

METROWEST Highway Model Local Model Validation Report

Prepared for
West of England Authorities

08 October 2015

CH2MHILL®

1 The Square
Temple Quay
Bristol
BS1 6DG

Document History

GBATS4M Model Update

METROWEST Highway Model LMVR

West of England Authorities

This document has been issued and amended as follows:

Version	Date	Description	Created by	Verified by	Approved by
1.0	17.10.2014	Initial Draft Report	Pete Knightbridge		
1.1	14.4.2015	Draft Report	Pete Knightbridge	Katherine Williams	Chris Bushell
1.2	08.10.2015	Final Report	Pete Knightbridge	Katherine Williams	Chris Bushell

Contents

Section	Page
Introduction	6
1.1 Background	6
1.2 Report Structure	7
Model Usage and Design Considerations	8
2.1 MetroWest.....	8
2.2 Potential Further Uses	8
2.3 Model Design Considerations	8
Model Standards, Criteria and Acceptability Guidelines	10
3.1 Overview	10
3.2 Validation Criteria and Acceptability Guidelines	10
3.3 Convergence Criteria and Standards	11
3.4 Trip Matrix Changes	11
Key Features of the Model	13
4.1 Source Model.....	13
4.2 Modelling software.....	13
4.3 Base Year.....	13
4.4 Model Network Area	13
4.5 Time Periods	15
4.6 Pre Peak Queuing.....	15
4.7 Zoning System.....	15
4.8 Signal Timings	17
4.9 User Classes	17
4.10 Assignment Methodology.....	17
4.11 Representation of Car Parks	18
4.12 Generalised Cost and Parameter Values	18
4.12.1 Values of Time	18
4.12.2 Vehicle Operating Costs.....	19
Survey Data	20
5.1 Overview	20
5.2 Roadside Interview Sites.....	21
Sample Size and Logic Checks	21
5.3 Traffic Counts on Cordons and Screenlines	22
5.4 Data Processing.....	27
5.5 Journey Time Surveys	27
5.6 Accuracy of Journey Time Surveys.....	28
Network Development.....	30
6.1 Source Networks.....	30
6.2 Link Coding.....	30
6.3 Junction Coding.....	31
6.4 Centroid Connectors	31

Trip Matrix Development	32
7.1 Matrix Development process	32
7.2 GBATS3 Matrix Merge	32
7.3 RSI Data	33
7.4 Merging RSI Data	33
7.5 Calibration of the Initial Trip Matrices	34
Network Calibration and Validation	35
8.1 Network Calibration	35
8.2 Route Choice Calibration	35
8.3 Route Choice Validation	36
Trip Matrix Calibration and Validation	37
9.1 Prior Trip Matrix	37
9.2 Application of Matrix Estimation	37
9.3 Changes due to Matrix Estimation	37
9.4 Park and Ride Matrices	39
9.5 Further Trip Matrix Segmentation	39
Assignment Calibration and Validation	41
10.1 Overview	41
10.2 Cruise Times	41
10.3 Traffic Flows	43
10.4 Journey Times	49
10.5 Model Convergence	50
10.6 Stress Test	50
Conclusion	51
11.1 Overview	51
Appendix A: Other Traffic Count Sites	52
Appendix B: Network Coding Standards	54
Appendix C: Matrix Estimation Checks	56
Appendix D: Route Choice Calibration	62
Appendix E: Traffic Link Flow Validation	77
Appendix F: Distance-Travel Time Graphs	104
Appendix G: Model Convergence Graphs	105

Figures

Figure 1.1 - GBATS3 Localised Core Areas	6
Figure 1.2 - GBATS4M Modelling Suite.....	7
Figure 2.1 - Metro Corridors	8
Figure 4.1 - GBATS4M Highway Model Central Modelled Area.....	14
Figure 4.2 - GBATS4M Highway Model Fully Modelled Area.....	14
Figure 4.3 - GBATS4M Central Model Area Zones	16
Figure 4.4 - GBATS4M Wider Model Area Zones	16
Figure 5.1 - City Centre RSI Locations	21
Figure 5.2- Calibration Traffic Count Sites	26
Figure 5.3- Validation Traffic Count Sites	26
Figure 5.4 - GBATS4M Highway Model Journey Time Survey Routes	28
Figure 6.1 - GBATS4M Free Flow Speed.....	31
Figure 9.1 - GBATS4M Sector Plan.....	38
Figure 10.1 - AM Peak Traffic Flow Validation and Calibration Screenlines	44
Figure 10.2 - Inter Peak Traffic Flow Validation and Calibration Screenlines	46
Figure 10.3 - PM Peak Traffic Flow Validation and Calibration Screenlines	48

Tables

Table 3.1 - DMRB Acceptability Guidelines.....	10
Table 3.2- TAG M3.1 Convergence Criteria.....	11
Table 3.3 - TAG M3.1 Significance of Matrix Estimation changes	12
Table 4.1 - Vehicle to PCU Factors	17
Table 4.2 - Generalised User Class - Value of Time and Distance	19
Table 5.1 - Calibration Traffic Count Data	23
Table 5.2 - Validation Traffic Count Data	25
Table 5.3 – Monthly Traffic Flow Factors	27
Table 5.4 - Annual Traffic Flow Factors	27
Table 5.5 - Accuracy of Journey Time Data.....	29
Table 7.1 – CSM RSI Locations Used	32
Table 7.2 - Initial Trip Matrix Comparison	34
Table 9.1 - Matrix Estimation (Prior vs Post ME2 matrix) Regression Analysis Summary	38
Table 9.2 - Matrix Estimation (Prior vs Post ME2 matrix) Total Mean Trip Length	38
Table 9.3 - Matrix Estimation (Prior vs Post ME2 matrix) Sector Matrix Changes	39
Table 9.4 - RSI Light Vehicle User Class Splits	39
Table 9.5 - RSI Light Vehicle User Class Splits	40
Table 10.1 – Inter-Peak Model Cruise Time Check.....	42
Table 10.2 – AM Peak Link Flow Validation Summary.....	43
Table 10.3 – Inter Peak Link Flow Validation Summary.....	45
Table 10.4 – PM Peak Link Flow Validation Summary.....	47
Table 10.5 - GBATS4M Net Journey Time (mins) Validation	49
Table 10.6 - GBATS4M Convergence Summary	50

Figures contain Ordnance Survey Data - Crown Copyright All Rights Reserved. Bristol City Council 100023406

Introduction

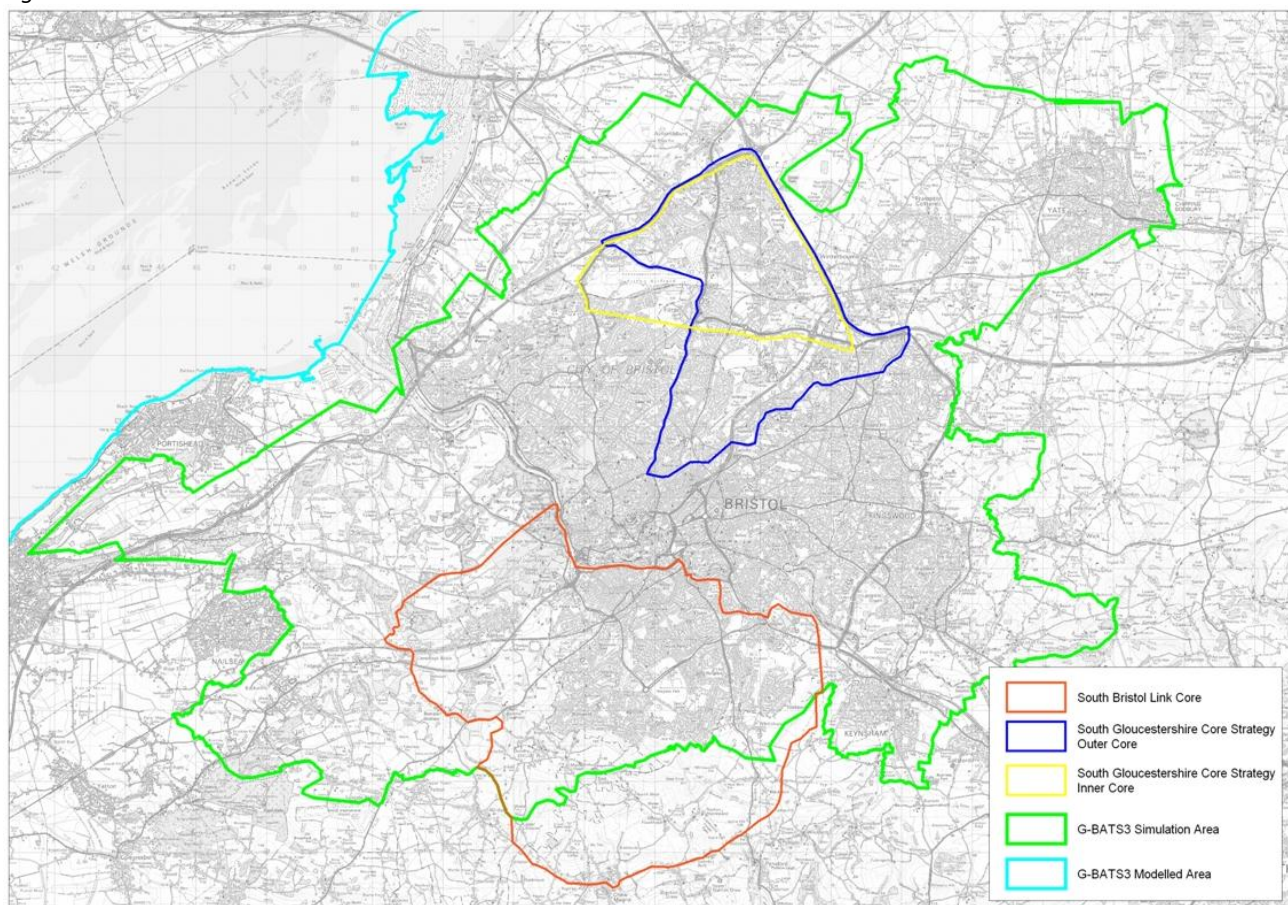
1.1 Background

This report has been prepared by CH2M Hill as part of their commission to update the Greater Bristol Area Transport Study (GBATS) modelling suite for Bristol City Council (BCC), on behalf of the West of England authorities.

The updated GBATS model has been specified to be suitable for assessing the MetroWest major scheme Phases 1 and 2. The Bristol Area Traffic Study (BATS) model was originally built and validated to a base year of 2001. Since then it has been updated to BATS2 as a part of the Greater Bristol Bus Network study in 2004 and further updated to the GBATS3 strategic model with a base year of 2006. The GBATS3 model was used as the starting point for four localised studies. In each case the model was updated, recalibrated and revalidated with the local study area core as its focus. Figure 1.1 shows the core areas of the localised models. The four studies are below:

- Ashton Vale to Temple Meads Rapid Transit (AVTM, 2006 Base year, 580 active zones);
- Northern Fringe to Hengrove Package (NFHP, 2009, 584);
- South Bristol Link (SBL, 2009 & 2012, 616); and
- South Gloucestershire Core Strategy (SGCS, 2011, 591).

Figure 1.1 - GBATS3 Localised Core Areas



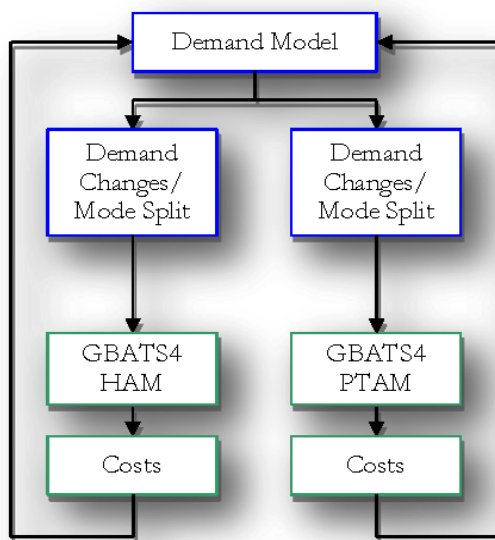
The updated model is called the GBATS4 Metro Model (GBATS4M). The GBATS4M model consists of:

- A Highway Assignment Model representing vehicle based movements across the Greater Bristol area for a 2013 autumn weekday morning peak hour (08:00-09:00), an average inter-peak hour (10:00-16:00) and an evening peak hour (17:00-18:00);
- A Public Transport (PT) Assignment Model representing bus and rail based movements across the same area and time periods; and
- A five-stage multi-modal incremental Variable Demand Model (VDM) that forecasts changes in trip frequency and choice of main mode, time period of travel, destination, and sub-mode choice, in response to changes in generalised costs across the 12-hour period (07:00 – 19:00).

The GBATS4M highway model is closely integrated with the GBATS4M PT model. The two models use different software packages (SATURN and EMME, respectively) but are identical in terms of road network structure, and zone system. The bus routes and frequencies in the PT model are used in the highway model.

The GBATS4M highway model is fully integrated within the GBATS4M VDM. The GBATS4M highway model provides highway transport costs to the GBATS4M VDM which, in turn, provides trip matrices for the GBATS4M highway model. The relationship between the elements of the modelling system is shown in Figure 1.2.

Figure 1.2 - GBATS4M Modelling Suite



1.2 Report Structure

This model development report consists of the following sections, after the Introduction:

- Section 2 – Model Usage and Design Considerations;
- Section 3 – Model Standards, Criteria and Acceptability Guidelines;
- Section 4 – Key Features of the model;
- Section 5 – Survey Data;
- Section 6 – Network Development;
- Section 7 – Trip Matrix Development;
- Section 8 – Network Calibration and Validation;
- Section 9 – Trip Matrix Calibration and Validation;
- Section 10 – Assignment Calibration and Validation and
- Section 11 – Conclusion

SECTION 2

Model Usage and Design Considerations

2.1 MetroWest

The GBATS4M modelling suite provides a tool with which to test the ability of future transport proposals to support forecast travel demand. At a general level this includes:

- Investigation of new development proposals; and
- Longer-term strategic planning of the transport network.

The specific purpose of the model is for assessing the MetroWest major scheme Phases 1 and 2. Figure 2.1 shows a schematic of the MetroWest scheme. The primary focus of GBATS4M highway model is the MetroWest scheme corridors.

2.2 Potential Further Uses

The GBATS4M modelling suite could (with further validation if necessary) also be used to forecast and assess a range of alternative potential interventions. While not a definitive list, the following future year schemes could potentially be assessed:

- Bristol Arena
- Temple Circus Roundabout / Redcliffe Way;
- Temple Quarter Enterprise Zone;
- Central Area Action Plan;
- Changes to bus operations;
- Park and Ride schemes;
- North Fringe VISSIM interface;
- Strategic wider area schemes; and
- Major development proposals in the wider urban area.

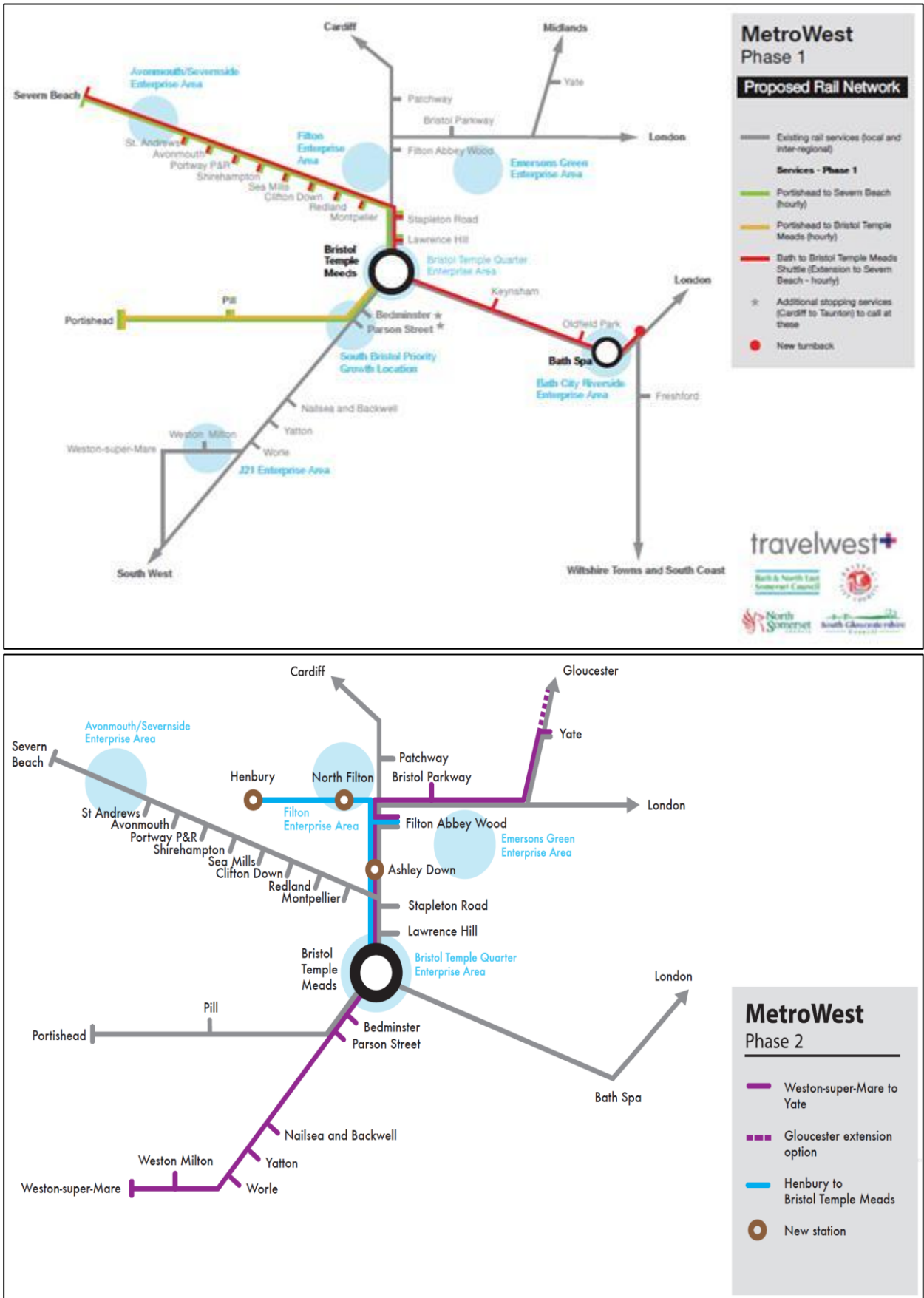
2.3 Model Design Considerations

The principal objective of the GBATS4M highway model is to represent travel conditions on the highway network for the appraisal of the MetroWest scheme and should therefore provide:

- changes in the travel cost between the base year and forecast years for input to the GBATS4M VDM;
- changes in traffic flows along the MetroWest corridors for input to the appraisal; and
- changes in wider area travel costs for input to the economic appraisal.

The GBATS4M highway model is a SATURN model updated from the most recent versions of the GBATS3 highway model (South Bristol Link, 2012 and SGCS, 2011). In order to improve the model validation the focus has been to update the trip matrices and network along the routes most likely to be most affected by MetroWest. To facilitate this, a programme of traffic counts and trip pattern surveys were undertaken around Bristol. Where available, reliable existing survey data was also utilised. Details are provided in section 5.

Figure 2.1 - Metro Corridors



SECTION 3

Model Standards, Criteria and Acceptability Guidelines

3.1 Overview

The model has been designed and developed using the UK Department for Transport (DfT) Transport Analysis Guidance (TAG). The current, relevant guidance is DfT TAG UNIT M3.1 Highway Assignment Modelling, January 2014. Referenced throughout this report as: 'TAG M3.1'.

3.2 Validation Criteria and Acceptability Guidelines

Highway model validation acceptability guidelines are specified in TAG M3.1. However, TAG M3.1 states if these guidelines are not met this does not necessarily mean the model is not 'fit for purpose', or indeed if they are met that the model is automatically deemed so. If these criteria cannot be fully met, the importance of the relevant locations to overall model validation and assessment of proposed schemes should be reviewed to ensure the model is still fit for purpose. Further, TAG M3.1 states if necessary the impact of matrix estimation should be reduced so that they do not become significant, and a lower standard of validation reported.

The validation criteria and acceptability guidelines as specified in TAG M3.1 are shown in Table 3.1 below. The observed flow and screenline flow criteria are applied to "all vehicles" and "cars/LGVs".

Table 3.1 - DMRB Acceptability Guidelines

Table 5.12 Link Acceptability Guidelines

Criteria and Measure		Acceptability Guideline	
Flow Difference Criteria			
1	Total screenline flows (normally > 5 links) to be within +/- 5%	All (or nearly all) screenlines	
2	Observed (individual) link flow < 700vph	Modelled flow within +/- 100vph	> 85% of links
	Observed (individual) link flow 700 to 2700vph	Modelled flow within +/- 15%	> 85% of links
	Observed (individual) link flow > 2700vph	Modelled flow within +/- 400vph	> 85% of links
GEH Criteria			
3	GEH statistic for individual link flows <5		> 85% of links
Journey Time Validation			
4	Modelled times along routes should be within 15% (or 1 minute, if higher)		> 85% of links

The GEH statistic, included in Table 3.1, is used as an indicator of the extent to which the modelled flows match the corresponding observed flows. This is recommended in the guidelines contained in TAG M3.1 and is defined as:

$$GEH = \sqrt{\frac{(M - C)^2}{0.5(M + C)}}$$

Where:

M = modelled flow; and

C = observed flow.

3.3 Convergence Criteria and Standards

SATURN is specifically designed to model congested networks which contain alternative routes between zones. The software uses algorithms which seek to achieve Wardrop's First Principle of Traffic Equilibrium and provides the following (TAG M3.1) recommended convergence indicators:

- The percentage of links on which flows or costs change by less than a fixed percentage between successive iterations;
- The difference between the costs along the chosen routes and those along the minimum cost routes, summed across the whole network, and expressed as a percentage of the minimum costs, usually known as 'Delta' or the '%GAP'.

To ensure a satisfactory model convergence, TAG M3.1 recommends the criteria shown in Table 3.2.

Table 3.2- TAG M3.1 Convergence Criteria

Criteria and Measure	Type	Acceptable values
Delta and %GAP	Proximity	Less than 0.1% or at least stable with convergence fully documented and all other criteria met
Percentage of links with flow change (P) < 1% or Percentage of links with cost change (P2) < 1%	Stability	Four consecutive iterations greater than 98%

TAG M3.1 (section 3.3.6 and 3.3.7) states the following:

“The percentages of links with small flow or cost changes both provide pragmatic views of the stability of the assignment, rather than the degree of convergence. The measures are necessary but not sufficient indicators of convergence. It is recommended that, in addition to satisfying the true convergence measures described below, assignment model iterations should continue until at least four successive values of 'P' or 'P2' in excess of 98% have been obtained. If this cannot be achieved, especially in a future year assignment, this may be an indication of instability caused by the level of traffic demand being higher than can be absorbed by the network capacity. “

“The Delta statistic or %GAP is a truer measure of convergence. Delta values generally decrease towards a minimum value as the number of iterations increases but will not do so monotonically....Delta should be used as the first choice measure of assignment convergence. “

The terminating criteria for the assignment-simulation iterative procedure used in the model are based on the %GAP criteria, with further checks on the “stability” criteria.

3.4 Trip Matrix Changes

The development of 'prior' matrices, using OD survey data for city centre trips and the use of the source highway models (SBL and SGCS) 'prior' matrices, has been undertaken. TAG M3.1 recommends that the changes brought about by matrix estimation should be carefully monitored by the following means:

- scatter plots of matrix zonal cell values, prior to and post matrix estimation, with regression statistics (slopes, intercepts and R2 values);
- scatter plots of zonal trip ends, prior to and post matrix estimation, with regression statistics (slopes, intercepts and R2 values);

- trip length distributions, prior to and post matrix estimation, with means and standard deviations; and
- sector to sector level matrices, prior to and post matrix estimation, with absolute and percentage changes.

The changes brought about by matrix estimation should not be significant. The criteria by which the significance of the changes brought about by matrix estimation may be judged are given in Table 3.3.

Table 3.3 - TAG M3.1 Significance of Matrix Estimation changes

Criteria and Measure	Significance Criteria
Matrix zonal cell levels	Slope within $0.98 < \text{Slope} < 1.02$, Intercept near zero, R^2 in excess of 0.95
Matrix zonal trip ends	Slope within $0.99 < \text{Slope} < 1.01$, Intercept near zero, R^2 in excess of 0.98
Trip length distributions	Means within 5%, Standard deviations within 5%
Sector to sector level matrices	Differences within 5%

Key Features of the Model

4.1 Source Models

The GBATS3 SBL 2012 model was the main source model used as a starting point for the initial parameters and majority network area of GBATS4M highway model. The SGCS 2011 model network and zone structure was used as the primary source for the North Fringe area of GBATS4M highway model by merging the two models.

The source models have been used as a starting point since they have been developed using TAG-compliant processes and successfully supported schemes through statutory processes which have been open to public scrutiny.

4.2 Modelling software

The GBATS4M highway model uses SATURN version 11.2.05 whilst both VDM and PT model use INRO EMME 4.11

4.3 Base Year

The GBATS4M modelling system has a 2013 base year and represents the travel conditions for a typical October weekday.

4.4 Model Network Area

The GBATS4M highway model area retains the same/similar geographical coverage as the GBATS3 source model, i.e. the 'simulation' (detailed) network extends to cover the Bristol urban area, roughly to the boundary of the West of England Partnership (WEP). Outside this area a 'buffer' network and zone system is used to cover the rest of the UK.

The focus of the improvements for the GBATS4M was primarily the corridors most likely to be impacted by MetroWest, the central area and key radial routes. This included a review / update of all bus routes and bus priority measures in the central area and radial routes approaching the centre. The red line in Figure 4.1 shows the area considered to be the central area in this regard. This corresponds to the middle cordon, used for data collection purposes as referred to in section 5.

Figure 4.2 shows the wider model area, including the extents of both the simulation and buffer network.

Figure 4.1 - GBATS4M Highway Model Central Modelled Area

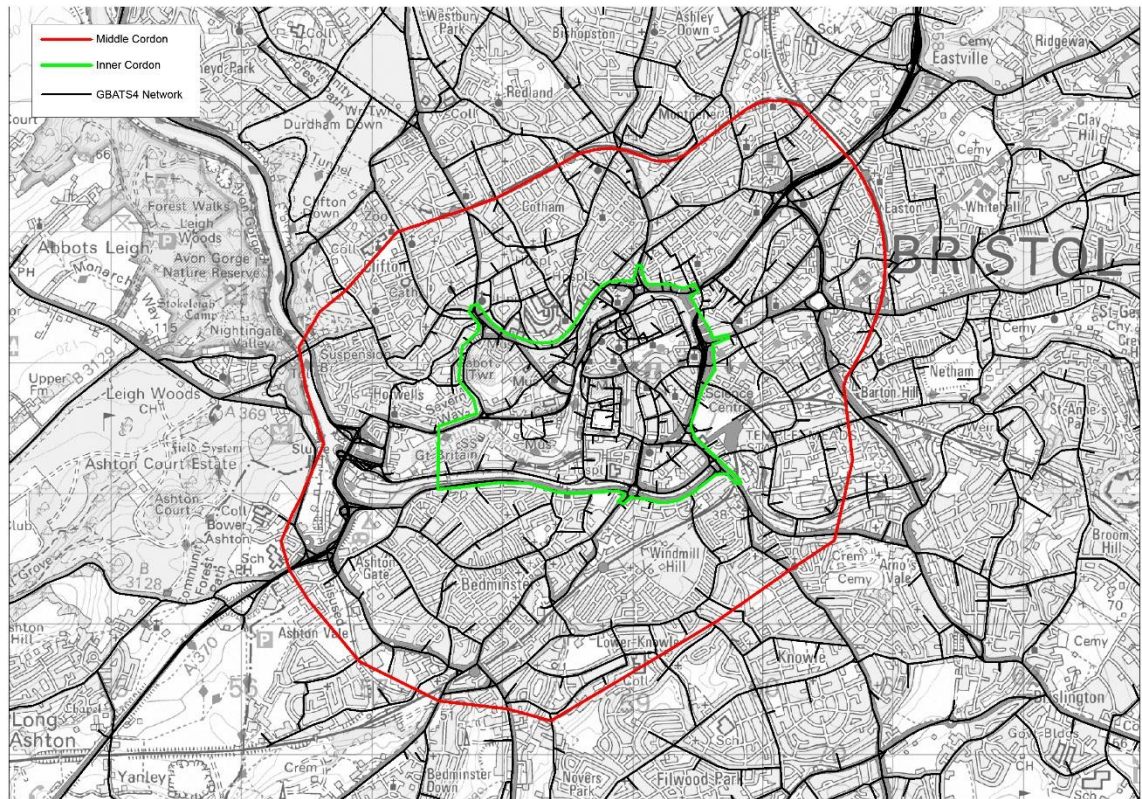
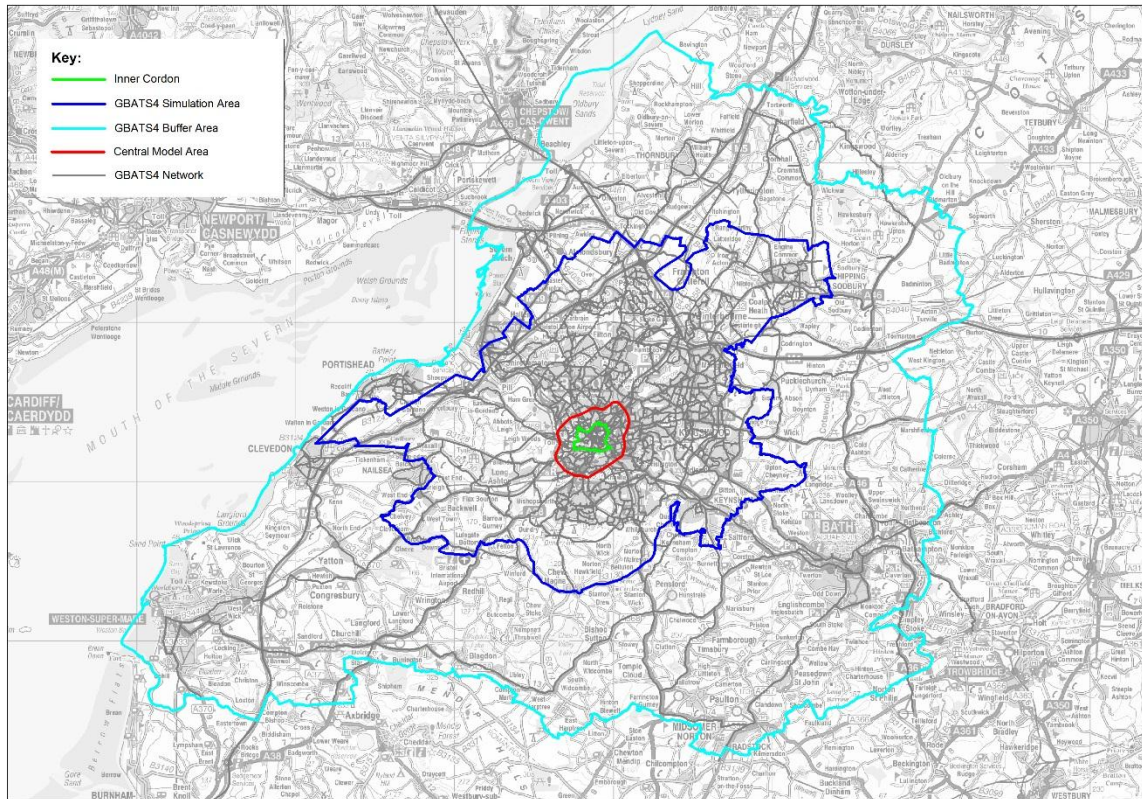


Figure 4.2 - GBATS4M Highway Model Fully Modelled Area



4.5 Time Periods

The GBATS4M highway model is based on trip making patterns on a typical October weekday in 2013. Data relating to other times was normalised to match this date.

