2.00 | ✓ | ✓ |
| TC-8.6 A141/Knights End Road (W to S) | 5 | 12 | -8 | -168% | 2.63 | ✓ | ✓ |
| TC-8.8 A141/Knights End Road (N to S) | 635 | 629 | 6 | 1% | 0.23 | ✓ | ✓ |
| TC-8.10 A141/Knights End Road (E to S) | 12 | 0 | 12 | 100% | 4.90 | ✓ | ✓ |
| **Screenline Total** | **2162** | **2231** | **-69** | **-3%** | **1.48** | ✓ | ✓ |
| | | | | | | | |
| **Western Screenline (Validation)** | | | | | | | |
| E-1.1 Wisbech Road (EB) | 371 | 428 | -57 | -15% | 2.83 | ✓ | ✓ |
| E-1.2 Wisbech Road (WB) | 562 | 710 | -148 | -26% | 5.87 | × | × |
| E-8.1 Burrowmoor Road (EB) | 144 | 61 | 83 | 58% | 8.23 | ✓ | × |
| E-8.2 Burrowmoor Road (WB) | 104 | 80 | 24 | 23% | 2.48 | ✓ | ✓ |
| E-9.1 Gaul Road (EB) | 104 | 103 | 0 | 0% | 0.05 | ✓ | ✓ |
| E-9.2 Gaul Road (WB) | 62 | 87 | -25 | -40% | 2.89 | ✓ | ✓ |
| TC-8.3 A141/Knights End Road (S to E) | 2 | 0 | 2 | 100% | 2.00 | ✓ | ✓ |
| TC-8.5 A141/Knights End Road (W to E) | 8 | 2 | 6 | 77% | 2.75 | ✓ | ✓ |
| TC-8.7 A141/Knights End Road (N to E) | 162 | 133 | 29 | 18% | 2.38 | ✓ | ✓ |
| TC-8.10 A141/Knights End Road (E to S) | 12 | 0 | 12 | 100% | 4.90 | ✓ | ✓ |
| TC-8.11 A141/Knights End Road (E to W) | 5 | 17 | -12 | -242% | 3.64 | ✓ | ✓ |
| TC-8.12 A141/Knights End Road (E to N) | 78 | 0 | 78 | 100% | 12.49 | ✓ | × |
| **Screenline Total** | **1614** | **1621** | **-7** | **0%** | **0.18** | ✓ | ✓ |
| | | | | | | | |

**March Inner Cordon (Calibration)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-14.1 B1101 High Street/St Peters Road (N to E) | 58 | 59 | -1 | -2% | 0.18 | ✓ | ✓ |
| TC-14.2 B1101 High Street/St Peters Road (N to S) | 293 | 329 | -36 | -12% | 2.06 | ✓ | ✓ |
| TC-14.3 B1101 High Street/St Peters Road (E to S) | 128 | 122 | 6 | 5% | 0.52 | ✓ | ✓ |
| TC-14.4 B1101 High Street/St Peters Road (E to N) | 168 | 41 | 127 | 75% | 12.42 | × | × |
| TC-14.5 B1101 High Street/St Peters Road (S to N) | 355 | 439 | -84 | -24% | 4.23 | ✓ | ✓ |
| TC-14.6 B1101 High Street/St Peters Road (S to E) | 54 | 57 | -3 | -6% | 0.45 | ✓ | ✓ |
| TC-19.1 B1099 Wisbech Road/Norwood Road (N to E) | 68 | 68 | 0 | -1% | 0.05 | ✓ | ✓ |
| TC-19.3 B1099 Wisbech Road/Norwood Road (E to W) | 321 | 325 | -4 | -1% | 0.24 | ✓ | ✓ |
| TC-19.4 B1099 Wisbech Road/Norwood Road (E to N) | 70 | 68 | 2 | 3% | 0.23 | ✓ | ✓ |
| TC-19.6 B1099 Wisbech Road/Norwood Road (W to E) | 210 | 158 | 52 | 25% | 3.80 | ✓ | ✓ |
| TC-22.1 B1101 High Street/Elwyn Road/Market Place (N to E) | 208 | 216 | -8 | -4% | 0.57 | ✓ | ✓ |
| TC-22.3 B1101 High Street/Elwyn Road/Market Place (E to S) | 83 | 82 | 1 | 1% | 0.14 | ✓ | ✓ |
| TC-22.4 B1101 High Street/Elwyn Road/Market Place (E to N) | 223 | 240 | -17 | -8% | 1.11 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-22.6 B1101 High Street/Elwyn Road/Market Place (S to E) | 60 | 60 | 0 | 0% | 0.03 | ✓ | ✓ |
| TC-27.1 Burrowmoor Road/Gaul Road (NE to SW) | 110 | 110 | 0 | 0% | 0.00 | ✓ | ✓ |
| TC-27.2 Burrowmoor Road/Gaul Road (NE to NW) | 62 | 62 | 0 | 0% | 0.00 | ✓ | ✓ |
| TC-27.3 Burrowmoor Road/Gaul Road (SW to NW) | 13 | 5 | 8 | 63% | 2.77 | ✓ | ✓ |
| TC-27.4 Burrowmoor Road/Gaul Road (SW to NE) | 167 | 166 | 0 | 0% | 0.03 | ✓ | ✓ |
| TC-27.5 Burrowmoor Road/Gaul Road (NW to NE) | 141 | 142 | 0 | 0% | 0.03 | ✓ | ✓ |
| TC-27.6 Burrowmoor Road/Gaul Road (NW to SW) | 14 | 14 | 0 | 2% | 0.06 | ✓ | ✓ |
| E-2.1 Norwood Road (SB) | 183 | 179 | 4 | 2% | 0.27 | ✓ | ✓ |
| E-2.2 Norwood Road (NB) | 175 | 167 | 9 | 5% | 0.66 | ✓ | ✓ |
| E-3.1 Monitoring Elm Road (SB) | 332 | 336 | -4 | -1% | 0.20 | ✓ | ✓ |
| E-3.2 Elm Road (NB) | 246 | 243 | 3 | 1% | 0.21 | ✓ | ✓ |
| E-4.1 Creek Road (WB) | 33 | 34 | -1 | -2% | 0.13 | ✓ | ✓ |
| E-4.2 Creek Road (EB) | 31 | 56 | -24 | -78% | 3.69 | ✓ | ✓ |
| **Cordon Total** | **4015** | **3976** | **39** | **1%** | **0.62** | **✓** | **✓** |
| | | | | | | | |
| **River Screenline (Validation)** | | | | | | | |
| E-10.1 A141 March Bypass (SB) | 876 | 850 | 26 | 3% | 0.88 | ✓ | ✓ |
| E-10.2 A141 March Bypass (NB) | 718 | 765 | -47 | -7% | 1.74 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-21.1 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (E to S) | 271 | 300 | -29 | -11% | 1.70 | ✓ | ✓ |
| TC-21.4 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to W) | 379 | 341 | 38 | 10% | 2.03 | ✓ | ✓ |
| TC-21.5 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to N) | 47 | 61 | -14 | -29% | 1.88 | ✓ | ✓ |
| TC-21.6 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to E) | 265 | 256 | 9 | 3% | 0.56 | ✓ | ✓ |
| TC-21.9 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (W to S) | 286 | 214 | 72 | 25% | 4.55 | ✓ | ✓ |
| **Screenline Total** | **2842** | **2787** | **55** | **2%** | **1.04** | **✓** | **✓** |
| | | | | | | | |
| **Wimblington Screenline (Calibration)** | | | | | | | |
| TC-5.2 A141/King Street (N to W) | 19 | 16 | 3 | 14% | 0.65 | ✓ | ✓ |
| TC-5.3 A141/King Street (S to W) | 4 | 9 | -5 | -134% | 2.07 | ✓ | ✓ |
| TC-5.5 A141/King Street (W to N) | 30 | 28 | 1 | 4% | 0.21 | ✓ | ✓ |
| TC-5.6 A141/King Street (W to S) | 22 | 20 | 2 | 10% | 0.50 | ✓ | ✓ |
| TC-6.1 A141/B1101 Wimblington Road (S to W) | 134 | 160 | -27 | -20% | 2.19 | ✓ | ✓ |
| TC-6.2 A141/B1101 Wimblington Road (S to N) | 111 | 125 | -14 | -13% | 1.29 | ✓ | ✓ |
| TC-6.3 A141/B1101 Wimblington Road (S to E) | 13 | 0 | 13 | 98% | 5.01 | ✓ | × |
| TC-6.6 A141/B1101 Wimblington Road (W to S) | 114 | 119 | -5 | -4% | 0.43 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-6.8 A141/B1101 Wimblington Road (N to S) | 88 | 89 | -1 | -1% | 0.08 | ✓ | ✓ |
| TC-6.10 A141/B1101 Wimblington Road (E to S) | 5 | 0 | 5 | 100% | 3.15 | ✓ | ✓ |
| TC-16.2 A141/B1093 Doddington Road (N to W) | 62 | 20 | 42 | 68% | 6.59 | ✓ | × |
| TC-16.3 A141/B1093 Doddington Road (S to W) | 43 | 38 | 5 | 12% | 0.84 | ✓ | ✓ |
| TC-16.5 A141/B1093 Doddington Road (W to N) | 49 | 48 | 2 | 3% | 0.23 | ✓ | ✓ |
| TC-16.6 A141/B1093 Doddington Road (W to S) | 22 | 23 | -1 | -4% | 0.19 | ✓ | ✓ |
| **Screenline Total** | **717** | **696** | **21** | **3%** | **0.79** | ✓ | ✓ |

## Validation Count Results

**Table A.2 – AM Peak Validation Count Results**

| Description | Observed Flow | Modelled Flow | Diff | % Diff | GEH | DMRB Flow | DMRB GEH |
|---|---|---|---|---|---|---|---|
| E-1.1 Wisbech Road (EB) | 371 | 428 | -57 | -15% | 2.83 | ✓ | ✓ |
| E-1.2 Wisbech Road (WB) | 562 | 710 | -148 | -26% | 5.87 | × | × |
| E-5.1 Upwell Road (WB) | 124 | 102 | 22 | 18% | 2.05 | ✓ | ✓ |
| E-5.2 Upwell Road (EB) | 70 | 110 | -40 | -57% | 4.22 | ✓ | ✓ |
| E-7.1 Knights End Road (EB) | 173 | 135 | 39 | 22% | 3.13 | ✓ | ✓ |
| E-7.2 Knights End Road (WB) | 91 | 17 | 74 | 81% | 10.05 | ✓ | × |
| E-8.1 Burrowmoor Road (EB) | 144 | 61 | 83 | 58% | 8.23 | ✓ | × |
| E-8.2 Burrowmoor Road (WB) | 104 | 80 | 24 | 23% | 2.48 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| E-9.1 Gaul Road (EB) | 104 | 103 | 0 | 0% | 0.05 | ✓ | ✓ |
| E-9.2 Gaul Road (WB) | 62 | 87 | -25 | -40% | 2.89 | ✓ | ✓ |
| E-10.1 A141 March Bypass (SB) | 876 | 850 | 26 | 3% | 0.88 | ✓ | ✓ |
| E-10.2 A141 March Bypass (NB) | 718 | 765 | -47 | -7% | 1.74 | ✓ | ✓ |
| E-11.1 Town Bridge (SB) | 535 | 548 | -13 | -2% | 0.56 | ✓ | ✓ |
| E-11.2 Town Bridge (NB) | 736 | 788 | -52 | -7% | 1.88 | ✓ | ✓ |
| R-1.1 B1101 Elm Road (NB) | 184 | 251 | -67 | -36% | 4.53 | ✓ | ✓ |
| R-1.2 B1101 Elm Road (SB) | 281 | 204 | 76 | 27% | 4.90 | ✓ | ✓ |
| R-2.1 B1099 Upwell Road (WB) | 94 | 102 | -8 | -9% | 0.84 | ✓ | ✓ |
| R-2.2 B1099 Upwell Road (EB) | 133 | 110 | 23 | 17% | 2.10 | ✓ | ✓ |
| R-3.1 B1101 Wimblington Road (NB) | 457 | 467 | -9 | -2% | 0.44 | ✓ | ✓ |
| R-3.2 B1101 Wimblington Road (SB) | 419 | 449 | -30 | -7% | 1.44 | ✓ | ✓ |
| R-5.1 A141 Wisbech Road (NB) | 756 | 799 | -43 | -6% | 1.54 | ✓ | ✓ |
| R-5.2 A141 Wisbech Road (SB) | 834 | 845 | -11 | -1% | 0.38 | ✓ | ✓ |
| TC-8.1 A141/Knights End Road (S to W) | 16 | 3 | 13 | 79% | 4.11 | ✓ | ✓ |
| TC-8.2 A141/Knights End Road (S to N) | 616 | 671 | -55 | -9% | 2.17 | ✓ | ✓ |
| TC-8.3 A141/Knights End Road (S to E) | 2 | 0 | 2 | 100% | 2.00 | ✓ | ✓ |
| TC-8.4 A141/Knights End Road (W to N) | 37 | 0 | 37 | 100% | 8.59 | ✓ | × |
| TC-8.5 A141/Knights End Road (W to E) | 8 | 2 | 6 | 77% | 2.75 | ✓ | ✓ |
| TC-8.6 A141/Knights End Road (W to S) | 5 | 12 | -8 | -168% | 2.63 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-8.7 A141/Knights End Road (N to E) | 162 | 133 | 29 | 18% | 2.38 | ✓ | ✓ |
| TC-8.8 A141/Knights End Road (N to S) | 635 | 629 | 6 | 1% | 0.23 | ✓ | ✓ |
| TC-8.9 A141/Knights End Road (N to W) | 29 | 0 | 29 | 100% | 7.62 | ✓ | × |
| TC-8.10 A141/Knights End Road (E to S) | 12 | 0 | 12 | 100% | 4.90 | ✓ | ✓ |
| TC-8.11 A141/Knights End Road (E to W) | 5 | 17 | -12 | -242% | 3.64 | ✓ | ✓ |
| TC-8.12 A141/Knights End Road (E to N) | 78 | 0 | 78 | 100% | 12.49 | ✓ | × |
| TC-13.1 B1101 High Street/Burrowmoor Road (N to S) | 303 | 294 | 9 | 3% | 0.53 | ✓ | ✓ |
| TC-13.2 B1101 High Street/Burrowmoor Road (N to SW & NW) | 123 | 120 | 3 | 2% | 0.24 | ✓ | ✓ |
| TC-13.3 B1101 High Street/Burrowmoor Road (S to SW & NW) | 105 | 82 | 23 | 22% | 2.41 | ✓ | ✓ |
| TC-13.4 B1101 High Street/Burrowmoor Road (S to N) | 449 | 411 | 38 | 8% | 1.83 | ✓ | ✓ |
| TC-13.9 B1101 High Street/Burrowmoor Road (SW & NW to N) | 199 | 197 | 2 | 1% | 0.11 | ✓ | ✓ |
| TC-13.10 B1101 High Street/Burrowmoor Road (SW & NW to S) | 79 | 122 | -43 | -55% | 4.32 | ✓ | ✓ |
| TC-21.1 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (E to S) | 271 | 300 | -29 | -11% | 1.70 | ✓ | ✓ |
| TC-21.2 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (E to W) | 83 | 84 | -2 | -2% | 0.17 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-21.3 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (E to N) | 4 | 0 | 4 | 100% | 2.83 | ✓ | ✓ |
| TC-21.4 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to W) | 379 | 341 | 38 | 10% | 2.03 | ✓ | ✓ |
| TC-21.5 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to N) | 47 | 61 | -14 | -29% | 1.88 | ✓ | ✓ |
| TC-21.6 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to E) | 265 | 256 | 9 | 3% | 0.56 | ✓ | ✓ |
| TC-21.7 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (W to N) | 3 | 0 | 3 | 100% | 2.45 | ✓ | ✓ |
| TC-21.8 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (W to E) | 55 | 38 | 17 | 31% | 2.52 | ✓ | ✓ |
| TC-21.9 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (W to S) | 286 | 214 | 72 | 25% | 4.55 | ✓ | ✓ |
| TC-23.1 B1099 Upwell road/Elwyn Road (N to E) | 103 | 109 | -6 | -6% | 0.61 | ✓ | ✓ |
| TC-23.2 B1099 Upwell road/Elwyn Road (N to W) | 62 | 97 | -36 | -58% | 4.01 | ✓ | ✓ |
| TC-23.3 B1099 Upwell road/Elwyn Road (E to W) | 191 | 66 | 125 | 65% | 11.01 | ✗ | ✗ |
| TC-23.4 B1099 Upwell road/Elwyn Road (E to N) | 81 | 101 | -20 | -25% | 2.15 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-23.5 B1099 Upwell road/Elwyn Road (W to N) | 39 | 45 | -7 | -18% | 1.06 | ✓ | ✓ |
| TC-23.6 B1099 Upwell road/Elwyn Road (W to E) | 90 | 71 | 19 | 21% | 2.14 | ✓ | ✓ |
| TC-24.1 Hundreds Road/Norwood Road (N to E) | 39 | 20 | 19 | 48% | 3.46 | ✓ | ✓ |
| TC-24.2 Hundreds Road/Norwood Road (N to S) | 77 | 17 | 59 | 77% | 8.62 | ✓ | × |
| TC-24.3 Hundreds Road/Norwood Road (E to S) | 113 | 162 | -49 | -43% | 4.16 | ✓ | ✓ |
| TC-24.4 Hundreds Road/Norwood Road (E to N) | 70 | 25 | 45 | 65% | 6.62 | ✓ | × |
| TC-24.5 Hundreds Road/Norwood Road (S to N) | 100 | 95 | 5 | 5% | 0.53 | ✓ | ✓ |
| TC-24.6 Hundreds Road/Norwood Road (S to E) | 65 | 72 | -6 | -9% | 0.74 | ✓ | ✓ |
| TC-26.1 Estover Road/Creek Road (E to S) | 2 | 13 | -11 | -569% | 4.10 | ✓ | ✓ |
| TC-26.2 Estover Road/Creek Road (E to W) | 16 | 26 | -10 | -64% | 2.24 | ✓ | ✓ |
| TC-26.3 Estover Road/Creek Road (S to W) | 29 | 29 | -1 | -2% | 0.11 | ✓ | ✓ |
| TC-26.4 Estover Road/Creek Road (S to E) | 3 | 12 | -9 | -288% | 3.19 | ✓ | ✓ |
| TC-26.5 Estover Road/Creek Road (W to E) | 6 | 7 | -1 | -15% | 0.36 | ✓ | ✓ |
| TC-26.6 Estover Road/Creek Road (W to S) | 22 | 9 | 13 | 59% | 3.26 | ✓ | ✓ |
| LC-1.1 B1101 Station Road Level Crossing (NB) | 239 | 243 | -4 | -1% | 0.23 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LC-1.2 B1101 Station Road Level Crossing (SB) | 328 | 336 | -8 | -2% | 0.41 | ✓ | ✓ |
| | | | **Overall Validation Count Results** | | | **97%** | **87%** |