Following a review of local traffic count data, the three modelled time periods have been retained from the source model as follows:

- AM peak, representing hourly traffic flow between 08:00 and 09:00;
- Inter peak, representing average hourly traffic flow between 10:00 and 16:00; and
- PM peak, representing hourly traffic flow between 17:00 and 18:00.

4.6 Pre Peak Queuing

For SATURN to adequately represent network performance in congested urban conditions, information on the amount of traffic queuing in the network at the start of the modelled hour is needed. The PASSQ option in SATURN enables this feature and requires information about queuing from the previous hour.

The PASSQ option has been used for the AM and PM peak models and has been derived from factoring the matrix for the relevant peak to represent the previous model hour; 07:00-08:00 for the AM peak and 16:00-17:00 for the PM peak. Initial factors have been developed based on averages of representative counts across the model area. PASSQ flows/queues passed to the peak have been checked to ensure they are not higher than observed flows for the peak hour. The pre-peak counts for both the AM and PM were sufficiently close to the peak hour, that 100% of the peak traffic was used in the pre-peak hours.

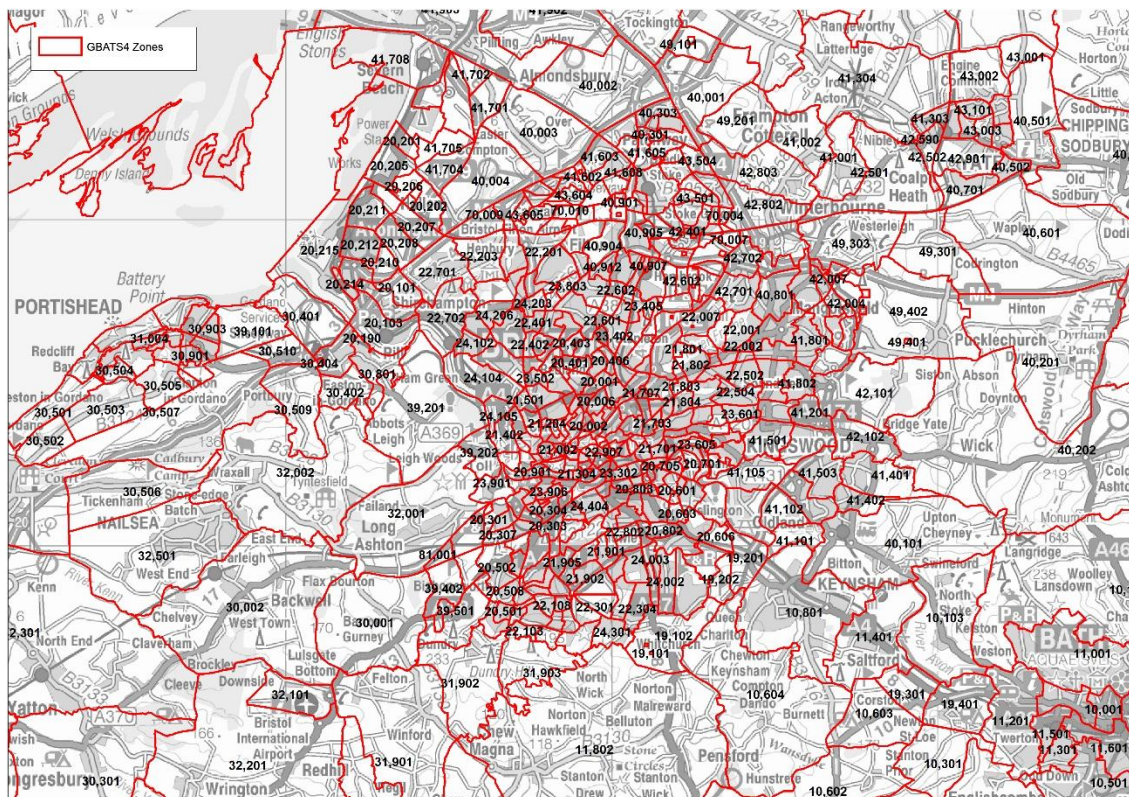
4.7 Zoning System

The GBATS4M highway model zone system and network structure exactly matches that of the PT model.

The GBATS4M modelling suite zoning system comprises 650 zones covering the whole of Great Britain. A detailed zoning system was developed to represent the Greater Bristol Urban area and its surroundings. This is shown in Figure 4.3 and 4.4.



Figure 4.4 - GBATS4M Wider Model Area Zones



4.8 Signal Timings

Signal timings and staging were inherited from the GBATS3 models, thorough checks were undertaken to correct any anomalies along the MetroWest corridors and key junctions, such as the Hambrook interchange, using local knowledge, past experience and traffic flow data.

4.9 User Classes

The development of the GBATS4M highway model matrices initially incorporated two user classes, namely cars / light goods vehicles and heavy goods vehicles. PCU factors for the different classes in GBATS4M highway model are shown in Table 4.1.

Following validation of the two-user class model, the matrices were segmented to six user classes as follows for use in forecasting:

- Car, Non-business (low Income);
- Car, Non-business (medium Income);
- Car, Non-business (high Income);
- Car business;
- Light Goods Vehicles; and
- Heavy Goods Vehicles (HGVs).

TAG M3.1, App D, provides two PCU values for HGVs: 2.5 PCUs for motorways and all-purpose dual carriageways or 2.0 PCUs for all other road types. SATURN only allows for one value to be used within the model. It is assumed that the motorway network around the Bristol conurbation influences the distribution of through trips on the local road network so the higher value has been used throughout.

Table 4.1 - Vehicle to PCU Factors

Type	Car/LGV	HGV	Bus
Equivalent PCUs	1.0	2.5	3.0

4.10 Assignment Methodology

The GBATS4M highway model uses SATURN assignment software. SATURN uses the SATALL module to iterate between successive loops of SATASS module (which assigns the user class matrices to the network in accordance with Wardrop's First Principle of Traffic Equilibrium using the Frank-Wolfe algorithm) and SATSIM module (which takes the flows derived by SATASS and calculates the revised flow/delay relationships at each junction within the simulated area) until the resulting travel times and flows do not change significantly (that is, the process has 'converged').

The process starts with SATASS using the free-flow times (without any delays arising from vehicle interactions at the simulated junctions) from the network building program, SATNET. After the first set of path-builds in SATASS, the resulting flows are passed to SATSIM for the turn-based flow/delay curves representing the detailed interactions at each junction to be updated. These revised flow/delay relationships are passed back to SATASS for the travel time and flows to be recalculated. Further details may be found in the SATURN User Manual.

The choice of convergence algorithm used for the final GBATS4M assignment is detailed in the separate note: "GBATS4M Assignment Methodologies TN1 September 2014".

4.11 Representation of Car Parks

The highway model does not represent car parks explicitly. There is a fine zoning system within the central area, which covers some car parks. The trip matrix is based on ultimate origin or destination zone rather than the zone in which the vehicle is parked. As a result there are no associated car parking charges and parking capacities modelled within the highway model. However, average parking charges are reflected in the VDM, and hence reflected in the GBATS4M mode split and destination choice calculations.

4.12 Generalised Cost and Parameter Values

The generalised cost functions described in TAG M3.1 for trip routeing in the model are applied with parameters derived from TAG A1.3 (May 2014) *“User and provider impacts”* and the WebTAG Databook, May 2014. This relates travel costs to a combination of travel time and the cost per kilometre in terms of vehicle operating and maintenance. The value of time varies by purpose (either working or non-working time), vehicle type and occupancy levels. Similarly, operating and maintenance costs are journey purpose and vehicle dependent and vary by speed.

The speed assumed in the derivation of the generalised cost parameters is the average network speed in the source model.

All monetary values are calculated at 2013 prices.

4.12.1 Values of Time

Perceived values are used throughout. Note that, in the case of HGVs, and cars and LGVs in work time, the perceived and resource values are the same. The process is summarised below:

- equivalent 2013 values were calculated by applying the specified growth in working and non-working values of time, set at 2010 values, (Table A1.3.2 in the Databook) together with the change in prices using the RPI index;
- the relative proportions of Car Non-work for ‘Other’ and ‘Commuting’ were calculated from the RSI surveys;
- the equivalent values for vehicles were calculated by applying the occupancies obtained from the 2013 RSI surveys;
- HGV travel was assumed to be in work time with the split between OGV1 and OGV2 recorded from the RSI surveys; and
- The values were converted from £ per hour to p/min.

4.12.2 Vehicle Operating Costs

Vehicle Operating Costs were calculated using TAG A1.3 (May 2014) and defined separately for fuel and non-fuel elements before being combined for the use in the SATURN assignment. Non-fuel costs were only taken into consideration by travellers in work-time.

Fuel Costs

The consumption of fuel, adjusted by the fuel efficiency factors, was multiplied by the cost per litre to provide the cost per km in the model base year (2013), using the formula below from TAG A1.3.

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

Where: L = 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.

Fuel duty was included in the calculations as a perceived cost as businesses are not able to reclaim it. However, VAT was excluded because businesses are able to recover it. For non-work purposes, the perceived cost of the fuel Vehicle Operating Cost was the market price. LGV fuel costs were derived using the same work/non-work proportions used to calculate their average Value of Time.

Non-Fuel Costs

The non-fuel cost element was derived using the formula set out in TAG A1.3 and was a function of average network speed.

$$C = a_1 + b_1/v$$

Where: C = cost in pence per kilometre travelled;

a₁ is a parameter for distance related to costs defined for each vehicle category

b₁ is a parameter for vehicle capital saving defined for each vehicle category (only for work vehicles)

v = average link speed in kilometres per hour;

The cost was calculated using the same average network speeds from the source model and the fuel costs converted from 2010 to 2013 prices. No further adjustments were required as the non-fuel costs were assumed to remain constant, in real terms, over time. As noted above, the non-fuel cost element was only included for work trips.

Assignment Parameters

The resulting assignment parameters are summarised below in Table 4.2.

Table 4.2 - Generalised User Class - Value of Time and Distance

User Class	AM Peak		Inter Peak		PM Peak	
	Time (PPM)	Distance (PPK)	Time (PPM)	Distance (PPK)	Time (PPM)	Distance (PPK)
Car - Non Business Low Income	9.28	8.28	12.98	8.18	11.75	8.33
Car - Non Business Medium Income	12.95	8.28	16.38	8.18	15.25	8.33
Car - Non Business High Income	18.27	8.28	20.70	8.18	19.90	8.33
Car - Business	49.25	13.22	49.25	13.12	49.25	13.27
LGV	19.27	18.40	19.27	18.29	19.27	18.49
HGV	22.70	37.27	22.70	37.25	22.70	37.36

Note: All values in pence (2013 prices)

SECTION 5

Survey Data

5.1 Overview

The highway model matrix development included the use of new (2013) roadside interview (RSI) and count data. The model calibration and validation was undertaken using two types of survey data, namely traffic counts and journey times.

Traffic counts were required for expanding new RSI data, calibrating trip matrices and validating the model. Journey times were required for calibrating cruise speeds and validating the model.

Traffic count data was provided by local authorities and the Highways Agency (now Highways England) data from the TRADS website. Count data was available in a number of forms including:

- Manual classified counts (MCC);
- Temporary automatic traffic counts (ATC) on non-trunk/motorway roads;
- Permanent ATCs on non-trunk/motorway roads;
- Traffic signals (UTC);
- Junction turning counts; and
- TRADS counts on motorways.

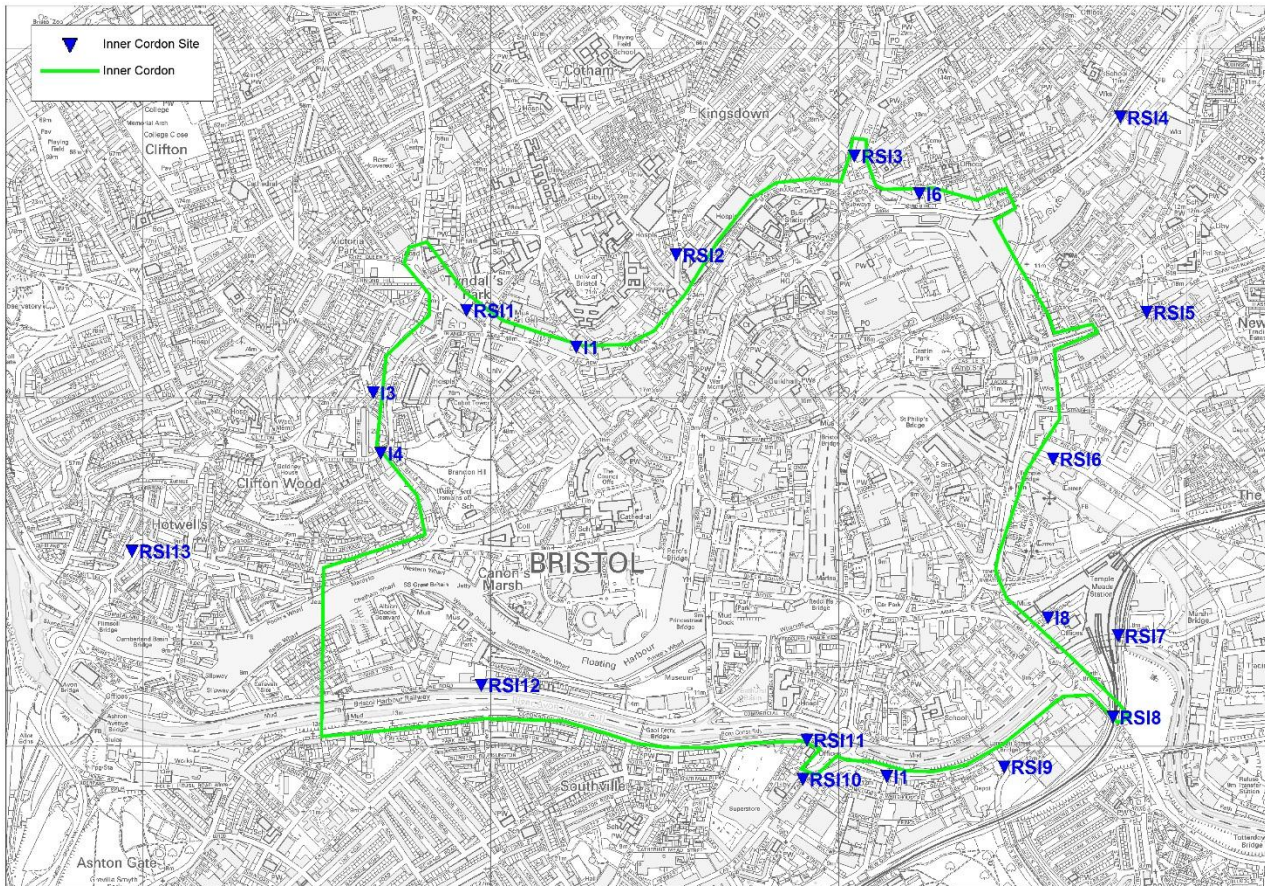
Observed Journey time data was examined using Trafficmaster™ journey time data supplied to the local authorities by the Department for Transport. Trafficmaster™ journey time data uses anonymised data for a large volume of vehicle types (cars, light and heavy vehicles) specially equipped with GPS devices. These devices record speed and location information which is collated, digitally mapped and matched to the Integrated Transport Network (ITN) layer. Any link that has been traversed by a Trafficmaster™ vehicle within each 15 minute time period within the day has a Trafficmaster record™. Separate records are created for each vehicle class.

Further details of surveys are reported in the 'GBATS4 Model Update - Report of Surveys and Existing Data Review'.

5.2 Roadside Interview Sites

A series of RSI surveys, which form the inner cordon of the GBATS4M highway model, were undertaken. They provided accurate origin/destination data for trips entering/exiting the city centre area. Figure 5.1 shows the location of the RSI sites (labelled RSI'n'), which cover the busiest routes across the inner cordon, and other locations. Minor roads were not covered by RSI surveys (labelled as I'n').

Figure 5.1 - City Centre RSI Locations



Sample Size and Logic Checks

The Design Manual for Roads and Bridges (DMRB) Volume 5, Section 1, Part 4, 'Traffic surveys by Roadside Interview'. Annex 8 contains advice on the sample size required to give results to a sufficient level of accuracy. The equation used to calculate the sample size required is as follows:

$$q = \frac{P(1-P)Q^3}{(E/1.96)^2(Q-1) + P(1-P)Q^2}$$

Where:

q = Sample size

P = Proportion of vehicles with a particular attribute

Q = Total traffic flow

E = Level of accuracy (expressed as a no. of vehicles)

The above equation requires an estimate to be made for the number of trips being made to a particular zone (P). Annex 8 states that "When data is being collected for a large multi-zoned modal, it is impossible

to calculate this for every O-D pair for each RSI site as the origins and destinations are not yet known. Once a survey site has been established it is best practice to collect as much data as reasonably practical.”

A total of 10007 surveys were conducted/received. Of these 9027 (90%) were flagged by the survey company as being “valid” while 980 were flagged as “invalid”. Reasons for survey records being flagged as invalid include round trips, partial completion, complete refusal or illogical movements (where a stated trip origin or destination does not appear to match with the interview point). More detailed checks were then carried out during matrix development to assess whether any of the “invalid” survey records could be utilized and double checking the surveys deemed “valid”. After this process 8324 (83%) were seen as “valid” trips to be used for updating the matrix.

The “valid” trips were determined by geocoding each RSI origin and destination record to a zone number based on its Ordinance Survey Grid Reference appended to it. Checks were undertaken to ensure that all characteristics of a trip fell within predefined ranges, such as specified ranges for vehicle type definition, occupancy and trip purpose. Logic checks were also undertaken and to assist in this process the 650 zone system was redefined as 22 sectors.

Full details of the sample rates achieved for each site and vehicle type are shown in the ‘GBATS4 Model Update - Report of Surveys and Existing Data Review’.

5.3 Traffic Counts on Cordons and Screenlines

A wide range of traffic counts, forming a number of calibration and validation screenlines and cordons, across the area were conducted. Screenlines and cordons were selected to capture all the major trip movements. The screenlines were designed to be sufficiently long to show the quality of the matrix and the cordons were intended to be suitably ‘watertight’ and include all main roads in the network that intersect them.

The calibration screenlines were the inner cordon, South, East, North West Inner, River and Railway sections of the city as shown in Figure 5.2.

The validation screenlines were the Outer, Middle and North West Outer and North East cordons as shown in Figure 5.3.

Any data not collected in October 2013 was adjusted using the using factors described in the next section. Tables and figures summarise the count locations as follows:

- Tables 5.1 and 5.2 provide details of the various counts used for calibration and validation.
- Figure 5.2 shows the location of all Calibration traffic count sites.
- Figure 5.3 shows the location of all Validation traffic count sites.

Further details of Highways Agency TRADS count sites (from October 2013), Wider Area and Central area sites can be found in **Appendix A**.

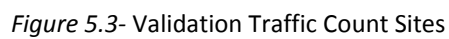
Table 5.1 - Calibration Traffic Count Data

	Ref No.	Source	Road	Location	Available Data	Date
Inner Cordon	RSI1	CH2M	A4018 Whiteladies Road	south of Queens Avenue	MCC/ATC	9/10/2013
	I5	CH2M	Woodland Rd	north of Park Row	ATC	22/06/2013
	RSI2	CH2M	Horfield Road	south of St Michaels Hill	MCC/ATC	11/10/2013
	RSI3	CH2M	A38 North Road	north of St James Barton roundabout	MCC/ATC	9/10/2013
	I6	CH2M	York Street	north of A4044 Newfoundland St	ATC	19/06/2013
	RSI4	CH2M	A4032 Newfoundland Street	at gyratory signals	MCC/ATC	9/10/2013
	RSI5	CH2M	A420 Old Market Street	east of Old market roundabout	MCC/ATC	9/10/2013
	RSI6	CH2M	Avon Street	east of Temple Way	MCC/ATC	9/10/2013
	I8	CH2M	Station Approach Rd	in/out of Temple Meads	ATC	19/06/2013
	RSI7	CH2M	Feeder Road	north of Bath Bridge roundabout	MCC/ATC	9/10/2013
	RSI8	CH2M	A4 Bath Road	south of Bath Bridge roundabout	MCC/ATC	11/10/2013
	RSI9	CH2M	St Lukes Road	south of railway	MCC/ATC	9/10/2013
	I1 I2	CH2M	Whitehouse Street/Spring Street	south of A370 York Rd	ATC	18/06/2013
	RSI10	CH2M	Bedminster Parade	south of Bedminster Bridge	MCC/ATC	9/10/2013
	RSI11	CH2M	A370 Coronation Road	west of Bedminster Bridge	MCC/ATC	9/10/2013
	RSI12	CH2M	Cumberland Road	west of Bedminster Bridge	MCC/ATC	9/10/2013
	RSI13	CH2M	Hotwell Road	west of Jacobs Well roundabout	MCC/ATC	15/10/2013
	I4	CH2M	Constitution Hill	west of Jacob's Wells Rd	ATC	19/06/2013
East Screenline	I3	CH2M	Lower Clifton Hill (one way)	west of Jacob's Wells Rd	ATC	19/06/2013
	E1	SGC	A4174	east of Bristol Rd	ATC	3/06/2013
	E2	CH2M	Downend Rd	west of Stanbury Av	ATC	6/03/2014
	E3	CH2M	Staplehill Rd	west of Lewington Rd	ATC	19/03/2014
	E4	CH2M	Lodge Hill	west of Cotteral Av	ATC	1/03/2014
	E5	CH2M	Two Mile Hill Rd	west of New Queens Way	ATC	1/03/2014
	E6	CH2M	Nags Head Hill	south of Nicholas Lane	ATC	1/03/2014
	E7	BCC	Crews Hole Road	north of Troopers Hill Road	MCC	29/03/2011
	E9	BCC	Bath Rd	east of Ironmould Lane	ATC	23/07/2012
Noth West InnerScreenline	NWI2	BCC	Shirehampton Rd	south of Kings Weston Rd	ATC perm, MCC	24/07/2011
	NWI3	CH2M	Henbury Rd	south of Hyland Grove	ATC	1/03/2014
	NWI4	BCC	A4018 Passage Rd	south of Eastover Close	ATC perm	10/07/2011
	NWI5		Grey Stoke Av	south of Concorde Drive	MCC	15/02/2011
	NWI7	CH2M	Southmead Rd	south of Charis Av	ATC	1/03/2014
	NWI8	BCC	Kellaway Av	south of Abbots Way	ATC perm, MCC	23/10/2011
	NWI9		Gloucester Rd	south of Wellington Hill	MCC	21/03/2011
	NWI10	CH2M	Muller Rd	north of Stottbury Rd	ATC	1/03/2014
	NWI11	CH2M	Coldhabour Lane	north of M32	ATC	1/03/2014
	NWI12	SGC	Filton Rd	west of M32	ATC perm, MCC	30/09/2013
	NWI13	SGC	Hambrook Rd	north of Curtis Lane	ATC	30/09/2013
	NWI14	SGC	Winterbourne Rd	west of Old Gloucester Rd	ATC perm, MCC	25/02/2013
	NWI15	TRADS	M4	J20-J19	TRADS	2014

	Ref No.	Source	Road	Location	Available Data	Date
South Screenline	S1	CH2M	Bridgewater Rd	north of Winford Grove	ATC	1/03/2014
	S2	BCC	Bishopsworth Rd	btw Wrigton Close	ATC_perm	3/02/2012
	S3	CH2M	St Peters Rise	south of Headley Park	ATC	27/03/2014
	S4	CH2M	Hengrove Way	east of Cater Rd	ATC	19/03/2014
	S5	CH2M	Hawkfield Rd	south of Baiscoes Av	ATC	6/03/2014
	S6	CH2M	Whitchurch Lane	south of Hawkfield Way	ATC	19/03/2014
	S7	BCC	Bamfield	north of Oatfields Av	MCC	3/02/2011
	S8	CH2M	Wells Rd	north of Hengrove Lane	ATC	19/03/2014
	S9	CH2M	Bath Rd	south of A4174	ATC	19/03/2014
	S10	CH2M	School Road	south of Allison Rd	ATC	6/03/2014
	S11	BCC	Allison Rd	btw Allison Av	MCC	13/01/2010
River Screenline	R1	TRADS	M5	J18-J19	TRADS	2013
	R3	CH2M	A3029 Brunel Way (N)	south of Bennett Way	MCC	20/06/2013
	R4	BCC	A3029 Brunel Way (S)	north of Jessops underpass	MCC	13/10/2011
	R5	BCC	Princes Street Bridge	south of The Grove	MCC	23/11/2011
	R6	CH2M	Bedminster Bridge	north of Bedminster Parade	MCC	26/06/2013
	R7	CH2M	Redcliffe Way	east of Welsh Back	MCC	26/06/2013
	R8	BCC	Bristol Bridge, Victoria Street	south of Baldwin Street	MCC	24/11/2011
	R9	BCC	Passager Street	north of Temple Back	MCC	04/11/2011
	R10	BCC	Temple Way	north of Temple Back	MCC	04/11/2011
	R11	CH2M	Bath Bridge	south of Temple Gate	MCC	27/06/2013
	R12	CH2M	Avon Street	north of Feeder Road	ATC	19/06/2013
	R13	BCC	Albert Road	north of A4 Bath Road	MCC	25/11/2011
	R15	CH2M	St Phillips Causeway	north of Whitby Road	MCC	25/06/2013
	R16	BCC	Marsh Lane	north of Feeder Road	MCC	17/02/2011
	R17	BCC	Nethan Road	north of Feeder Road	MCC	13/07/2009
	R18	BCC	Feeder Road	north of Whitby Road	MCC	17/11/2011
Railway Screenline	RW1	CH2M	A4176 Portway	south of Roman Way	MCC	20/06/2013
	RW5	CH2M	Clifton Down	west of Pembroke Road	ATC	19/06/2013
	RW22	CH2M	Kingsland Road	south of Day's Rd	ATC	19/06/2013
	RW2	CH2M	Avon Street	east of New Kingsley Road	ATC	9/10/2013
	RW26	CH2M	B3021 St Johns Lane	south of A38 Sheene Road	ATC	18/06/2013
	RW27	BCC	A38 Parsons Street	south of A38 West Street	MCC	20/10/2010
	RW28	BCC	A38 Bedminster Down Road	south of A3029 Winterstoke Road	MCC	17/06/2009
	RW30	CH2M	Whitby Road	south of Feeder Road	ATC	19/06/2013
	RW34	SGC	A4174	north of A4 Keynsham By-Pass	ATC	23/01/2012
	RW35	CH2M	A4175 Keynsham Road	between The Ave and Chandos Rd	ATC	19/06/2013
	RW36	CH2M	Muller Road	Shaldon Rd and Petherbridge Way	ATC	18/06/2013
	RW37	BCC	Lockleaze Road		MCC	23/09/2009
	RW38	CH2M	Bonnington Walk	east of Wordsworth Rd	ATC	19/06/2013
	RW39	SGC	A4174 Station Road	east of Filton Avenue	ATC	30/09/2013
	RW40	SGC	Gipsy Patch Lane	west of Station Road	ATC	30/09/2013
	RW41	SGC	A38 Gloucester Road	south of Stoke Lane	MCC	6/12/2013
	RW42	TRADS	M5	J16-J17	TRADS	2014
	M5J19	CH2M	M5J19	All Movements	FURNESS	1/04/2013

Table 5.2 - Validation Traffic Count Data

	Ref No.	Source	Road	Location	Available Data	Date
Outer Cordon	O1	NS	A38 Bridgewater Road	south of Kings Head Lane	ATC	2013
	O2	NS	A370 Long Ashton Bypass	south of B3128	ATC	2013
	O3	NS	B3128 Ashton Road	east of Long Ashton Rd	ATC	2013
	O4	CH2M	A369 Clanage Road	north of Kennel Lodge Road	ATC	01/03/2014
	O5	NS	B3129 Clifton Suspension Bridge	Leigh Woods	ATC	25/09/2013
	O6	CH2M	A4 Portway	west of Sylvan Way	ATC	19/03/2014
	O7	BCC	B4054 Shirehampton Road	east of Penpole Lane	MCC	28/11/2011
	O8	CH2M	Kings Weston Lane	north of Campbells Farm Drive	ATC	01/03/2014
	O9	CH2M	Hallen Road	north of Marissal Road	ATC	01/03/2014
	O10	SGC	A4018 Cribbs Causeway	west of Hollywood Lane	ATC	27/05/2013
	O11	SGC	Merlin Road	south of Highwood Lane	ATC	30/09/2013
	O12	SGC	Highwood Lane	east of Merlin Road	ATC	04/11/2013
	O13	SGC	A38 Gloucester Rd	north of Bradley Stoke Way	ATC	30/09/2013
	O14	SGC	B4427 Old Gloucester Road	north of Trench Lane	ATC	26/08/2013
	O15	SGC	B4057 Beacon Lane	east of M4	ATC	30/09/2013
	O16	TRADS	M32	M4 - M32 J1	TRADS	October 2013
	O17	SGC	B4058 Bristol Road	east of Old Gloucester Road	ATC	30/09/2013
	O18	SGC	A432 Badminton Road	north of Cuckoo Lane	ATC	30/09/2013
	O19	SGC	Westerleigh Road	south of M4	ATC	30/09/2013
	O20	SGC	Shortwood Road	east of Siston Lane	ATC	30/09/2013
	O21	SGC	A420 London Rd	east of Nashcombe Hill	ATC	26/08/2013
	O22	SGC	A431 Bath Road	east of A4175 Cherry Garden	ATC	30/09/2013
	O23	B&NES	A4 Bath Road	east of Keynsham By-Pass	ATC	2013
	O24	B&NES	B3116 Wells Way	south of Courtenay Rd	ATC	2013
	O25	B&NES	A37 Bristol Road	south of Norton Lane, Whitchurch	ATC	2013
	O26	CH2M	Queens Rd	south of Bearbridge Road	ATC	05/03/2014
Middle cordon	M2	CH2M	A4176 Portway	south of Bridge Valley Road	ATC	18/06/2013
	M4	BCC	College Road	south of Clifton Down	MCC	20/06/2011
	M5	CH2M	Pembroke Road	south of Clifton Down	MCC	19/06/2013
	M7	BCC	Whiteladies Road	north of Cotham Hill	MCC	17/06/2011
	M8	BCC	Hampton Road	north of Waverley Road	MCC	17/06/2011
	M9	BCC	Redland Grove	south of South Road	MCC	17/06/2011
	M10	BCC	Redland Road	south of Zetland Road	MCC	23/06/2011
	M11	CH2M	A38 Cheltenham Road	north of Cotham Brow	ATC	18/06/2013
	M12	CH2M	North Road	north of Cheltenham Rd	ATC	14/03/2014
	RW14	BCC	Ashley Hill	south of Hurlington Road	MCC	27/06/2011
	MM12	BCC	Glenfrome Road	Railway Line	MCC	27/06/2011
	M13	BCC	M32	north of Jct 3	MCC	21/06/2011
	M14	BCC	Stapleton Road	south of Berwick Road	MCC	14/06/2011
	M15	BCC	Easton Road	west of Whitehall Road	MCC	16/06/2011
	M16	CH2M	A420 Lawrence Hill	east of Croydon St	ATC	19/06/2013
	M17	BCC	Ducie Road	North of Morton Street	ATC	11/09/2011
	M18	CH2M	Barrow Road	south of Lincoln St	ATC	19/06/2013
	M19	CH2M	A4320 St Phillips Causeway	south of Day's Rd	ATC	19/06/2013
	M20	BCC	Feeder Road	west of St Phillips Causeway	MCC	24/06/2011
	M21	BCC	Albert Road	west of St Phillips Causeway	MCC	30/06/2011
	M22	BCC	Bath Road	east of Park Street	MCC	13/06/2011
	M23	BCC	Wells Road	south of School Road	MCC	13/06/2011
	MM23	CH2M	Redcatch Road	north of Axbridge Road	MCC	27/06/2013
	M24	CH2M	Wedmore Vale	north of Glynn Vale	ATC	18/06/2013
	M25	BCC	Novers Hill	South of Parson Street	MCC	16/02/2010
	M26	CH2M	A4174 Hartcliffe Way	south of Parson St	ATC	18/06/2013
	M27	CH2M	A38 Bedminster Down Road	north of Bishopsworth Rd	ATC	18/06/2013
	M28	CH2M	South Liberty Lane	west of Nelson St	ATC	18/06/2013
	M29	CH2M	Ashton Drive	near rail bridge	ATC	18/06/2013
	M30	CH2M	A370 Ashton Road	east of B3128 merge	ATC	18/06/2013
NorthWest Outer	NWO1	TRADS	M5	J17-18a	TRADS	2012
	NWO2	SGC	A4018 Cribbs Causeway	s/o The Laurels	ATC	3/06/2013
	NWO4	SGC	Gloucester Rd North	south of Filton Avenue	ATC-perm	30/09/2013
	NWO5	SGC	Great Stoke Way	north of Filton Rd	ATC-perm	30/09/2013
	NWO6	TRADS	M32	M32 J1 Within	TRADS	October 2013
	NWO7	CH2M	Bristol Rd	north of A4174	ATC	06/03/2014
Northeast Screenline	NE1	CH2M	Frenchay park Rd	east of Ham Lane	ATC	01/03/2014
	NE2	BCC	Blackberry Hill	east of Small Lane	MCC	15/03/2011
	NE3	BCC	Fishponds Road	west of Alcove Rd	MCC	19/01/2011
	NE4	BCC	Berkley Rd	south of Lodge Causeway	ATC	16/10/2011
	NE5	CH2M	Charlton Road	south of King Johns Rd	ATC	01/03/2014
	NE6	CH2M	Lodge Rd	south of Britton Gardens	ATC	01/03/2014
	NE7	CH2M	Downend Rd	north of Cross St	ATC	01/03/2014
	NE8	CH2M	Syston Way	west of Northend Rd	ATC	06/03/2014
	NE9	CH2M	Lees Hill	south of High View Road	ATC	06/03/2014
	NE10	CH2M	Pound Rd	south of High View Road	ATC	06/03/2014
	NE12	SGC	Station Rd	south of Chiphouse Rd	ATC Temp	01/03/2014



5.4 Data Processing

The model represents a typical weekday in October 2013. The traffic data used in the model was collected over a range of different sources (see Tables 5.1 and 5.2). Therefore, factors were needed to account for monthly variations, as shown in Table 5.3.

Table 5.3 – Monthly Traffic Flow Factors

Site	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
883	Temple Way Underpass	11391	11410	11613	11946	11990	12124	12125	11947	11681	11342	11091	11171
886	Brunel Way	12055	12605	12395	12390	12570	12397	12363	12192	12410	12396	12336	12234
20702071	A4320 Easton Way	16105	16931	17082	16996	16776	16617	16850	16064	17002	17501	17417	17144
32033204	A4174 Avon Ring Road	11214	11676	12029	12464	12960	12998	14936	14738	14757	14497	13704	12066
40000044	A4018 Queen's Road	12930	16293	17393	18226	18311	18153	17877	17505	17769	17882	17430	16671
50000002	A4174 Callington Road	7271	7505	7908	7105	7229	7299	7333	7484	7090	7031	7128	7205
80000179	A4018 Park Street	4966	5180	5286	5358	5352	5333	5312	5111	5302	5377	5252	5296
80000200	A4320 St Philips C'way	8356	7395	8874	8517	8539	8513	8732	8493	8854	9148	8746	8685
80000330	A4 Anchor Road	6322	6678	6796	6731	6743	6672	6709	6766	6667	6679	6765	6722
80000403	A4162 Sylvan Way	4696	4927	5717	5923	5917	5805	5765	5490	5752	5841	5935	5827
80003010	Kings Weston Ln	2023	2144	2216	2303	2303	2313	2240	2244	2298	2270	2234	2132
Total		97330	102744	107310	107961	108690	108225	110243	108034	109580	109964	108037	105153
Factor		1.13	1.07	1.02	1.02	1.01	1.02	1.00	1.02	1.00	1.00	1.02	1.05

Local annual data collected (located in South Gloucestershire, as BCC data was not available) suggested that growth was relatively flat between 2009 (generally the oldest available data) and 2013, as shown in Table 5.4. Therefore no annual adjustment factors were applied.

Table 5.4 - Annual Traffic Flow Factors

Year	South Glos Counts	Index	% Change from 2013
2009	289240	132	0.990
2010	288658	131	0.991
2011	288055	131	0.992
2012	286865	131	0.996
2013	285479	130	1.000

5.5 Journey Time Surveys

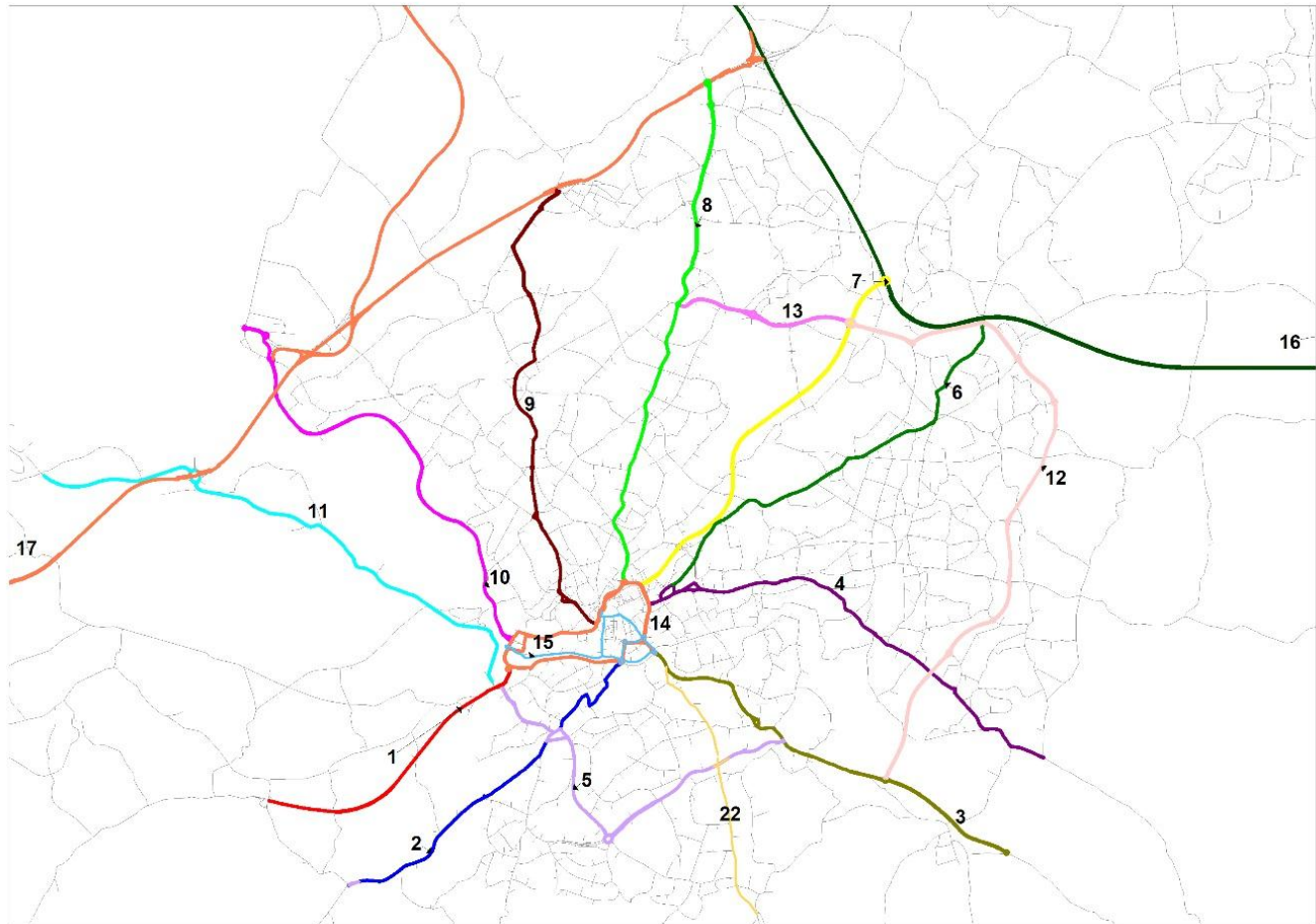
Observed Journey time data was examined using Trafficmaster™ journey time data supplied to the local authorities by the Department for Transport. TAG M3.1 recommends that *“journey time routes should cover as wide a range of route types as possible and cover the Fully Modelled Area as evenly as possible. For models developed for the appraisal of specific interventions, routes should include those from which it is expected traffic will be affected by the scheme, as well as covering the scheme itself as appropriate.”*

TAG M3.1 underlines the importance of setting accurate cruise speeds. Although not a specific TAG requirement, Trafficmaster™ journey time data was used to check model cruise times. The cruise speed by link type was estimated by calculating the between-junction link speed on all links during the 7am to 7pm period. During this period, the highest average speed (in 15 minute intervals) recorded for each link was considered to be a reasonable approximation of link cruise time; which in the highway model is the link journey time, excluding junction delay.

The journey time routes are shown in Figure 5.4.

The journey time data used represents mean values from all weekdays in October 2013, filtered to exclude school holidays. During this time period the main road through Barrow Gurney was shut due to repairs to a water main. This had a substantial impact on travel times through both routes 1 and 2. Therefore May 2013 data was used as an alternative for these routes during the morning and evening peaks.

Figure 5.4 - GBATS4M Highway Model Journey Time Survey Routes



5.6 Accuracy of Journey Time Surveys

Table 5.5 summarises the number of runs undertaken for each route by time period, and the resulting standard deviation and accuracy. The accuracy values are a measure of the variability of the journey time surveys and were calculated following the advice given in DMRB guidance (Volume 13, Section 1, Part 5, Chapter 11 'Economic Assessment of Road Schemes').

$$m = \frac{\sum X_i}{n} \quad s = \sqrt{\frac{\sum (X_i - m)^2}{n-1}} \quad a = t \cdot \frac{s}{m \cdot \sqrt{n}}$$

Where :

n = the number of observations of journey time

m = the estimate of true mean journey time

s = the estimate of the standard deviation of true mean journey time

t = t-distribution, which depends on $(n-1)$ number of degrees of freedom, and the confidence level (95%)

a = accuracy

The guidance recommends that, as a general rule, it should be realistic to aim for an accuracy of $\pm 10\%$ in the estimate of observed journey time on the existing route, at the 95% confidence level. On individual links the level of accuracy need not be so great.

For all observed routes, the mean values are shown to meet TAG M3.1 guidelines and standards.

Table 5.5 - Accuracy of Journey Time Data

Route Description		Mean No. Vehs in Sample (Weighted by Distance)			Standard Deviation			Accuracy (95% Confidence)		
		AM	IP	PM	AM	IP	PM	AM	IP	PM
1	A370 Inbound (Backwell to Ashton Gate)	46	300	18	1.7	1.7	0.5	4.9%	1.8%	2.7%
1	A370 Outbound (Jessop Underpass to Backwell)	27	464	53	1.2	1.8	0.9	5.0%	1.6%	2.4%
2	A38 Inbound (Barrow Gurney to Bedminster Bridge)	44	382	48	1.9	2.2	2.2	3.3%	1.2%	3.4%
2	A38 Outbound (Bedminster Bridge to Barrow Gurney)	39	420	51	1.7	1.4	2.2	4.1%	1.0%	3.8%
3	A4 Inbound (Keynesham to Bath Bridge)	82	673	78	4.4	1.8	2.1	3.1%	0.9%	2.5%
3	A4 Outbound (Bath Bridge to Keynesham)	100	551	70	3.0	0.7	1.9	3.1%	0.4%	2.5%
4	A431 Inbound (Willsbridge to Old Market St)	54	284	44	2.6	0.6	1.6	2.3%	0.3%	2.2%
4	A431 Outbound (Old Market St Jct to Willsbridge)	45	289	48	1.4	0.8	2.0	2.1%	0.4%	2.2%
5	A38 Eastbound (Ashton Gate to Brislington)	92	447	64	4.3	2.2	3.1	3.1%	1.1%	3.0%
5	A38 Westbound (Brislington to Ashton Gate)	72	435	55	3.0	1.8	2.2	3.0%	0.9%	2.7%
6	A432 Inbound (A4174 Badminton Rbt to Old Market St)	48	220	30	3.3	1.7	1.7	2.7%	1.0%	2.7%
6	A432 Outbound (West St to A4174 Badminton Rbt)	28	212	35	2.5	1.6	1.9	3.7%	0.9%	2.5%
7	M32 Inbound (M32 J1 to Cabot Circus)	205	1560	203	2.2	0.7	1.4	2.3%	0.7%	3.0%
7	M32 Outbound (Cabot Circus to M32 J1)	266	1686	222	0.9	0.4	1.0	2.0%	0.5%	2.7%
8	A38 Inbound (M5 J16 to St James Barton Rbt)	70	398	49	3.3	1.8	2.3	2.4%	0.7%	2.2%
8	A38 Outbound (St James Barton Rbt to M5 J16)	57	389	45	2.9	2.5	2.9	2.4%	1.0%	2.5%
9	A4018 Inbound (M5 J17 Cribbs to Clifton Triangle)	75	412	64	3.4	1.5	2.1	2.6%	0.9%	2.3%
9	A4018 Outbound (College Green to M5 J17 Cribbs)	58	417	57	1.6	1.5	1.5	2.3%	0.9%	2.1%
10	A4 Portway Inbound (Avonmouth to Hotwells)	73	475	52	1.7	1.1	1.9	1.9%	0.7%	2.8%
10	A4 Portway Outbound (Hotwells to Avonmouth)	57	452	53	1.0	1.1	0.7	2.1%	0.9%	1.7%
11	A369 Inbound (Portishead to A4 Bristol Gate)	90	459	82	4.2	1.0	1.4	3.6%	0.7%	1.8%
11	A369 Outbound (A4 Bristol Gate to Portishead)	78	497	73	1.2	0.7	1.5	1.6%	0.4%	1.9%
12	A4174 Eastbound (Filton Rbt to A4)	132	990	140	3.7	1.0	3.6	2.3%	0.3%	1.9%
12	A4174 Westbound (A4 to Filton Rbt)	126	898	147	3.8	1.1	3.0	2.1%	0.3%	1.9%
14	City Centre Outer Loop (Clockwise)	63	518	57	3.5	1.6	3.9	2.5%	0.6%	2.5%
14	City Centre Outer Loop (Anti-Clockwise)	67	466	51	3.4	0.7	2.8	2.5%	0.3%	2.5%
15	City Centre Inner Loop (Clockwise)	31	227	33	2.7	1.7	2.6	3.3%	1.1%	3.1%
15	City Centre Inner Loop (Anti-Clockwise)	48	270	34	2.1	1.6	2.4	3.2%	1.4%	4.7%
16	M4 Mainline Eastbound (J22 to J18)	304	1816	300	3.0	0.6	1.6	1.2%	0.1%	0.9%
16	M4 Mainline Westbound (J18 to J22)	264	1901	314	1.9	0.8	1.6	1.1%	0.2%	0.9%
17	M5 Mainline Northbound (J20 to M4)	427	2256	381	0.8	0.7	2.4	0.6%	0.2%	1.4%
17	M5 Mainline Southbound (M4 to J20)	346	2443	352	0.9	0.7	1.5	0.7%	0.2%	1.0%

SECTION 6

Network Development

6.1 Source Networks

As a starting point, the GBATS3 2012 South Bristol Link (SBL) model was the primary source model for the majority of the network area of the GBATS4M highway model. The 2011 SGC Core Strategy Model (CSM) model was used as the primary source for the North Fringe area of the GBATS4M highway model. The two networks were merged and a thorough check of the network was undertaken to ensure that the model coding is representative of the October 2013 Bristol area road network. This included checks as outlined below.

6.2 Link Coding

The network development process involved checking and adjusting the highway network principally along the journey time routes, and other routes where necessary to calibrate the model.

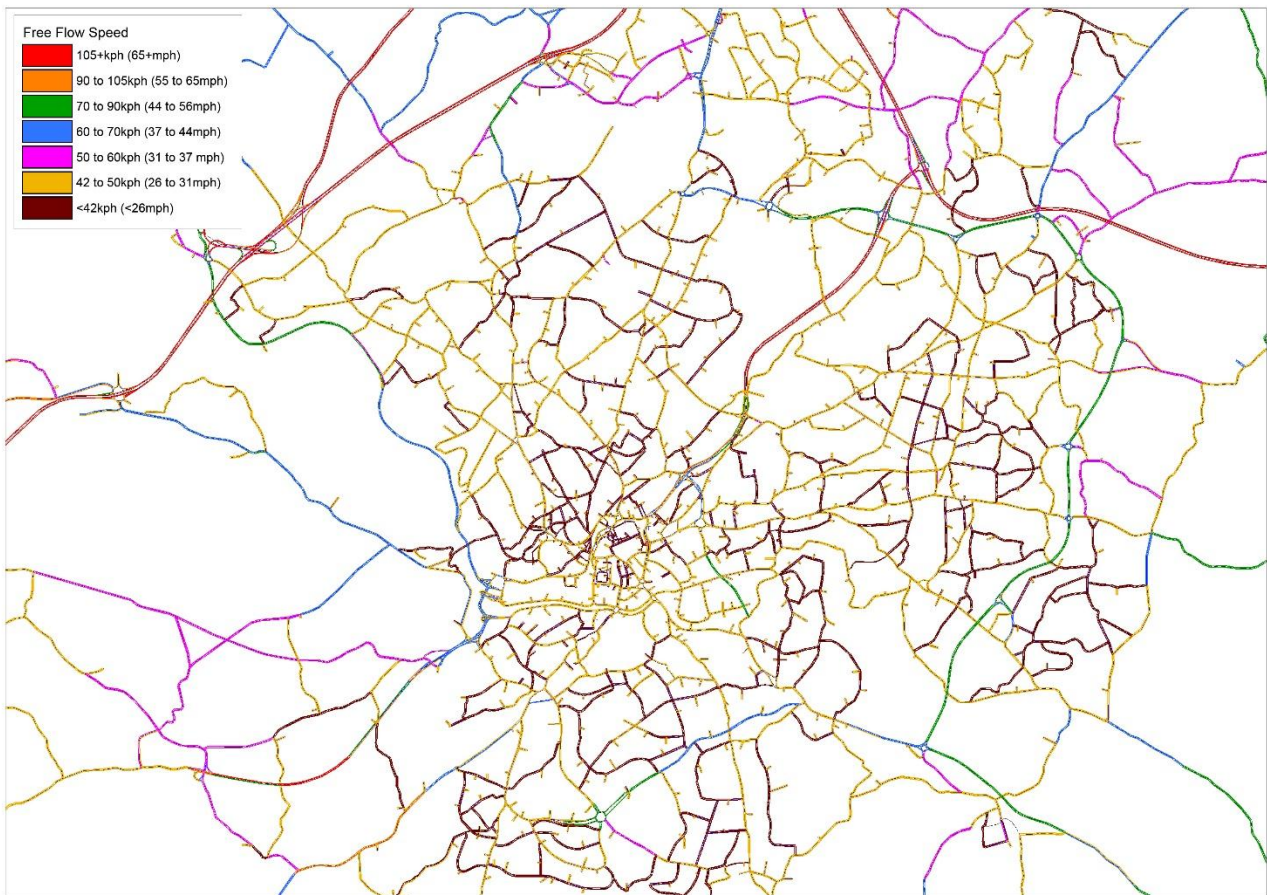
All links in simulated area were allocated distances derived from a detailed GIS based analysis of mapping to provide an estimation of road lengths.

The road classification system and local network speed limits were used to apply free-flow speed limits to individual links in the network. Speed/flow curves on specific links in the simulation area have been included to a) represent interactions on links which are otherwise not directly modelled, such as in busy retail/high street areas which are impacted by on-street parking, bus stops, pedestrians and non-modelled junctions and b) high speed inter-urban roads (i.e roads with a speed limit greater than or equal to 50 mph) which have been defined using the standard Cost Benefit Analysis (COBA) speed/flow classification.

The Trafficmaster™ journey time data was used to validate the cruise speed of the inter-peak model (see section 10).

The free flow speeds used in the simulation area are shown in Figure 6.1.

Figure 6.1 - GBATS4M Free Flow Speed



6.3 Junction Coding

The coding of junctions within SATURN requires a range of information. This included the use of web-based imagery and site visits. The following checks were undertaken for all the key nodes within the simulation area, including all nodes on MetroWest corridors, with corrections where required:

- Junction type, layout, lane usage and flare length;
- Junction geometry and turn capacities;
- Signal stages and timings;
- Junction delay, and particularly junctions with highest delay, as identified by the SATURN software.

6.4 Centroid Connectors

The allocation of centroid connectors for internal zones were examined to verify that trips are loading onto the network at locations that are both sensible and realistic. Centroid connectors for external zones were also checked and corrected where required. Internal zones are those in the simulation network and external zones are those in the buffer network.

Summary details of the network coding standards utilised are found in **Appendix B**.

SECTION 7

Trip Matrix Development

7.1 Matrix Development process

The development of GBATS4M 'prior' trip matrices involved new RSI OD survey data for city centre trips and the use of the 2012 SBL model and the 2011 SGC CSM 'prior' matrices. The source model prior matrices were used rather than the validated assignment matrices so that any matrix estimation effects were not incorporated into the new GBATS4 model. The matrix development process for light vehicles was undertaken as described below. Due to the relatively low sample rate for heavy goods vehicles (HGVs) in the 2013 RSI surveys, a check of trip patterns for HGVs for the central area in the source model matrices was undertaken in relation to Trafficmaster™ OD data. This showed a reasonable fit in terms of trip lengths and spatial patterns. Hence no adjustment was made to the OD data for HGVs in the development of prior matrices.

7.2 GBATS3 Matrix Merge

The SBL 2012 model was deemed the most appropriate starting point for the updated GBATS4M Metro Model, however the northern part of the model was out of date as the CSM model of this area had been developed to test schemes to the north of the city. Therefore, the two models needed to be merged, both network and matrices, to fully update the GBATS4M model. The SBL 2012 and CSM 2011 model matrices were merged using the following process:

- Expand SBL and CSM matrices to have a consistent zoning system (650 zones) – (total trips remained the same);
- Expand SBL and CSM networks to have a consistent zoning system (650 zones);
- Assign both models using the updated networks and matrices;
- Undertake a select link on both model assignments for each time period, at each RSI location used in the development of the CSM model, but not used in the SBL model (see Table 7.1 for sites);
- Remove the SBL select link matrices from the SBL prior matrices and replace with the SGCS select link matrices; and
- Assign GBATS3 merged 'prior' matrices to the SBL 2012 network.

Table 7.1 – CSM RSI Locations Used

Site Location	Year
Aztec West	2011
Bradley Stoke Way	2011
Hayes Way	2011
Highwood Lane	2011
Merlin Road	2011
Lysander Road	2011
A38 Gloucester Road	2009
Hatchet Road	2009
B4427 Old Gloucester Road	2009
Great Stoke Way	2009
A432 Badminton Road	2009
A4174 Avon Ring Road	2009
B4057 Beacon Lane	2006

B4058 Bristol Road	2006
A369 Portbury Hundred	2009

7.3 RSI Data

The 2013 RSI data was used to develop an observed matrix of trip movements to/from the city centre, i.e. the part of the matrix based on 2013 fully observed data. It was assumed that the level of vehicular trips with both origin and destination within the inner cordon was not significant.

The RSI data was processed as follows:

- Range and logic checks to determine the data was 'sensible';
- Allocate trips to 'super-zones', defined based on groups of nearby model assignment zones;
- Disaggregate trips to assignment zones within each super-zone based on residential and/or employment demographic data to produce a 'smoothed' distribution of trips within super zones;
- Expand origin/destination trips to the manual classified count (MCC) collected on the day of interview, by time period and vehicle type; and
- Correct to the automatic traffic count (ATC) collected over a two week period, to remove any bias with the day of interview.

The use of a super-zone system, combined with demographic-based trip allocation to assignment zones removed any 'unevenness' (as far as possible) from the RSI data collected.

For example, if a trip was observed at an RSI site between two assignment zones this would be identified as a trip between the super-zones containing these assignment zones. Trips would then be disaggregated back to the assignment zone level pro rata using demographic data for each zone. This effectively smoothed the observed trips across nearby zones. This was undertaken in line with DMRB matrix building guidance; specifically Vol 12 Section 1 Chapter 8 as referenced by TAG M3.1.

The creation of the non-interview direction matrices was undertaken by transposing the AM, Inter-Peak and PM interview direction matrices. The AM transpose was used for the PM non-interview direction and the PM transpose was used for the AM non-interview direction. This meant that the trips seen travelling (interview direction) into the city in one time period travelled back in the other time period, i.e. 'home to work' trips in the AM become 'work to home' trips in the PM. For the inter-peak model it is assumed that trips enter and leave within the same time period. This approach was applied to trips of all purposes. The resulting purpose split for transposed trips in each time period was controlled to the purpose split for observed trips in each time period. The factors required to control the purpose splits were reviewed to ensure best use was made of the observed data.

7.4 Merging RSI Data

Once hourly trip purpose matrices for each site were developed, the RSI data was 'merged' to create observed RSI matrices. To avoid double counting of trips passing through the area enclosed by the inner cordon, interview direction data was used in preference to transposed data.

The hourly observed matrices were then used to replace the OD trips within the source model highway matrices, using the following methodology:

- Undertaken a select link on the GBATS3 merged 'prior' matrices / SBL 2012 network assignment, at each RSI location and output an OD matrix;
- Remove all RSI OD trips from the original matrix; and
- Add the RSI observed matrices to the matrices created in the step above.

The merged observed and updated source model trip matrices then became the initial prior matrices for the model matrix development process.

7.5 Calibration of the Initial Trip Matrices

TAG M3.1 recommends that the 'prior' trip matrix should be validated by comparing total screenline and cordon model flows and counts. If screenline and cordon totals are not within 5%, then remedial action should be considered.

Table 7.2 shows the model screenline output when the initial prior matrices were assigned to the network and the model flows were compared to the count for each screenline and cordon. Where the difference in the total screenline count was greater than 5%, then appropriate OD pairs (which crossed the screenline) were factored to match the observed flow. This iterative process was continued until an appropriate 'prior' matrix was created, which fulfilled the TAG M3.1 criteria. This process did not disaggregate light and heavy vehicles.

Table 7.2 - Initial Trip Matrix Comparison

Screenlines and Cordon	No. Links observed	AM Peak		Inter Peak		PM Peak	
		Observed Total (PCUs)	Initial Matrix vs Obs % Diff	Observed Total (PCUs)	Initial Matrix vs Obs % Diff	Observed Total (PCUs)	Initial Matrix vs Obs % Diff
Calibration Total	163	144,654	-2%	122,397	-5%	149,598	-3%
Inner (In)	19	14,232	-1%	10,216	-6%	11,030	-4%
Inner (Out)	18	10,975	-9%	10,461	-5%	14,527	-6%
East (In)	8	6,612	4%	5,053	1%	5,342	0%
East (Out)	8	4,963	25%	5,456	-1%	7,917	3%
NW Inner (In)	13	13,434	-3%	11,192	-9%	13,488	-8%
NW Inner (Out)	13	12,330	10%	9,984	-6%	13,851	1%
South (In)	11	6,063	11%	5,655	2%	6,321	3%
South (Out)	11	6,042	-1%	5,703	4%	6,835	7%
River (WBSB)	16	18,175	-8%	17,279	-3%	22,218	-3%
River (EBNB)	16	23,640	-4%	17,640	-2%	19,778	-6%
RW (ALL)	30	28,188	-8%	23,759	-12%	28,291	-2%
Validation Total	146	119,970	-7%	93,005	-8%	122,986	-9%
Outer (In)	26	25,522	-5%	16,282	-4%	21,238	-12%
Outer (Out)	26	19,660	-15%	15,827	-5%	24,825	-7%
Middle (In)	30	23,785	-7%	17,425	-8%	19,770	-8%
Middle (Out)	30	18,054	-5%	17,360	-8%	23,120	-8%
NW Outer (In)	6	10,937	-9%	8,744	-3%	12,082	-8%
NW Outer (Out)	6	11,634	0%	9,006	1%	11,666	-1%
NE (In)	11	4,889	-6%	4,215	-30%	5,320	-25%
NE (Out)	11	5,490	-12%	4,147	-35%	4,964	-11%
All	309	264,624	-4%	215,403	-6%	272,584	-5%

Network Calibration and Validation

8.1 Network Calibration

Highway network calibration was undertaken to ensure that the model fully replicated the observed traffic characteristics in terms of speeds, throughputs and delays. This was done by systematically reviewing model assignments and modifying the network parameters to improve the model's fit against observed calibration data. Checks were made to ensure:

- Link speeds on the network are realistic and speed/flow calculations are operating as expected; and
- Delay calculations at junctions are realistic.