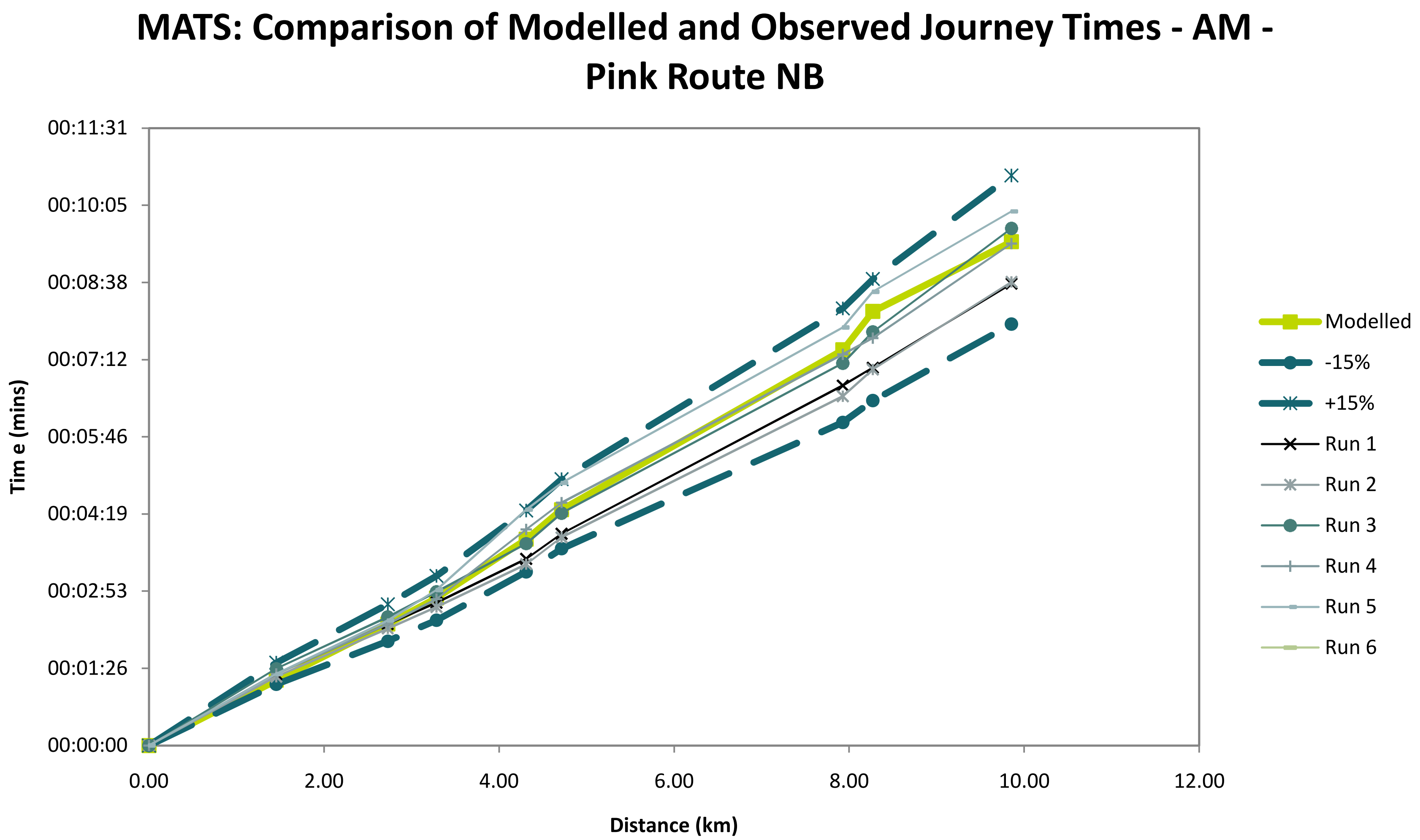



**Figure A.1 – Pink Route NB – AM Peak**

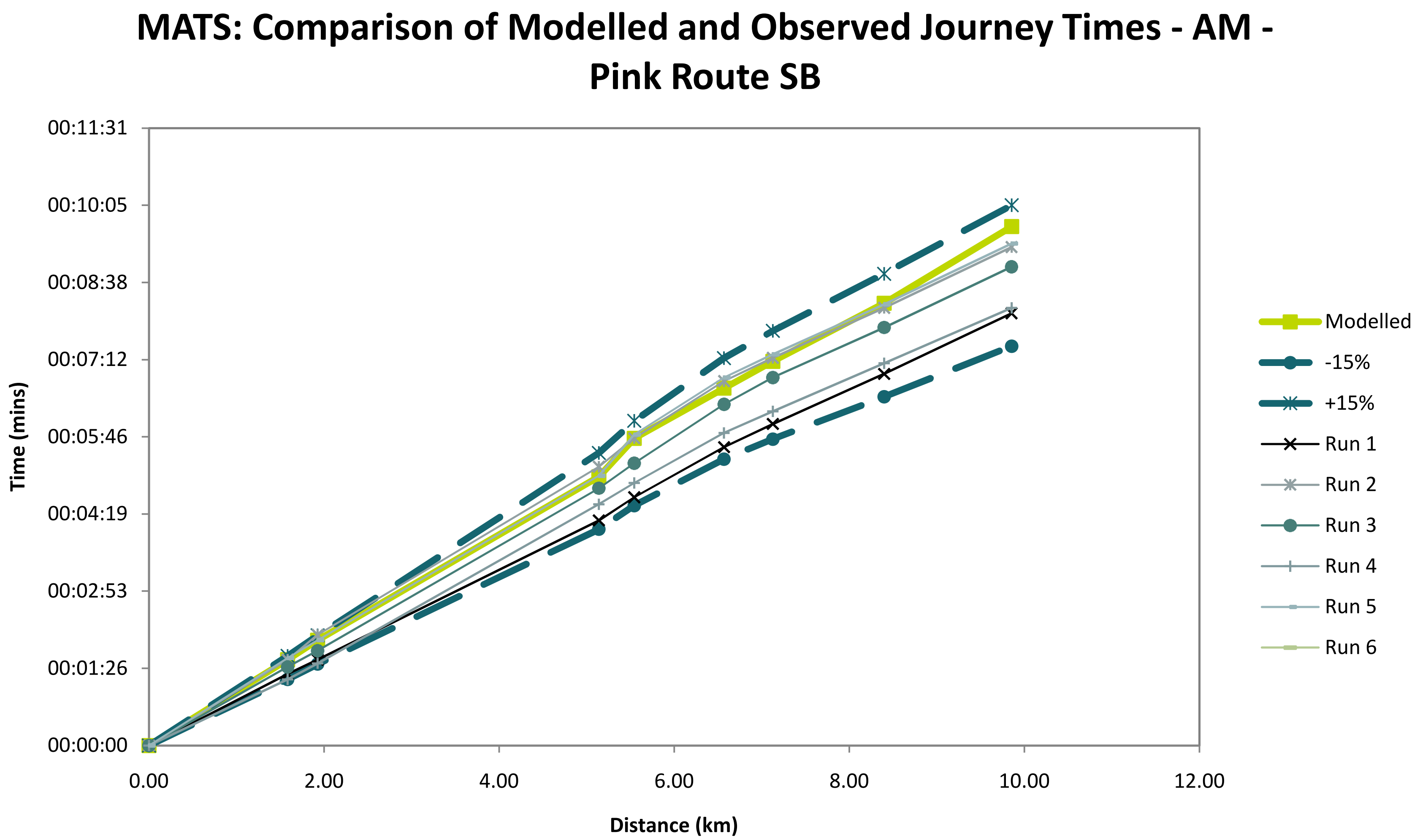



Figure A.2 – Pink Route SB – AM Peak

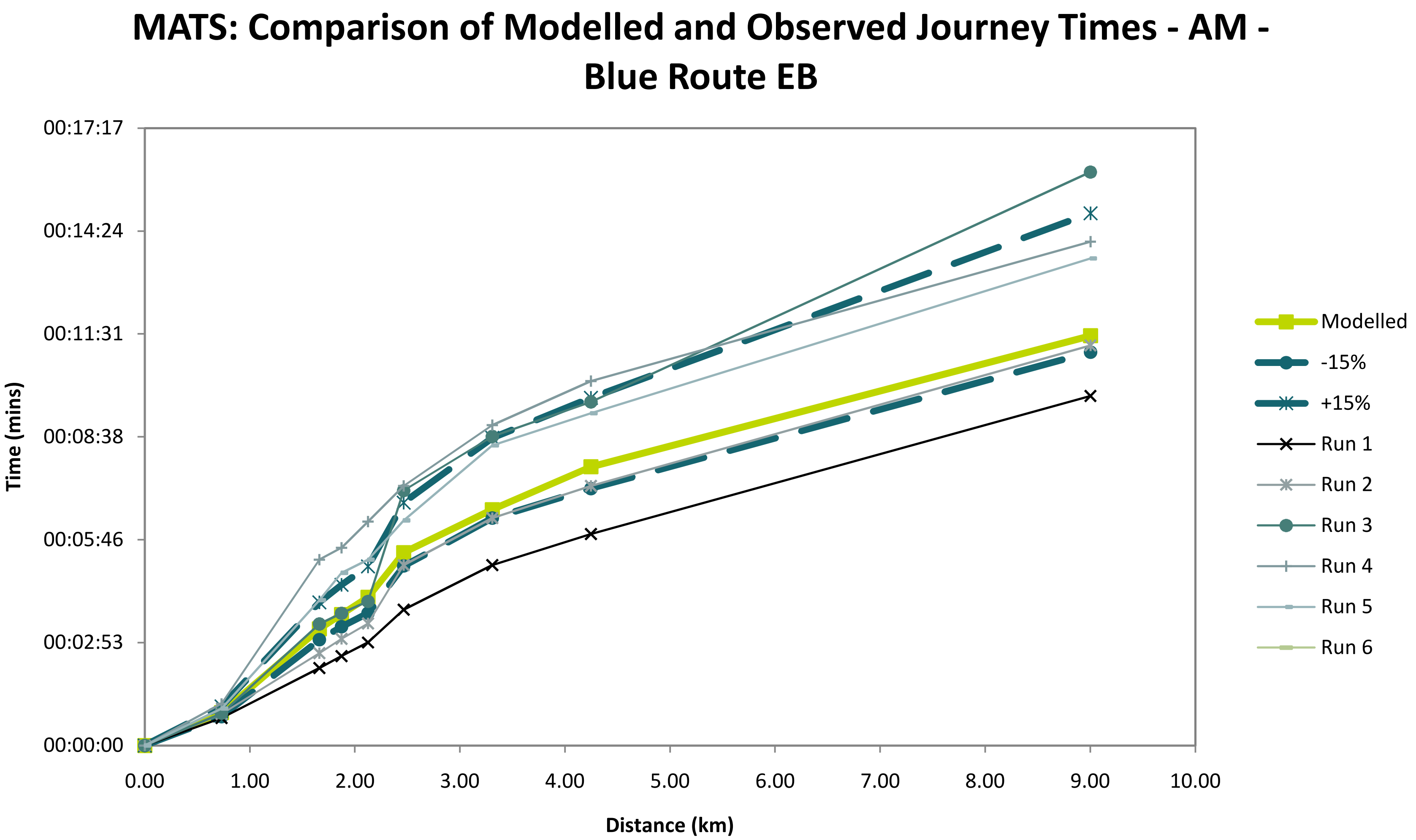



Figure A.3 – Blue Route EB – AM Peak

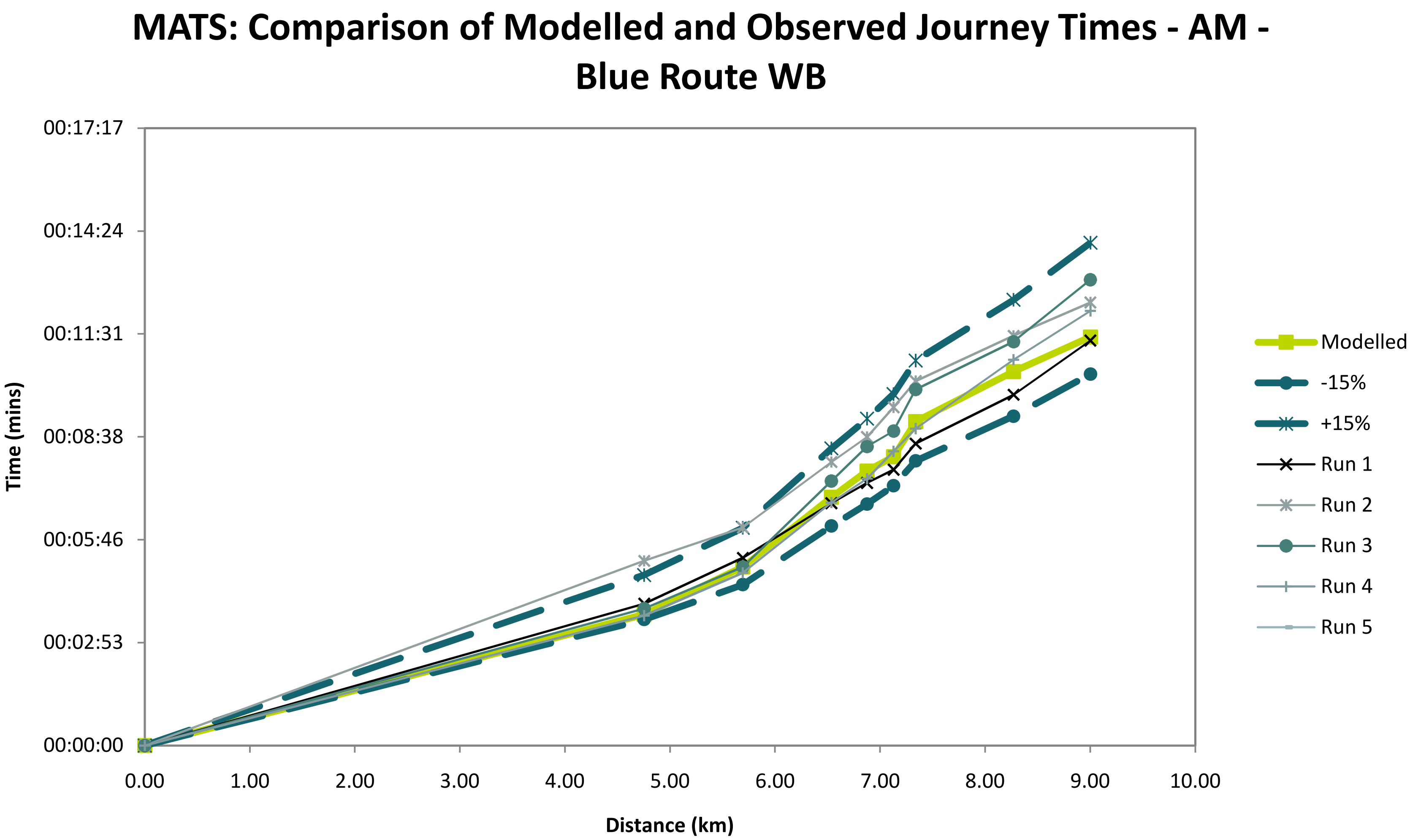



Figure A.4 – Blue Route WB – AM Peak

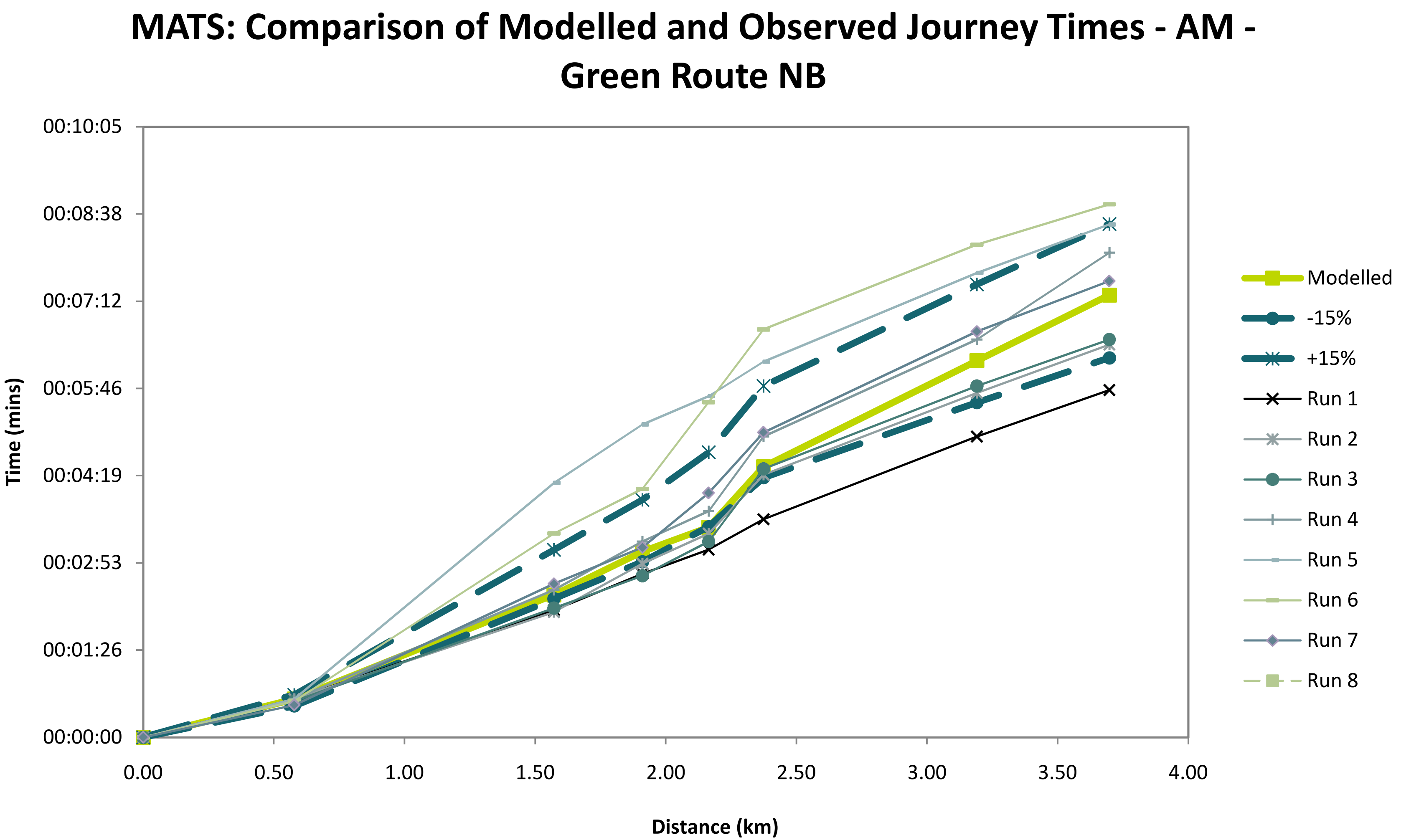



**Figure A.5 – Green Route NB – AM Peak**

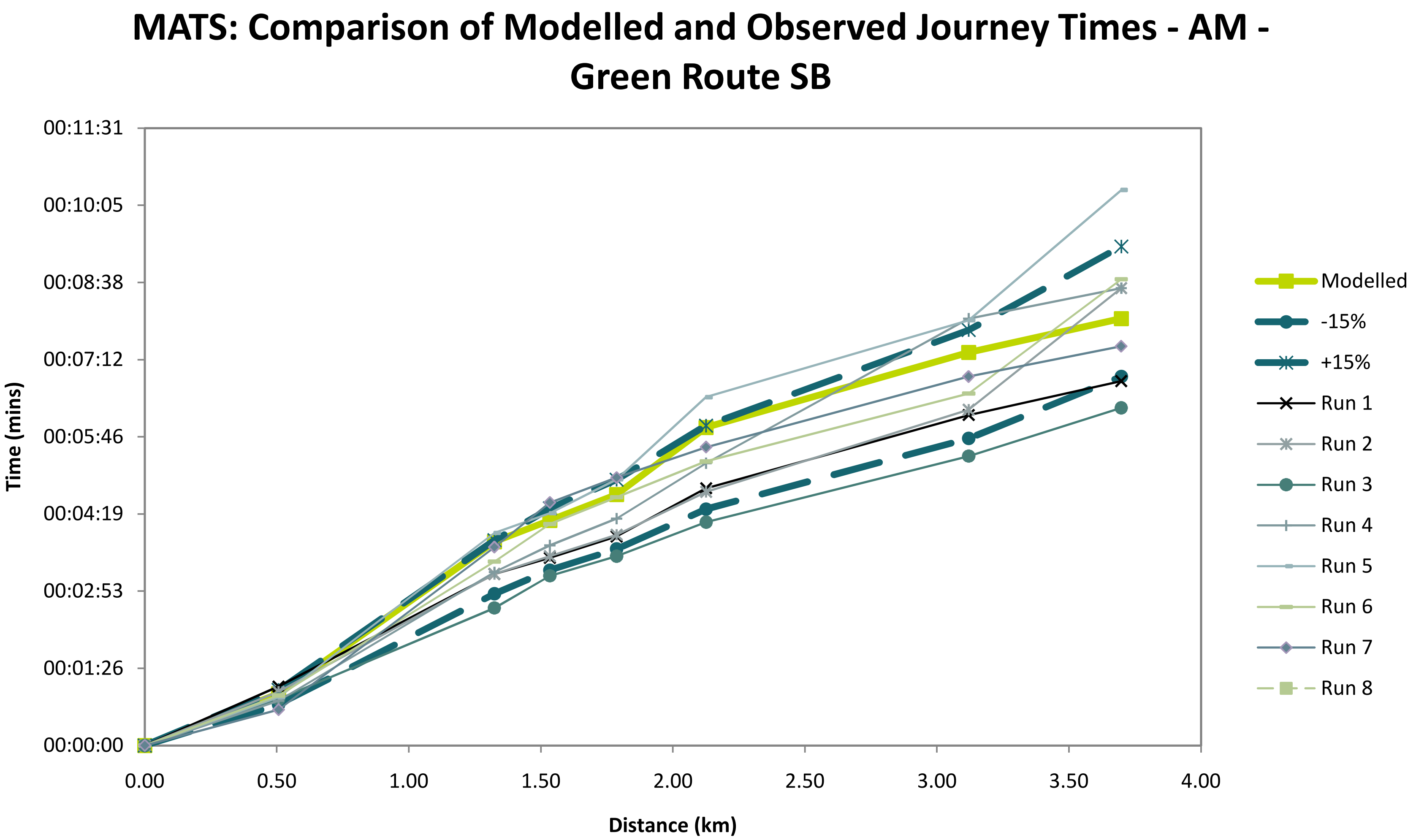



Figure A.6 – Green Route SB – AM Peak

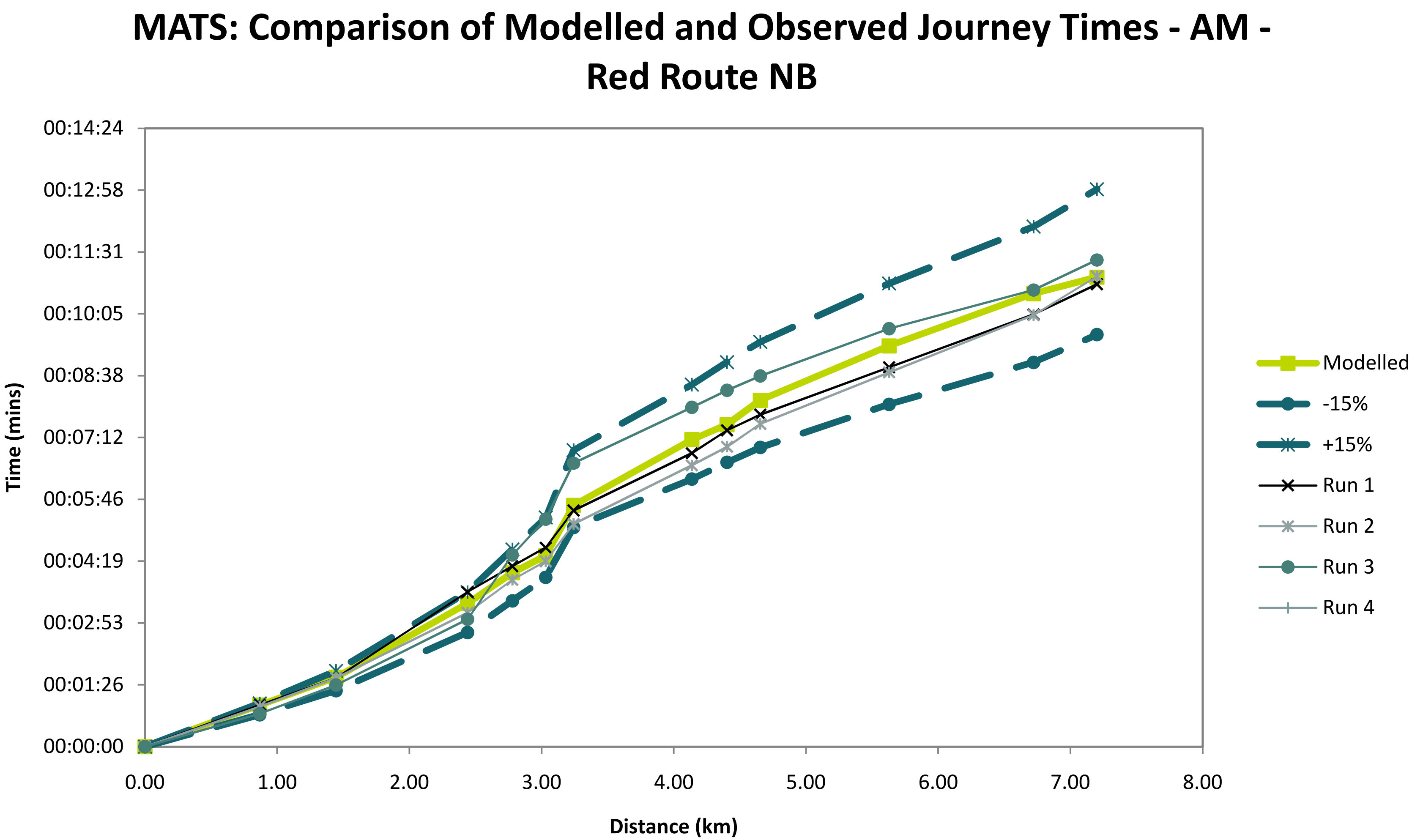



Figure A.7 – Red Route NB – AM Peak

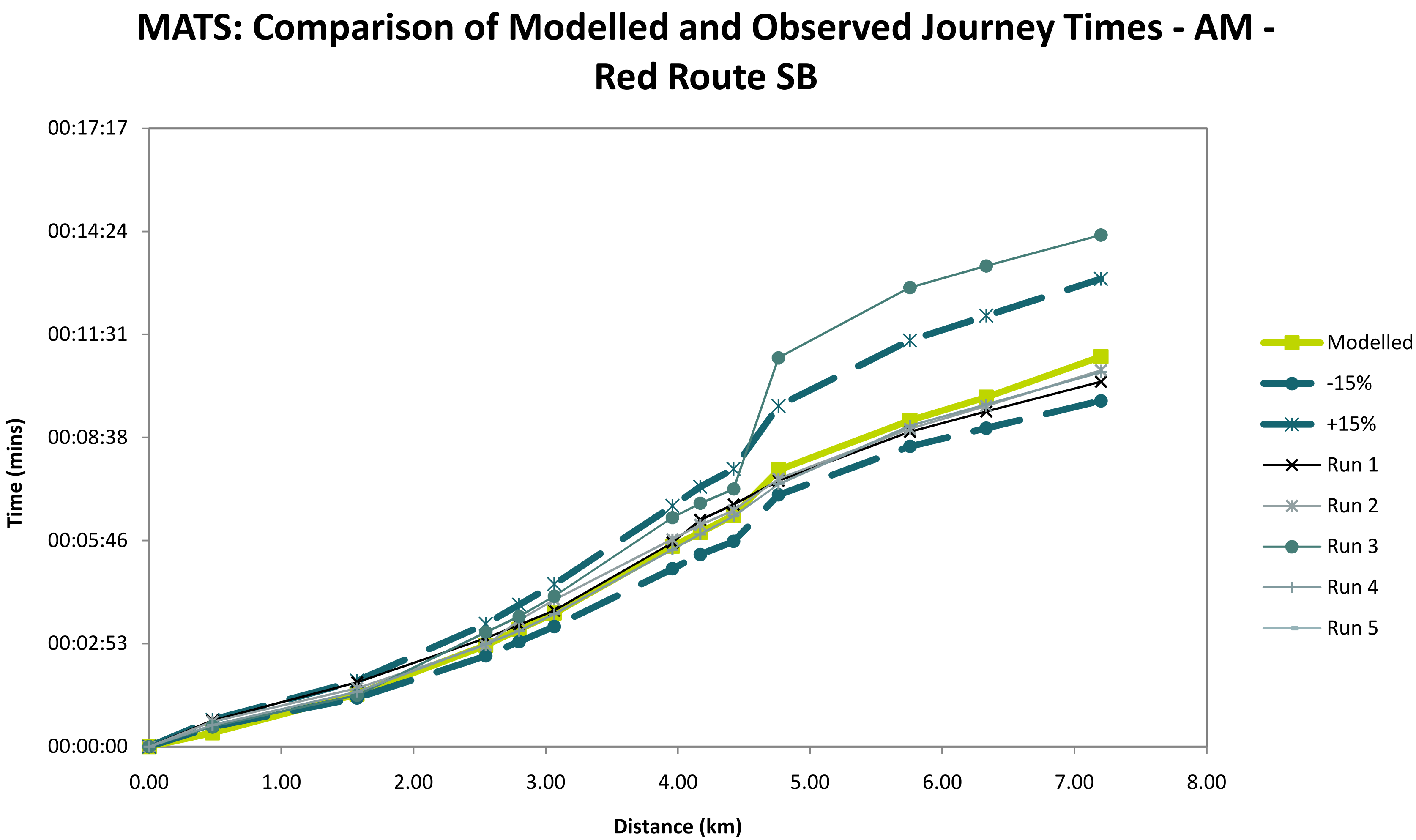



Figure A.8 – Red Route SB – AM Peak

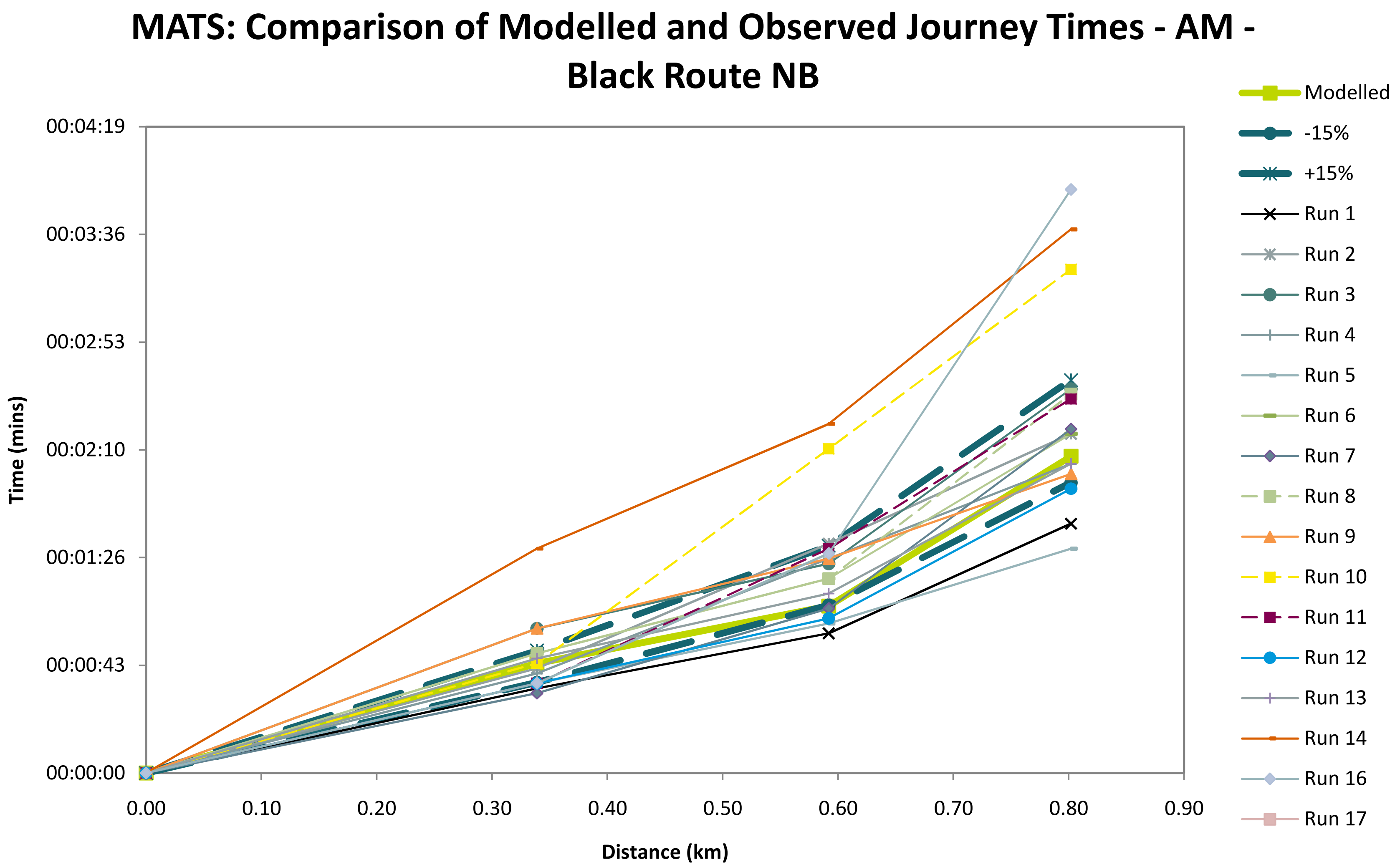



Figure A.9 – Black Route NB – AM Peak

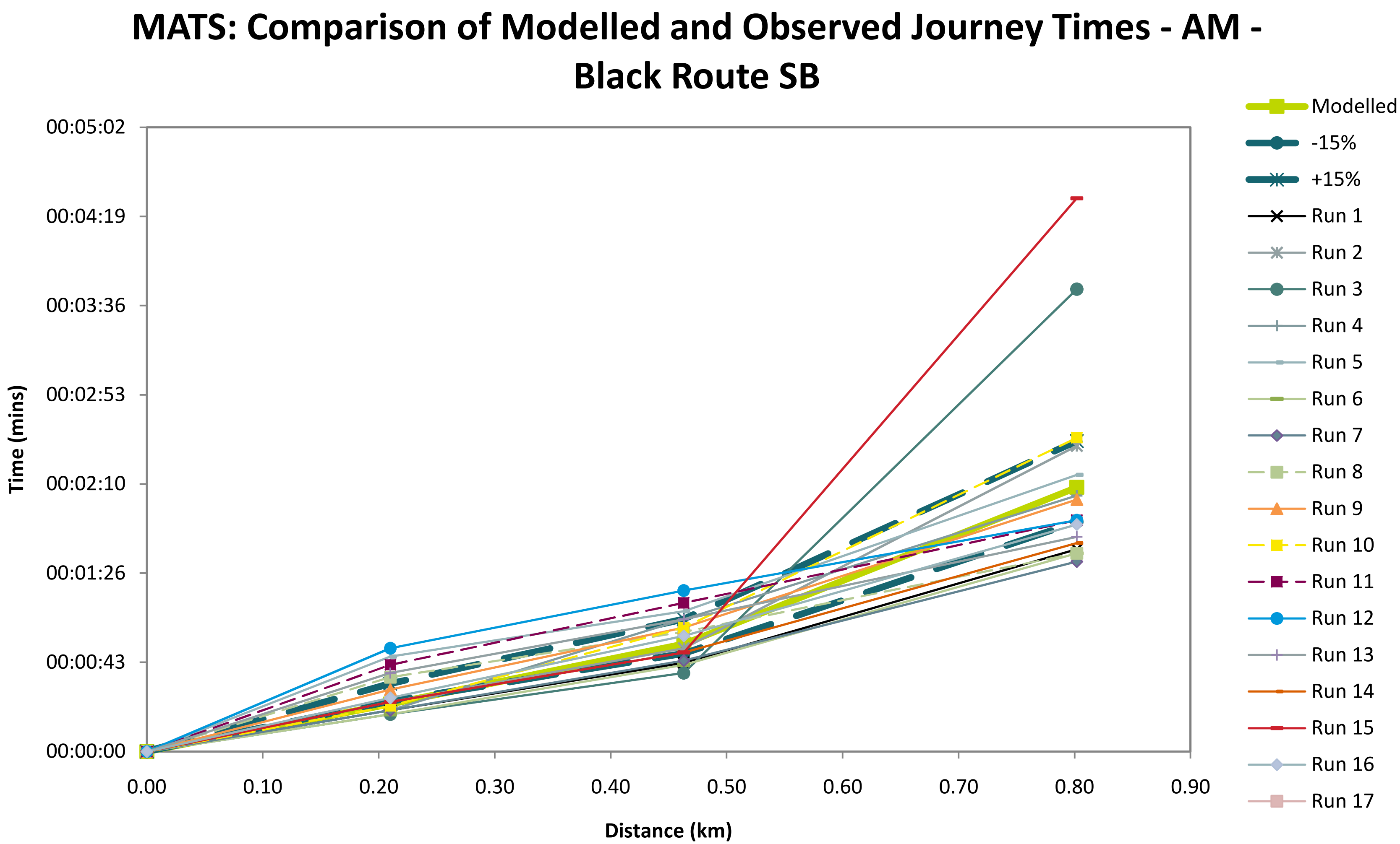



**Figure A.10 – Black Route SB – AM Peak**

## Inter Peak

### Screenline Results

**Table A.3 – Inter Peak Screenline Results**

| Description | Observed Flow | Modelled Flow | Diff | % Diff | GEH | DMRB Flow | DMRB GEH |
|---|---|---|---|---|---|---|---|
| **Northern Screenline (Calibration)** | | | | | | | |
| TC-15.1 A141/Hostmoor Avenue (N to E) | 144 | 122 | 22 | 15% | 1.90 | ✓ | ✓ |
| TC-15.2 A141/Hostmoor Avenue (N to S) | 470 | 583 | -113 | -24% | 4.94 | ✗ | ✓ |
| TC-15.4 A141/Hostmoor Avenue (S to N) | 602 | 706 | -104 | -17% | 4.06 | ✗ | ✓ |
| TC-25.1 Hundreds Road/Melbourne Avenue (N to S) | 21 | 0 | 21 | 100% | 6.45 | ✓ | ✗ |
| TC-25.2 Hundreds Road/Melbourne Avenue (N to W) | 14 | 13 | 1 | 8% | 0.30 | ✓ | ✓ |
| TC-25.4 Hundreds Road/Melbourne Avenue (S to N) | 23 | 0 | 23 | 100% | 6.71 | ✓ | ✗ |
| TC-25.5 Hundreds Road/Melbourne Avenue (W to N) | 14 | 16 | -3 | -21% | 0.74 | ✓ | ✓ |
| TC-1.1 B1101 Elm Road/Estover Road/Norwood Road (N to S & E) | 178 | 210 | -33 | -18% | 2.34 | ✓ | ✓ |
| TC-1.2 B1101 Elm Road/Estover Road/Norwood Road (N to W) | 53 | 53 | 0 | 1% | 0.07 | ✓ | ✓ |
| TC-1.4 B1101 Elm Road/Estover Road/Norwood Road (E to W & N) | 36 | 51 | -15 | -41% | 2.26 | ✓ | ✓ |
| TC-1.5 B1101 Elm Road/Estover Road/Norwood Road (S to W & N) | 189 | 180 | 9 | 5% | 0.65 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-1.7 B1101 Elm Road/Estover Road/Norwood Road (W to N) | 61 | 59 | 2 | 3% | 0.24 | ✓ | ✓ |
| **Screenline Total** | **1804** | **1995** | **-190** | **-11%** | **4.36** | ✗ | ✗ |
| | | | | | | | |
| **Eastern Screenline (Validation)** | | | | | | | |
| R-2.1 RSI B1099 Upwell Road (WB) | 94 | 112 | -19 | -20% | 1.84 | ✓ | ✓ |
| R-2.2 RSI MCC SkyHigh 2010 B1099 Upwell Road (EB) | 96 | 113 | -17 | -18% | 1.65 | ✓ | ✓ |
| TC-26.1 Estover Road/Creek Road (E to S) | 5 | 21 | -16 | -319% | 4.43 | ✓ | ✓ |
| TC-26.2 Estover Road/Creek Road (E to W) | 10 | 27 | -17 | -175% | 4.01 | ✓ | ✓ |
| TC-26.3 Estover Road/Creek Road (S to W) | 26 | 10 | 17 | 63% | 3.94 | ✓ | ✓ |
| TC-26.4 Estover Road/Creek Road (S to E) | 6 | 20 | -15 | -251% | 4.02 | ✓ | ✓ |
| TC-26.5 Estover Road/Creek Road (W to E) | 13 | 26 | -13 | -103% | 2.99 | ✓ | ✓ |
| TC-26.6 Estover Road/Creek Road (W to S) | 26 | 10 | 16 | 62% | 3.74 | ✓ | ✓ |
| **Screenline Total** | **327** | **358** | **-32** | **-10%** | **1.70** | ✗ | ✓ |
| | | | | | | | |
| **Southern Screenline** | | | | | | | |
| R-3.1 B1101 Wimblington Road (NB) | 350 | 392 | -42 | -12% | 2.19 | ✓ | ✓ |
| R-3.2 B1101 Wimblington Road (SB) | 327 | 396 | -69 | -21% | 3.64 | ✓ | ✓ |
| TC-8.1 A141/Knights End Road (S to W) | 15 | 17 | -2 | -16% | 0.59 | ✓ | ✓ |
| TC-8.2 A141/Knights End Road (S to N) | 499 | 524 | -25 | -5% | 1.12 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-8.3 A141/Knights End Road (S to E) | 5 | 0 | 5 | 100% | 3.31 | ✓ | ✓ |
| TC-8.6 A141/Knights End Road (W to S) | 14 | 15 | 0 | -3% | 0.10 | ✓ | ✓ |
| TC-8.8 A141/Knights End Road (N to S) | 474 | 493 | -18 | -4% | 0.81 | ✓ | ✓ |
| TC-8.10 A141/Knights End Road (E to S) | 5 | 0 | 5 | 100% | 3.26 | ✓ | ✓ |
| **Screenline Total** | **1690** | **1837** | **-147** | **-9%** | **3.49** | ✗ | ✓ |
| | | | | | | | |
| **Western Screenline (Validation)** | | | | | | | |
| E-1.1 Wisbech Road (EB) | 367 | 344 | 22 | 6% | 1.19 | ✓ | ✓ |
| E-1.2 Wisbech Road (WB) | 442 | 438 | 5 | 1% | 0.23 | ✓ | ✓ |
| E-8.1 Burrowmoor Road (EB) | 81 | 75 | 6 | 7% | 0.66 | ✓ | ✓ |
| E-8.2 Burrowmoor Road (WB) | 74 | 51 | 23 | 31% | 2.88 | ✓ | ✓ |
| E-9.1 Gaul Road (EB) | 86 | 104 | -19 | -22% | 1.90 | ✓ | ✓ |
| E-9.2 Gaul Road (WB) | 54 | 96 | -42 | -78% | 4.84 | ✓ | ✓ |
| TC-8.3 A141/Knights End Road (S to E) | 5 | 0 | 5 | 100% | 3.31 | ✓ | ✓ |
| TC-8.5 A141/Knights End Road (W to E) | 8 | 25 | -17 | -207% | 4.13 | ✓ | ✓ |
| TC-8.7 A141/Knights End Road (N to E) | 64 | 22 | 41 | 65% | 6.27 | ✓ | ✗ |
| TC-8.10 A141/Knights End Road (E to S) | 5 | 0 | 5 | 100% | 3.26 | ✓ | ✓ |
| TC-8.11 A141/Knights End Road (E to W) | 5 | 32 | -26 | -481% | 6.11 | ✓ | ✗ |