Modelled speeds, traffic flows and journey times were compared to observed data. Any significant differences were subsequently reviewed and the network updated accordingly.

A large number of checks were iteratively undertaken, throughout the process, to calibrate the models. This included:

- Reviewing the warnings produced by SATNET;
- Inspecting excessive junction delays to check network coding;
- Monitoring where model flows were too high or low and checking the coding of the principle route and alternate competing routes.

All output data for route choice calibration and validation is found in **Appendix D**.

8.2 Route Choice Calibration

Network calibration focuses on adjusting the network to perform to replicate the observed data. However, it is generally not considered a cost effective use of resources to check all modelled routes against travel time data. Therefore, checking of the routes chosen by traffic travelling through the network is used to calibrate the parts of the network not directly observed. In line with TAG M3.1, the selected origins and destinations focused on important centres of population and employment or key intersections. These were chosen so that the routes:

- relate to significant numbers of trips;
- are of significant length or cost (e.g. 20+ minutes);
- pass through areas of interest (e.g. scheme impacted areas);
- include both directions of travel (to sense check differences);
- link different compass areas (e.g. north to south, east to west, etc.); and
- coincide with journey time routes as appropriate.

TAG M3.1 suggests the number of pairs of zones to be examined and displayed should be at least:

Number of OD pairs = (number of zones)^{0.25} x the number of user classes.

There are 650 zones and the model was developed and calibrated using 2 user classes equating to 10 routes (note the model was validated using 6 user classes). The OD routes selected to check are below:

1. Portishead – Bristol City Centre
2. Avonmouth – Bristol City Centre
3. Wales – Bristol City Centre
4. Yate – Bristol City Centre

5. Bath – Bristol City Centre
6. Weston-super-Mare – Bristol City Centre
7. Lawrance Weston – Hanham
8. Stoke Gifford – Bedminster
9. Clifton – Emerson Green
10. Filton - Brislington

8.3 Route Choice Validation

There are no validation criteria or prescribed mechanisms for route choice validation. Therefore, common practice is to provide plots of the trees (the paths from an origin to all destinations) chosen by the model from a number of locations. Routeings were checked in key corridors through and around the city centre to ensure plausible and realistic routeing of traffic, as above.

The following locations (by zone) for plotting trees, include: Wales, Gloucester, Yate, Bath, Weston-super-Mare, Portishead, Pill, Avonmouth, Westbury-on-Trym, Bradley Stoke, Filton, Stoke Gifford, Emersons Green, Fishponds, Kingswood, Brislington, Bedminster, St Phillips, City Centre and Clifton.

All output is found in **Appendix D**. Note: this output is based on the final version of the model, post matrix Estimation, with 6 user classes, see following section.

Trip Matrix Calibration and Validation

9.1 Prior Trip Matrix

The prior matrix was assigned to the model network to ensure that it produced trip patterns across the network that reasonably replicates the origins and destinations of trips in the model area. This was done by comparing modelled movements to observed independent counts and total screenline flows. This showed that whilst screenline and cordon totals showed a better fit to observed data than assignment of the initial trip matrices, the resulting flows still did not meet the model validation requirements. As such, matrix estimation was applied to the prior trip matrix to improve the matrix calibration.

9.2 Application of Matrix Estimation

The SATURN modules SATME2 and SATPIJA were used for matrix estimation. In combination they attempt to match assigned link flows in the model with observed traffic counts. The matrix estimation process forms part of the calibration process and is designed to modify the origin-destination volumes by reference to the observed traffic counts. Trips are adjusted in the prior matrix to produce the estimated matrix, which is most likely to be consistent with the traffic counts. The equation used may be written as:

$$T_{ij} = t_{ij} \prod_a X_a P_{ija}$$

Where:

T_{ij} = the output estimated matrix of OD pairs ij ; t_{ij} = the prior matrix of OD pairs ij ;
 \prod_a = the product over all counted links a ; X_a = the balancing factor associated with counted link;
 P_{ija} = the fraction of trips from i to j using link a .

Matrix estimation was undertaken on both light and heavy vehicles and was limited to the calibration sites shown in Figure 5.2.

9.3 Changes due to Matrix Estimation

TAG M3.1 advises that it is important that the process of matrix estimation does not significantly alter the characteristics of the prior matrix. The relevant criteria are described in section 3. The checks undertaken are shown as follows:

- Table 9.1 shows the regression analysis;
- Table 9.2 shows the total mean trip length check and;
- Table 9.3 shows the changes comparing the 'prior' and 'final post ME2' sector matrix totals;
- Figure 9.1 shows the corresponding sector plan.
- Additional output (including scatter plots and trip length distribution checks) is found in **Appendix C**.

An analysis of the output shows that the regression analysis guidance has been met with the exception of the R^2 value for AM cells, which is within rounding error tolerances. The mean trip length changes are well within the criteria. The total matrix change are each within 1% and individual sector changes are generally less than the recommended 5%, with the exception of only a few sectors which are all within 10%, and only marginally higher than 5%.

Measure	Cells							Trips Ends						
	Criteria	AM		IP		PM		Criteria	AM		IP		PM	
Intercept	near 0	0.005	✓	0.005	✓	0.004	✓	near 0	5.886	✓	3.267	✓	3.483	✓
Slope	0.98<X<1.02	0.98	✓	0.98	✓	0.97	×	0.99<X<1.01	0.99	✓	0.99	✓	0.98	✓
R ²	>0.95	0.947	×	0.960	✓	0.960	✓	>0.98	0.989	✓	0.996	✓	0.993	✓

Time Period / Criteria	AM Peak			Inter Peak			PM Peak		
	Prior	Final	% Diff	Prior	Final	% Diff	Prior	Final	% Diff
Mean Distance (kms)	23,555	23,555	0.0%	23,467	23,472	0.0%	23,642	23,668	-0.1%
Standard Deviation	26,547	26,547	0.0%	26,432	26,433	0.0%	26,525	26,537	0.0%

Table 9.3 - Matrix Estimation (Prior vs Post ME2 matrix) Sector Matrix Changes

Time / Sector	AM Peak			Inter Peak			PM Peak		
	Prior (2UC)	ME (6UC)	% Diff	Prior (2UC)	ME (6UC)	% Diff	Prior (2UC)	ME (6UC)	% Diff
1	5239	5211	-1%	6165	6242	1%	7858	7773	-1%
2	4829	4818	0%	4420	4500	2%	4959	4906	-1%
3	5247	5230	0%	4592	4641	1%	4789	4516	-6%
4	4827	4854	1%	5136	5206	1%	6104	5986	-2%
5	11939	12033	1%	10412	10578	2%	12343	12772	3%
6	3578	3589	0%	4708	4730	0%	7386	7182	-3%
7	10164	10169	0%	8316	8201	-1%	8057	8294	3%
8	13569	13499	-1%	10589	10762	2%	12398	12400	0%
9	8281	8274	0%	6536	6710	3%	8386	8622	3%
10	5091	5150	1%	4334	4469	3%	5265	5337	1%
11	7388	7241	-2%	6644	6862	3%	7956	7923	0%
12	8310	8456	2%	4861	5074	4%	7109	7183	1%
13	4833	4843	0%	3362	3390	1%	3612	3485	-3%
14	2935	2935	0%	1781	1806	1%	2152	2161	0%
15	3675	3698	1%	2542	2659	5%	3363	3535	5%
16	1091	1140	5%	1018	1057	4%	1319	1295	-2%
17	4360	4383	1%	3650	3782	4%	4511	4456	-1%
18	4990	4868	-2%	3673	3698	1%	3873	3876	0%
19	7044	7014	0%	4440	4512	2%	5487	5454	-1%
20	3679	3669	0%	3547	3395	-4%	3968	3994	1%
21	2055	2099	2%	1776	1789	1%	1747	1741	0%
22	2436	2457	1%	2581	2499	-3%	2383	2476	4%
Total	125561	125630	0%	105084	106561	1%	125059	125406	0%

9.4 Park and Ride Matrices

There are three park and ride sites in Bristol and each of the sites were surveyed. On bus origin-destination surveys were carried out at Brislington and Portway, Long Ashton was surveyed by BCC in 2013. This obtained OD data to provide both the car and bus leg of the journey. The car leg of the journey was added to the 'post-ME2' matrices for each of the sites.

9.5 Further Trip Matrix Segmentation

The models were developed, matrix estimation undertaken and calibrated using two-user classes. Further matrix segmentation was undertaken to include six user classes, detailed in Section 4. This segmentation was undertaken using income and purpose data obtained in the RSI surveys. The light vehicle user class was firstly split into 3 user classes using the percentage splits in Table 9.4.

Table 9.4 - RSI Light Vehicle User Class Splits

Purpose / Veh Type	AM	IP	PM
Car Non Business	78.6%	69.5%	84.8%
Car Business	8.6%	12.9%	5.1%
LGVs	12.7%	17.6%	10.1%

The Car Non Business trips were then split by income, on a sector basis to account for spatial variation. Table 9.5 shows the income split percentages by sector, based on the following criteria:

- Low (Less than £23,000)
- Medium (Between £23,000 and £46,000)
- High (More than £46,000)

Table 9.5 - RSI Light Vehicle User Class Splits

Sector	Origin End - AM and IP			Destination End - PM			Sector	Origin End - AM and IP			Destination End - PM		
	Low	Med	High	Low	Med	High		Low	Med	High	Low	Med	High
1	25%	42%	34%	28%	40%	32%	11	37%	47%	16%	35%	42%	22%
2	27%	44%	29%	27%	42%	31%	12	19%	43%	38%	32%	48%	20%
3	27%	42%	30%	55%	35%	10%	13	17%	43%	39%	15%	51%	34%
4	21%	46%	33%	38%	44%	18%	14	11%	18%	71%	27%	38%	36%
5	40%	37%	23%	31%	52%	17%	15	30%	41%	29%	19%	46%	35%
6	26%	40%	34%	36%	43%	21%	16	17%	59%	23%	15%	60%	26%
7	33%	43%	24%	31%	51%	18%	17	28%	46%	26%	28%	40%	31%
8	36%	45%	19%	37%	45%	18%	18	22%	36%	43%	19%	50%	31%
9	41%	42%	17%	29%	45%	26%	19	21%	32%	47%	31%	42%	27%
10	35%	53%	12%	35%	47%	19%	20	12%	42%	46%	21%	48%	31%

Assignment Calibration and Validation

10.1 Overview

The final assignment was undertaken with the final (post ME) matrix and calibrated network, using the processes previously described. Validation checks were made on comparing model cruise time, traffic flow on links and net journey time. The output from the models, compared against observed data, is found in the following section. The final section presents results from model convergence.

10.2 Cruise Times

Output from the Trafficmaster™ journey time database was used to check the cruise time of the inter-peak model. The observed cruise time was estimated by calculating the lowest time (in 15 minute intervals) during the 7am to 7pm period. This was considered to be a reasonably accurate reflection of actual cruise time.

Inter peak model output is shown in Table 10.1. The location of the journey time routes is shown in Figure 5.4. A check of just one time period was undertaken since the coding of model speeds is consistent between time periods. Further this is not a TAG requirement but merely an additional model check to confirm appropriate generation of delays between links and junctions.

62% of modelled routes are within 5% of observed times. 82% of routes are within 10%. All routes are within 15%. The model is therefore considered sufficient to present an accurate representation of observed cruise speeds.

Table 10.1 – Inter-Peak Model Cruise Time Check

	Route Description	Dist (km)	Cruise Time (mins)			Av Cruise Speed (kph)
			Obs	Model	% Diff	
1	A370 Inbound (Backwell to Ashton Gate)	9.6	8.1	9.1	12%	71
1	A370 Outbound (Jessop Underpass to Backwell)	9.5	8.6	8.9	4%	67
2	A38 Inbound (Barrow Gurney to Bedminster Bridge)	7.6	11.3	9.8	-13%	40
2	A38 Outbound (Bedminster Bridge to Barrow Gurney)	7.6	9.7	9.9	3%	47
3	A4 Inbound (Keynesham to Bath Bridge)	8.3	11.4	10.6	-6%	44
3	A4 Outbound (Bath Bridge to Keynesham)	8.3	10.4	10.3	-1%	48
4	A431 Inbound (Willsbridge to Old Market St)	9.2	14.6	14.7	1%	38
4	A431 Outbound (Old Market St Jct to Willsbridge)	9.6	13.7	15.3	12%	42
5	A38 Eastbound (Ashton Gate to Brislington)	8.0	12.4	12.6	1%	39
5	A38 Westbound (Brislington to Ashton Gate)	8.6	13.2	13.7	4%	39
6	A432 Inbound (A4174 Badminton Rbt to Old Market St)	9.4	15.2	16.3	8%	37
6	A432 Outbound (West St to A4174 Badminton Rbt)	9.4	15.4	15.7	2%	37
7	M32 Inbound (M32 J1 to Cabot Circus)	6.2	4.9	4.3	-11%	77
7	M32 Outbound (Cabot Circus to M32 J1)	6.0	3.8	3.6	-7%	94
8	A38 Inbound (M5 J16 to St James Barton Rbt)	10.3	16.3	17.0	4%	38
8	A38 Outbound (St James Barton Rbt to M5 J16)	10.3	16.6	16.7	0%	37
9	A4018 Inbound (M5 J17 Cribbs to Clifton Triangle)	8.2	12.3	11.9	-4%	40
9	A4018 Outbound (College Green to M5 J17 Cribbs)	8.2	12.5	12.7	1%	39
#	A4 Portway Inbound (Avonmouth to Hotwells)	9.8	10.8	10.8	0%	55
#	A4 Portway Outbound (Hotwells to Avonmouth)	9.7	9.8	9.6	-2%	59
#	A369 Inbound (Portishead to A4 Bristol Gate)	11.5	11.6	12.1	4%	59
#	A369 Outbound (A4 Bristol Gate to Portishead)	12.8	13.2	13.4	2%	58
#	A4174 Eastbound (Filton Rbt to A4)	17.1	17.3	17.1	-1%	59
#	A4174 Westbound (A4 to Filton Rbt)	17.1	17.6	16.6	-6%	58
#	City Centre Outer Loop (Clockwise)	9.3	17.2	17.0	-1%	32
#	City Centre Outer Loop (Anti-Clockwise)	8.1	14.5	13.9	-4%	34
#	City Centre Inner Loop (Clockwise)	7.0	13.8	14.0	1%	31
#	City Centre Inner Loop (Anti-Clockwise)	3.7	8.0	8.6	7%	28
#	M4 Mainline Eastbound (J22 to J18)	34.5	18.9	18.3	-3%	109
#	M4 Mainline Westbound (J18 to J22)	34.6	18.5	18.4	0%	112
#	M5 Mainline Northbound (J20 to M4)	24.1	14.2	12.7	-10%	102
#	M5 Mainline Southbound (M4 to J20)	24.2	14.0	12.5	-11%	103

% All routes within x% of observed

<5%	<10%	<15%
62%	82%	100%

10.3 Traffic Flows

Tables 10.2 (AM), 10.3 (IP) and 10.4 (PM) present a summary of the link flow validation on all the cordons and screenlines. The location of the calibration and validation screenlines is shown in Figures 5.2 and 5.3. Detailed individual link outputs are found in **Appendix E**.

The flow validation criteria and acceptability guidelines (as specified in TAG M3.1, see Table 3.1) have been met for all screenline and cordon links in all modelled time periods for both calibration and validated links in relation to checks for “all vehicles”. Additional checks have been undertaken for light vehicles (LVs), i.e. cars/LGVs. For LVs the traffic flow criteria has been met for both GEH values and DMRB flow criteria for calibration and validation screenlines for all time periods with the exception of validation screenlines in the AM and PM peaks, which are very close to the criteria, both with a value of 84%. When the model fit is considered as a whole this is deemed to be acceptable since the corresponding value against GEH criteria is 86% and 85% for each peak respectively and the value across all screenlines is 86% for both peaks. All (or nearly all) screenlines are within 5% of the observed data.

Figures 10.1 to 10.3 show the GEH values in graphical form. Note that GEH values have been assigned a negative value where model flow is lower than observed.

Table 10.2 – AM Peak Link Flow Validation Summary

Screenlines and Cordon	No. Links	% Links GEH (PCUs)		% links DMRB flow (PCUs)	Observed Total (PCUs)	Model vs Obs Total (PCUs)	Model vs Obs % Diff (PCUs)	% Links GEH (LVs)	% links DMRB Flow (LVs)
		<5	<7					<5	
Calibration total	163	88%	98%	88%	144,654	-1,614	-1%	87%	89%
Inner (In)	19	84%	95%	79%	14,232	384	3%	79%	84%
Inner (Out)	18	94%	100%	83%	10,975	94	1%	83%	94%
East (In)	8	88%	100%	88%	6,612	-142	-2%	75%	75%
East (Out)	8	100%	100%	100%	4,963	-142	-3%	100%	100%
NW Inner (In)	13	92%	100%	85%	13,434	-402	-3%	92%	92%
NW Inner (Out)	13	85%	92%	92%	12,330	238	2%	100%	100%
South (In)	11	91%	91%	82%	6,063	37	1%	91%	91%
South (Out)	11	82%	100%	91%	6,042	55	1%	82%	91%
River (WBSB)	16	81%	100%	81%	18,175	168	1%	75%	69%
River (EBNB)	16	88%	100%	94%	23,640	-869	-4%	88%	88%
RW (ALL)	30	87%	97%	93%	28,188	-1,035	-4%	90%	93%
Validation total	146	92%	98%	88%	119,970	-368	0%	86%	84%
Outer (In)	26	88%	100%	77%	25,522	-463	-2%	81%	73%
Outer (Out)	26	96%	96%	96%	19,660	-170	-1%	96%	88%
Middle (In)	30	93%	93%	87%	23,785	-386	-2%	87%	87%
Middle (Out)	30	90%	100%	90%	18,054	106	1%	87%	90%
NW Outer (In)	6	83%	100%	83%	10,937	730	7%	67%	50%
NW Outer (Out)	6	100%	100%	83%	11,634	-217	-2%	83%	100%
NE (In)	11	91%	100%	91%	4,889	-46	-1%	82%	91%
NE (Out)	11	100%	100%	100%	5,490	79	1%	91%	73%
All	309	90%	98%	88%	264,624	-1,982	-1%	86%	86%

Figure 10.1 - AM Peak Traffic Flow Validation and Calibration Screenlines



Table 10.3 – Inter Peak Link Flow Validation Summary

Screenlines and Cordon	No. Links observed	% Links GEH (PCUs)		% links DMRB Flow (PCUs)	Observed Total (PCUs)	Model vs Obs Total (PCUs)	Model vs Obs % Diff (PCUs)	% Links GEH (LVs)	% links DMRB Flow (LVs)
		<5	<7					<5	
Calibration Total	163	87%	96%	88%	122,397	-3,444	-3%	89%	93%
Inner (In)	19	79%	89%	79%	10,216	-496	-5%	79%	84%
Inner (Out)	18	78%	94%	83%	10,461	-253	-2%	83%	94%
East (In)	8	88%	88%	88%	5,053	-383	-8%	75%	88%
East (Out)	8	88%	100%	100%	5,456	-276	-5%	100%	100%
NW Inner (In)	13	92%	100%	92%	11,192	-185	-2%	100%	100%
NW Inner (Out)	13	100%	100%	100%	9,984	-126	-1%	100%	100%
South (In)	11	100%	100%	100%	5,655	30	1%	91%	91%
South (Out)	11	100%	100%	100%	5,703	47	1%	100%	100%
River (WBSB)	16	88%	88%	88%	17,279	-241	-1%	88%	94%
River (EBNB)	16	75%	100%	75%	17,640	-457	-3%	81%	81%
RW (ALL)	30	83%	97%	87%	23,759	-1,105	-5%	90%	93%
Validation Total	146	90%	99%	89%	93,005	-2,096	-2%	92%	93%
Outer (In)	26	100%	100%	92%	16,282	-856	-5%	100%	96%
Outer (Out)	26	92%	100%	88%	15,827	-356	-2%	92%	92%
Middle (In)	30	80%	97%	80%	17,425	-921	-5%	90%	93%
Middle (Out)	30	87%	100%	93%	17,360	-762	-4%	100%	100%
NW Outer (In)	6	83%	100%	100%	8,744	282	3%	83%	100%
NW Outer (Out)	6	67%	100%	83%	9,006	274	3%	100%	100%
NE (In)	11	100%	100%	91%	4,215	173	4%	73%	64%
NE (Out)	11	100%	100%	91%	4,147	71	2%	82%	91%
All	309	88%	97%	89%	215,403	-5,540	-3%	91%	93%

Figure 10.2 - Inter Peak Traffic Flow Validation and Calibration Screenlines



Table 10.4 – PM Peak Link Flow Validation Summary

Screenlines and Cordon	No. Links observed	% Links GEH (PCUs)		% links DMRB Flow (PCUs)	Observed Total (PCUs)	Model vs Obs Total (PCUs)	Model vs Obs % Diff (PCUs)	% Links GEH (LVs)	% links DMRB Flow (LVs)
		<5	<7					<5	
Calibration Total	163	85%	91%	88%	149,598	-311	0%	88%	88%
Inner (In)	19	84%	89%	89%	11,030	65	1%	84%	89%
Inner (Out)	18	67%	78%	78%	14,527	-263	-2%	72%	72%
East (In)	8	100%	100%	100%	5,342	-275	-5%	100%	100%
East (Out)	8	88%	100%	100%	7,917	-225	-3%	100%	100%
NW Inner (In)	13	85%	92%	85%	13,488	-544	-4%	85%	85%
NW Inner (Out)	13	92%	92%	77%	13,851	-254	-2%	92%	92%
South (In)	11	100%	100%	100%	6,321	32	1%	100%	100%
South (Out)	11	82%	82%	82%	6,835	403	6%	82%	73%
River (WBSB)	16	94%	100%	94%	22,218	753	3%	94%	94%
River (EBNB)	16	75%	81%	75%	19,778	455	2%	69%	75%
RW (ALL)	30	87%	97%	93%	28,291	-457	-2%	97%	97%
Validation Total	146	89%	97%	91%	123,001	-1,800	-1%	85%	84%
Outer (In)	26	96%	100%	92%	21,239	-316	-1%	85%	81%
Outer (Out)	26	88%	96%	88%	24,827	-533	-2%	85%	85%
Middle (In)	30	87%	100%	93%	19,779	-470	-2%	90%	90%
Middle (Out)	30	87%	87%	87%	23,123	140	1%	73%	73%
NW Outer (In)	6	67%	100%	83%	12,082	-522	-4%	83%	83%
NW Outer (Out)	6	100%	100%	100%	11,667	228	2%	83%	100%
NE (In)	11	91%	100%	100%	5,320	-189	-4%	91%	100%
NE (Out)	11	91%	100%	91%	4,964	-139	-3%	100%	82%
All	309	87%	94%	89%	272,599	-2,111	-1%	86%	86%

Figure 10.3 - PM Peak Traffic Flow Validation and Calibration Screenlines



10.4 Journey Times

All observed data is from October 2013 (excluding school half term), using output from the Trafficmaster™ journey time database, with the exception of Routes 1 & 2, where local roadworks in Barrow Gurney were underway, hence May 2013 data was utilised. The location of the routes is shown in Figure 5.4. Table 10.5 shows a good model fit to observed journey times in all time periods. **Appendix F** shows distance-time graphs.

Table 10.5 - GBATS4M Net Journey Time (mins) Validation

Route Description		AM Peak			Inter Peak			PM Peak		
		Obs	Model	% Diff	Obs	Model	% Diff	Obs	Model	% Diff
1	A370 Inbound (Backwell to Ashton Gate)	10.1	10.5	4%	10.8	9.5	-12%	9.8	9.7	-1%
1	A370 Outbound (Jessop Underpass to Backwell)	9.7	9.6	-1%	10.3	9.5	-7%	10.2	11.7	15%
2	A38 Inbound (Barrow Gurney to Bedminster Bridge)	17.6	15.6	-11%	18.2	16.2	-11%	18.8	17.3	-8%
2	A38 Outbound (Bedminster Bridge to Barrow Gurney)	13.6	14.0	3%	12.7	13.9	9%	16.6	18.0	9%
3	A4 Inbound (Keynesham to Bath Bridge)	30.9	26.5	-14%	15.1	16.1	7%	19.2	21.3	11%
3	A4 Outbound (Bath Bridge to Keynesham)	19.2	20.1	5%	14.4	14.9	4%	18.6	20.6	10%
4	A431 Inbound (Willsbridge to Old Market St)	30.7	33.5	9%	20.4	21.2	4%	22.8	22.6	-1%
4	A431 Outbound (Old Market St Jct to Willsbridge)	20.7	23.0	11%	20.9	22.4	7%	25.8	28.6	11%
5	A38 Eastbound (Ashton Gate to Brislington)	29.2	25.1	-14%	18.8	21.4	14%	26.1	29.6	14%
5	A38 Westbound (Brislington to Ashton Gate)	23.3	23.0	-1%	17.9	20.7	16%	21.8	24.6	13%
6	A432 Inbound (A4174 Badminton Rbt to Old Market St)	35.6	34.0	-4%	23.0	25.1	9%	23.6	26.0	10%
6	A432 Outbound (West St to A4174 Badminton Rbt)	26.3	28.8	9%	23.4	26.7	14%	26.0	25.7	-1%
7	M32 Inbound (M32 J1 to Cabot Circus)	13.1	12.5	-5%	5.1	5.7	11%	6.2	6.8	10%
7	M32 Outbound (Cabot Circus to M32 J1)	5.6	5.3	-6%	4.1	4.3	5%	4.8	4.2	-12%
8	A38 Inbound (M5 J16 to St James Barton Rbt)	33.6	36.2	8%	24.7	25.9	5%	30.4	31.2	2%
8	A38 Outbound (St James Barton Rbt to M5 J16)	32.2	31.2	-3%	24.9	24.8	-1%	35.3	29.9	-15%
9	A4018 Inbound (M5 J17 Cribbs to Clifton Triangle)	29.7	21.4	-28%	16.7	16.0	-4%	22.9	19.6	-14%
9	A4018 Outbound (College Green to M5 J17 Cribbs)	18.1	18.4	2%	16.3	17.5	7%	18.9	19.4	3%
10	A4 Portway Inbound (Avonmouth to Hotwells)	20.8	17.5	-16%	13.7	14.4	5%	18.3	18.8	3%
10	A4 Portway Outbound (Hotwells to Avonmouth)	12.0	12.6	5%	10.9	11.6	6%	11.9	12.3	3%
11	A369 Inbound (Portishead to A4 Bristol Gate)	24.2	21.8	-10%	13.2	14.9	13%	16.6	16.4	-1%
11	A369 Outbound (A4 Bristol Gate to Portishead)	16.7	17.6	5%	15.3	16.4	7%	19.0	19.8	4%
12	A4174 Eastbound (Filton Rbt to A4)	28.0	26.4	-5%	22.1	23.5	7%	31.5	27.3	-13%
12	A4174 Westbound (A4 to Filton Rbt)	31.7	36.2	14%	21.1	22.2	5%	26.1	25.3	-3%
14	City Centre Outer Loop (Clockwise)	35.5	34.5	-3%	24.0	27.3	14%	41.5	39.9	-4%
14	City Centre Outer Loop (Anti-Clockwise)	32.2	31.1	-4%	20.3	22.3	10%	32.4	37.6	16%
15	City Centre Inner Loop (Clockwise)	30.5	26.7	-12%	20.9	21.8	4%	29.4	29.1	-1%
15	City Centre Inner Loop (Anti-Clockwise)	19.4	19.5	0%	13.6	14.4	6%	17.9	20.0	11%
16	M4 Mainline Eastbound (J22 to J18)	28.0	24.4	-13%	19.6	19.8	1%	21.0	20.6	-2%
16	M4 Mainline Westbound (J18 to J22)	20.5	20.4	-1%	20.2	20.2	0%	20.9	20.4	-3%
17	M5 Mainline Northbound (J20 to M4)	14.4	14.2	-2%	14.8	13.7	-7%	17.5	14.0	-20%
17	M5 Mainline Southbound (M4 to J20)	14.9	13.4	-10%	14.5	13.3	-8%	14.9	14.0	-6%
% All routes within x% of observed		10%	15%	20%	10%	15%	20%	10%	15%	20%
		69%	94%	97%	72%	97%	100%	56%	91%	100%

10.5 Model Convergence

The convergence for each model period is summarised in Table 10.6 and shows that the three models have achieved TAG M3.1 proximity %GAP criteria (the first choice measure of assignment convergence, see section 3.2). The stability criteria is achieved, based on change in delay (used as a proxy for cost) but has not for flow change. TAG M3.1 states that the convergence criteria must be met for either flow or cost and hence overall the convergence criteria is met.

Table 10.6 - GBATS4M Convergence Summary

Measure		AM Peak		Inter Peak		PM Peak	
No. Loops till termination		16		20		44	
Final 4 Loops Mean	Gap %	0.08	✓	0.01	✓	0.05	✓
	% Flow change (P <1%)	91	×	96	×	96	×
	% Delay change (P2 <1%)	98	✓	100	✓	99	✓

10.6 Stress Test

After achieving a near-fully validated model a 'stress test' of the Base AM and PM models was undertaken by increasing the total numbers of trips in the matrices by 30% and reassigning. This revealed some minor network faults which previous checks had not detected. The changes were made and feed back into the iterative model development process.

Conclusion

11.1 Overview

The model has been validated using the guidance, measures and criteria recommended in TAG M3.1. The following comparisons between modelled and observed data have been reported:

- Total flows for cordons and screenlines;
- Traffic Flows on individual links; and
- Journey times (both cruise and net) for a range of key routes.

The analysis shows that the three models meet the acceptability guidelines:

- Regarding matrix estimation changes;
- For traffic flows on links across the total cordon and screenlines and at the individual calibration, and independent validation sites; and
- For journey times.

All three models achieve acceptable levels of convergence and are stable based on delay/cost.

Stress test confirmed the network is fit for future year testing, in particular the MetroWest Phase 1 and 2 schemes.