| TC-8.12 A141/Knights End Road (E to N) | 36 | 0 | 36 | 100% | 8.51 | ✓ | ✗ |
| **Screenline Total** | **1228** | **1187** | **40** | **3%** | **1.16** | ✓ | ✓ |

**March Inner Cordon (Calibration)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-14.1 B1101 High Street/St Peters Road (N to E) | 89 | 54 | 35 | 40% | 4.17 | ✓ | ✓ |
| TC-14.2 B1101 High Street/St Peters Road (N to S) | 300 | 325 | -25 | -8% | 1.41 | ✓ | ✓ |
| TC-14.3 B1101 High Street/St Peters Road (E to S) | 69 | 91 | -22 | -32% | 2.46 | ✓ | ✓ |
| TC-14.4 B1101 High Street/St Peters Road (E to N) | 124 | 48 | 77 | 62% | 8.28 | ✓ | × |
| TC-14.5 B1101 High Street/St Peters Road (S to N) | 332 | 338 | -6 | -2% | 0.34 | ✓ | ✓ |
| TC-14.6 B1101 High Street/St Peters Road (S to E) | 66 | 85 | -19 | -29% | 2.20 | ✓ | ✓ |
| TC-19.1 B1099 Wisbech Road/Norwood Road (N to E) | 54 | 39 | 15 | 28% | 2.21 | ✓ | ✓ |
| TC-19.3 B1099 Wisbech Road/Norwood Road (E to W) | 319 | 264 | 55 | 17% | 3.24 | ✓ | ✓ |
| TC-19.4 B1099 Wisbech Road/Norwood Road (E to N) | 68 | 50 | 18 | 27% | 2.38 | ✓ | ✓ |
| TC-19.6 B1099 Wisbech Road/Norwood Road (W to E) | 244 | 157 | 87 | 36% | 6.12 | ✓ | × |
| TC-22.1 B1101 High Street/Elwyn Road/Market Place (N to E) | 226 | 226 | 0 | 0% | 0.03 | ✓ | ✓ |
| TC-22.3 B1101 High Street/Elwyn Road/Market Place (E to S) | 72 | 55 | 17 | 23% | 2.09 | ✓ | ✓ |
| TC-22.4 B1101 High Street/Elwyn Road/Market Place (E to N) | 193 | 233 | -39 | -20% | 2.68 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-22.6 B1101 High Street/Elwyn Road/Market Place (S to E) | 64 | 38 | 26 | 41% | 3.70 | ✓ | ✓ |
| TC-27.1 Burrowmoor Road/Gaul Road (NE to SW) | 86 | 86 | 0 | 1% | 0.05 | ✓ | ✓ |
| TC-27.2 Burrowmoor Road/Gaul Road (NE to NW) | 67 | 98 | -31 | -46% | 3.38 | ✓ | ✓ |
| TC-27.3 Burrowmoor Road/Gaul Road (SW to NW) | 6 | 1 | 5 | 81% | 2.66 | ✓ | ✓ |
| TC-27.4 Burrowmoor Road/Gaul Road (SW to NE) | 96 | 96 | 0 | 0% | 0.04 | ✓ | ✓ |
| TC-27.5 Burrowmoor Road/Gaul Road (NW to NE) | 100 | 100 | 0 | 0% | 0.00 | ✓ | ✓ |
| TC-27.6 Burrowmoor Road/Gaul Road (NW to SW) | 6 | 0 | 6 | 100% | 3.46 | ✓ | ✓ |
| E-2.1 Norwood Road (SB) | 149 | 147 | 2 | 1% | 0.14 | ✓ | ✓ |
| E-2.2 Norwood Road (NB) | 129 | 127 | 3 | 2% | 0.23 | ✓ | ✓ |
| E-3.1 Monitoring Elm Road (SB) | 225 | 216 | 8 | 4% | 0.56 | ✓ | ✓ |
| E-3.2 Elm Road (NB) | 206 | 206 | -1 | 0% | 0.05 | ✓ | ✓ |
| E-4.1 Creek Road (WB) | 42 | 56 | -14 | -34% | 2.06 | ✓ | ✓ |
| E-4.2 Creek Road (EB) | 40 | 55 | -14 | -36% | 2.10 | ✓ | ✓ |
| **Cordon Total** | **3520** | **3368** | **152** | **4%** | **2.59** | **✓** | **✓** |
| | | | | | | | |
| **River Screenline (Validation)** | | | | | | | |
| E-10.1 A141 March Bypass (SB) | 646 | 647 | -1 | 0% | 0.06 | ✓ | ✓ |
| E-10.2 A141 March Bypass (NB) | 586 | 625 | -39 | -7% | 1.57 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-21.1 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (E to S) | 302 | 298 | 4 | 1% | 0.23 | ✓ | ✓ |
| TC-21.4 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to W) | 295 | 300 | -5 | -2% | 0.29 | ✓ | ✓ |
| TC-21.5 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to N) | 19 | 0 | 19 | 100% | 6.16 | ✓ | × |
| TC-21.6 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to E) | 265 | 269 | -4 | -1% | 0.24 | ✓ | ✓ |
| TC-21.9 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (W to S) | 250 | 225 | 24 | 10% | 1.58 | ✓ | ✓ |
| **Screenline Total** | **2362** | **2363** | **-1.4** | **0%** | **0.03** | ✓ | ✓ |
| | | | | | | | |
| **Wimblington Screenline (Calibration)** | | | | | | | |
| TC-5.2 A141/King Street (N to W) | 22 | 22 | 0 | 1% | 0.05 | ✓ | ✓ |
| TC-5.3 A141/King Street (S to W) | 9 | 9 | 0 | -1% | 0.02 | ✓ | ✓ |
| TC-5.5 A141/King Street (W to N) | 24 | 22 | 1 | 6% | 0.27 | ✓ | ✓ |
| TC-5.6 A141/King Street (W to S) | 7 | 7 | 0 | -1% | 0.02 | ✓ | ✓ |
| TC-6.1 A141/B1101 Wimblington Road (S to W) | 122 | 125 | -4 | -3% | 0.34 | ✓ | ✓ |
| TC-6.2 A141/B1101 Wimblington Road (S to N) | 107 | 70 | 37 | 35% | 3.92 | ✓ | ✓ |
| TC-6.3 A141/B1101 Wimblington Road (S to E) | 6 | 0 | 6 | 98% | 3.48 | ✓ | ✓ |
| TC-6.6 A141/B1101 Wimblington Road (W to S) | 116 | 127 | -11 | -10% | 1.01 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-6.8 A141/B1101 Wimblington Road (N to S) | 106 | 45 | 61 | 58% | 7.05 | ✓ | ✗ |
| TC-6.10 A141/B1101 Wimblington Road (E to S) | 4 | 0 | 4 | 97% | 2.72 | ✓ | ✓ |
| TC-16.2 A141/B1093 Doddington Road (N to W) | 36 | 85 | -49 | -137% | 6.32 | ✓ | ✗ |
| TC-16.3 A141/B1093 Doddington Road (S to W) | 32 | 30 | 2 | 6% | 0.35 | ✓ | ✓ |
| TC-16.5 A141/B1093 Doddington Road (W to N) | 37 | 66 | -29 | -80% | 4.09 | ✓ | ✓ |
| TC-16.6 A141/B1093 Doddington Road (W to S) | 26 | 25 | 1 | 4% | 0.23 | ✓ | ✓ |
| **Screenline Total** | **654** | **634** | **19** | **3%** | **0.77** | ✓ | ✓ |