Appendix A: Other Traffic Count Sites

Figure A1: Highways Agency TRADS Sites and Wider Area counts

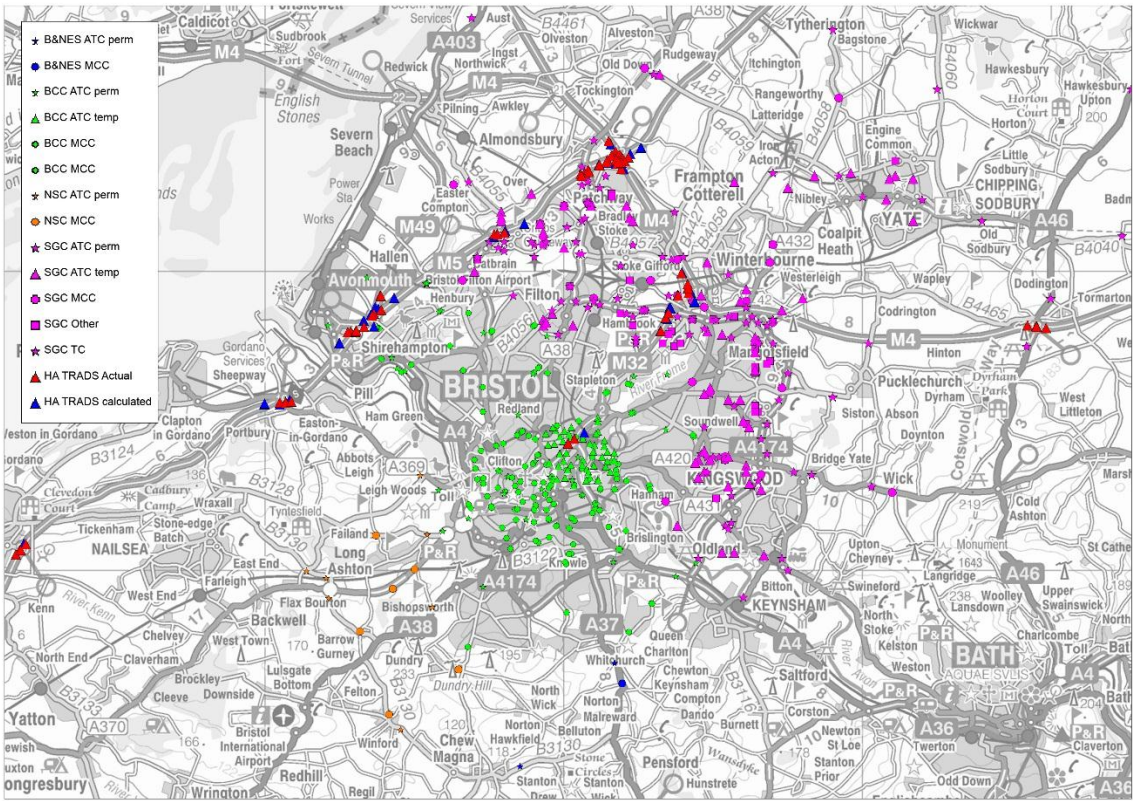
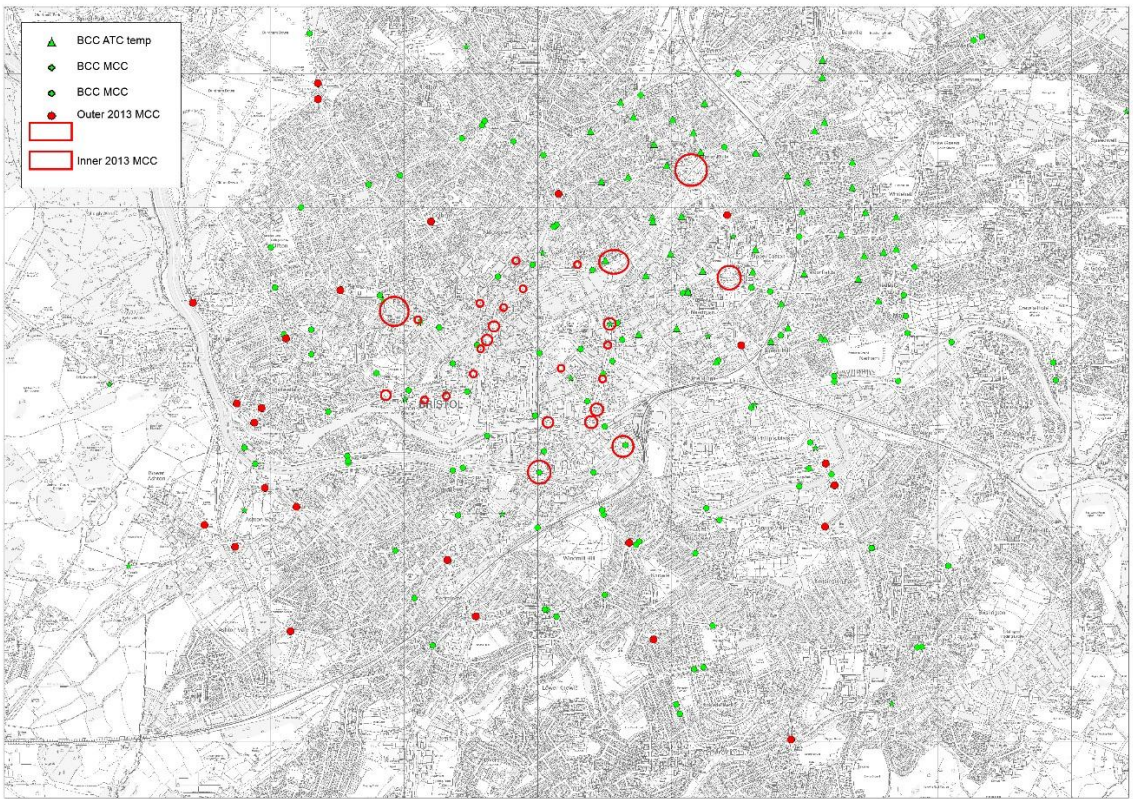


FIGURE A2
Central Area Count Sites



Appendix B: Network Coding Standards

Roundabouts

Roundabouts have entry and circulating saturation flows defined in the SATURN coding. The main factors determining the values of these are entry lane approach width / degree of flaring and the inscribed circle diameter.

TABLE B2

Roundabout saturation flows and GAP

Entry Arm Type		Mini	Small	Medium	Large	Very Large
Inscribed Diameter		~20m	~40m	~60m	~80m	~100m
Single Lane Narrow <3m, No Flare		900	950	1000	N/A	N/A
Single Lane Narrow <3m, Flare To 2 Lanes		1225	1325	1400	N/A	N/A
Single Lane Normal 3.5m, No Flare		1050	1075	1150	1200	1250
Single Lane Normal 3.5m, Flare To 2 Lanes		1475	1550	1625	1700	1800
Dual No Flare		N/A	2325	2400	2475	2525
Dual Flare To 3 Lanes		N/A	2725	2850	2950	3075

Entry Arm Type		Mini	Small	Medium	Large	Very Large
All Single	Cir	1950	2100	2500	N/A	N/A
	Gap	1.8	1.7	1.5	N/A	N/a
Mixed Single/Dual	Cir	N/A	2300	2650	3100	3300
	Gap	N/A	1.6	1.4	1.2	1.1
All Dual But No Flares To 3 Lanes	Cir	N/A	N/A	3550	4200	4500
	GAP	N/A	N/A	1.0	0.9	0.8
All Dual And Flared To 3 Lanes	Cir	N/A	N/A	3850	4500	4800
	GAP	N/A	N/A	0.9	0.8	0.8

Geometry	Mini	Small	Medium	Large	Very Large
Inscribed Diameter	~20m	~40m	~60m	~80m	~100m
Circulation Time (Seconds)	6	11	17	23	28

Signalised Junction Saturation flows

Signalised junctions typically have saturation flows per lane of between 1600 and 2050 depending on the lane width and the turn radii of left/right turns.

TABLE B1

Signalised junction saturation flows

Entry Arm Type	Left Turn	Straight	Right Turn
Single Lane Narrow <3m	1650	1900	1700
Single Lane Normal ~ 3.5m	1750	1950	1800
2 Lanes Narrow <6m	3500	3950	3600
2 Lanes Normal ~7m	3600	4100	3700
3lanes ~10m	N/A	6200	N/A

Priority Junctions

Unopposed Movements:

- Straight ahead 1700 to 1950;
- Left Turn 1650 to 1800;

TABLE B3

Priority junction saturation flows – opposed movements:

Visibility	Right Major	Left Minor	Straight Minor	Right Minor
Poor (<50m)	575	600	500	500
Average (50-120m)	615	625	575	575
Good (120-240m)	675	700	675	675

Gap acceptance at priority junctions is usually of the order of 1.5 to 2.5 seconds depending on the junction geometry.

EMME – SATURN Linkage for Bus Lanes

The coding of bus priority measures within the SATURN network needs to be accessed by EMME3 to ensure that travel time improvements from such measures are incorporated into the mode choice model. The coding of bus priority is based on the 'B-Code' method used in SATURN which allocates lanes on the main carriageway to exclusive bus usage. This method allows the bus lane to be allocated to either adjacent to the kerb or adjacent to the centre line.