## Validation Count Results

**Table A.4 – Inter Peak Validation Count Results**

| Description | Observed Flow | Modelled Flow | Diff | % Diff | GEH | DMRB Flow | DMRB GEH |
|---|---|---|---|---|---|---|---|
| E-1.1 Wisbech Road (EB) | 367 | 344 | 22 | 6% | 1.19 | ✓ | ✓ |
| E-1.2 Wisbech Road (WB) | 442 | 438 | 5 | 1% | 0.23 | ✓ | ✓ |
| E-5.1 Upwell Road (WB) | 82 | 112 | -31 | -38% | 3.12 | ✓ | ✓ |
| E-5.2 Upwell Road (EB) | 70 | 113 | -43 | -62% | 4.50 | ✓ | ✓ |
| E-7.1 Knights End Road (EB) | 64 | 47 | 17 | 26% | 2.23 | ✓ | ✓ |
| E-7.2 Knights End Road (WB) | 40 | 32 | 8 | 20% | 1.35 | ✓ | ✓ |
| E-8.1 Burrowmoor Road (EB) | 81 | 75 | 6 | 7% | 0.66 | ✓ | ✓ |
| E-8.2 Burrowmoor Road (WB) | 74 | 51 | 23 | 31% | 2.88 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| E-9.1 Gaul Road (EB) | 86 | 104 | -18 | -22% | 1.90 | ✓ | ✓ |
| E-9.2 Gaul Road (WB) | 54 | 96 | -42 | -78% | 4.84 | ✓ | ✓ |
| E-10.1 A141 March Bypass (SB) | 646 | 647 | -1 | 0% | 0.06 | ✓ | ✓ |
| E-10.2 A141 March Bypass (NB) | 586 | 625 | -39 | -7% | 1.57 | ✓ | ✓ |
| E-11.1 Town Bridge (SB) | 539 | 553 | -14 | -3% | 0.61 | ✓ | ✓ |
| E-11.2 Town Bridge (NB) | 622 | 630 | -8 | -1% | 0.33 | ✓ | ✓ |
| R-1.1 B1101 Elm Road (NB) | 167 | 162 | 6 | 3% | 0.44 | ✓ | ✓ |
| R-1.2 B1101 Elm Road (SB) | 163 | 157 | 6 | 4% | 0.50 | ✓ | ✓ |
| R-2.1 B1099 Upwell Road (WB) | 94 | 112 | -19 | -20% | 1.85 | ✓ | ✓ |
| R-2.2 B1099 Upwell Road (EB) | 96 | 113 | -17 | -18% | 1.65 | ✓ | ✓ |
| R-3.1 B1101 Wimblington Road (NB) | 350 | 392 | -42 | -12% | 2.19 | ✓ | ✓ |
| R-3.2 B1101 Wimblington Road (SB) | 327 | 396 | -69 | -21% | 3.64 | ✓ | ✓ |
| R-5.1 A141 Wisbech Road (NB) | 602 | 706 | -104 | -17% | 4.08 | × | ✓ |
| R-5.2 A141 Wisbech Road (SB) | 591 | 706 | -114 | -19% | 4.48 | × | ✓ |
| TC-8.1 A141/Knights End Road (S to W) | 15 | 17 | -2 | -16% | 0.59 | ✓ | ✓ |
| TC-8.2 A141/Knights End Road (S to N) | 499 | 524 | -25 | -5% | 1.12 | ✓ | ✓ |
| TC-8.3 A141/Knights End Road (S to E) | 5 | 0 | 5 | 100% | 3.31 | ✓ | ✓ |
| TC-8.4 A141/Knights End Road (W to N) | 34 | 0 | 34 | 100% | 8.21 | ✓ | × |
| TC-8.5 A141/Knights End Road (W to E) | 8 | 25 | -17 | -207% | 4.13 | ✓ | ✓ |
| TC-8.6 A141/Knights End Road (W to S) | 14 | 15 | 0 | -3% | 0.10 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-8.7 A141/Knights End Road (N to E) | 64 | 22 | 41 | 65% | 6.28 | ✓ | × |
| TC-8.8 A141/Knights End Road (N to S) | 474 | 492 | -18 | -4% | 0.81 | ✓ | ✓ |
| TC-8.9 A141/Knights End Road (N to W) | 31 | 0 | 31 | 100% | 7.91 | ✓ | × |
| TC-8.10 A141/Knights End Road (E to S) | 5 | 0 | 5 | 100% | 3.26 | ✓ | ✓ |
| TC-8.11 A141/Knights End Road (E to W) | 5 | 32 | -26 | -481% | 6.11 | ✓ | × |
| TC-8.12 A141/Knights End Road (E to N) | 36 | 0 | 36 | 100% | 8.51 | ✓ | × |
| TC-13.1 B1101 High Street/Burrowmoor Road (N to S) | 272 | 276 | -4 | -1% | 0.24 | ✓ | ✓ |
| TC-13.2 B1101 High Street/Burrowmoor Road (N to SW & NW) | 125 | 107 | 18 | 15% | 1.70 | ✓ | ✓ |
| TC-13.3 B1101 High Street/Burrowmoor Road (S to SW & NW) | 89 | 121 | -32 | -36% | 3.11 | ✓ | ✓ |
| TC-13.4 B1101 High Street/Burrowmoor Road (S to N) | 339 | 288 | 51 | 15% | 2.89 | ✓ | ✓ |
| TC-13.9 B1101 High Street/Burrowmoor Road (SW & NW to N) | 147 | 147 | -1 | 0% | 0.05 | ✓ | ✓ |
| TC-13.10 B1101 High Street/Burrowmoor Road (SW & NW to S) | 106 | 121 | -15 | -14% | 1.40 | ✓ | ✓ |
| TC-21.1 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (E to S) | 302 | 298 | 4 | 1% | 0.23 | ✓ | ✓ |
| TC-21.2 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (E to W) | 115 | 68 | 47 | 41% | 4.88 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-21.3 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (E to N) | 3 | 0 | 3 | 100% | 2.35 | ✓ | ✓ |
| TC-21.4 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to W) | 295 | 300 | -5 | -2% | 0.29 | ✓ | ✓ |
| TC-21.5 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to N) | 19 | 0 | 19 | 100% | 6.16 | ✓ | ✗ |
| TC-21.6 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to E) | 265 | 269 | -4 | -1% | 0.24 | ✓ | ✓ |
| TC-21.7 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (W to N) | 3 | 0 | 3 | 100% | 2.45 | ✓ | ✓ |
| TC-21.8 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (W to E) | 112 | 49 | 62 | 56% | 6.94 | ✓ | ✗ |
| TC-21.9 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (W to S) | 250 | 225 | 24 | 10% | 1.58 | ✓ | ✓ |
| TC-23.1 B1099 Upwell road/Elwyn Road (N to E) | 73 | 86 | -13 | -17% | 1.41 | ✓ | ✓ |
| TC-23.2 B1099 Upwell road/Elwyn Road (N to W) | 40 | 80 | -40 | -101% | 5.18 | ✓ | ✗ |
| TC-23.3 B1099 Upwell road/Elwyn Road (E to W) | 123 | 59 | 65 | 52% | 6.78 | ✓ | ✗ |
| TC-23.4 B1099 Upwell road/Elwyn Road (E to N) | 49 | 89 | -40 | -82% | 4.82 | ✓ | ✓ |
| TC-23.5 B1099 Upwell road/Elwyn Road (W to N) | 52 | 66 | -14 | -28% | 1.86 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-23.6 B1099 Upwell road/Elwyn Road (W to E) | 89 | 73 | 16 | 18% | 1.74 | ✓ | ✓ |
| TC-24.1 Hundreds Road/Norwood Road (N to E) | 71 | 51 | 20 | 28% | 2.58 | ✓ | ✓ |
| TC-24.2 Hundreds Road/Norwood Road (N to S) | 106 | 66 | 39 | 37% | 4.25 | ✓ | ✓ |
| TC-24.3 Hundreds Road/Norwood Road (E to S) | 59 | 81 | -22 | -38% | 2.64 | ✓ | ✓ |
| TC-24.4 Hundreds Road/Norwood Road (E to N) | 55 | 47 | 8 | 14% | 1.06 | ✓ | ✓ |
| TC-24.5 Hundreds Road/Norwood Road (S to N) | 93 | 56 | 36 | 39% | 4.18 | ✓ | ✓ |
| TC-24.6 Hundreds Road/Norwood Road (S to E) | 51 | 70 | -19 | -37% | 2.41 | ✓ | ✓ |
| TC-26.1 Estover Road/Creek Road (E to S) | 5 | 21 | -16 | -319% | 4.43 | ✓ | ✓ |
| TC-26.2 Estover Road/Creek Road (E to W) | 10 | 27 | -17 | -175% | 4.01 | ✓ | ✓ |
| TC-26.3 Estover Road/Creek Road (S to W) | 26 | 10 | 17 | 63% | 3.94 | ✓ | ✓ |
| TC-26.4 Estover Road/Creek Road (S to E) | 6 | 20 | -15 | -251% | 4.02 | ✓ | ✓ |
| TC-26.5 Estover Road/Creek Road (W to E) | 13 | 26 | -13 | -103% | 2.99 | ✓ | ✓ |
| TC-26.6 Estover Road/Creek Road (W to S) | 26 | 10 | 16 | 62% | 3.74 | ✓ | ✓ |
| LC-1.1 B1101 Station Road Level Crossing (NB) | 213 | 206 | 7 | 3% | 0.49 | ✓ | ✓ |
| LC-1.2 B1101 Station Road Level Crossing (SB) | 225 | 216 | 8 | 4% | 0.57 | ✓ | ✓ |
| | | | **Overall Validation Count Results** | | | **97%** | **87%** |

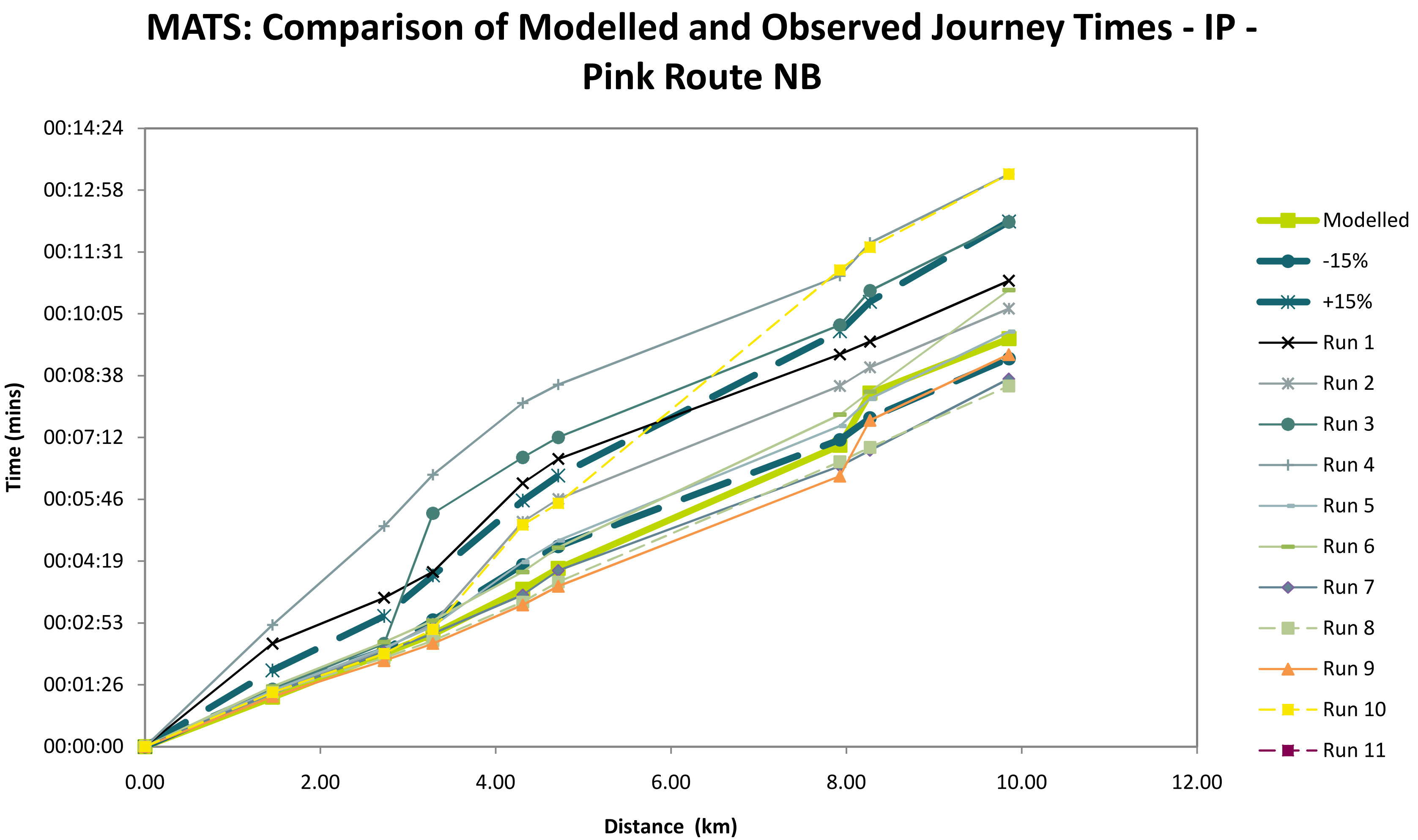



Figure A.11 – Pink Route NB – Inter Peak

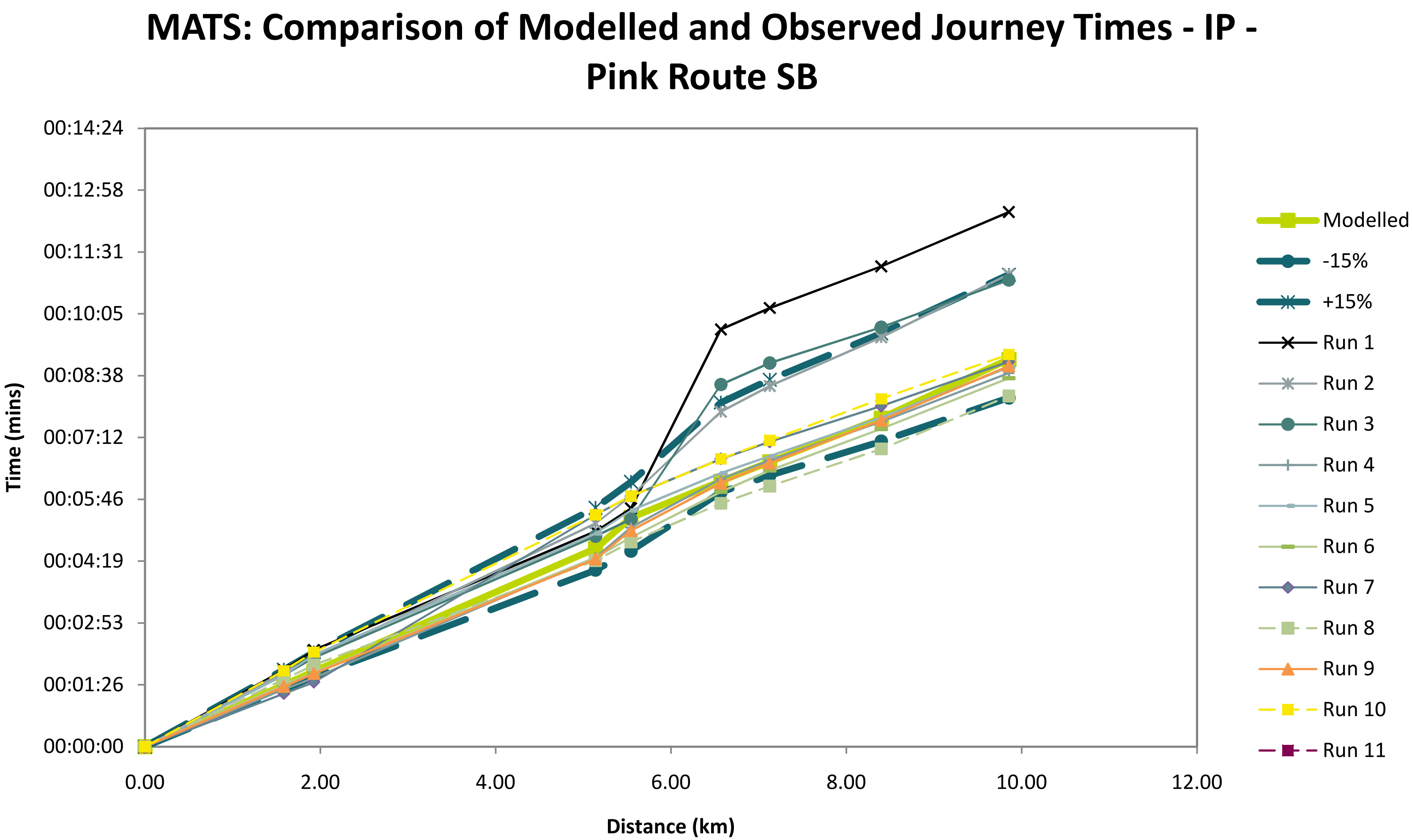



Figure A.12 – Pink Route SB – Inter Peak

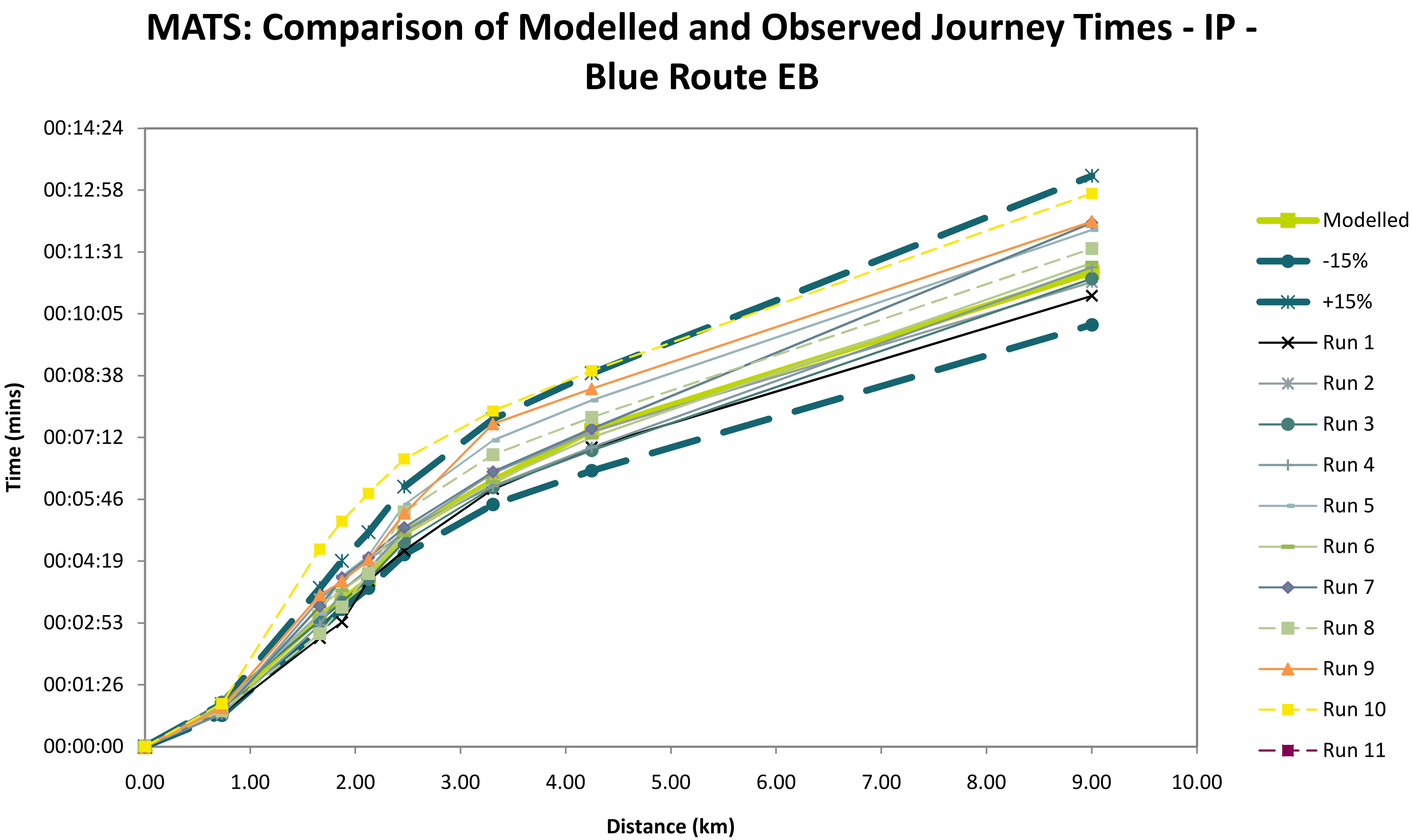



Figure A.13 – Blue Route EB – Inter Peak

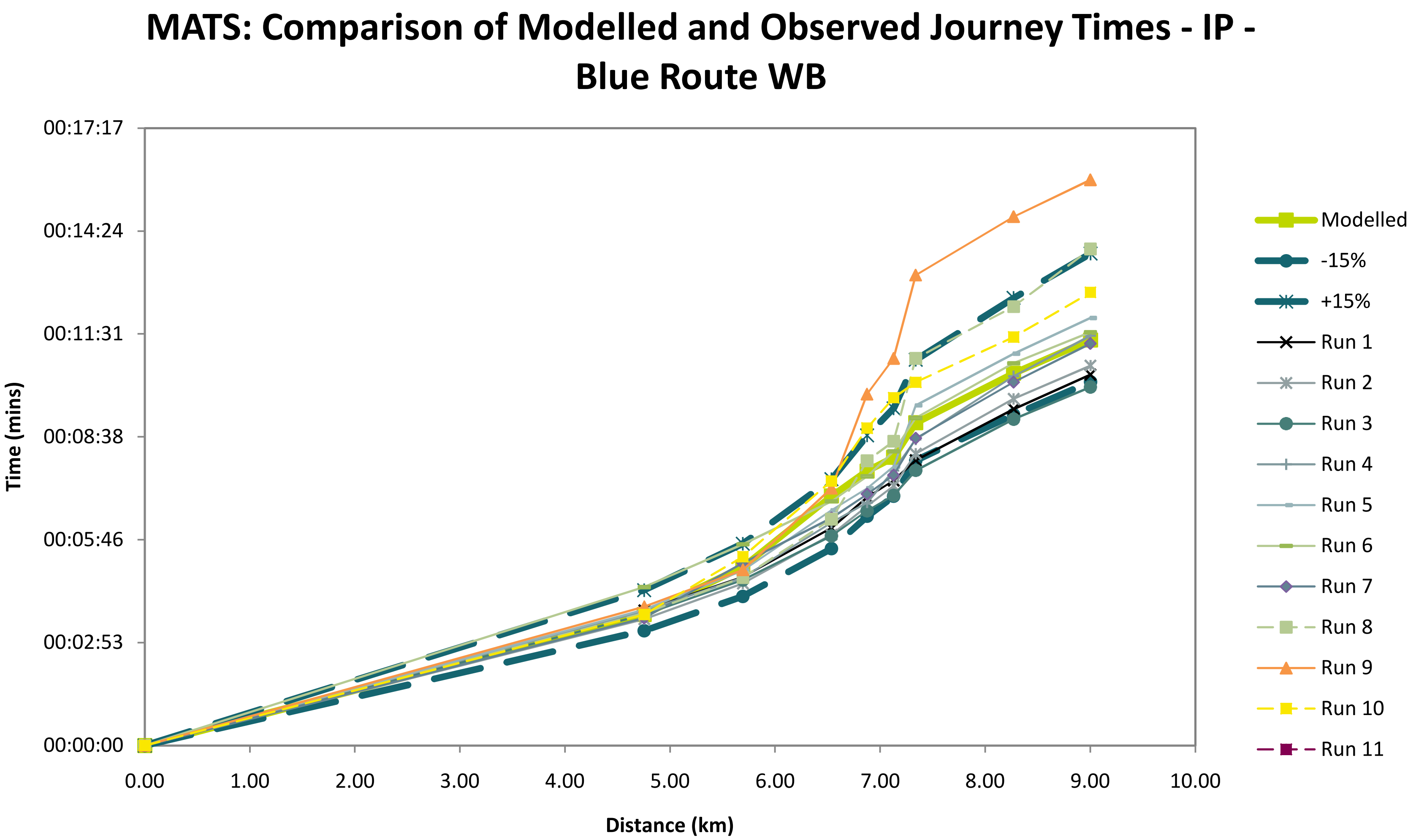



Figure A.14 – Blue Route WB – Inter Peak

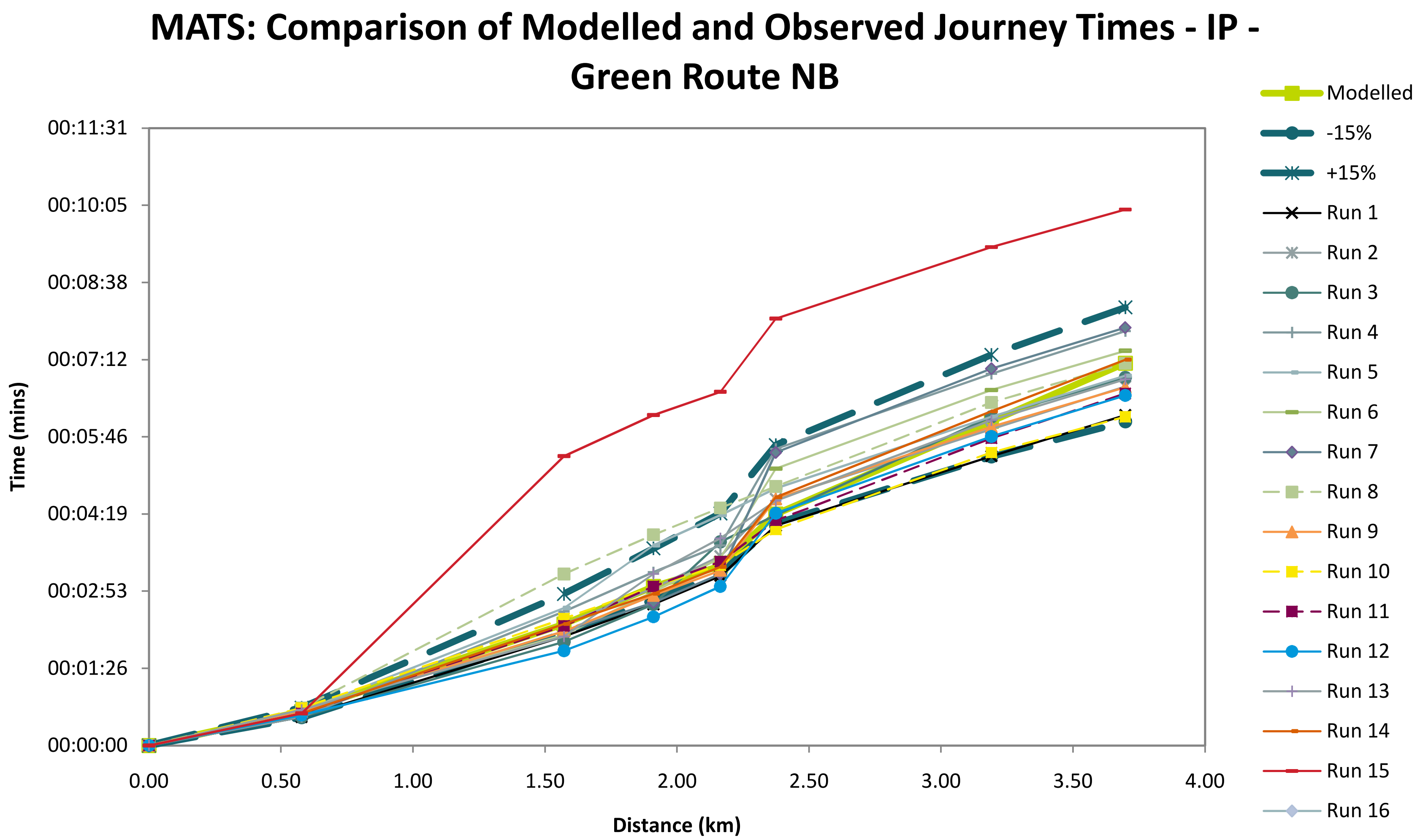



Figure A.15 – Green Route NB – Inter Peak

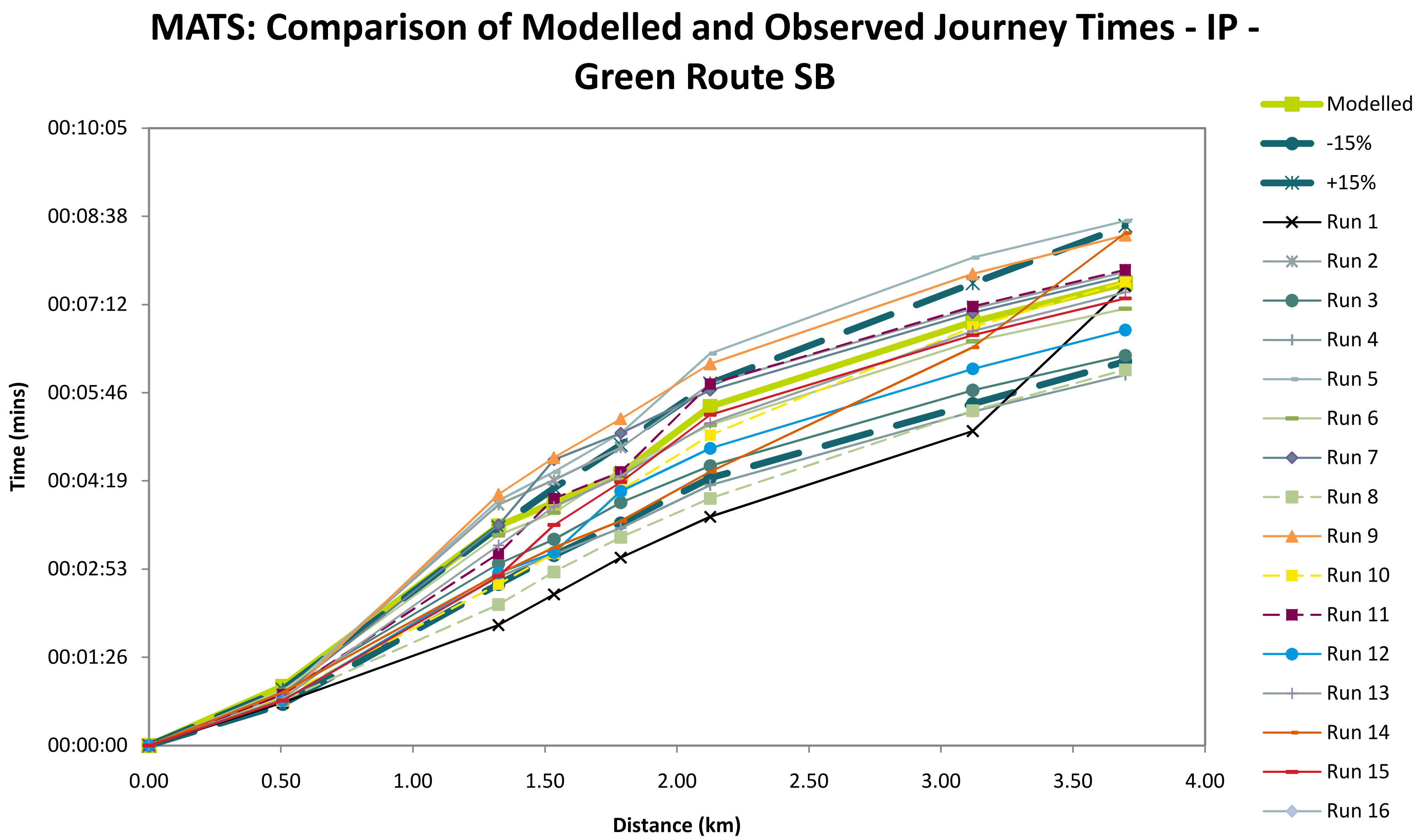



Figure A.16 – Green Route SB – Inter Peak

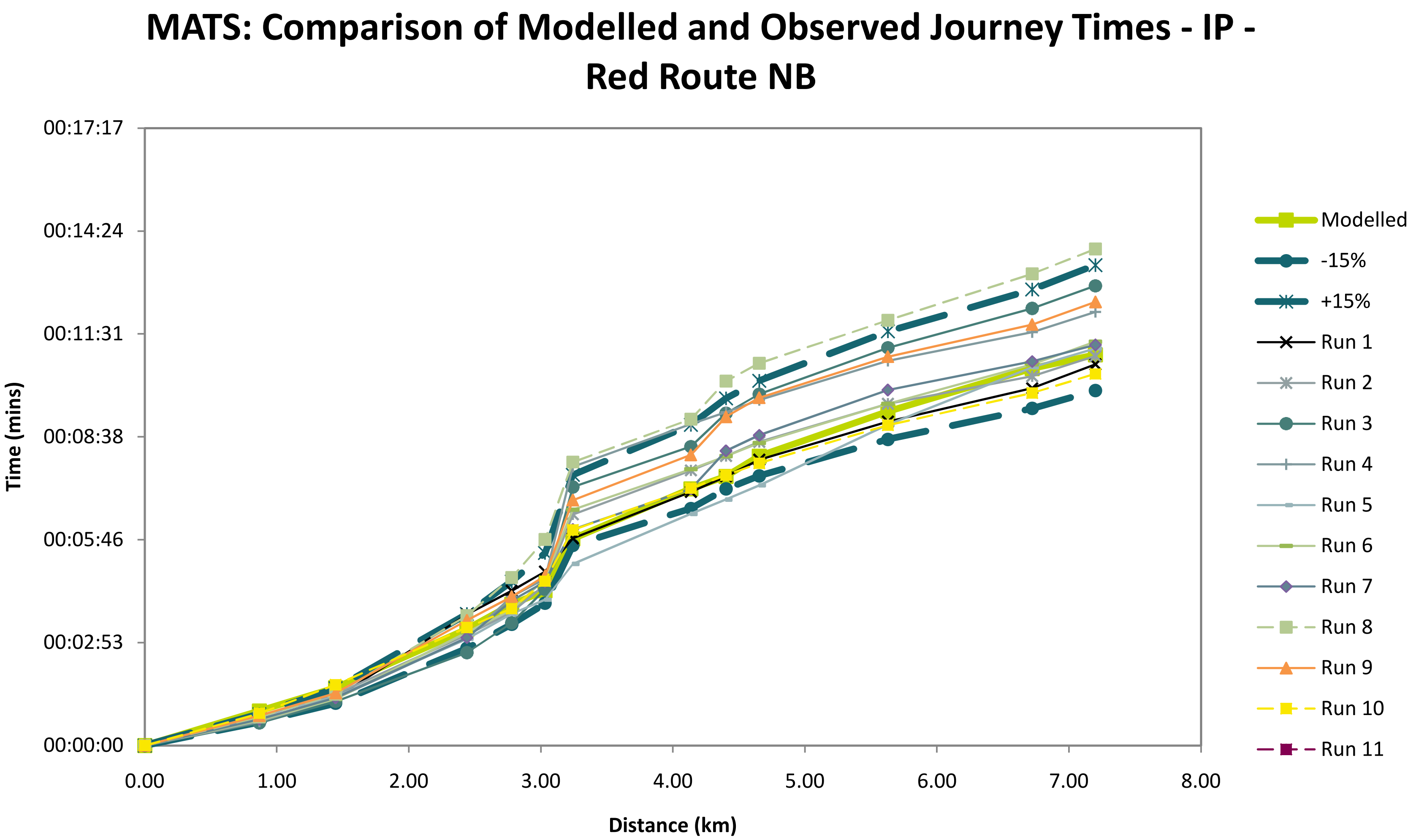



Figure A.17 – Red Route NB – Inter Peak

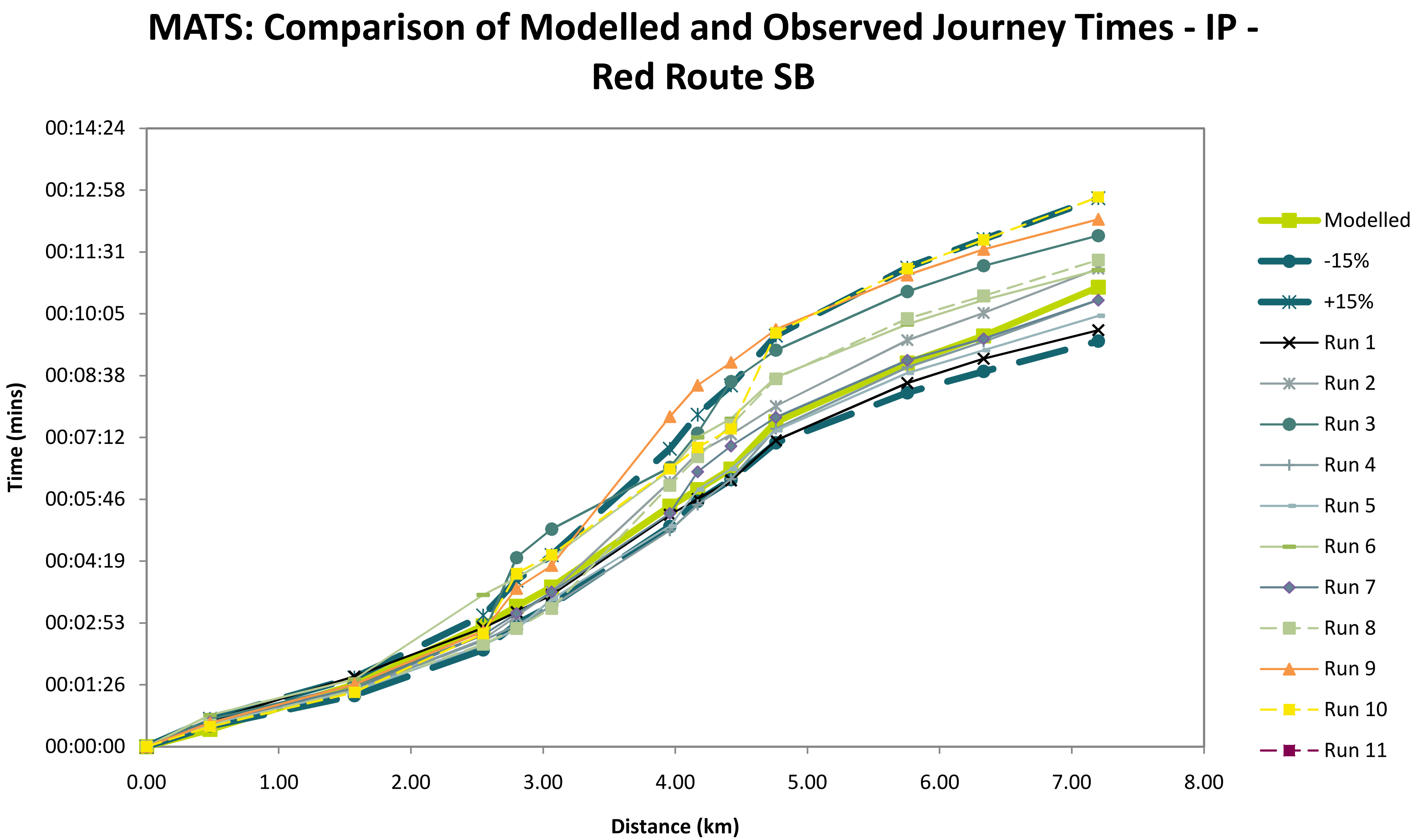



Figure A.18 – Red Route SB – Inter Peak

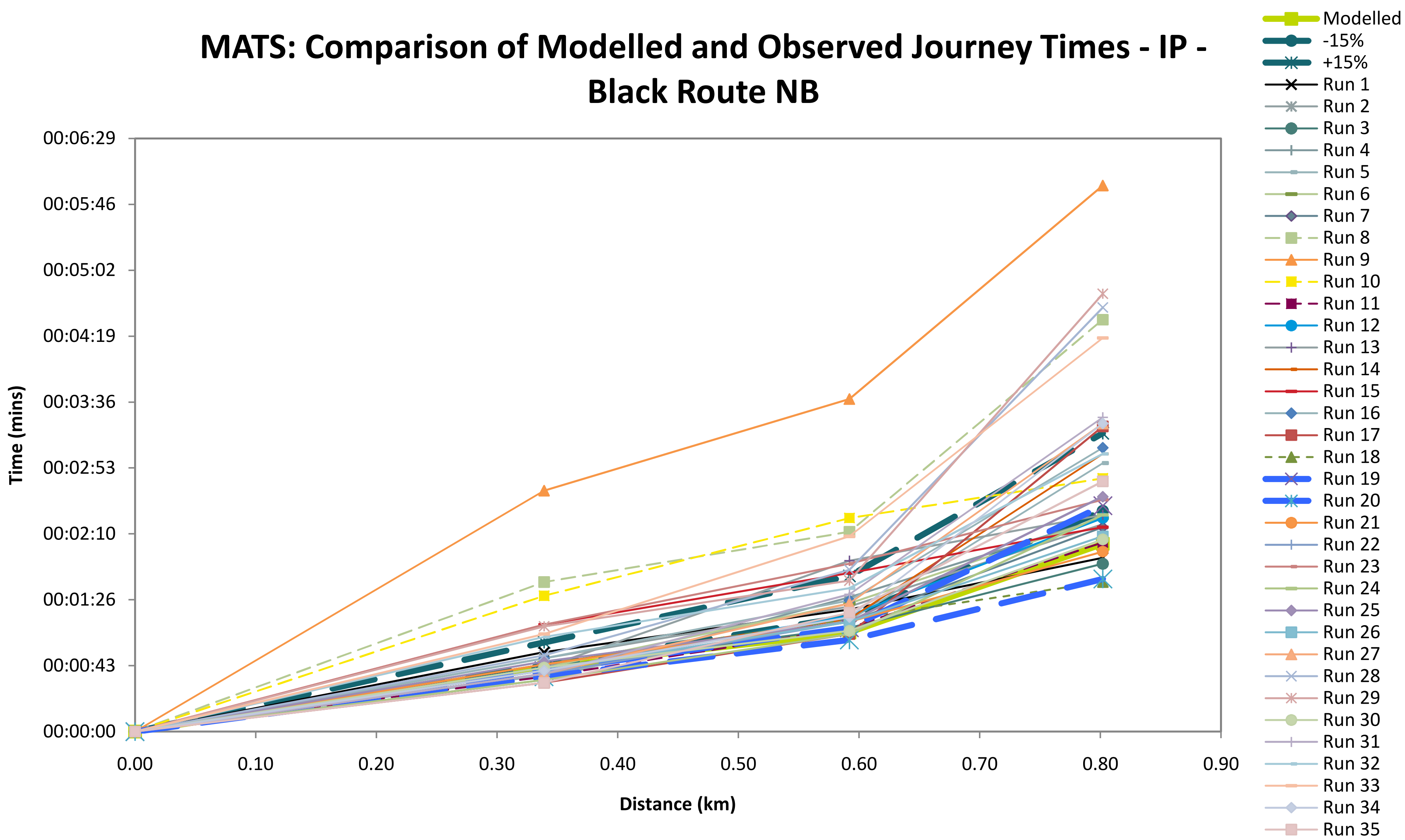



Figure A.19 – Black Route NB – Inter Peak

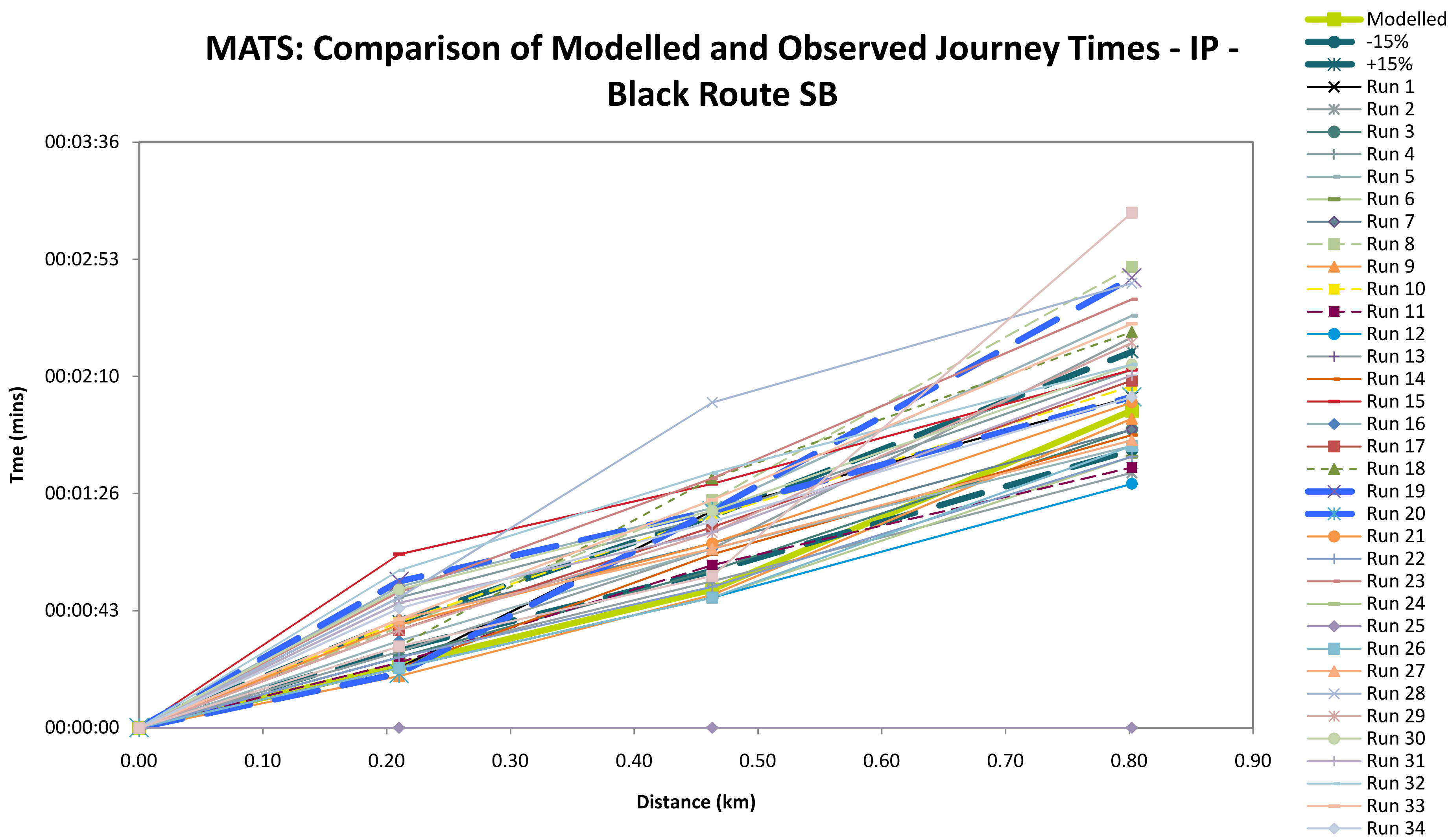



Figure A.20 – Black Route SB – Inter Peak

## PM Peak

### Screenline Results

**Table A.5 – PM Peak Screenline Results**

| Description | Observed Flow | Modelled Flow | Diff | % Diff | GEH | DMRB Flow | DMRB GEH |
|---|---|---|---|---|---|---|---|
| **Northern Screenline (Calibration)** | | | | | | | |
| TC-15.1 A141/Hostmoor Avenue (N to E) | 137 | 47 | 90 | 66% | 9.37 | ✓ | × |
| TC-15.2 A141/Hostmoor Avenue (N to S) | 692 | 708 | -16 | -2% | 0.61 | ✓ | ✓ |
| TC-15.4 A141/Hostmoor Avenue (S to N) | 865 | 901 | -37 | -4% | 1.23 | ✓ | ✓ |
| TC-25.1 Hundreds Road/Melbourne Avenue (N to S) | 4 | 0 | 4 | 100% | 2.83 | ✓ | ✓ |
| TC-25.2 Hundreds Road/Melbourne Avenue (N to W) | 2 | 2 | 0 | 0% | 0.00 | ✓ | ✓ |
| TC-25.4 Hundreds Road/Melbourne Avenue (S to N) | 1 | 0 | 1 | 100% | 1.41 | ✓ | ✓ |
| TC-25.5 Hundreds Road/Melbourne Avenue (W to N) | 3 | 18 | -15 | -509% | 4.68 | ✓ | ✓ |
| TC-1.1 B1101 Elm Road/Estover Road/Norwood Road (N to S & E) | 259 | 306 | -47 | -18% | 2.81 | ✓ | ✓ |
| TC-1.2 B1101 Elm Road/Estover Road/Norwood Road (N to W) | 79 | 79 | 0 | 0% | 0.00 | ✓ | ✓ |
| TC-1.4 B1101 Elm Road/Estover Road/Norwood Road (E to W & N) | 40 | 40 | 0 | 0% | 0.00 | ✓ | ✓ |
| TC-1.5 B1101 Elm Road/Estover Road/Norwood Road (S to W & N) | 229 | 228 | 2 | 1% | 0.12 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-1.7 B1101 Elm Road/Estover Road/Norwood Road (W to N) | 94 | 94 | 0 | 0% | 0.00 | ✓ | ✓ |
| **Screenline Total** | **2405** | **2424** | **-19** | **-1%** | **0.38** | ✓ | ✓ |
| | | | | | | | |
| **Eastern Screenline (Validation)** | | | | | | | |
| R-2.1 RSI B1099 Upwell Road (WB) | 126 | 138 | -12 | -10% | 1.09 | ✓ | ✓ |
| R-2.2 RSI MCC SkyHigh 2010 B1099 Upwell Road (EB) | 126 | 124 | 2 | 2% | 0.20 | ✓ | ✓ |
| TC-26.1 Estover Road/Creek Road (E to S) | 11 | 10 | 1 | 8% | 0.28 | ✓ | ✓ |
| TC-26.2 Estover Road/Creek Road (E to W) | 11 | 20 | -9 | -81% | 2.28 | ✓ | ✓ |
| TC-26.3 Estover Road/Creek Road (S to W) | 26 | 9 | 17 | 64% | 3.97 | ✓ | ✓ |
| TC-26.4 Estover Road/Creek Road (S to E) | 4 | 11 | -7 | -183% | 2.65 | ✓ | ✓ |
| TC-26.5 Estover Road/Creek Road (W to E) | 13 | 25 | -11 | -84% | 2.58 | ✓ | ✓ |
| TC-26.6 Estover Road/Creek Road (W to S) | 38 | 35 | 4 | 9% | 0.60 | ✓ | ✓ |
| **Screenline Total** | **420** | **416** | **4** | **1%** | **0.18** | ✓ | ✓ |
| | | | | | | | |
| **Southern Screenline (Validation)** | | | | | | | |
| R-3.1 B1101 Wimblington Road (NB) | 381 | 443 | -62 | -16% | 3.06 | ✓ | ✓ |
| R-3.2 B1101 Wimblington Road (SB) | 588 | 530 | 58 | 10% | 2.45 | ✓ | ✓ |
| TC-8.1 A141/Knights End Road (S to W) | 8 | 5 | 3 | 31% | 0.97 | ✓ | ✓ |
| TC-8.2 A141/Knights End Road (S to N) | 770 | 781 | -11 | -1% | 0.40 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-8.3 A141/Knights End Road (S to E) | 6 | 0 | 6 | 100% | 3.46 | ✓ | ✓ |
| TC-8.6 A141/Knights End Road (W to S) | 11 | 1 | 10 | 87% | 3.85 | ✓ | ✓ |
| TC-8.8 A141/Knights End Road (N to S) | 642 | 665 | -23 | -4% | 0.92 | ✓ | ✓ |
| TC-8.10 A141/Knights End Road (E to S) | 9 | 0 | 9 | 100% | 4.24 | ✓ | ✓ |
| **Screenline Total** | **2415** | **2426** | **-11** | **0%** | **0.23** | ✓ | ✓ |
| | | | | | | | |
| **Western Screenline (Validation)** | | | | | | | |
| E-1.1 Wisbech Road (EB) | 461 | 513 | -52 | -11% | 2.36 | ✓ | ✓ |
| E-1.2 Wisbech Road (WB) | 510 | 586 | -76 | -15% | 3.26 | ✓ | ✓ |
| E-8.1 Burrowmoor Road (EB) | 145 | 133 | 12 | 8% | 1.03 | ✓ | ✓ |
| E-8.2 Burrowmoor Road (WB) | 65 | 46 | 19 | 29% | 2.53 | ✓ | ✓ |
| E-9.1 Gaul Road (EB) | 153 | 172 | -20 | -13% | 1.53 | ✓ | ✓ |
| E-9.2 Gaul Road (WB) | 54 | 63 | -9 | -16% | 1.13 | ✓ | ✓ |
| TC-8.3 A141/Knights End Road (S to E) | 6 | 0 | 6 | 100% | 3.46 | ✓ | ✓ |
| TC-8.5 A141/Knights End Road (W to E) | 19 | 2 | 17 | 90% | 5.22 | ✓ | × |
| TC-8.7 A141/Knights End Road (N to E) | 84 | 36 | 48 | 57% | 6.16 | ✓ | × |
| TC-8.10 A141/Knights End Road (E to S) | 9 | 0 | 9 | 100% | 4.24 | ✓ | ✓ |
| TC-8.11 A141/Knights End Road (E to W) | 5 | 7 | -2 | -37% | 0.76 | ✓ | ✓ |
| TC-8.12 A141/Knights End Road (E to N) | 35 | 0 | 35 | 100% | 8.37 | ✓ | × |
| **Screenline Total** | **1546** | **1559** | **-13** | **-1%** | **0.33** | ✓ | ✓ |
| | | | | | | | |