Appendix C: Matrix Estimation Checks

FIGURE C1

AM Matrix Zonal Cells Scatterplot

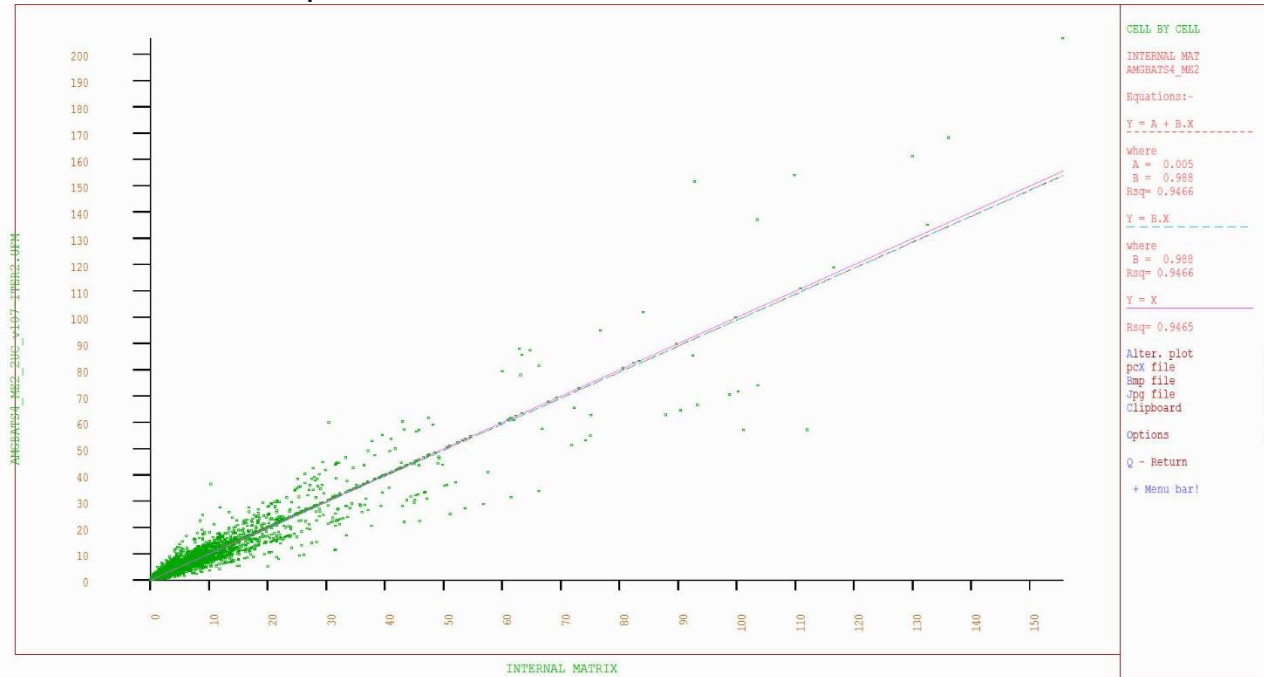


FIGURE C2

AM Matrix Zonal Trip Ends Scatterplot

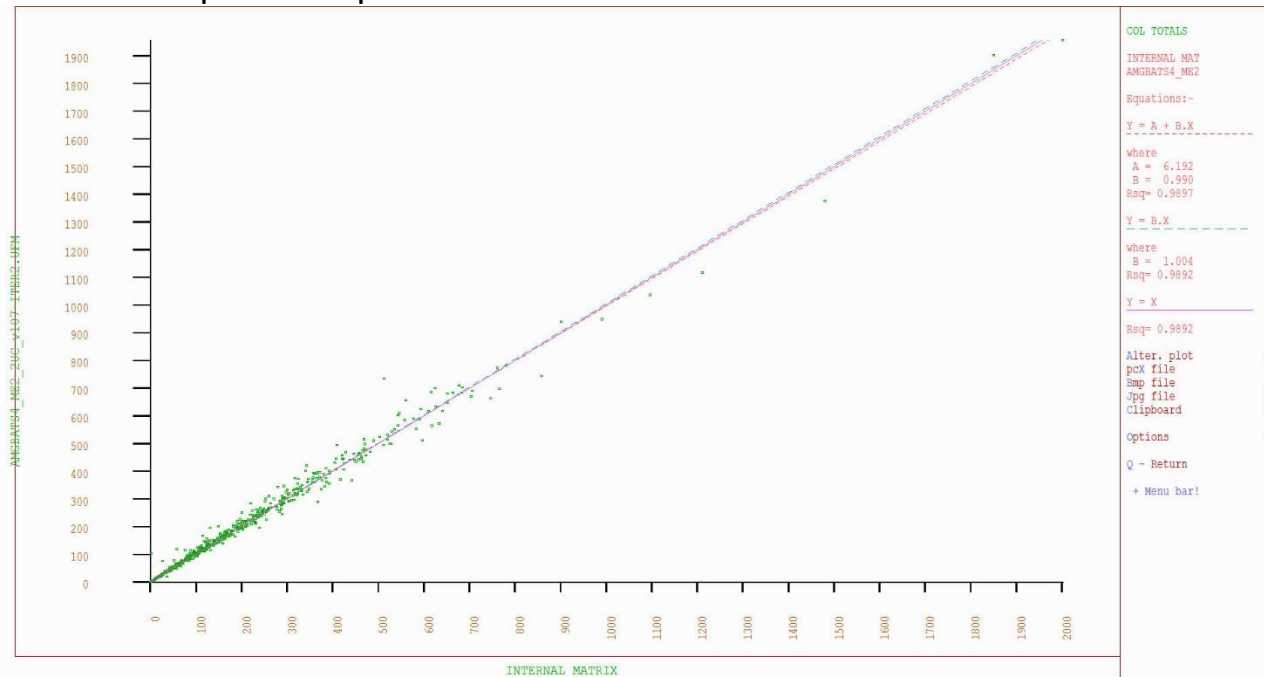


FIGURE C3
IP Matrix Zonal Cells Scatterplot

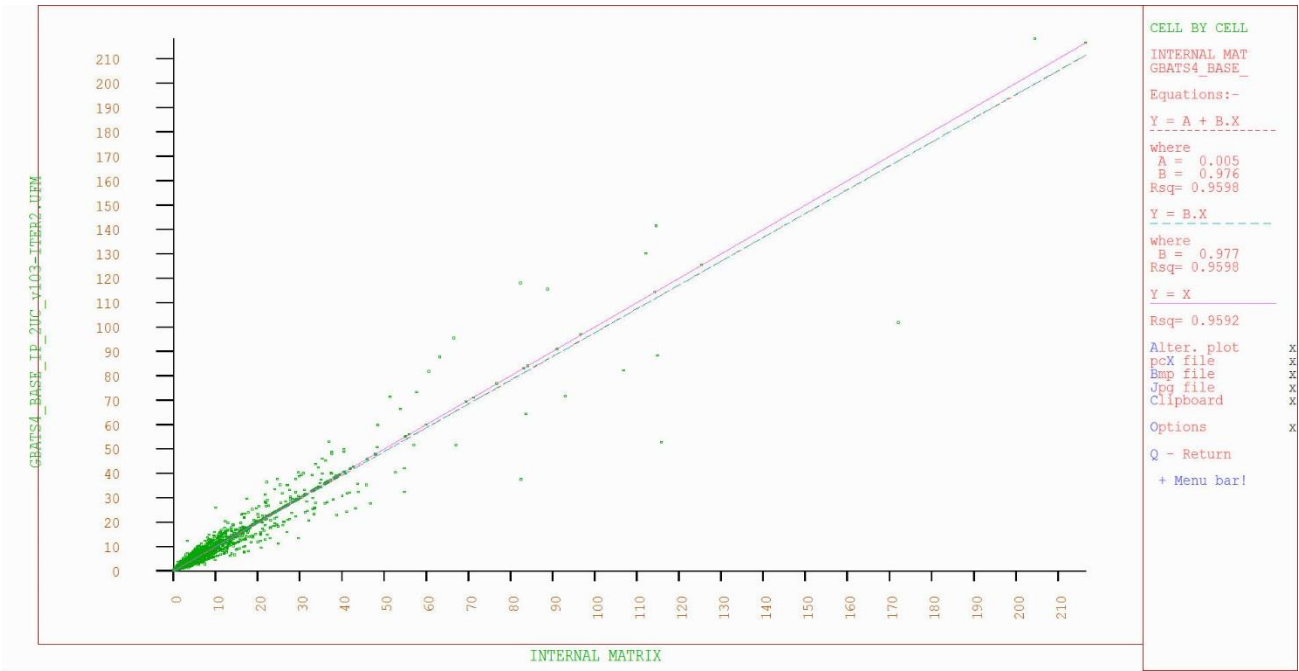


FIGURE C4
IP Matrix Zonal Trip Ends Scatterplot

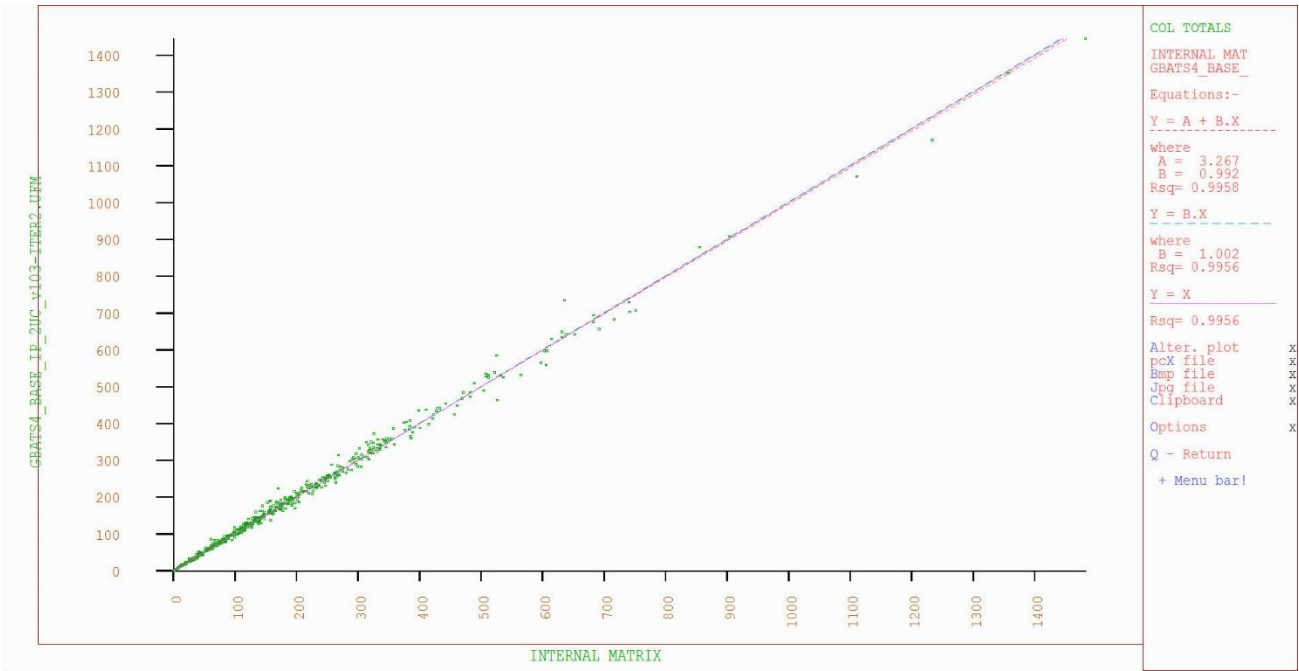


FIGURE C5
PM Matrix Zonal Cells Scatterplot

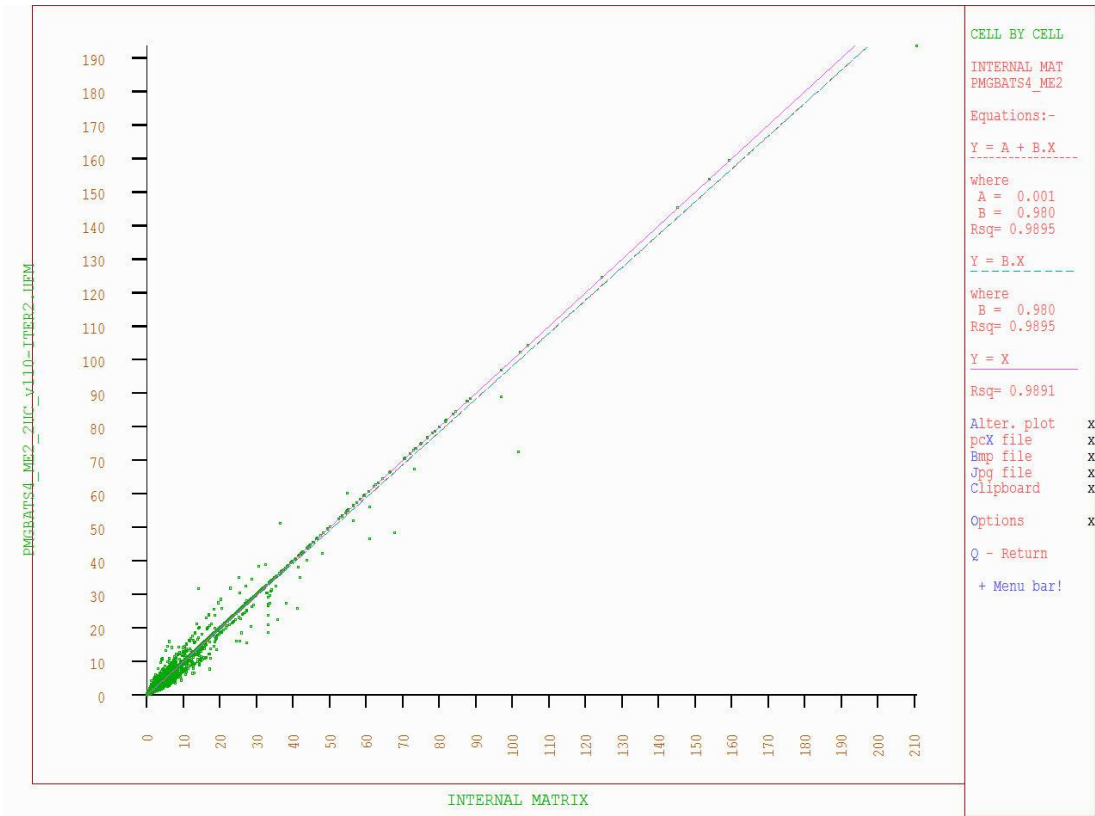


FIGURE C6
PM Matrix Zonal Trip Ends Scatterplot

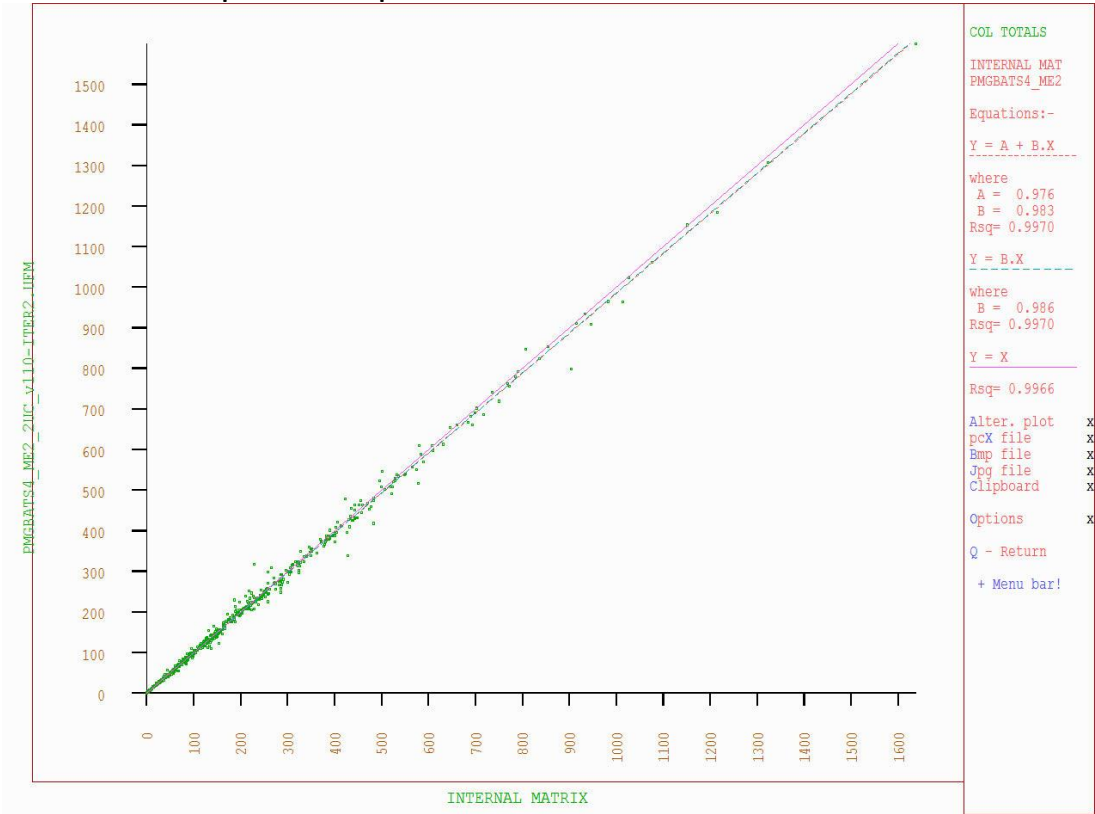


FIGURE C7
AM Trip Length Distribution

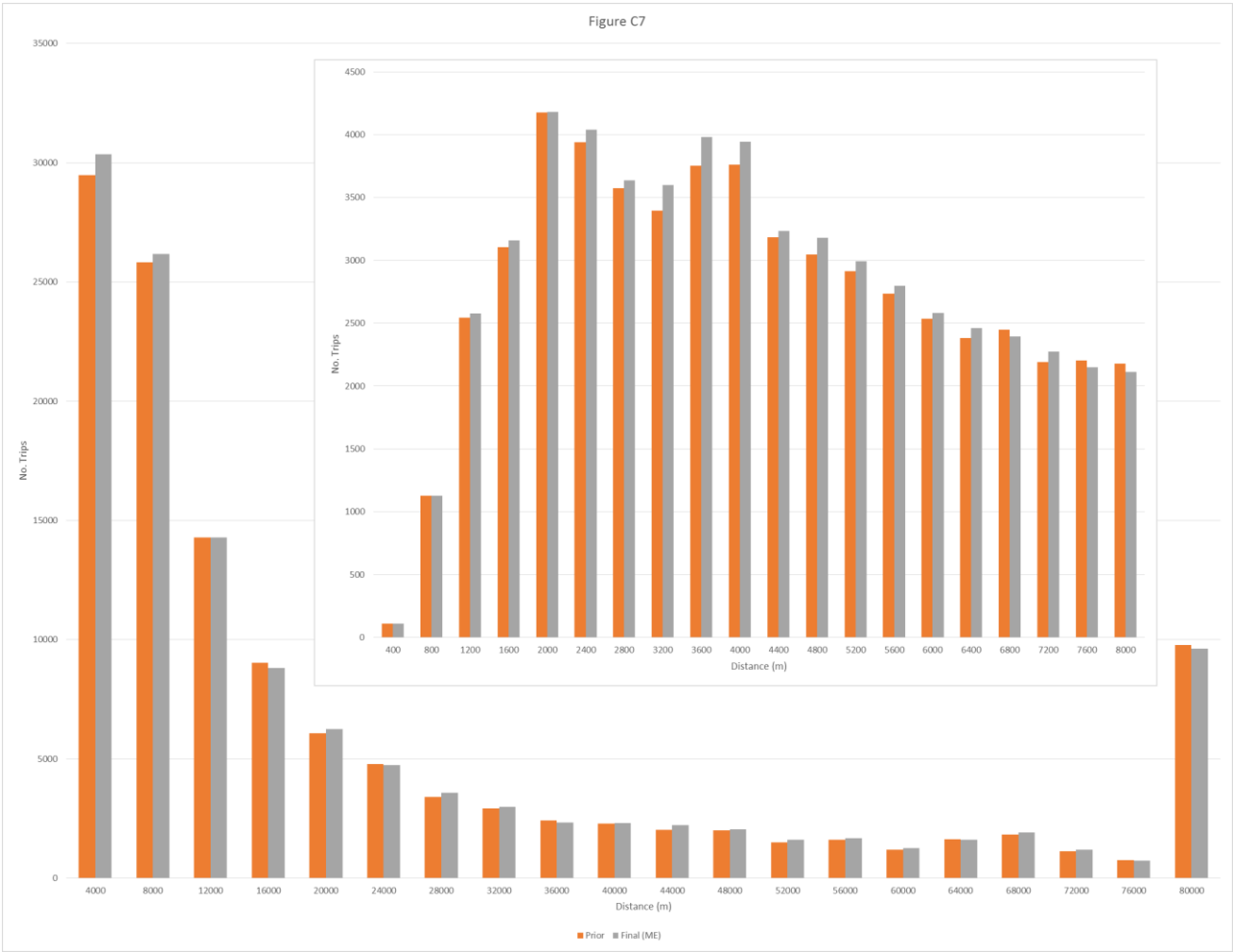


FIGURE C8
IP Trip Length Distribution

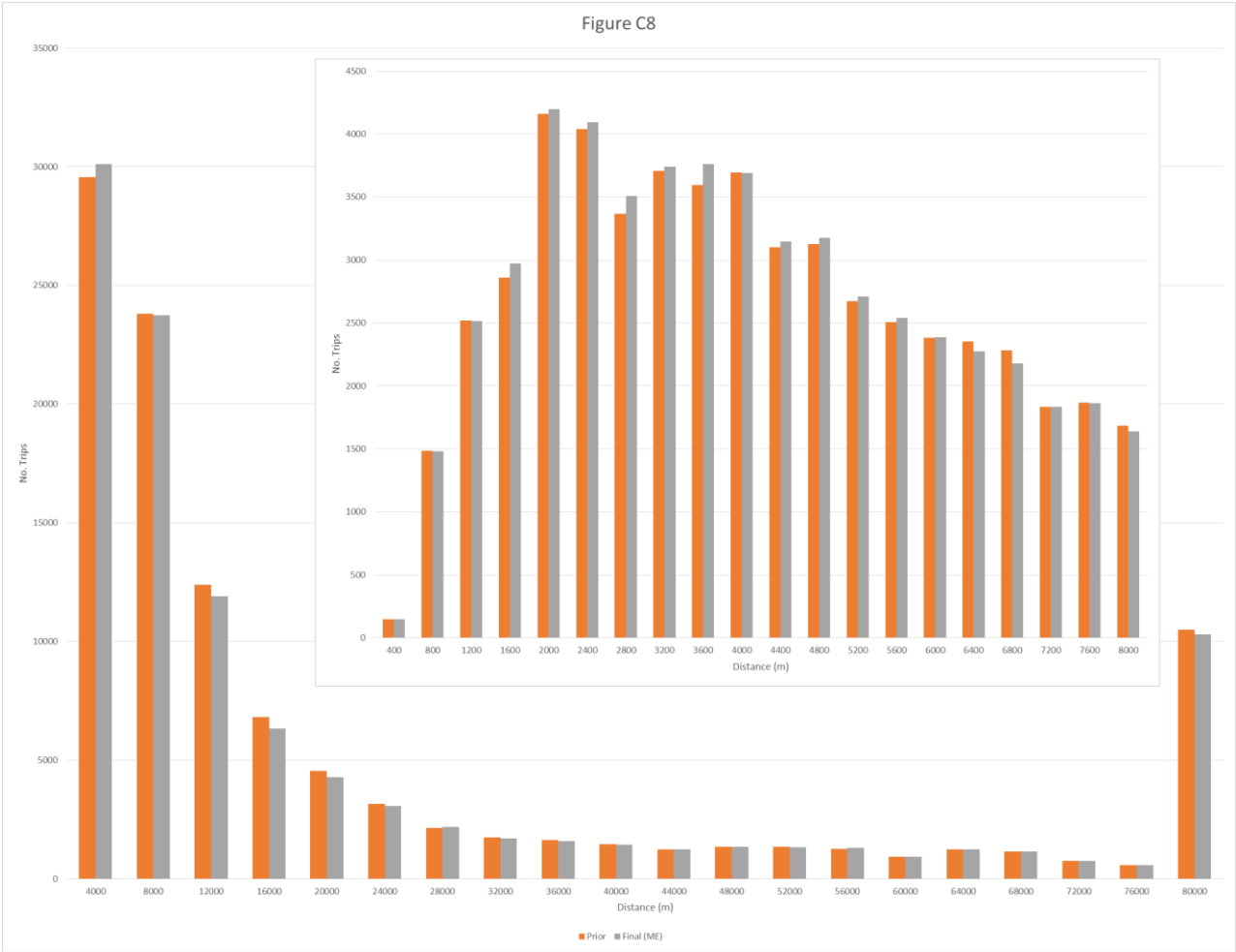
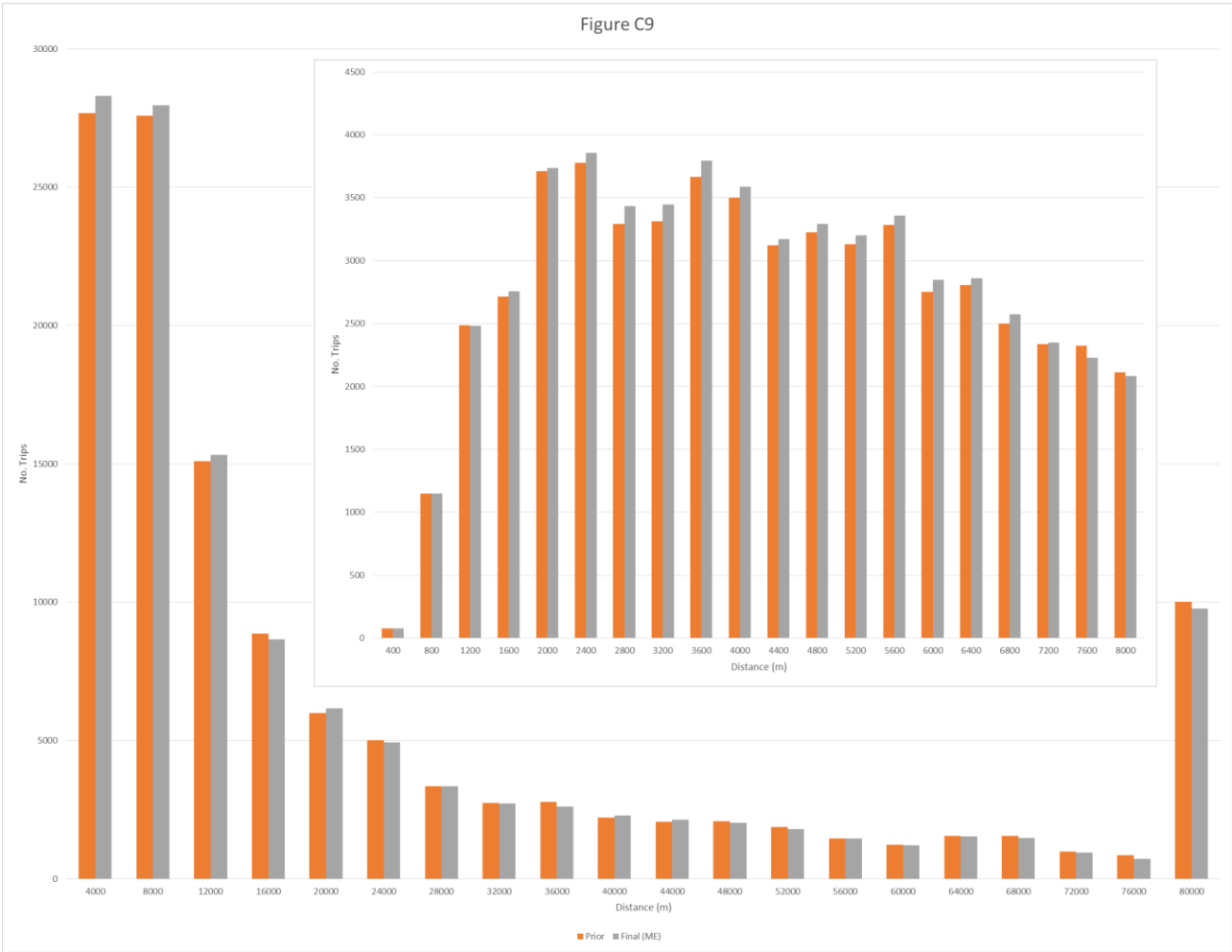
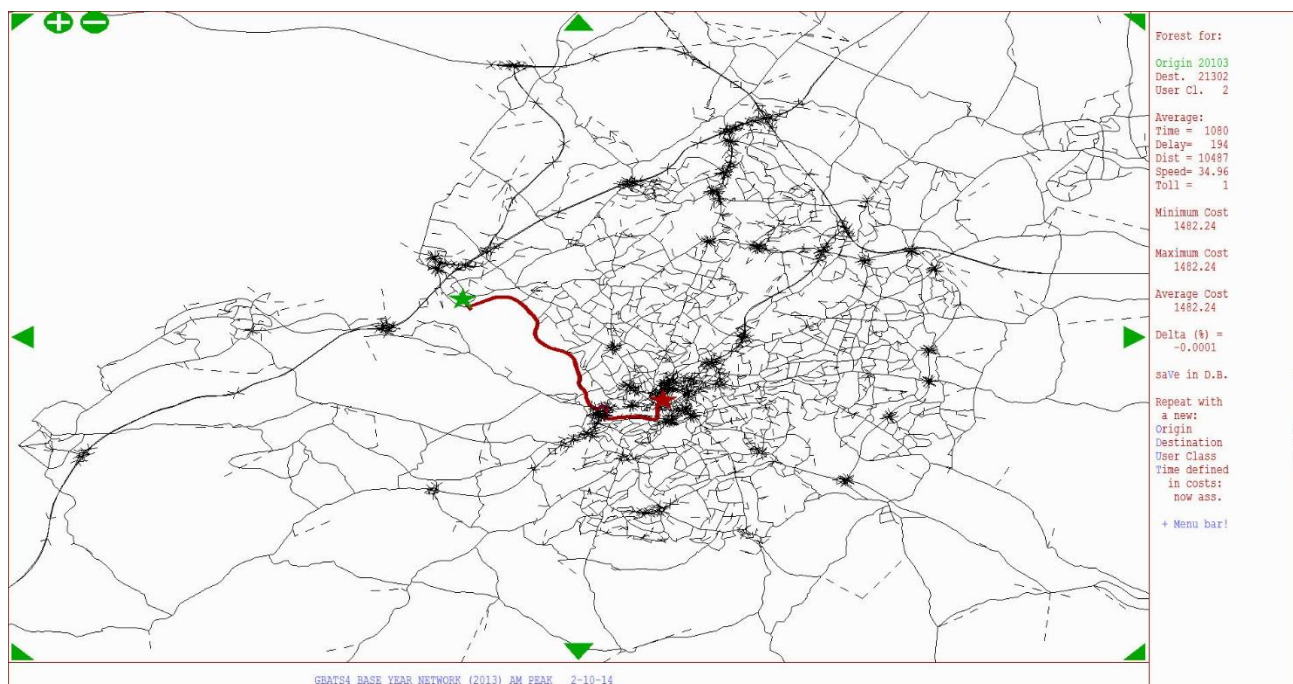
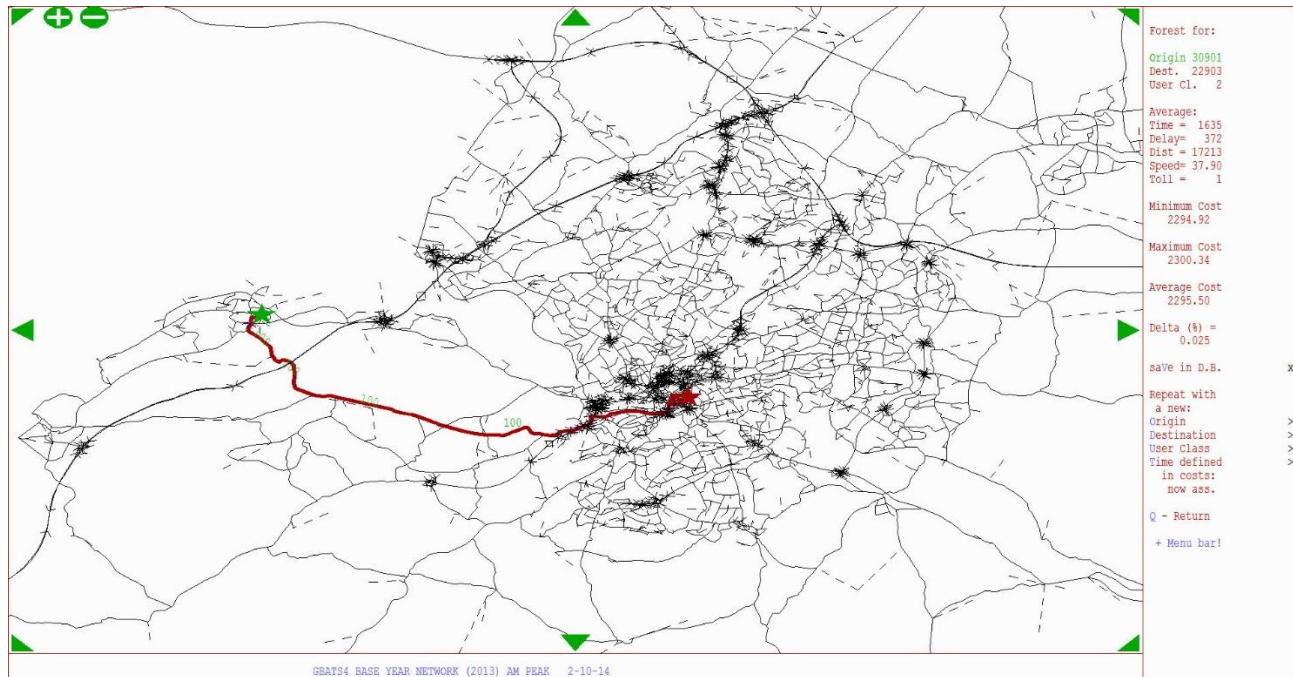


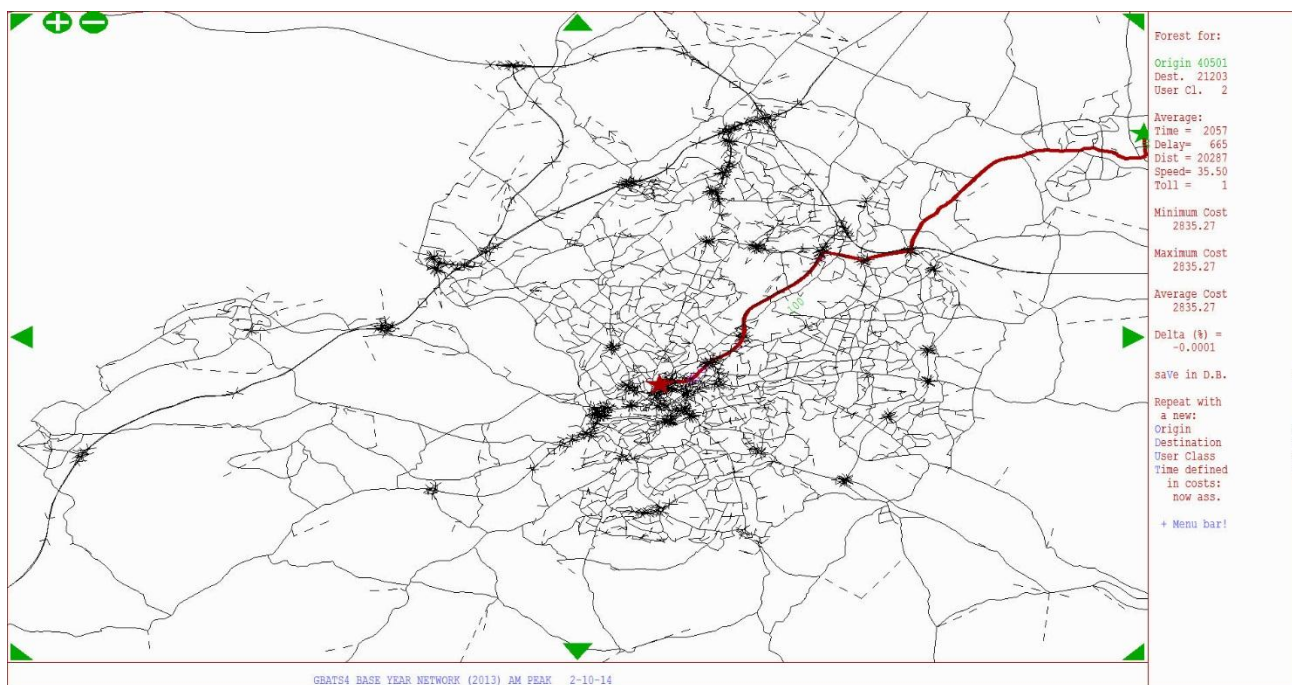
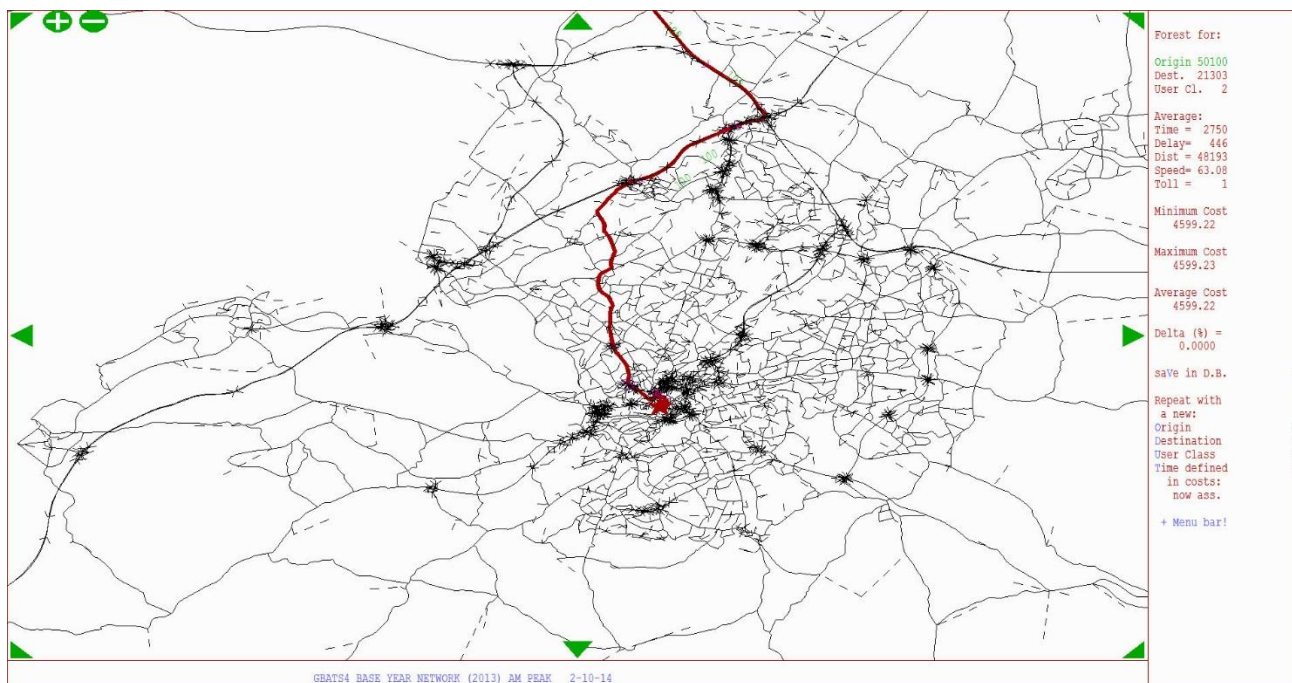
FIGURE C9
PM Trip Length Distribution

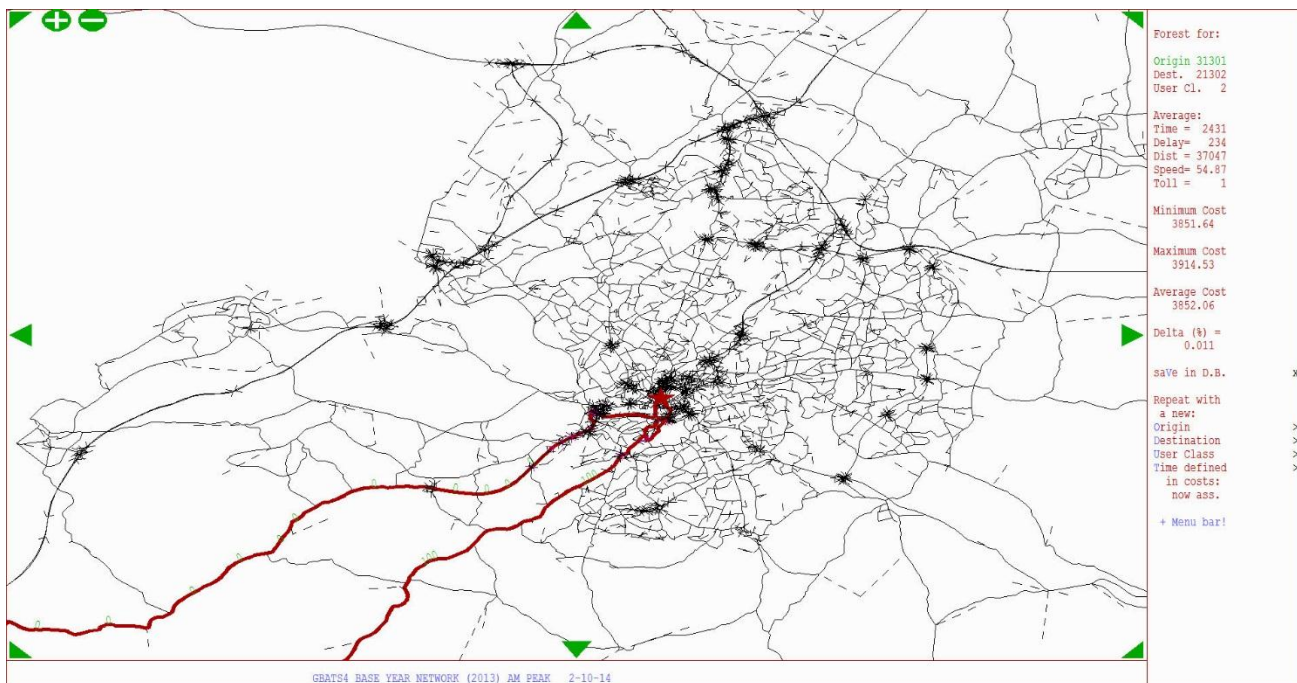
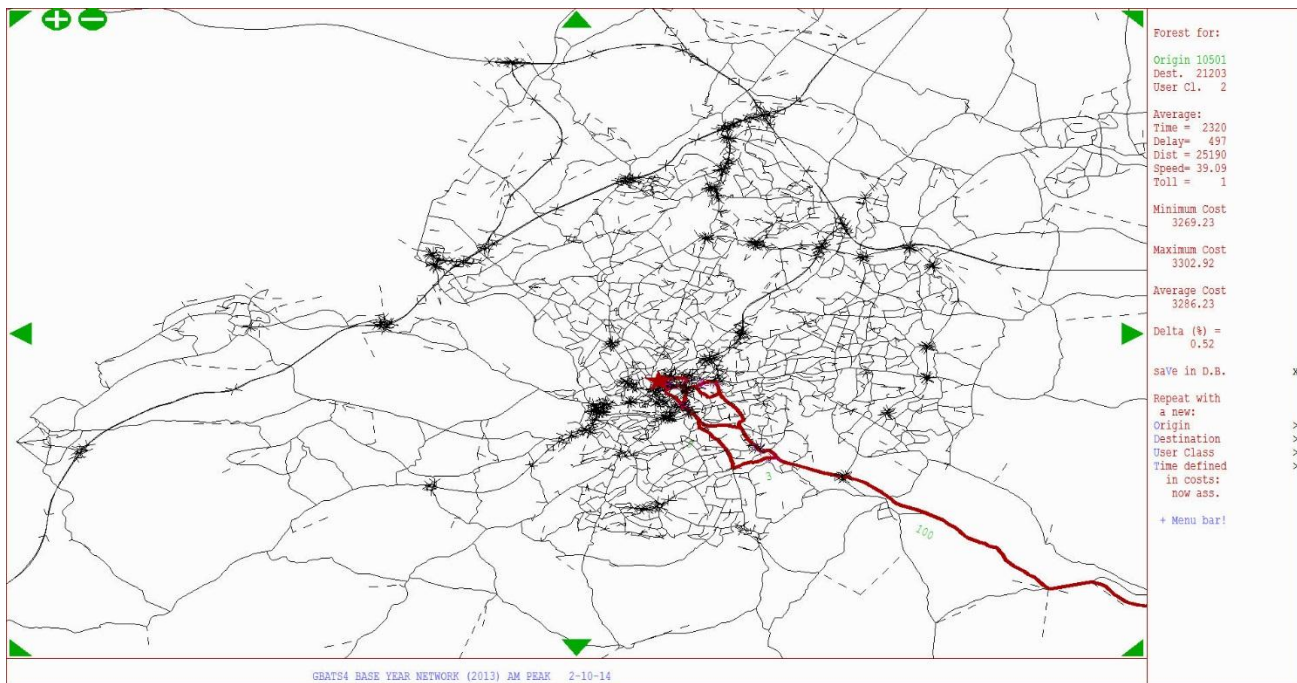


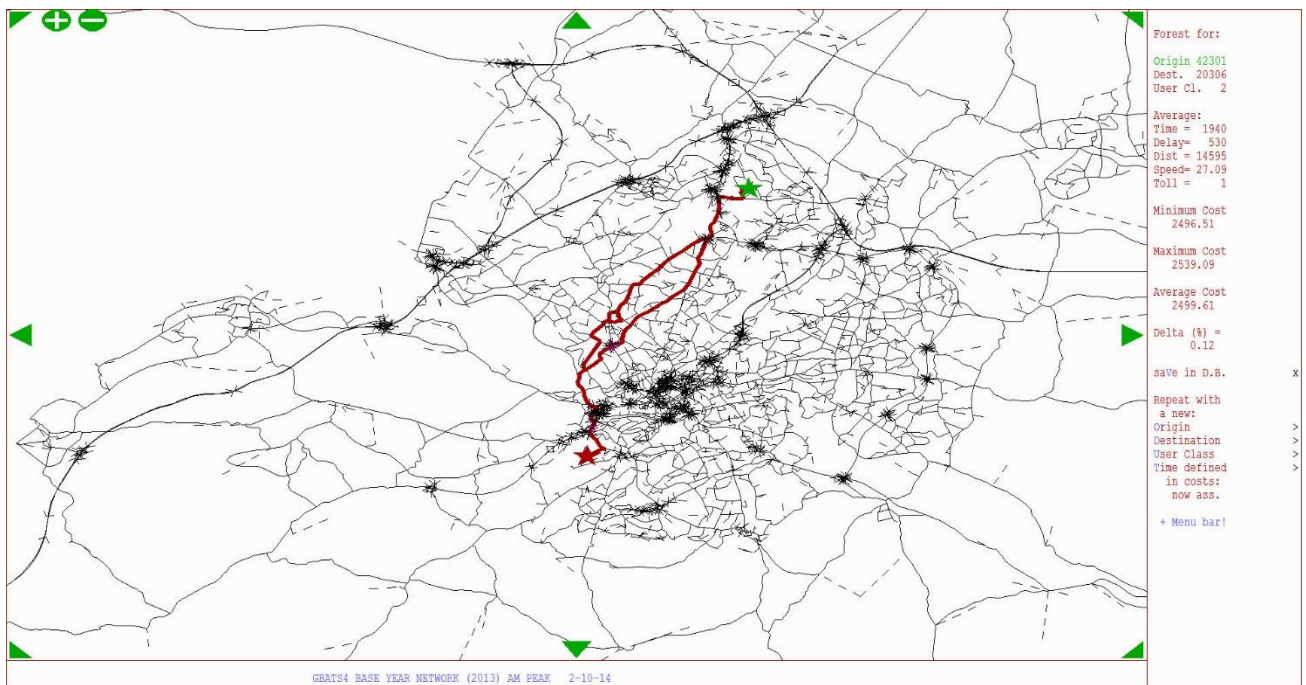
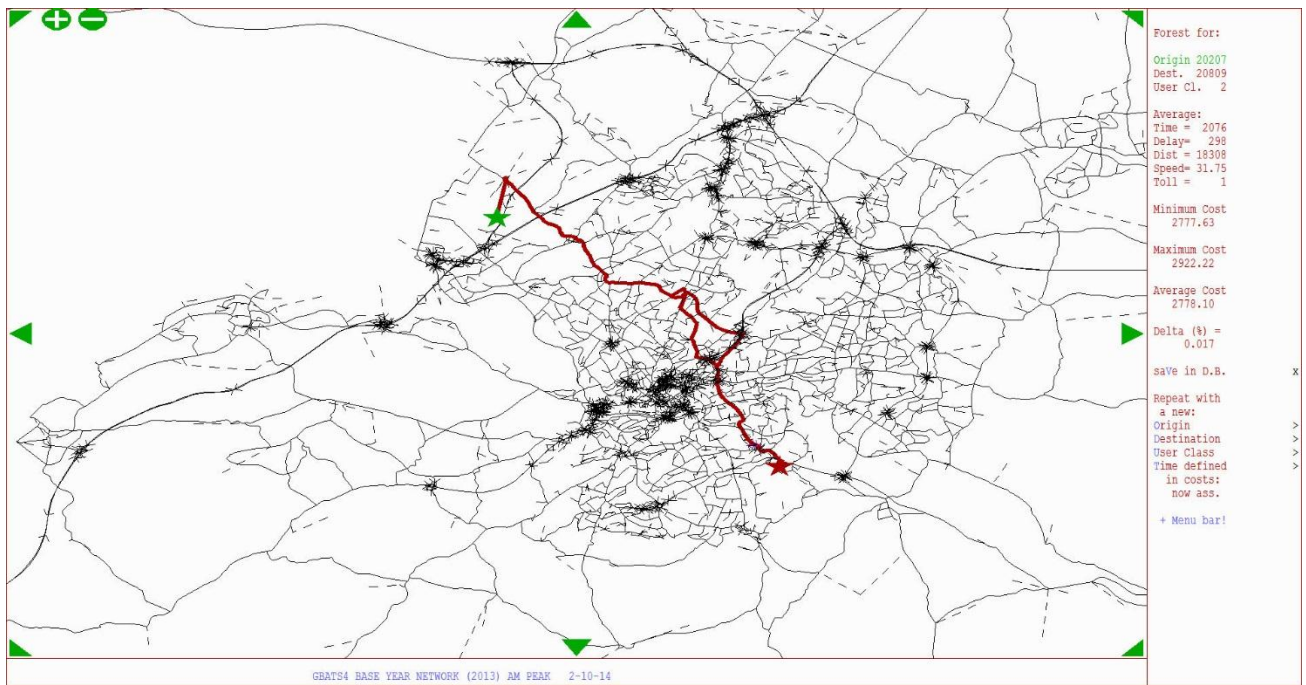
Appendix D: Route Choice Calibration