**March Inner Cordon (Calibration)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-14.1 B1101 High Street/St Peters Road (N to E) | 93 | 92 | 1 | 1% | 0.10 | ✓ | ✓ |
| TC-14.2 B1101 High Street/St Peters Road (N to S) | 351 | 398 | -47 | -13% | 2.41 | ✓ | ✓ |
| TC-14.3 B1101 High Street/St Peters Road (E to S) | 84 | 106 | -23 | -27% | 2.33 | ✓ | ✓ |
| TC-14.4 B1101 High Street/St Peters Road (E to N) | 124 | 74 | 50 | 40% | 4.99 | ✓ | ✓ |
| TC-14.5 B1101 High Street/St Peters Road (S to N) | 407 | 411 | -3 | -1% | 0.17 | ✓ | ✓ |
| TC-14.6 B1101 High Street/St Peters Road (S to E) | 109 | 110 | -1 | -1% | 0.06 | ✓ | ✓ |
| TC-19.1 B1099 Wisbech Road/Norwood Road (N to E) | 81 | 63 | 18 | 22% | 2.14 | ✓ | ✓ |
| TC-19.3 B1099 Wisbech Road/Norwood Road (E to W) | 330 | 326 | 4 | 1% | 0.23 | ✓ | ✓ |
| TC-19.4 B1099 Wisbech Road/Norwood Road (E to N) | 96 | 28 | 68 | 71% | 8.63 | ✓ | × |
| TC-19.6 B1099 Wisbech Road/Norwood Road (W to E) | 267 | 157 | 109 | 41% | 7.49 | × | × |
| TC-22.1 B1101 High Street/Elwyn Road/Market Place (N to E) | 319 | 321 | -2 | 0% | 0.09 | ✓ | ✓ |
| TC-22.3 B1101 High Street/Elwyn Road/Market Place (E to S) | 69 | 69 | 0 | 0% | 0.00 | ✓ | ✓ |
| TC-22.4 B1101 High Street/Elwyn Road/Market Place (E to N) | 183 | 261 | -78 | -43% | 5.24 | ✓ | × |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-22.6 B1101 High Street/Elwyn Road/Market Place (S to E) | 77 | 77 | 0 | 0% | 0.01 | ✓ | ✓ |
| TC-27.1 Burrowmoor Road/Gaul Road (NE to SW) | 130 | 134 | -4 | -3% | 0.34 | ✓ | ✓ |
| TC-27.2 Burrowmoor Road/Gaul Road (NE to NW) | 65 | 86 | -21 | -33% | 2.45 | ✓ | ✓ |
| TC-27.3 Burrowmoor Road/Gaul Road (SW to NW) | 5 | 5 | 0 | 0% | 0.00 | ✓ | ✓ |
| TC-27.4 Burrowmoor Road/Gaul Road (SW to NE) | 123 | 123 | 0 | 0% | 0.02 | ✓ | ✓ |
| TC-27.5 Burrowmoor Road/Gaul Road (NW to NE) | 143 | 153 | -10 | -7% | 0.79 | ✓ | ✓ |
| TC-27.6 Burrowmoor Road/Gaul Road (NW to SW) | 4 | 0 | 4 | 100% | 2.83 | ✓ | ✓ |
| E-2.1 Norwood Road (SB) | 212 | 212 | 0 | 0% | 0.00 | ✓ | ✓ |
| E-2.2 Norwood Road (NB) | 108 | 108 | 0 | 0% | 0.03 | ✓ | ✓ |
| E-3.1 Monitoring Elm Road (SB) | 273 | 286 | -13 | -5% | 0.77 | ✓ | ✓ |
| E-3.2 Elm Road (NB) | 260 | 255 | 6 | 2% | 0.36 | ✓ | ✓ |
| E-4.1 Creek Road (WB) | 54 | 82 | -29 | -53% | 3.46 | ✓ | ✓ |
| E-4.2 Creek Road (EB) | 37 | 60 | -23 | -61% | 3.26 | ✓ | ✓ |
| **Cordon Total** | **4207** | **4219** | **12** | **0%** | **0.18** | **✓** | **✓** |
| | | | | | | | |
| **River Screenline (Validation)** | | | | | | | |
| E-10.1 A141 March Bypass (SB) | 813 | 907 | -94 | -12% | 3.21 | ✓ | ✓ |
| E-10.2 A141 March Bypass (NB) | 750 | 803 | -53 | -7% | 1.90 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-21.1 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (E to S) | 396 | 435 | -39 | -10% | 1.91 | ✓ | ✓ |
| TC-21.4 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to W) | 369 | 337 | 32 | 9% | 1.69 | ✓ | ✓ |
| TC-21.5 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to N) | 26 | 0 | 26 | 100% | 7.14 | ✓ | × |
| TC-21.6 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to E) | 313 | 325 | -12 | -4% | 0.69 | ✓ | ✓ |
| TC-21.9 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (W to S) | 319 | 270 | 49 | 15% | 2.86 | ✓ | ✓ |
| **Screenline Total** | **2985** | **3077** | **-92** | **-3%** | **1.68** | **✓** | **✓** |
| | | | | | | | |
| **Wimblington Screenline (Calibration)** | | | | | | | |
| TC-5.2 A141/King Street (N to W) | 37 | 37 | 0 | 0% | 0.00 | ✓ | ✓ |
| TC-5.3 A141/King Street (S to W) | 17 | 17 | 0 | 0% | 0.00 | ✓ | ✓ |
| TC-5.5 A141/King Street (W to N) | 24 | 24 | 0 | 0% | 0.00 | ✓ | ✓ |
| TC-5.6 A141/King Street (W to S) | 8 | 8 | 0 | 0% | 0.01 | ✓ | ✓ |
| TC-6.1 A141/B1101 Wimblington Road (S to W) | 143 | 145 | -2 | -2% | 0.18 | ✓ | ✓ |
| TC-6.2 A141/B1101 Wimblington Road (S to N) | 123 | 110 | 13 | 11% | 1.20 | ✓ | ✓ |
| TC-6.3 A141/B1101 Wimblington Road (S to E) | 4 | 0 | 4 | 97% | 2.78 | ✓ | ✓ |
| TC-6.6 A141/B1101 Wimblington Road (W to S) | 179 | 181 | -2 | -1% | 0.14 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-6.8 A141/B1101 Wimblington Road (N to S) | 107 | 114 | -7 | -6% | 0.65 | ✓ | ✓ |
| TC-6.10 A141/B1101 Wimblington Road (E to S) | 6 | 0 | 6 | 100% | 3.46 | ✓ | ✓ |
| TC-16.2 A141/B1093 Doddington Road (N to W) | 46 | 69 | -23 | -51% | 3.06 | ✓ | ✓ |
| TC-16.3 A141/B1093 Doddington Road (S to W) | 78 | 73 | 5 | 6% | 0.57 | ✓ | ✓ |
| TC-16.5 A141/B1093 Doddington Road (W to N) | 48 | 20 | 28 | 58% | 4.77 | ✓ | ✓ |
| TC-16.6 A141/B1093 Doddington Road (W to S) | 24 | 24 | 0 | 1% | 0.04 | ✓ | ✓ |
| **Screenline Total** | **845** | **823** | **22** | **3%** | **0.76** | ✓ | ✓ |

## Validation Count Results

**Table A.6 – PM Peak Validation Count Results**

| Description | Observed Flow | Modelled Flow | Diff | % Diff | GEH | DMRB Flow | DMRB GEH |
|---|---|---|---|---|---|---|---|
| E-1.1 Wisbech Road (EB) | 461 | 513 | -52 | -11% | 2.36 | ✓ | ✓ |
| E-1.2 Wisbech Road (WB) | 510 | 586 | -76 | -15% | 3.26 | ✓ | ✓ |
| E-5.1 Upwell Road (WB) | 121 | 138 | -18 | -15% | 1.54 | ✓ | ✓ |
| E-5.2 Upwell Road (EB) | 102 | 124 | -22 | -22% | 2.09 | ✓ | ✓ |
| E-7.1 Knights End Road (EB) | 128 | 38 | 90 | 70% | 9.83 | ✓ | × |
| E-7.2 Knights End Road (WB) | 47 | 7 | 40 | 85% | 7.74 | ✓ | × |
| E-8.1 Burrowmoor Road (EB) | 145 | 133 | 12 | 8% | 1.03 | ✓ | ✓ |
| E-8.2 Burrowmoor Road (WB) | 65 | 46 | 19 | 29% | 2.53 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| E-9.1 Gaul Road (EB) | 153 | 172 | -20 | -13% | 1.53 | ✓ | ✓ |
| E-9.2 Gaul Road (WB) | 54 | 63 | -9 | -16% | 1.13 | ✓ | ✓ |
| E-10.1 A141 March Bypass (SB) | 813 | 907 | -94 | -12% | 3.21 | ✓ | ✓ |
| E-10.2 A141 March Bypass (NB) | 750 | 803 | -53 | -7% | 1.90 | ✓ | ✓ |
| E-11.1 Town Bridge (SB) | 687 | 722 | -35 | -5% | 1.32 | ✓ | ✓ |
| E-11.2 Town Bridge (NB) | 690 | 755 | -66 | -10% | 2.44 | ✓ | ✓ |
| R-1.1 B1101 Elm Road (NB) | 215 | 198 | 17 | 8% | 1.20 | ✓ | ✓ |
| R-1.2 B1101 Elm Road (SB) | 301 | 303 | -2 | -1% | 0.09 | ✓ | ✓ |
| R-2.1 B1099 Upwell Road (WB) | 126 | 138 | -12 | -10% | 1.09 | ✓ | ✓ |
| R-2.2 B1099 Upwell Road (EB) | 126 | 124 | 2 | 2% | 0.20 | ✓ | ✓ |
| R-3.1 B1101 Wimblington Road (NB) | 381 | 443 | -62 | -16% | 3.06 | ✓ | ✓ |
| R-3.2 B1101 Wimblington Road (SB) | 588 | 530 | 58 | 10% | 2.45 | ✓ | ✓ |
| R-5.1 A141 Wisbech Road (NB) | 829 | 901 | -72 | -9% | 2.45 | ✓ | ✓ |
| R-5.2 A141 Wisbech Road (SB) | 817 | 755 | 62 | 8% | 2.20 | ✓ | ✓ |
| TC-8.1 A141/Knights End Road (S to W) | 8 | 5 | 3 | 31% | 0.97 | ✓ | ✓ |
| TC-8.2 A141/Knights End Road (S to N) | 770 | 781 | -11 | -1% | 0.40 | ✓ | ✓ |
| TC-8.3 A141/Knights End Road (S to E) | 6 | 0 | 6 | 100% | 3.46 | ✓ | ✓ |
| TC-8.4 A141/Knights End Road (W to N) | 36 | 0 | 36 | 100% | 8.49 | ✓ | × |
| TC-8.5 A141/Knights End Road (W to E) | 19 | 2 | 17 | 90% | 5.22 | ✓ | × |
| TC-8.6 A141/Knights End Road (W to S) | 11 | 1 | 10 | 87% | 3.85 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-8.7 A141/Knights End Road (N to E) | 84 | 36 | 48 | 57% | 6.16 | ✓ | ✗ |
| TC-8.8 A141/Knights End Road (N to S) | 642 | 665 | -23 | -4% | 0.92 | ✓ | ✓ |
| TC-8.9 A141/Knights End Road (N to W) | 42 | 0 | 42 | 100% | 9.20 | ✓ | ✗ |
| TC-8.10 A141/Knights End Road (E to S) | 9 | 0 | 9 | 100% | 4.24 | ✓ | ✓ |
| TC-8.11 A141/Knights End Road (E to W) | 5 | 7 | -2 | -37% | 0.76 | ✓ | ✓ |
| TC-8.12 A141/Knights End Road (E to N) | 35 | 0 | 35 | 100% | 8.37 | ✓ | ✗ |
| TC-13.1 B1101 High Street/Burrowmoor Road (N to S) | 323 | 314 | 9 | 3% | 0.50 | ✓ | ✓ |
| TC-13.2 B1101 High Street/Burrowmoor Road (N to SW & NW) | 170 | 157 | 13 | 8% | 1.05 | ✓ | ✓ |
| TC-13.3 B1101 High Street/Burrowmoor Road (S to SW & NW) | 76 | 86 | -10 | -13% | 1.10 | ✓ | ✓ |
| TC-13.4 B1101 High Street/Burrowmoor Road (S to N) | 439 | 429 | 9 | 2% | 0.45 | ✓ | ✓ |
| TC-13.9 B1101 High Street/Burrowmoor Road (SW & NW to N) | 204 | 142 | 62 | 31% | 4.74 | ✓ | ✓ |
| TC-13.10 B1101 High Street/Burrowmoor Road (SW & NW to S) | 135 | 187 | -52 | -38% | 4.06 | ✓ | ✓ |
| TC-21.1 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (E to S) | 396 | 435 | -39 | -10% | 1.91 | ✓ | ✓ |
| TC-21.2 B1101 Broad St/B1099 Dartford Rd/B1101 Station Rd (E to W) | 74 | 68 | 6 | 8% | 0.71 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-21.3 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (E to N) | 4 | 0 | 4 | 100% | 2.83 | ✓ | ✓ |
| TC-21.4 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to W) | 369 | 337 | 32 | 9% | 1.69 | ✓ | ✓ |
| TC-21.5 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to N) | 26 | 0 | 26 | 100% | 7.14 | ✓ | × |
| TC-21.6 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (S to E) | 313 | 325 | -12 | -4% | 0.69 | ✓ | ✓ |
| TC-21.7 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (W to N) | 4 | 0 | 4 | 100% | 2.83 | ✓ | ✓ |
| TC-21.8 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (W to E) | 91 | 58 | 33 | 36% | 3.77 | ✓ | ✓ |
| TC-21.9 B1101 Broad Street/B1099 Dartford Road/B1101 Station Road (W to S) | 319 | 270 | 49 | 15% | 2.86 | ✓ | ✓ |
| TC-23.1 B1099 Upwell road/Elwyn Road (N to E) | 91 | 114 | -22 | -25% | 2.22 | ✓ | ✓ |
| TC-23.2 B1099 Upwell road/Elwyn Road (N to W) | 40 | 87 | -47 | -119% | 5.93 | ✓ | × |
| TC-23.3 B1099 Upwell road/Elwyn Road (E to W) | 123 | 94 | 29 | 24% | 2.78 | ✓ | ✓ |
| TC-23.4 B1099 Upwell road/Elwyn Road (E to N) | 54 | 69 | -15 | -28% | 1.92 | ✓ | ✓ |
| TC-23.5 B1099 Upwell road/Elwyn Road (W to N) | 76 | 96 | -21 | -28% | 2.26 | ✓ | ✓ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TC-23.6 B1099 Upwell road/Elwyn Road (W to E) | 114 | 105 | 9 | 8% | 0.82 | ✓ | ✓ |
| TC-24.1 Hundreds Road/Norwood Road (N to E) | 103 | 67 | 36 | 35% | 3.94 | ✓ | ✓ |
| TC-24.2 Hundreds Road/Norwood Road (N to S) | 167 | 120 | 47 | 28% | 3.93 | ✓ | ✓ |
| TC-24.3 Hundreds Road/Norwood Road (E to S) | 76 | 92 | -16 | -21% | 1.78 | ✓ | ✓ |
| TC-24.4 Hundreds Road/Norwood Road (E to N) | 47 | 30 | 17 | 35% | 2.65 | ✓ | ✓ |
| TC-24.5 Hundreds Road/Norwood Road (S to N) | 70 | 34 | 36 | 51% | 4.94 | ✓ | ✓ |
| TC-24.6 Hundreds Road/Norwood Road (S to E) | 84 | 74 | 10 | 12% | 1.15 | ✓ | ✓ |
| TC-26.1 Estover Road/Creek Road (E to S) | 11 | 10 | 1 | 8% | 0.28 | ✓ | ✓ |
| TC-26.2 Estover Road/Creek Road (E to W) | 11 | 20 | -9 | -81% | 2.28 | ✓ | ✓ |
| TC-26.3 Estover Road/Creek Road (S to W) | 26 | 9 | 17 | 64% | 3.97 | ✓ | ✓ |
| TC-26.4 Estover Road/Creek Road (S to E) | 4 | 11 | -7 | -183% | 2.65 | ✓ | ✓ |
| TC-26.5 Estover Road/Creek Road (W to E) | 13 | 25 | -11 | -84% | 2.58 | ✓ | ✓ |
| TC-26.6 Estover Road/Creek Road (W to S) | 38 | 35 | 4 | 9% | 0.60 | ✓ | ✓ |
| LC-1.1 B1101 Station Road Level Crossing (NB) | 264 | 255 | 10 | 4% | 0.59 | ✓ | ✓ |
| LC-1.2 B1101 Station Road Level Crossing (SB) | 276 | 286 | -10 | -4% | 0.61 | ✓ | ✓ |
| | | | | **Overall Validation Count Results** | | **100%** | **87%** |

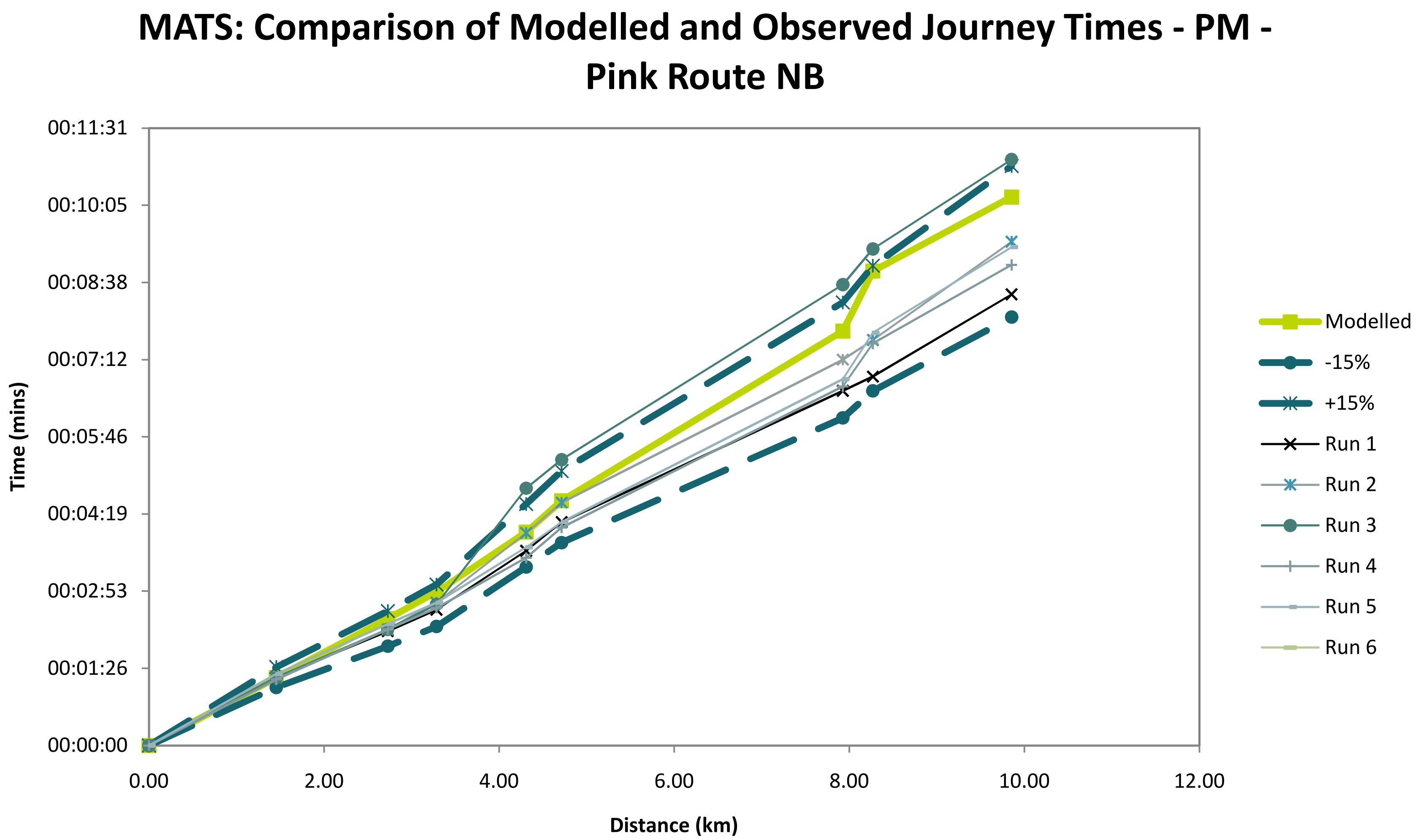



Figure A.21 – Pink Route NB – PM Peak

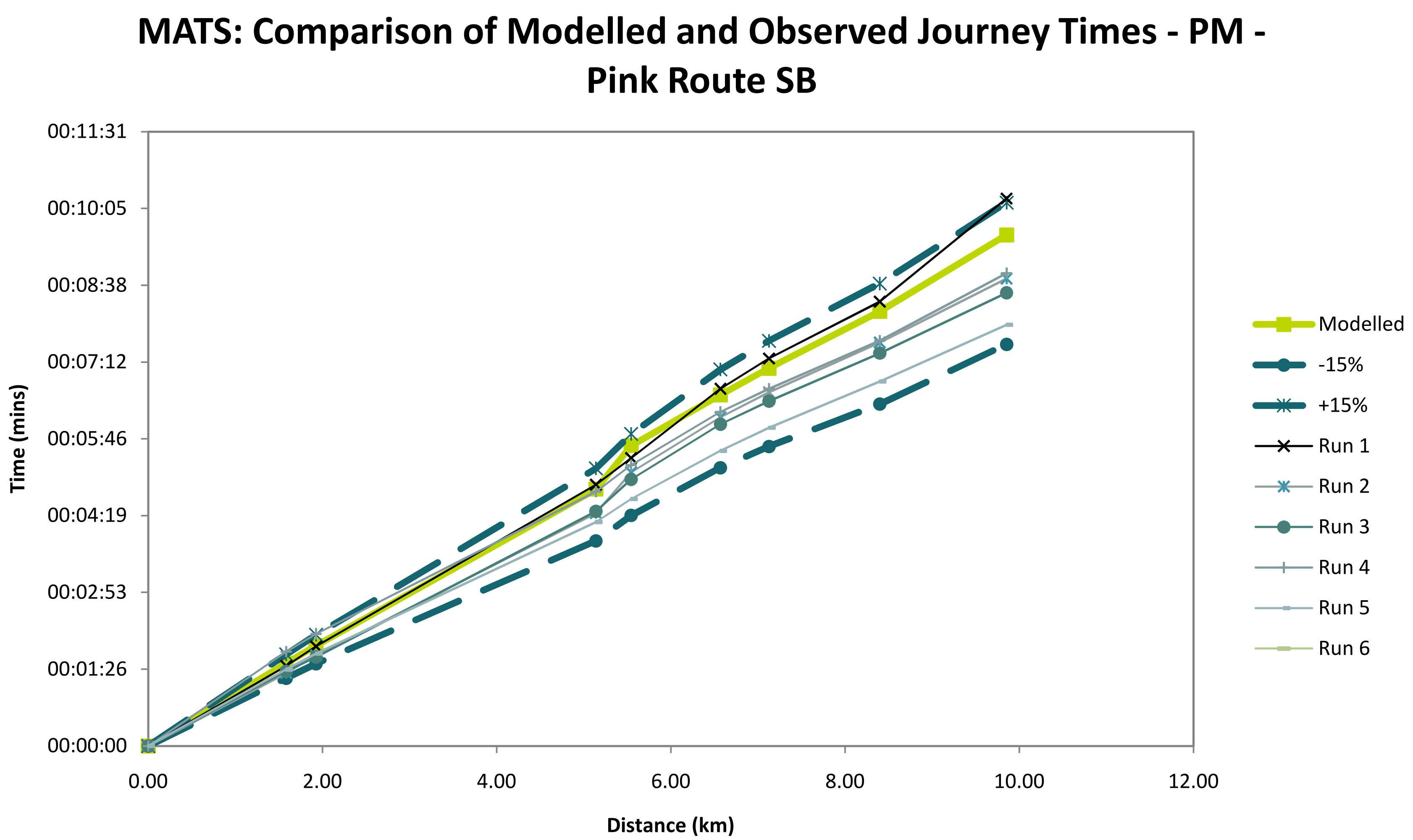



Figure A.22 – Pink Route SB – PM Peak

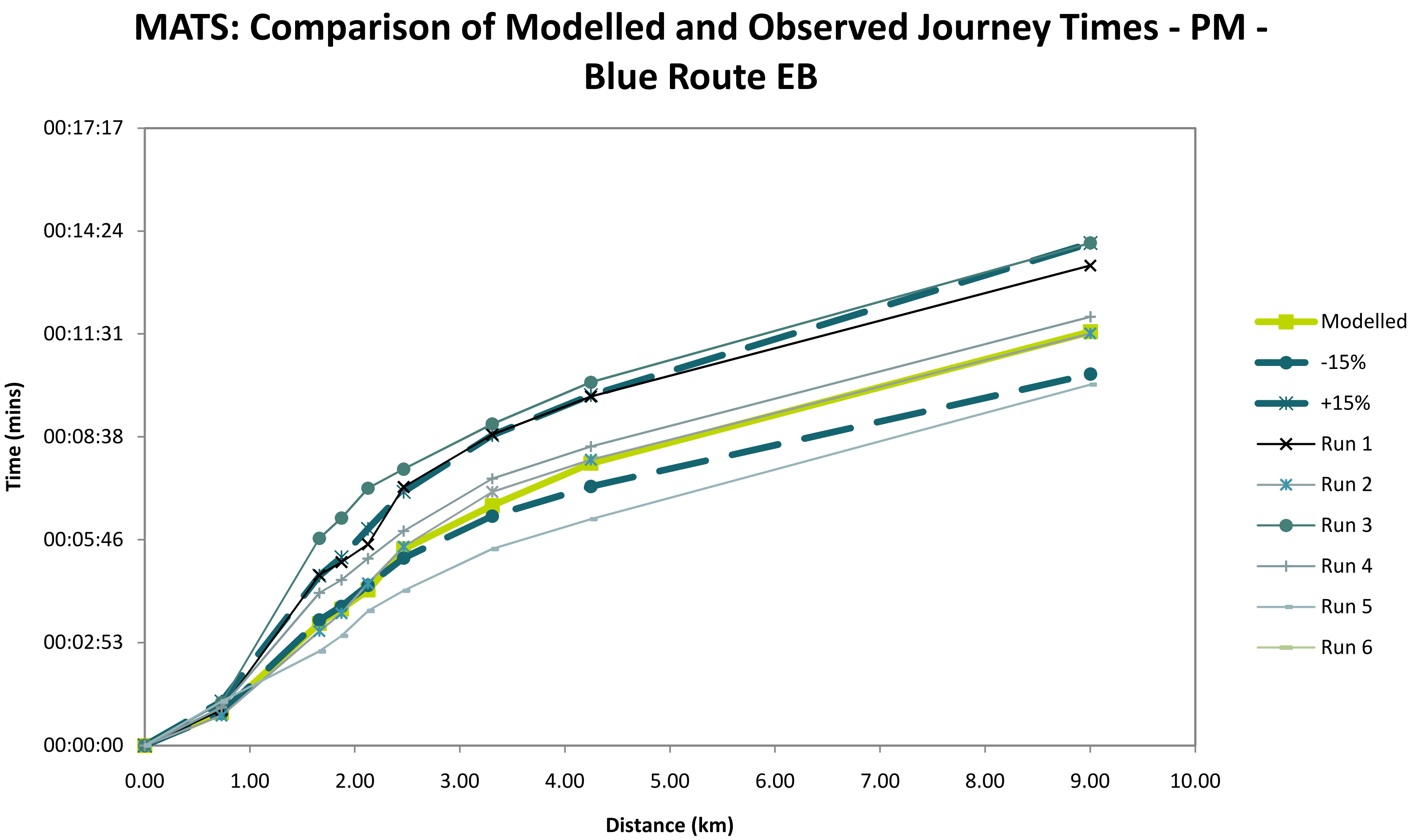



Figure A.23 – Blue Route EB – PM Peak

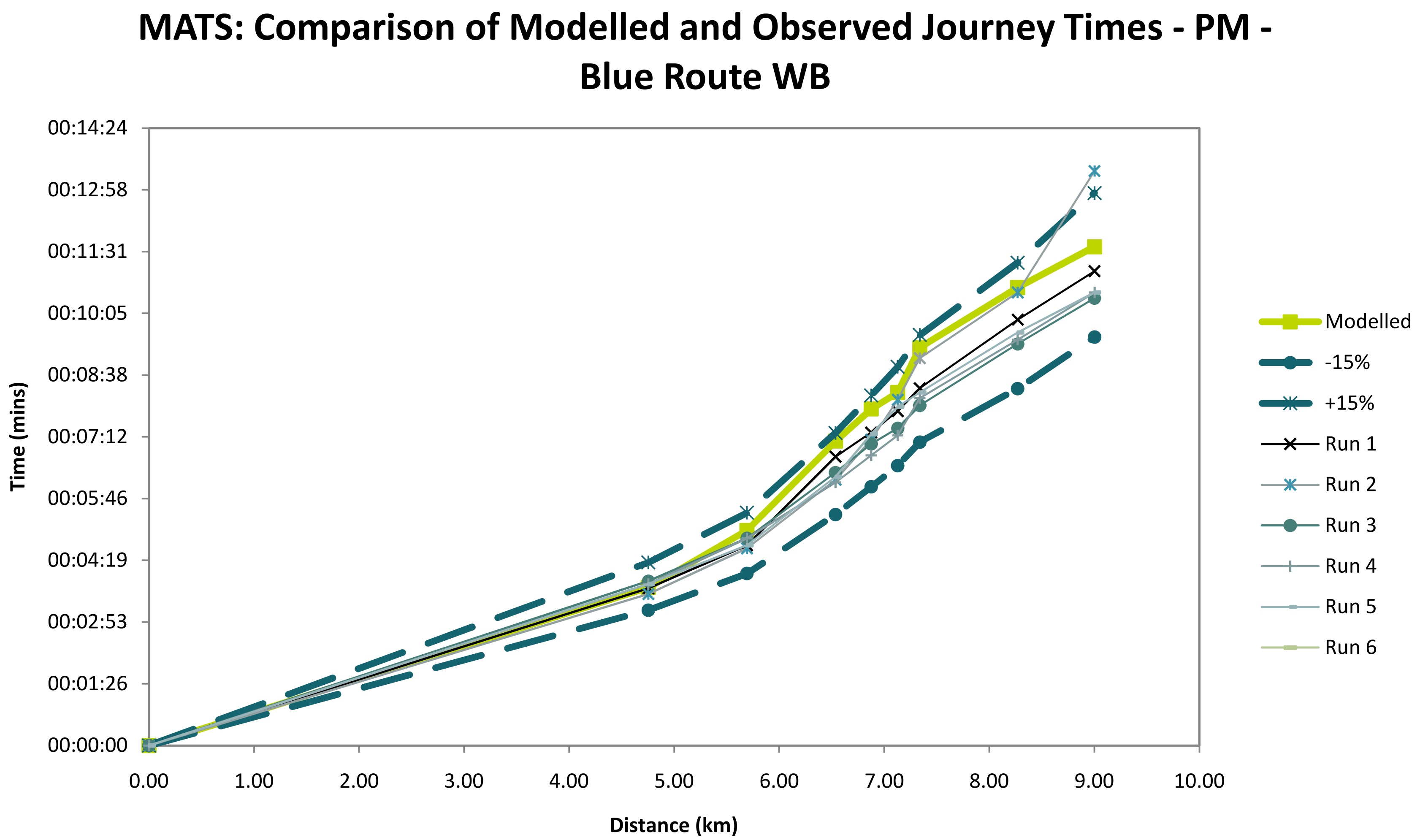



Figure A.24 – Blue Route WB – PM Peak

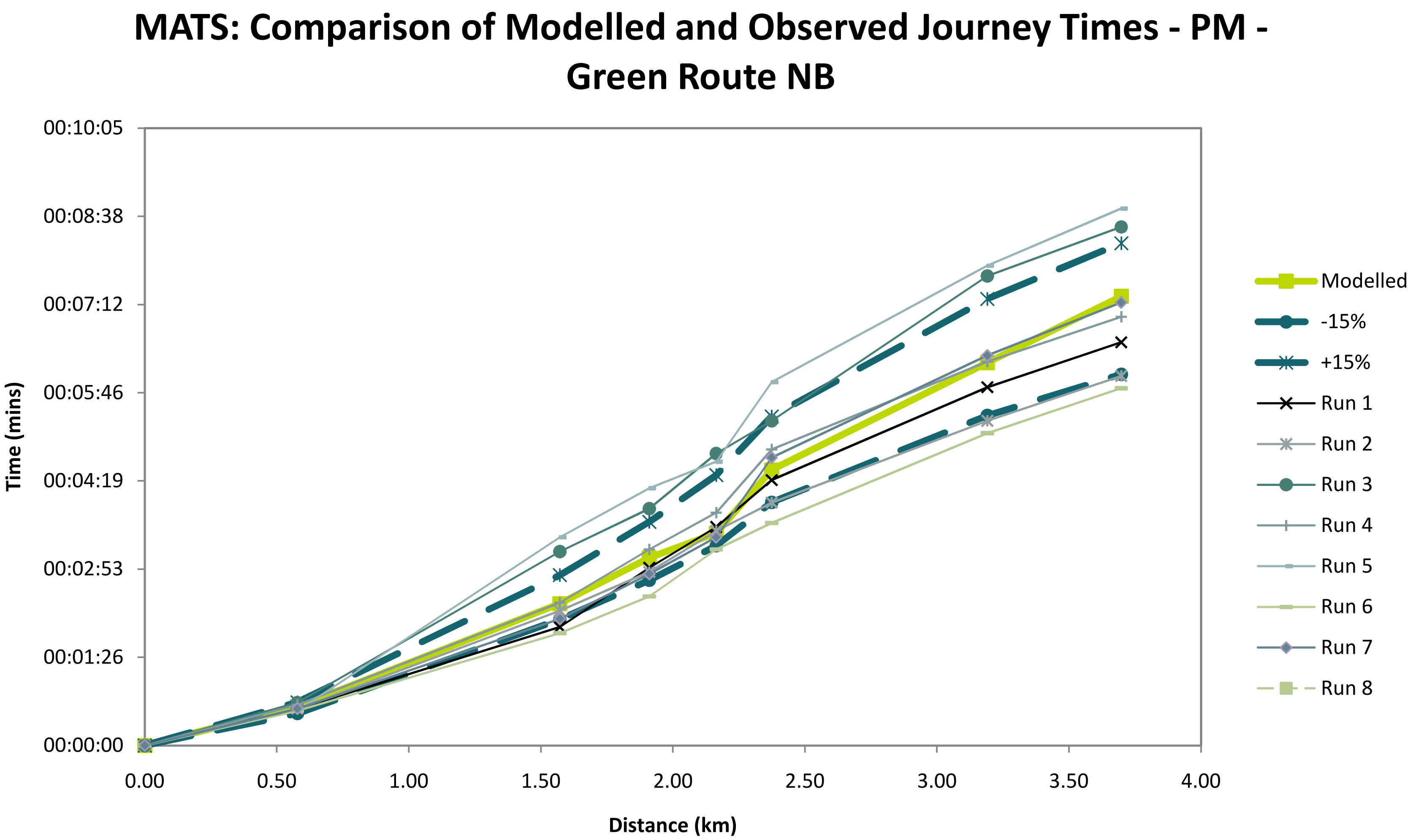



Figure A.25 – Green Route NB – PM Peak

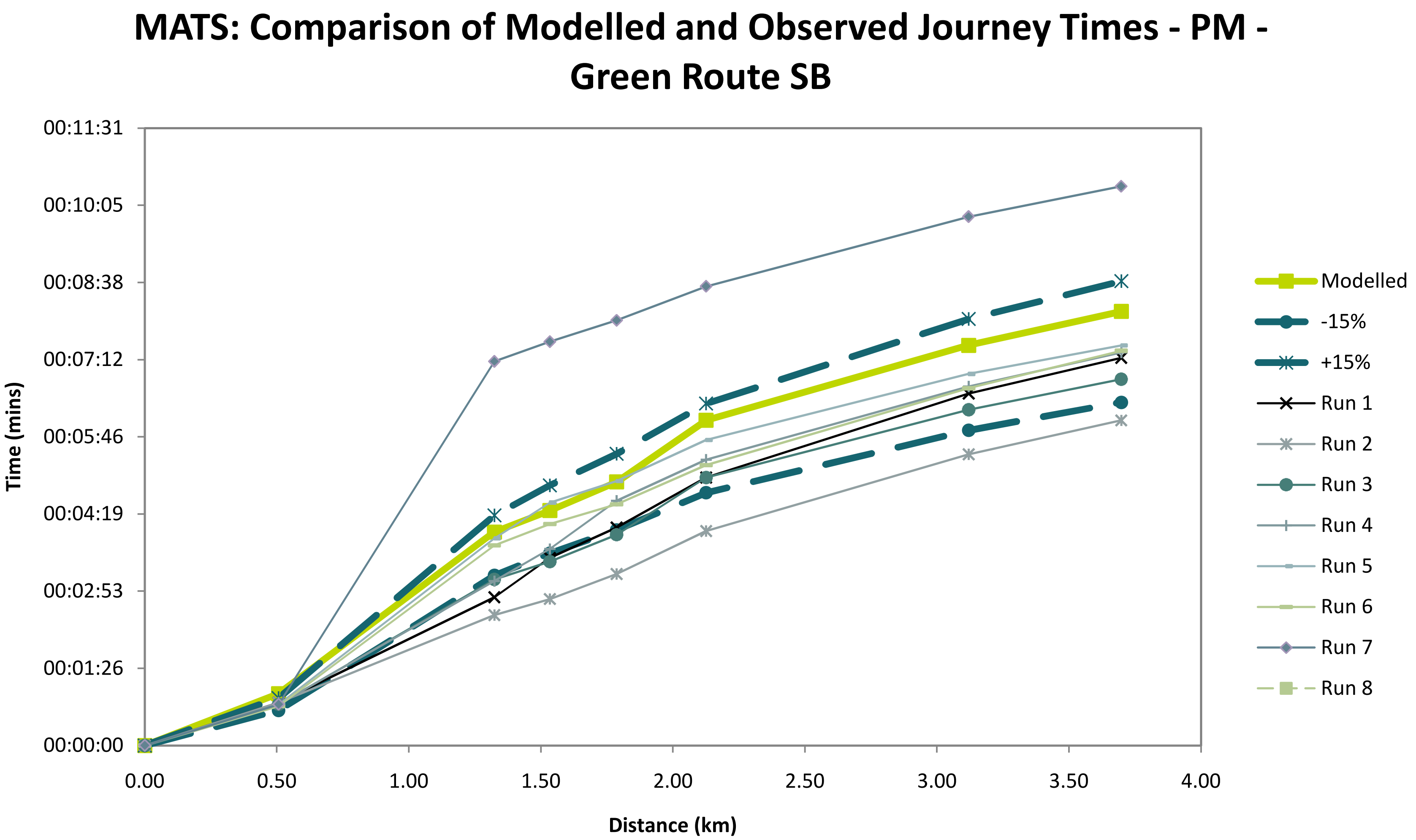



Figure A.26 – Green Route SB – PM Peak

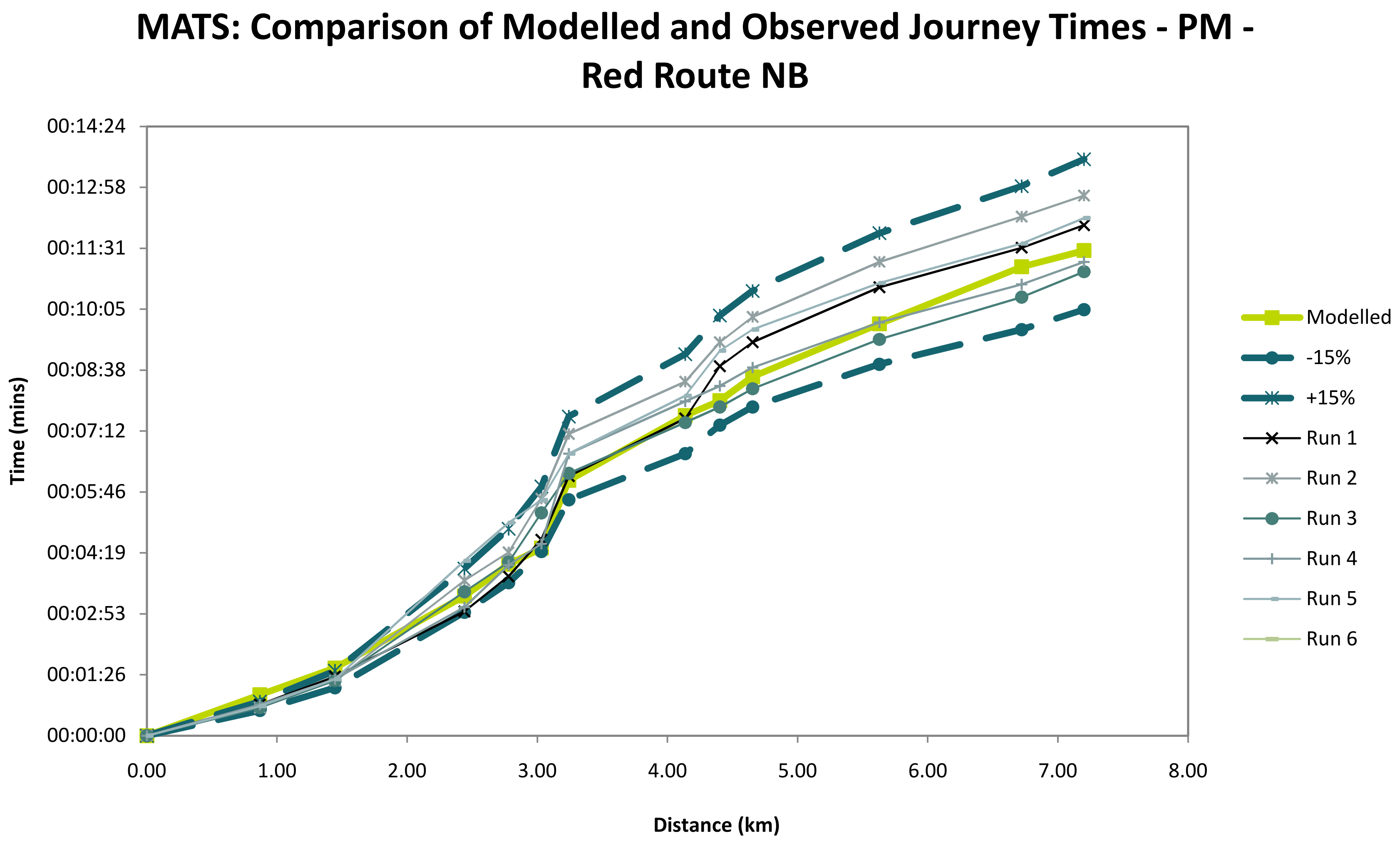



Figure A.27 – Red Route NB – PM Peak

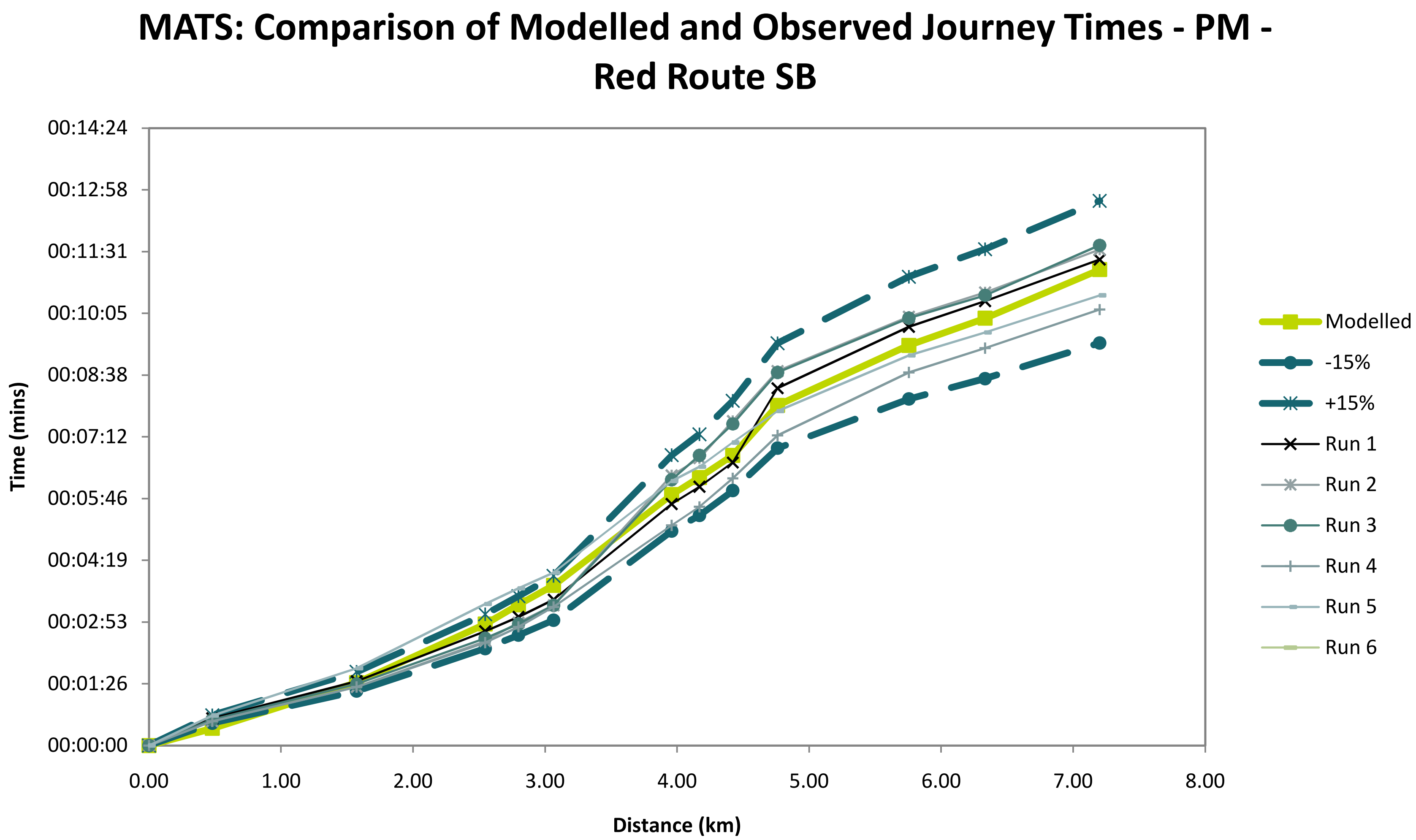



Figure A.28 – Red Route SB – PM Peak

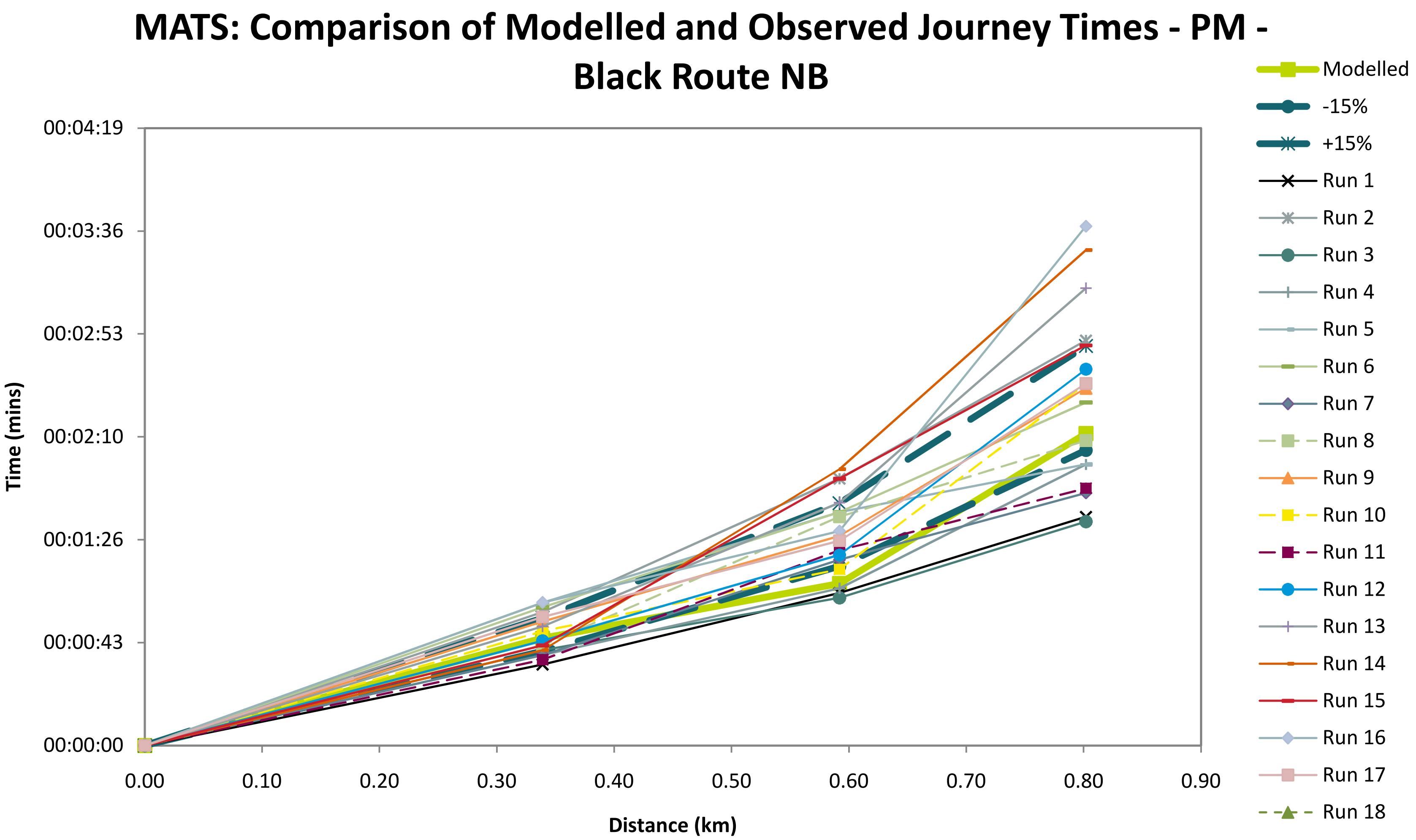