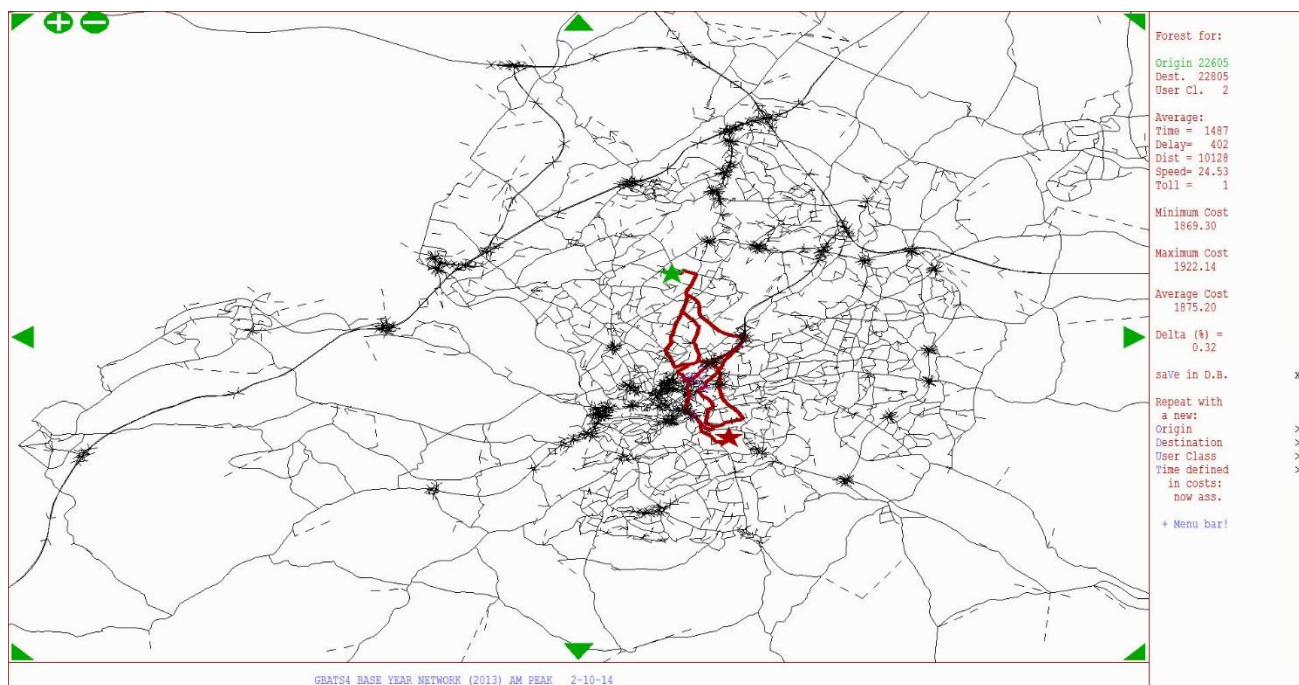
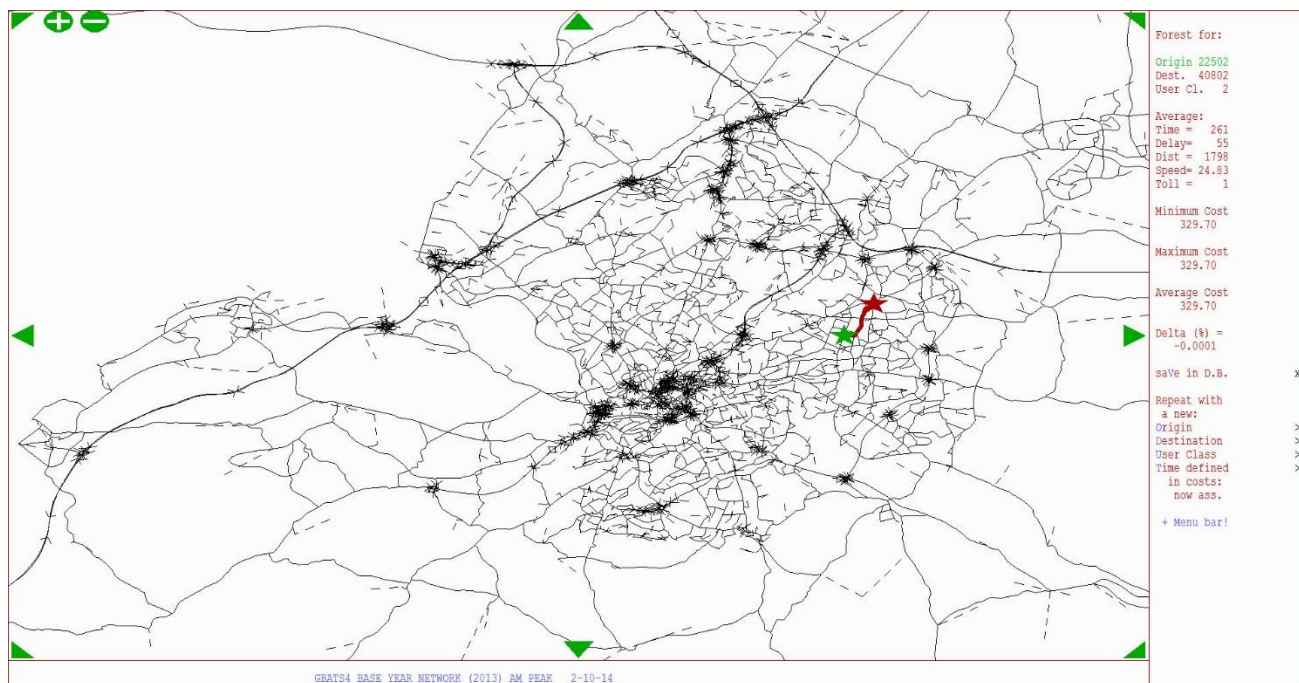
Part 1: Route Choice Path Plots



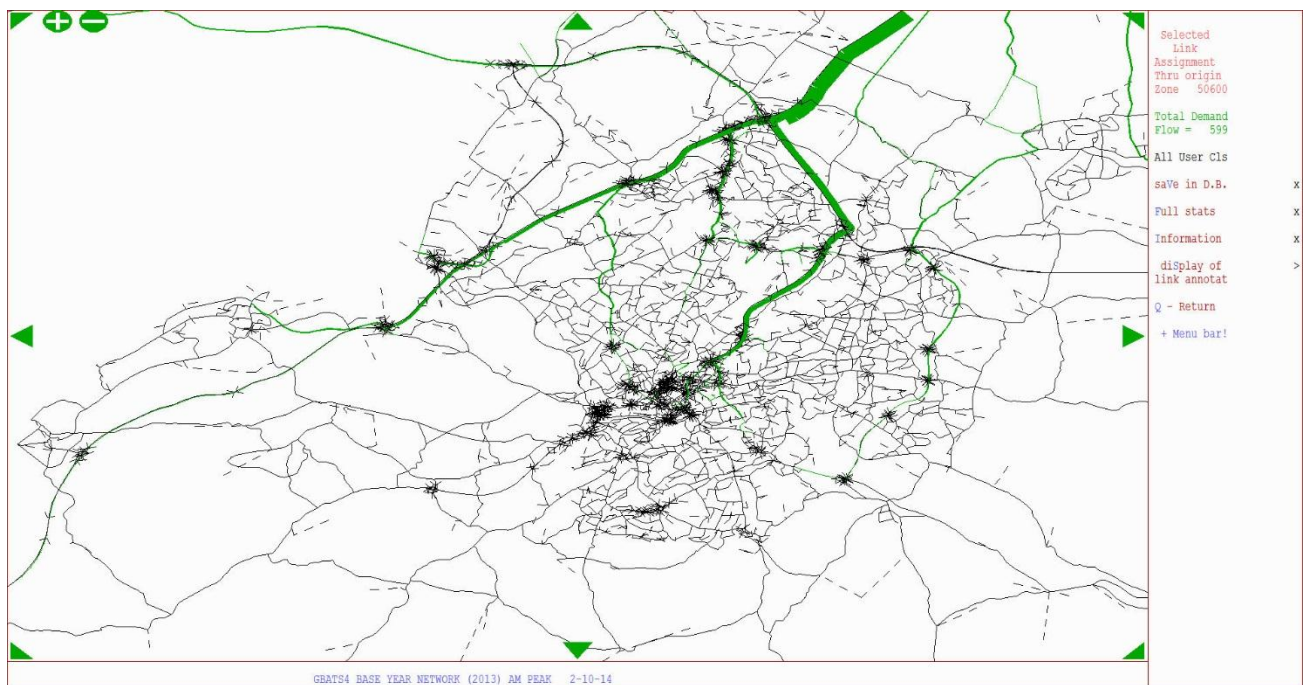
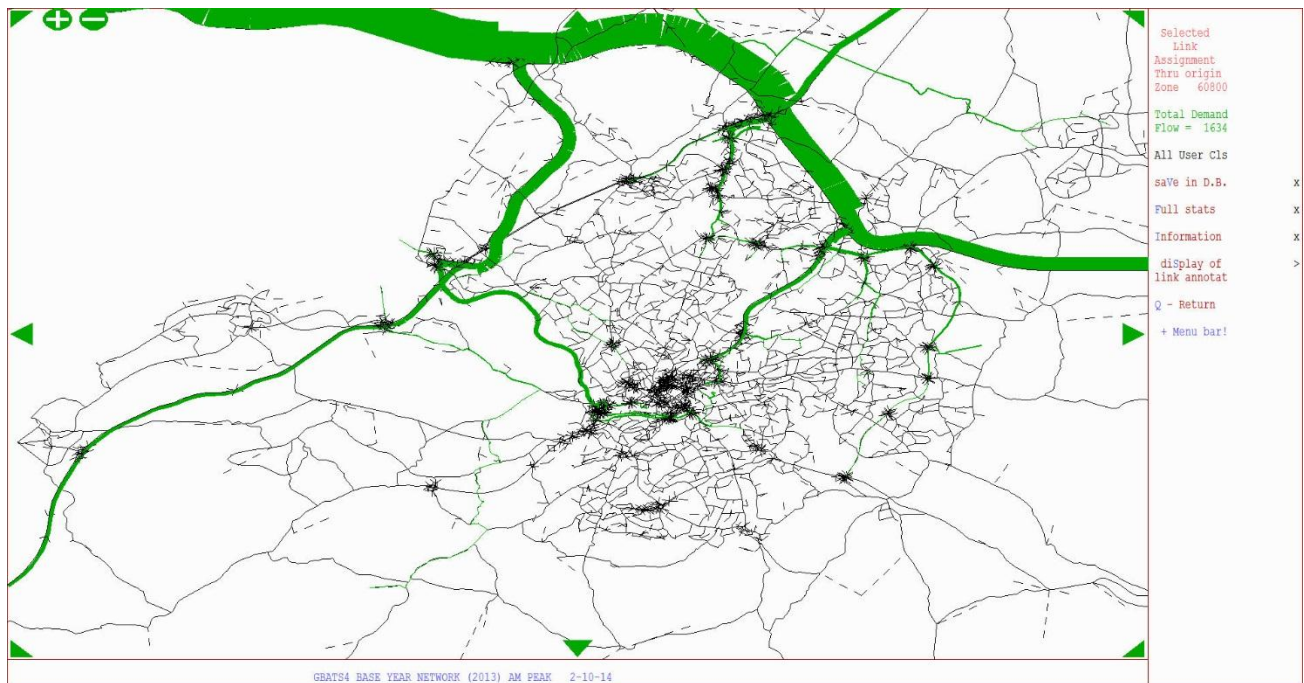


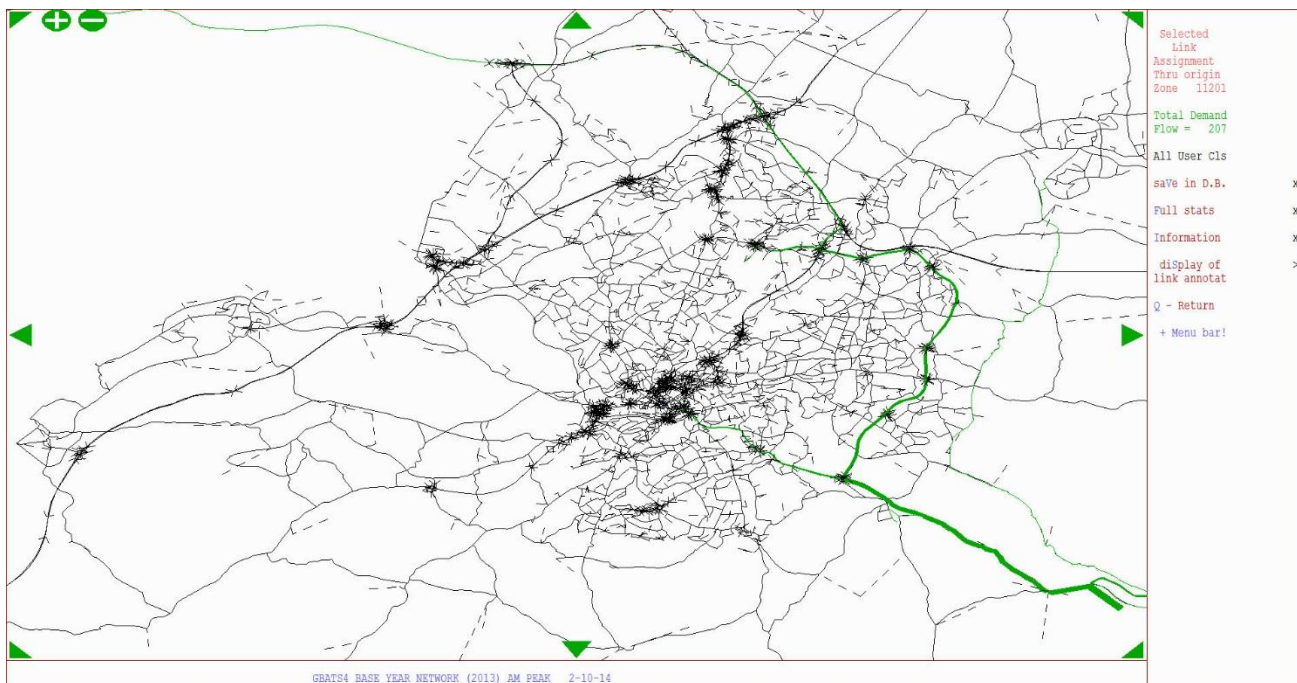
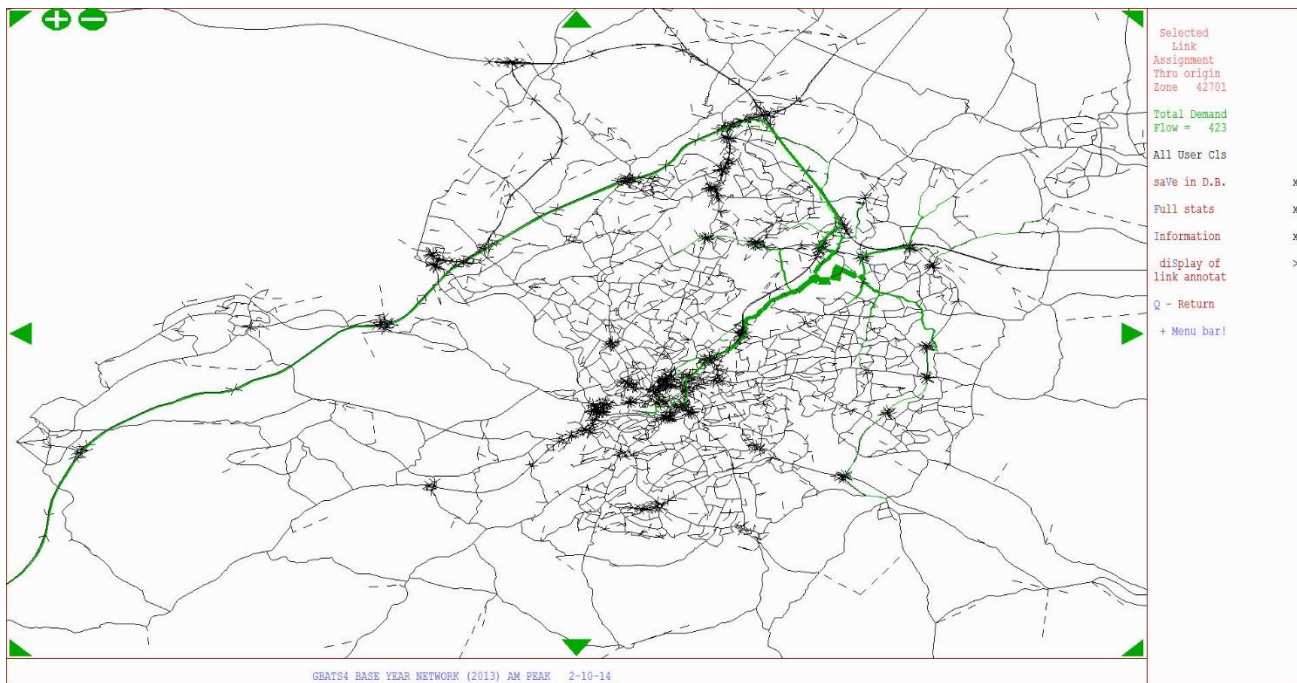


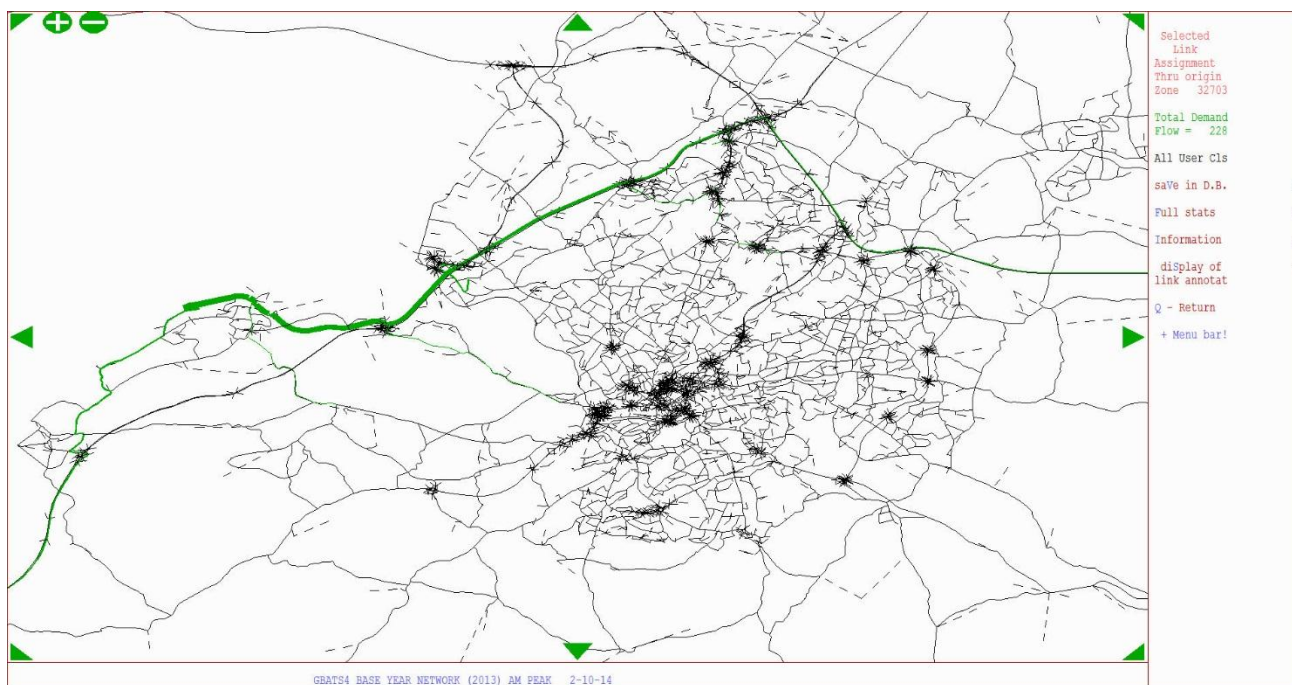
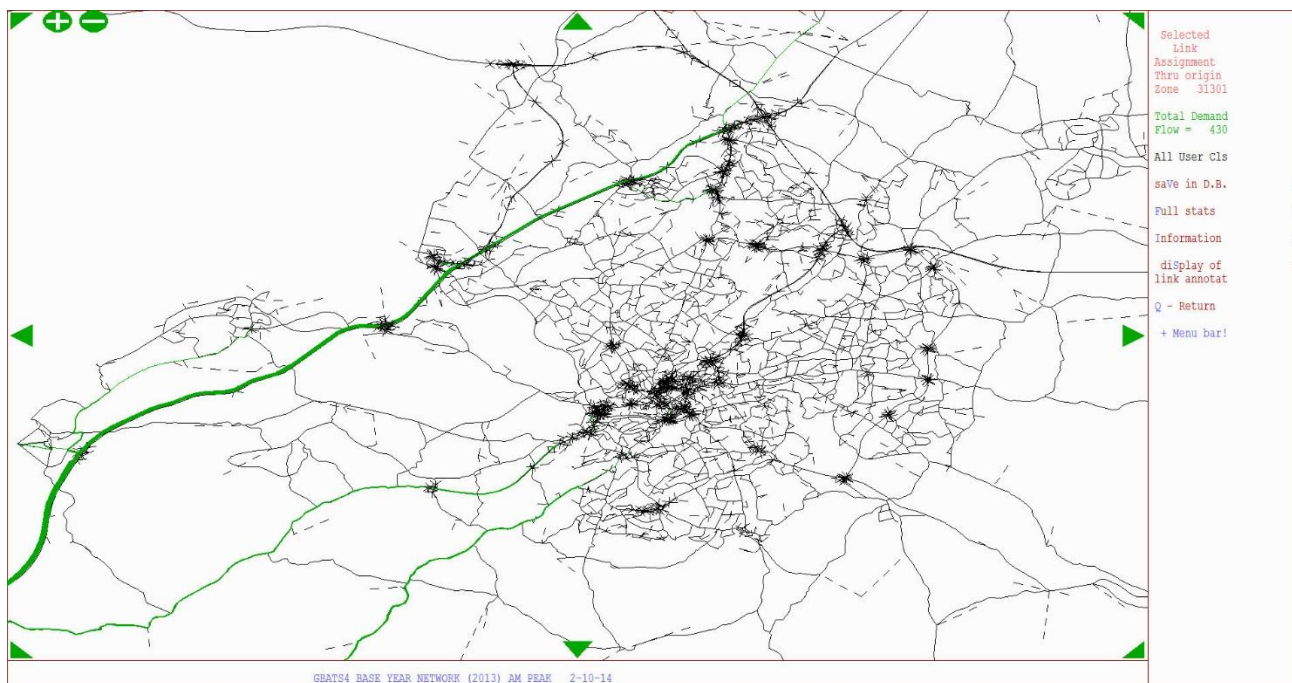


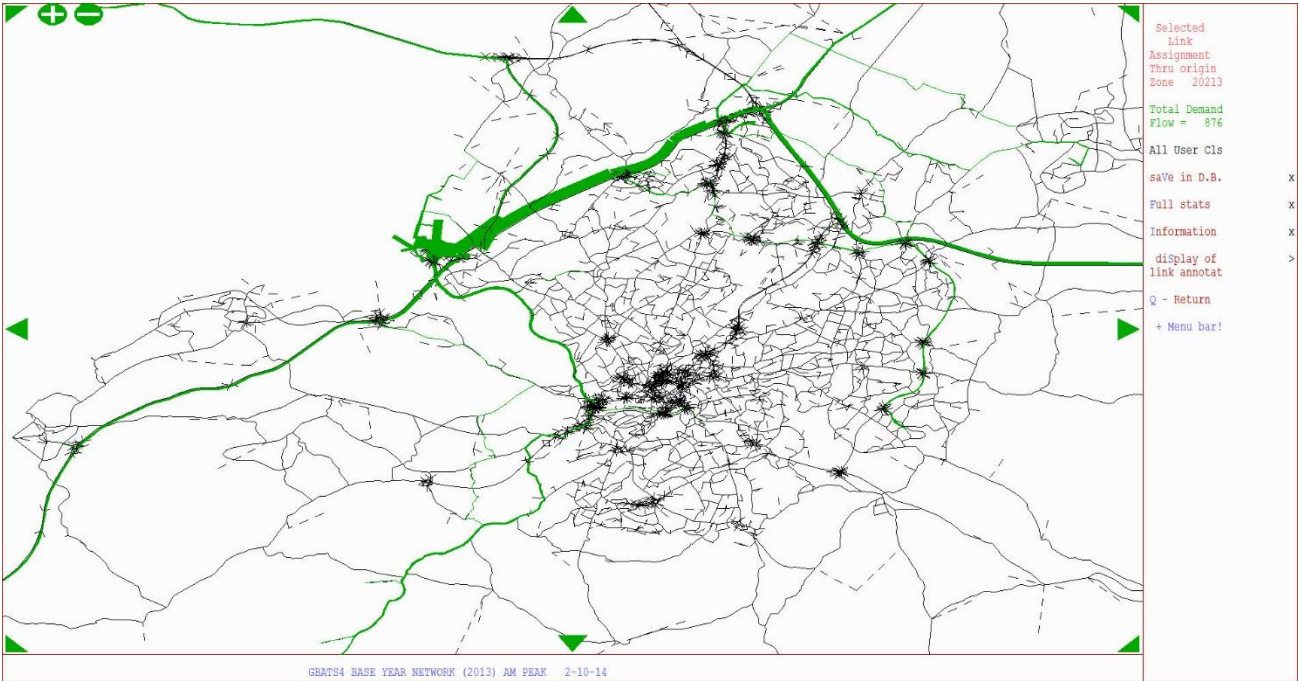
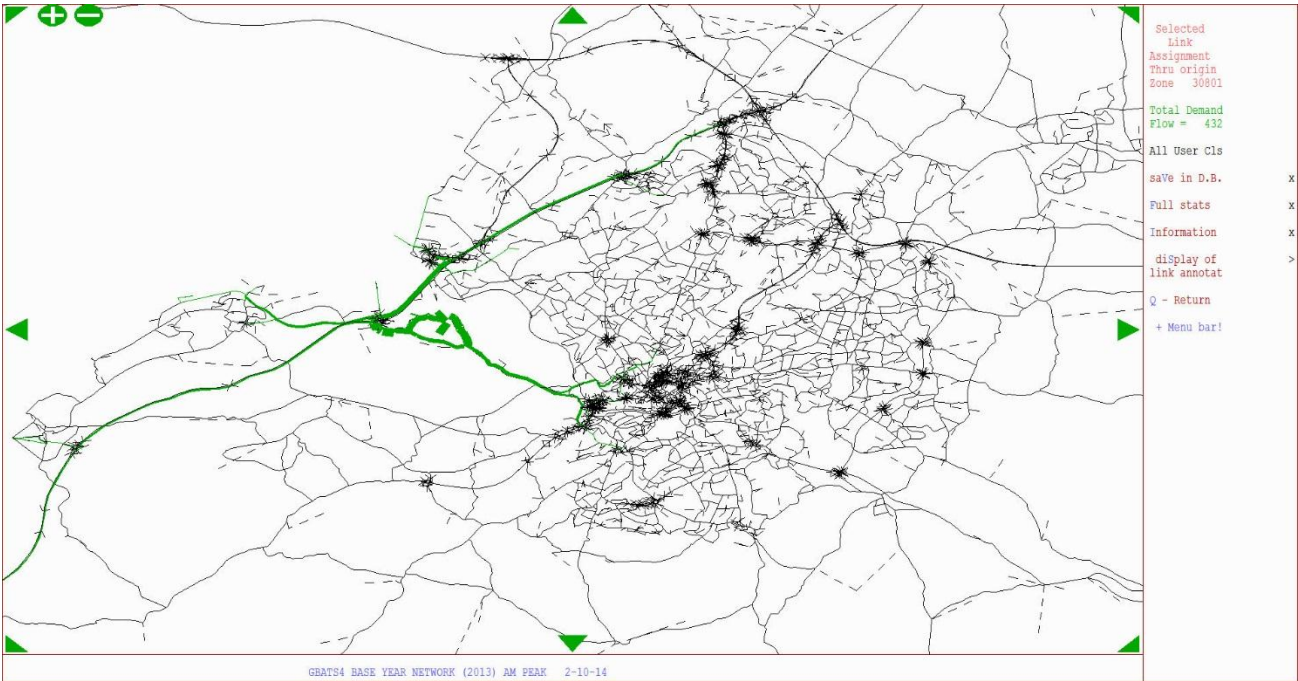


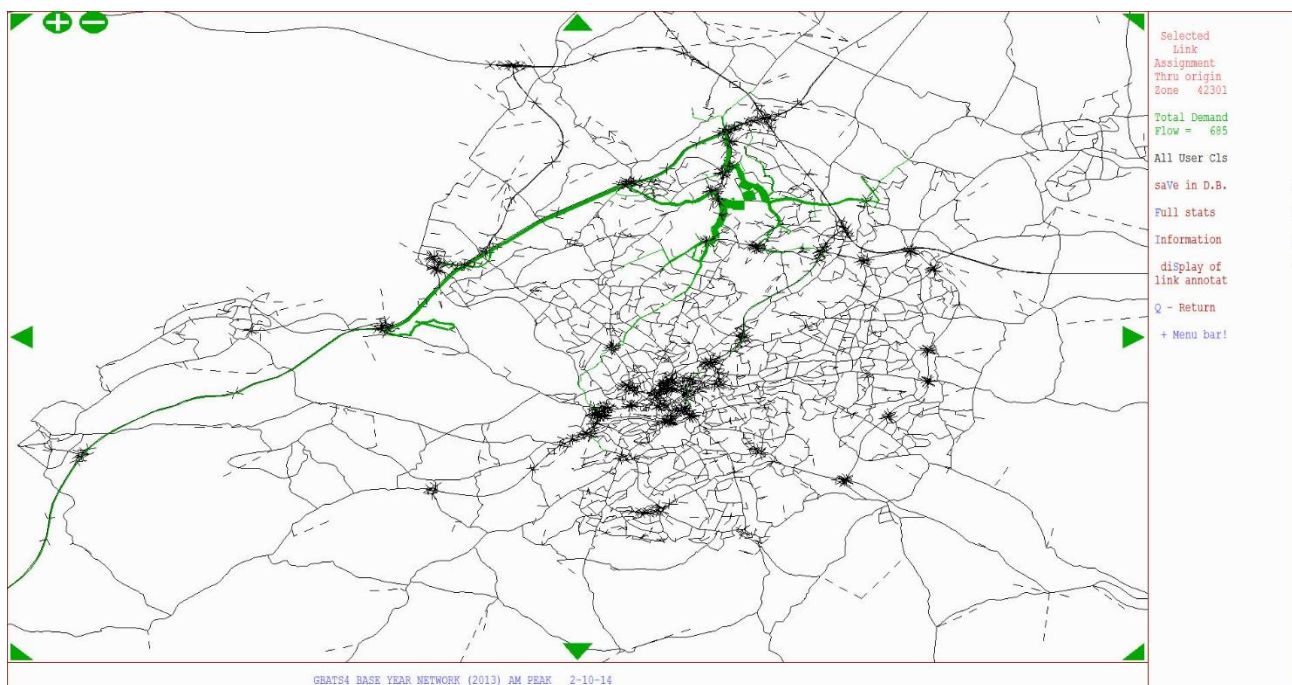
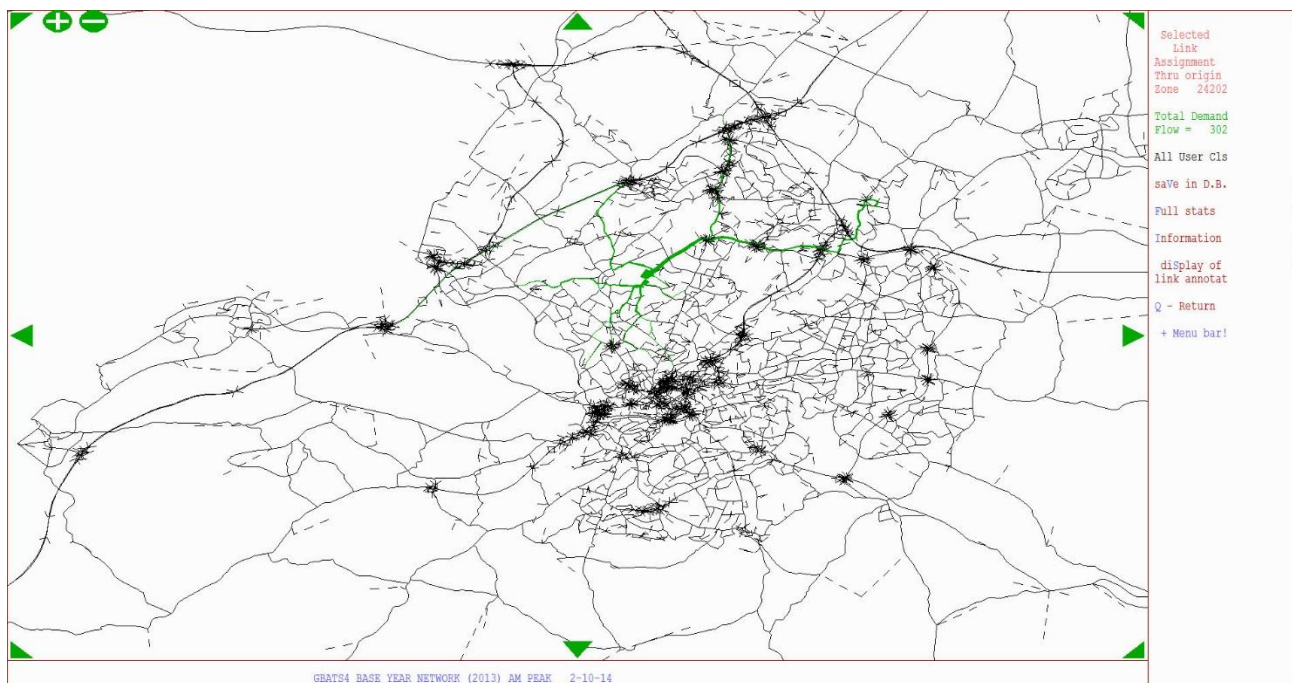
Part 2: Route Choice Tree Plots