Figure A.29 – Black Route NB – PM Peak

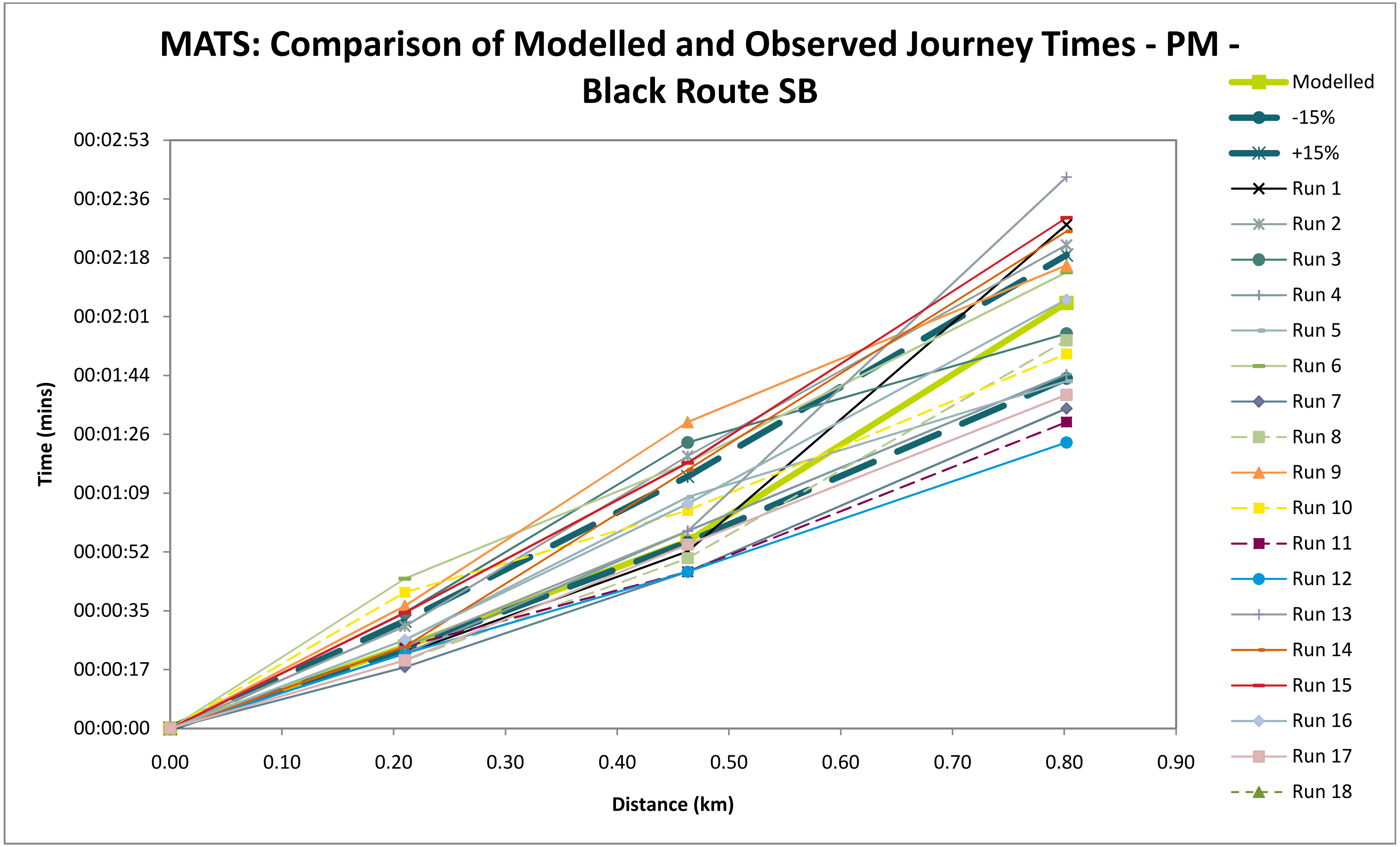



Figure A.30 – Black Route SB – PM Peak

# B. MATS Network and Sector System

## MATS Network

B.1 Figure B.1 and Figure B.2 below shows the MATS SATURN model network.

**Figure B.1 – MATS Network (Overview)**

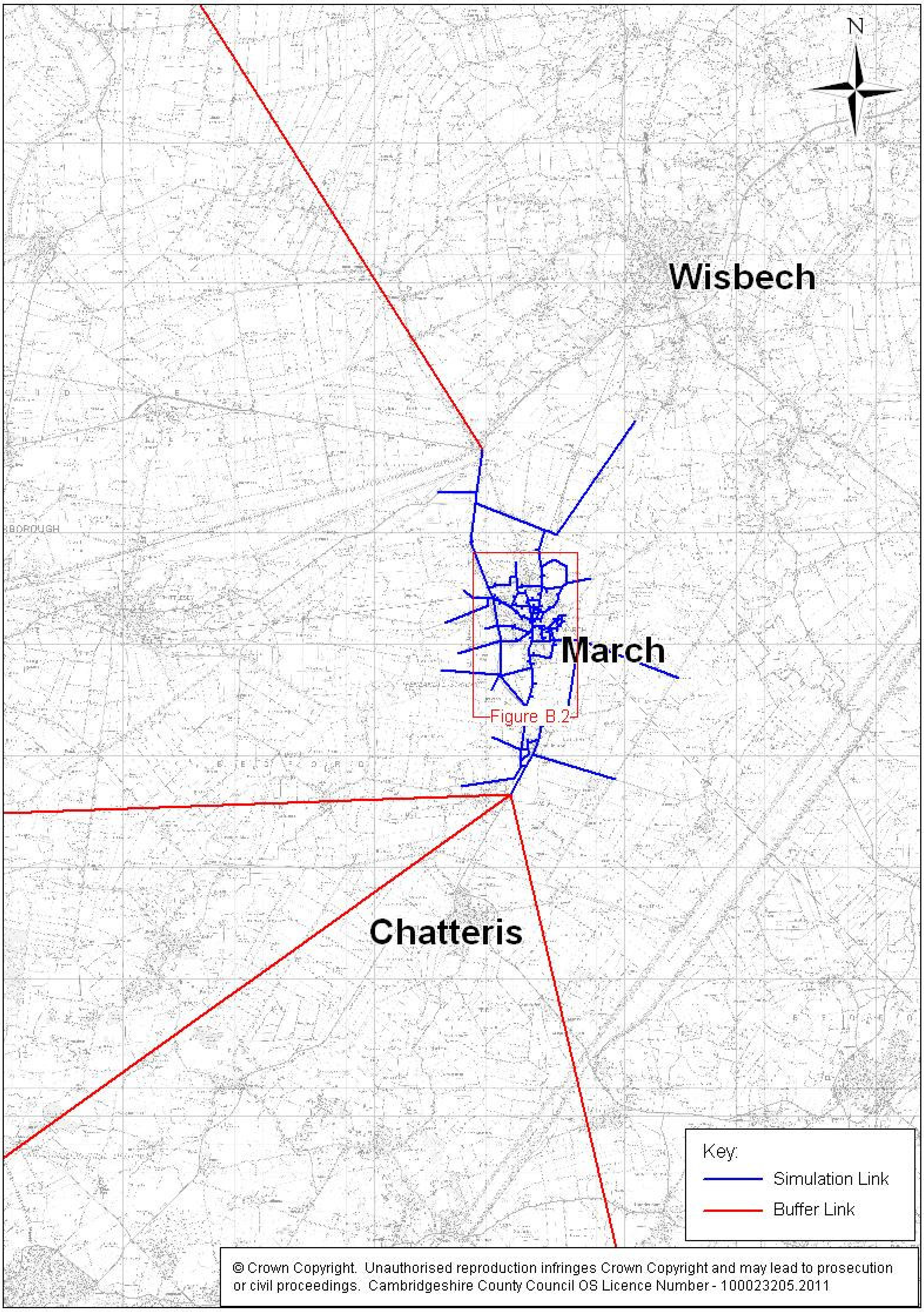
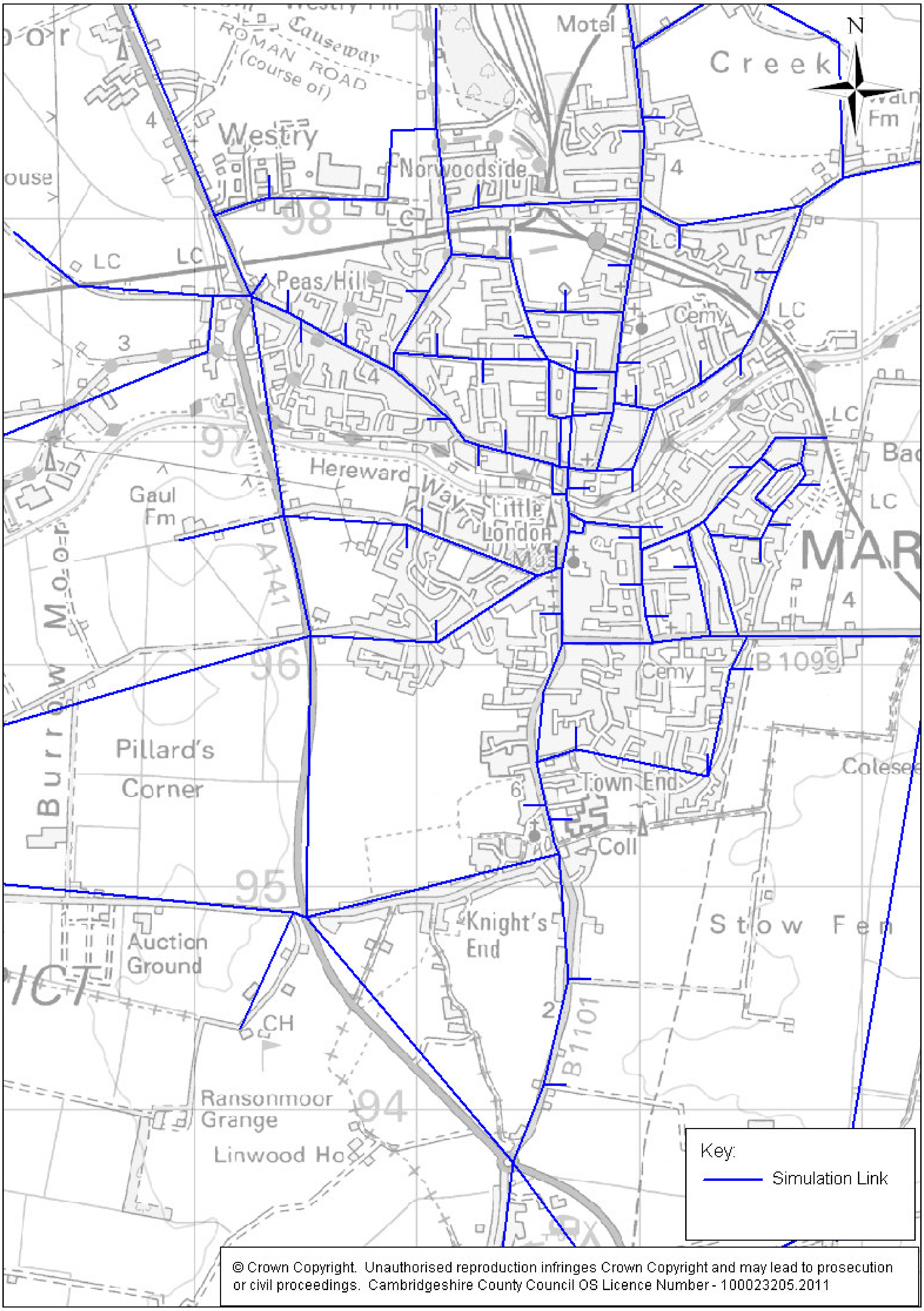


**Figure B.2 – MATS Network (March)**



## MATS Sector System

B.2 Figure B.3 and Figure B.4 below show the MATS 8 sector system.

**Figure B.3 – MATS Sector System (Overview)**

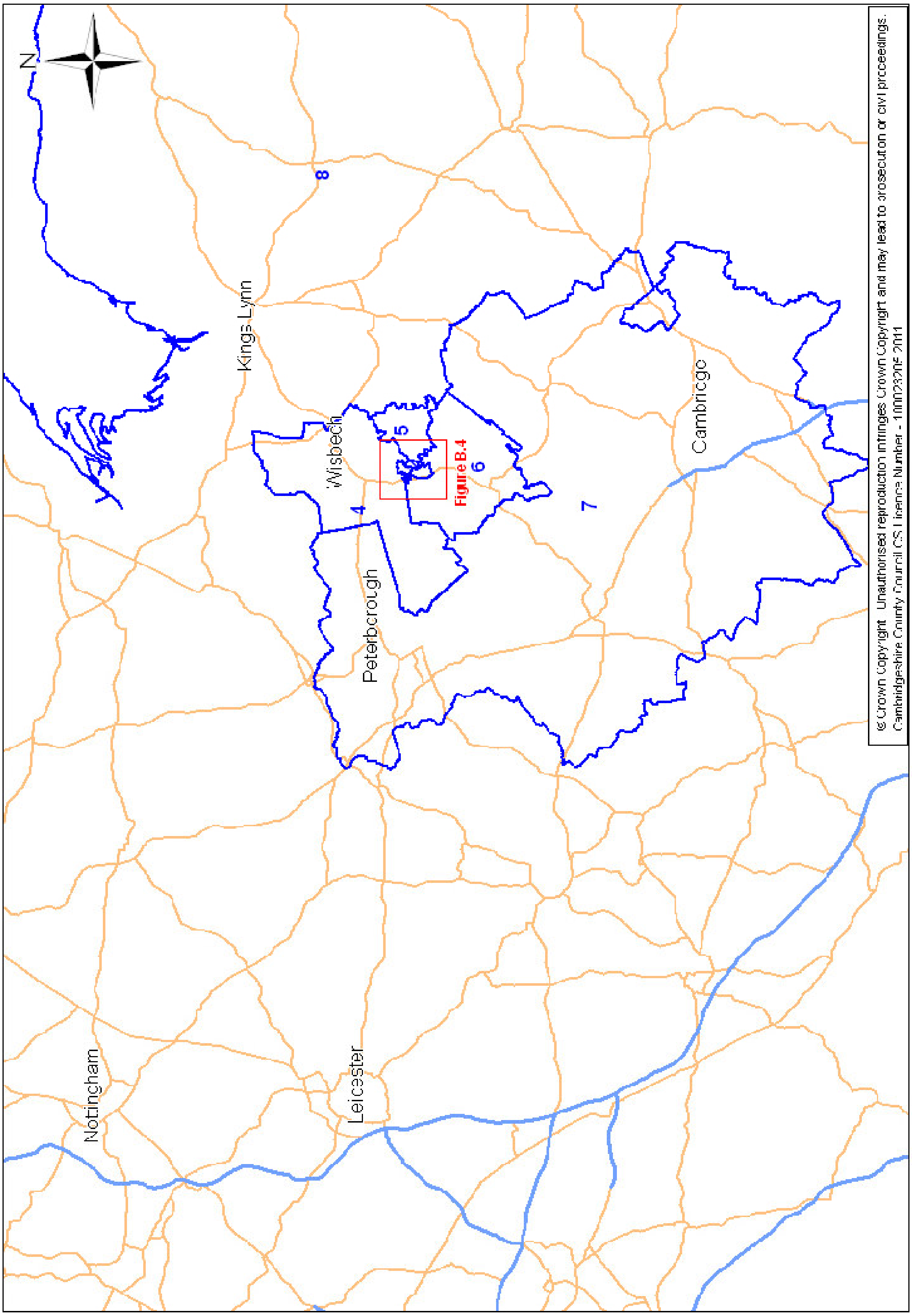
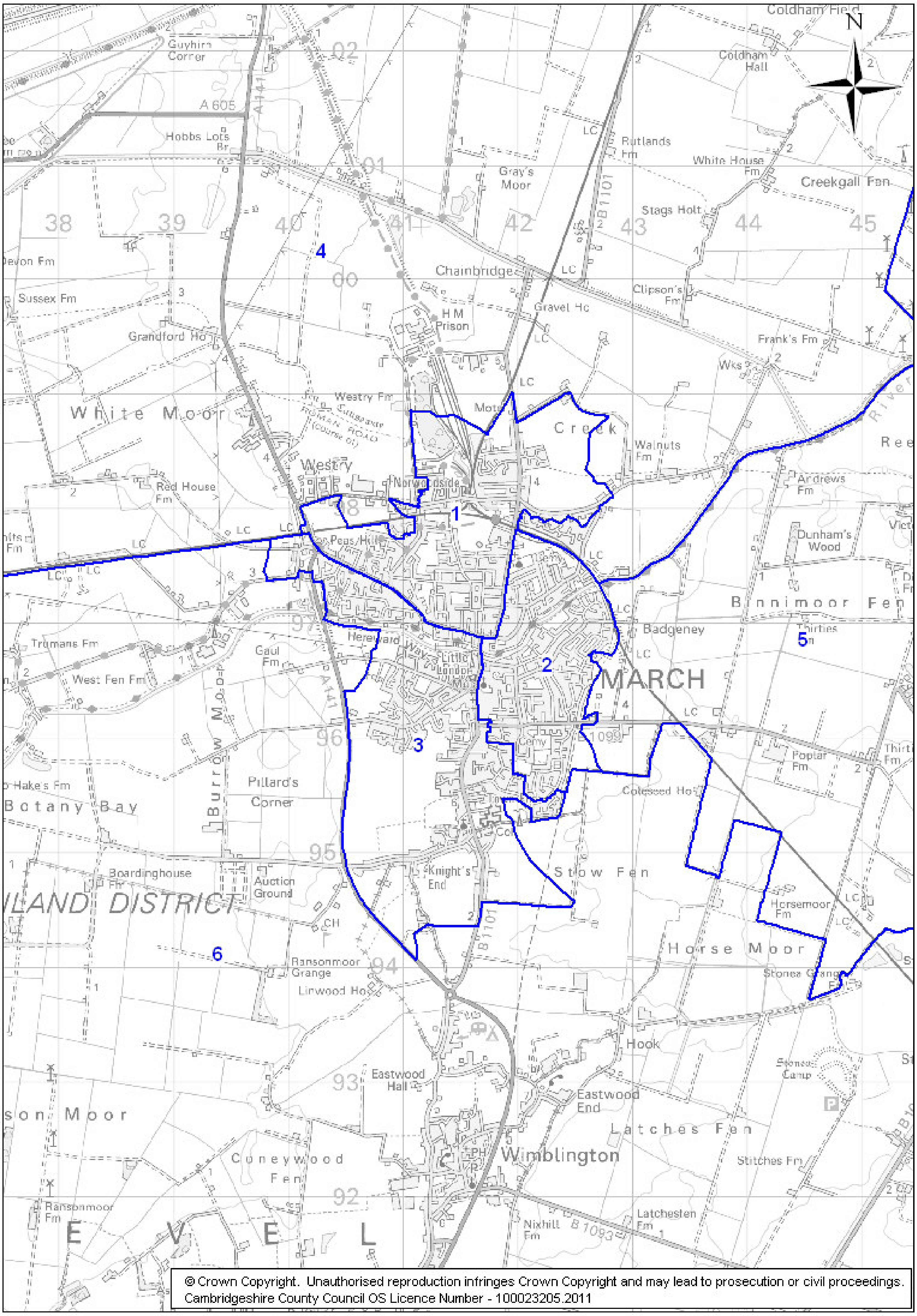


**Figure B.4 – MATS Sector System (March)**



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