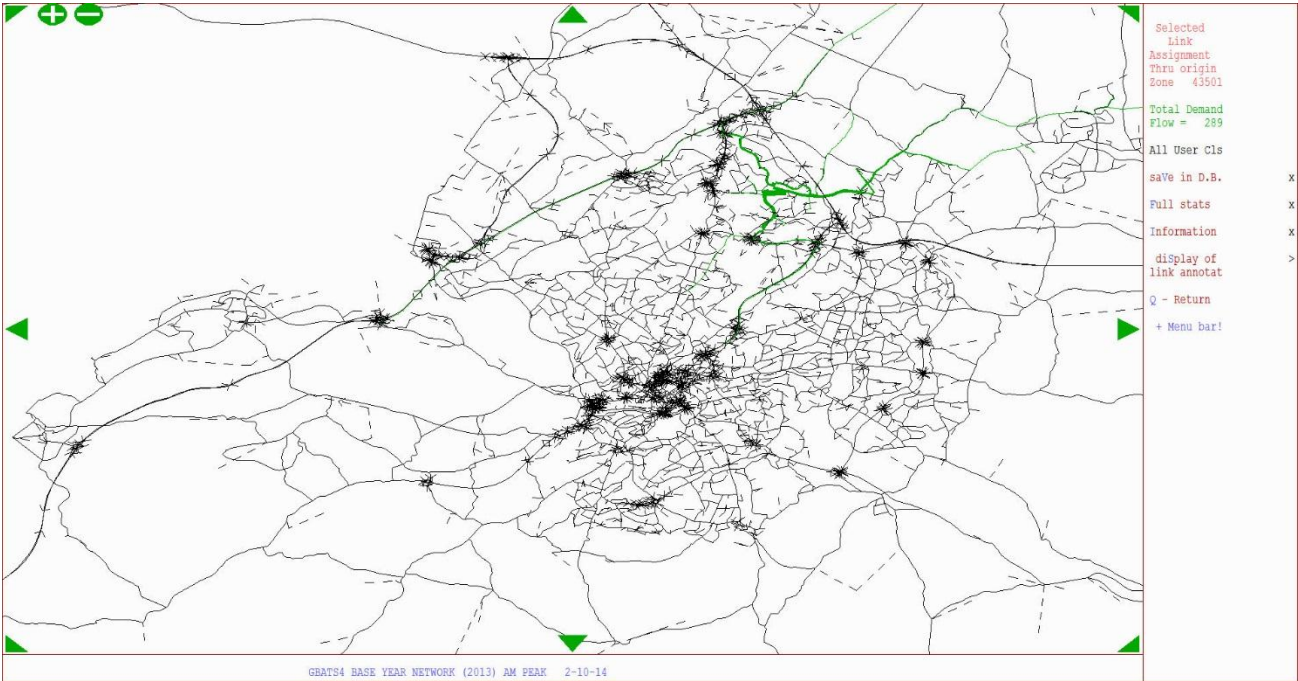
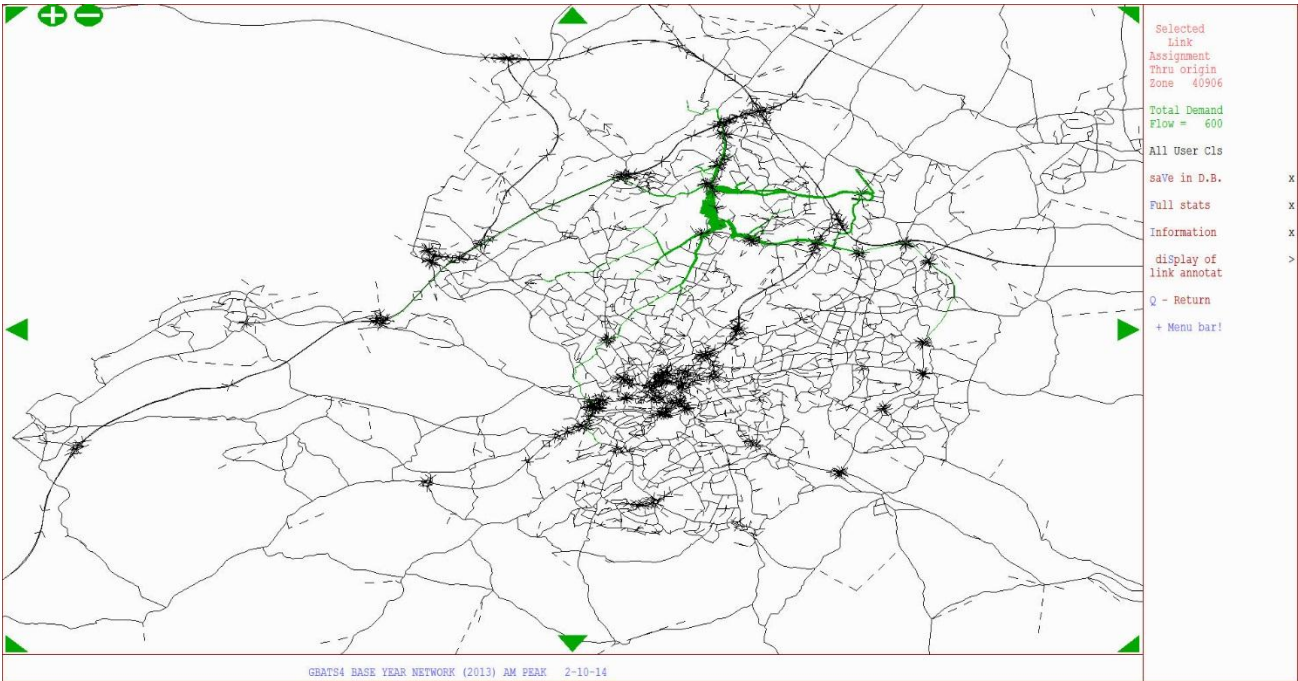


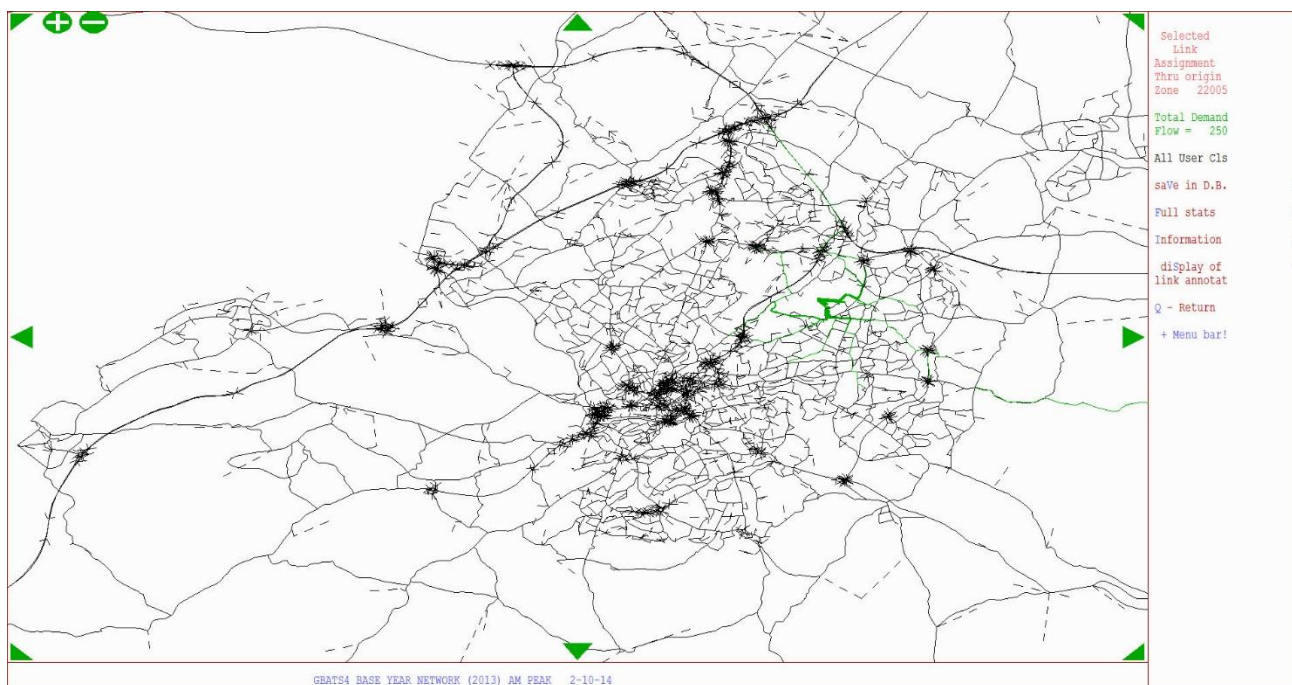
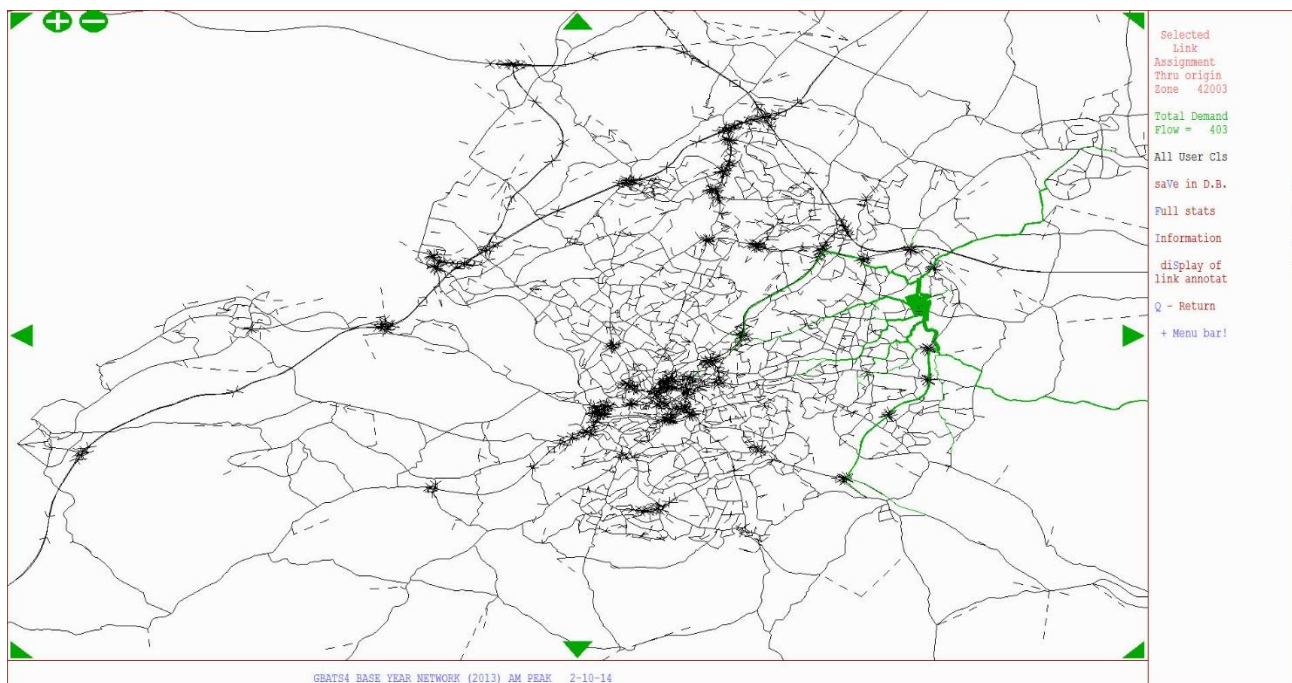


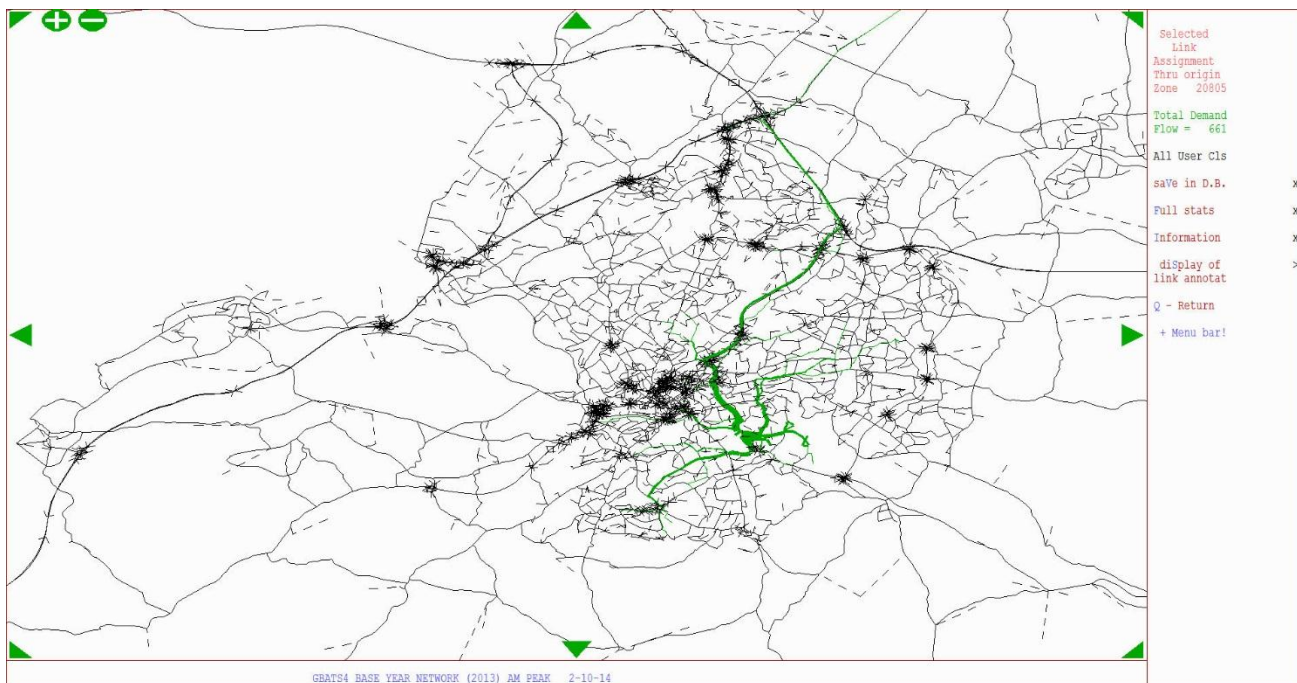
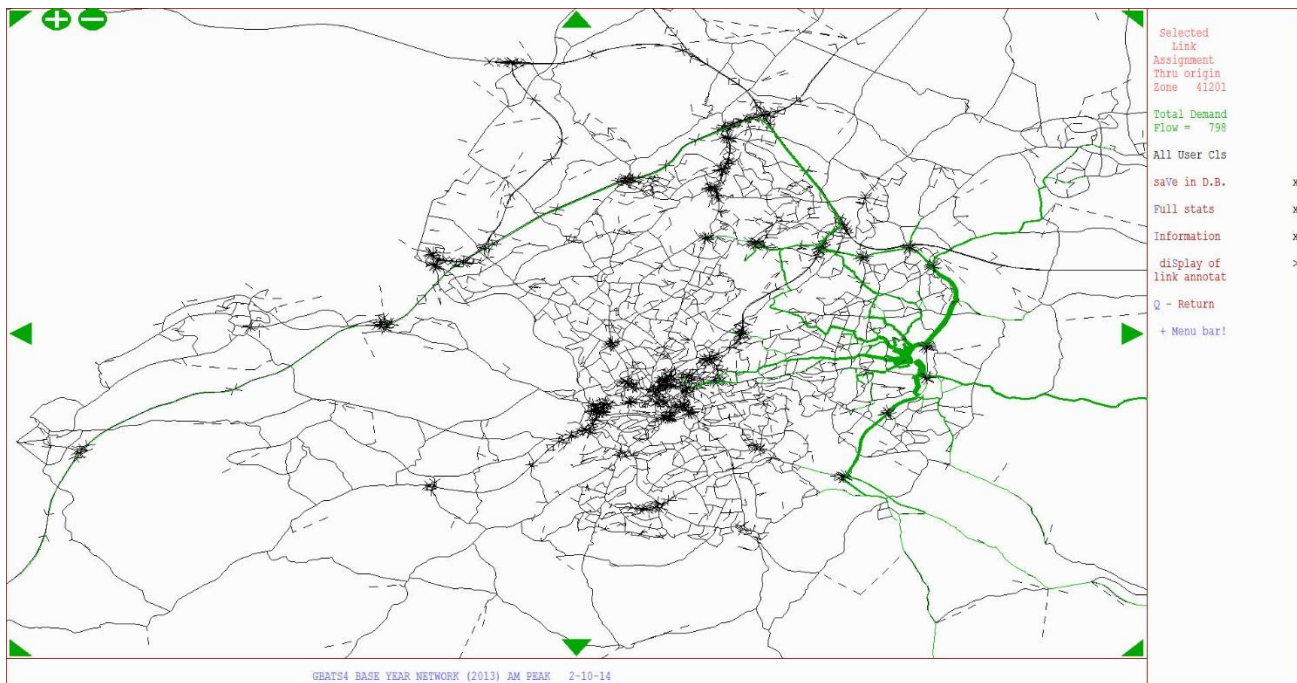


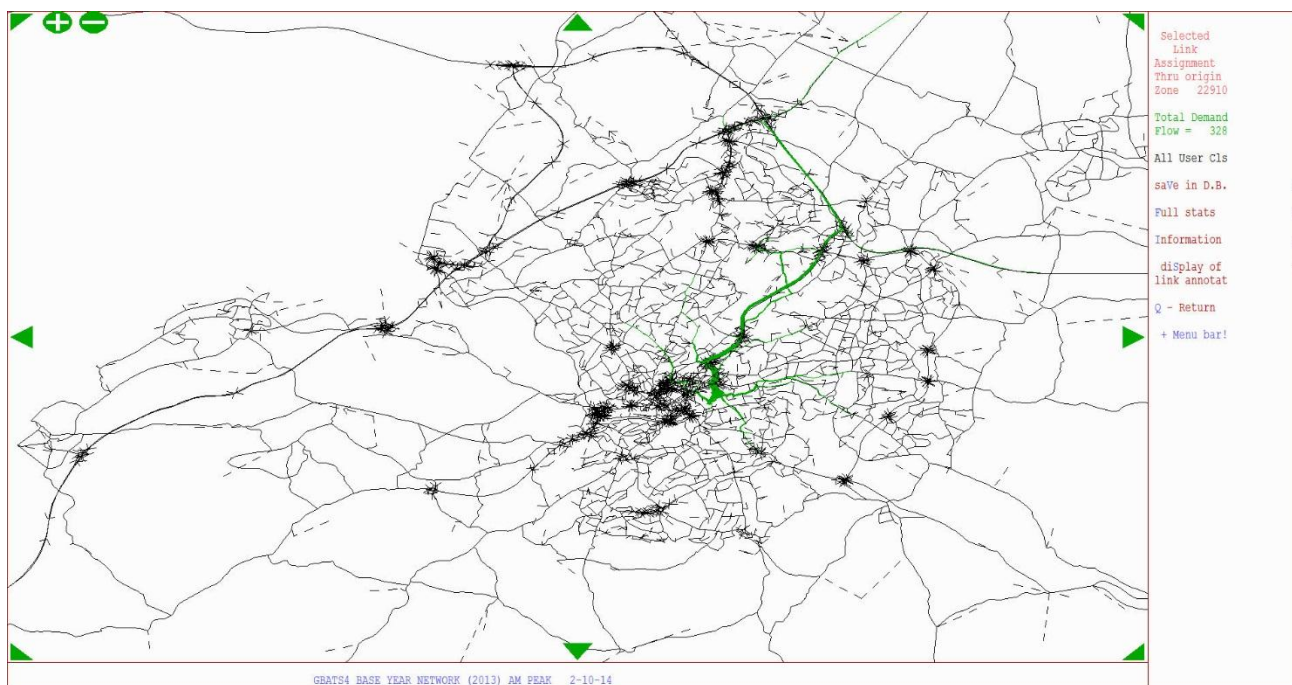
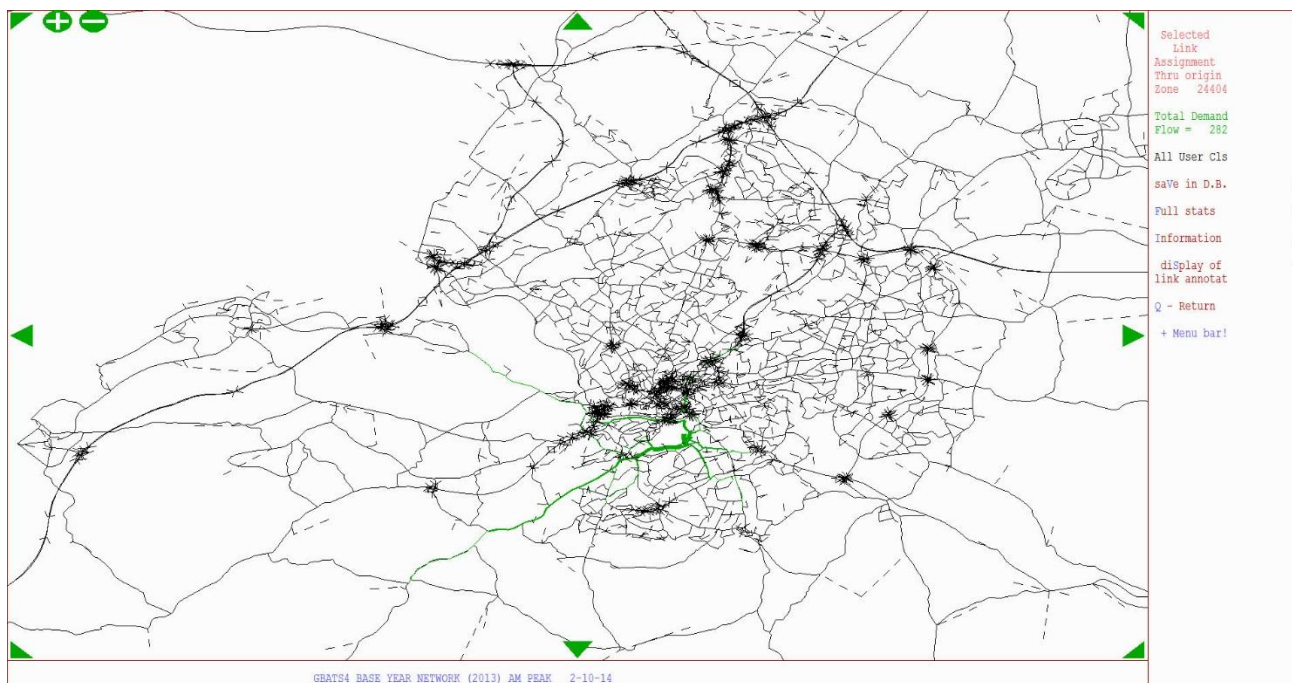


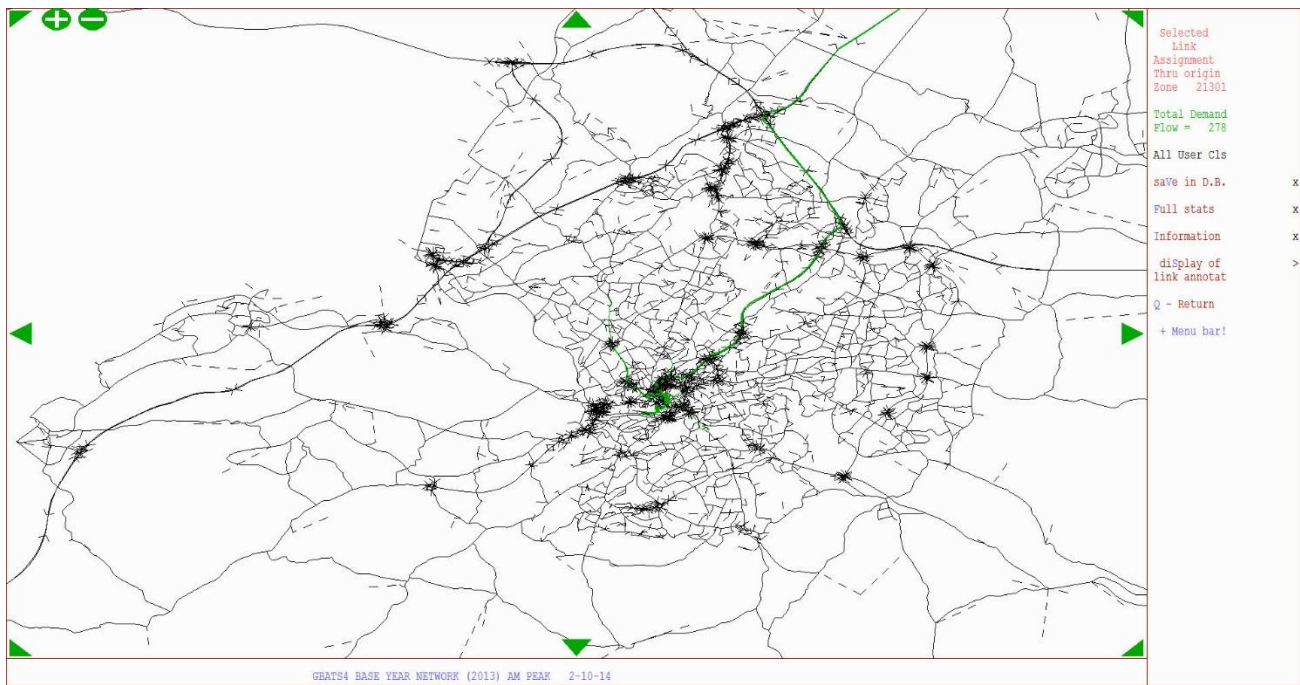












Appendix E: Traffic Link Flow Validation

TABLE E1

Morning Peak Traffic Flow Calibration Comparison

Ref No.	Road	Dir	A node	B node	Obs LV	Obs Total PCUs	Model LV	Model Total PCUs	GEH PCUs	GEH LVs
RSI1	A4018 Whiteladies Road	IN	1488	2709	1146	1310	1377	1520	5.6	6.5
I5	Woodland Rd	IN	2557	1226	243	350	264	292	3.2	1.3
RSI2	Horfield Road	IN	1863	1539	411	436	529	545	4.9	5.5
RSI3	A38 North Road	IN	1504	1566	690	874	647	803	2.4	1.6
I6	York Street	IN	2624	2625	37	39	35	37	0.4	0.4
RSI4	A4032 Newfoundland Street	IN	3976	3982	1773	1922	1861	1947	0.6	2.1
RSI5	A420 Old Market Street	IN	4034	1219	1506	1667	1608	1754	2.1	2.6
RSI6	Avon Street	IN	1769	1591	301	323	266	291	1.8	2.1
I8	Station Approach Rd	IN	1482	1480	236	403	147	280	6.6	6.4
RSI7	Feeder Road	IN	1286	1574	302	351	335	372	1.1	1.9
RSI8	A4 Bath Road	IN	1189	1572	1295	1534	1351	1473	1.6	1.5
RSI9	St Lukes Road	IN	2163	1191	361	364	425	434	3.5	3.3
I1_I2	Whitehouse/Spring Street	IN	2164	8250	207	222	146	154	5.0	4.6
RSI10	Bedminster Parade	IN	4022	2161	535	643	455	558	3.5	3.6
RSI11	A370 Coronation Road	IN	1489	1558	709	800	1129	1185	12.2	13.8
RSI12	Cumberland Road	IN	2668	1711	743	767	676	721	1.7	2.5
RSI13	Hotwell Road	IN	1164	1705	1815	2000	1844	2010	0.2	0.7
I4	Constitution Hill	IN	2558	2559	157	162	151	154	0.6	0.5
I3	Lower Clifton Hill (one way)	IN	2558	2560	59	66	85	85	2.2	3.0
RSI1	A4018 Whiteladies Road	OUT	1228	1229	1281	1456	1361	1517	1.6	2.2
I5	Woodland Rd	OUT	1226	2557	115	165	164	164	0.1	4.2
RSI2	Horfield Road	OUT	1539	1863	101	122	113	130	0.7	1.1
RSI3	A38 North Road	OUT	1607	1504	295	443	206	332	5.6	5.7
I6	York Street	OUT	2625	2624	88	93	18	52	4.7	9.7
RSI4	A4032 Newfoundland Street	OUT	1470	3977	2306	2499	2311	2428	1.4	0.1
RSI5	A420 Old Market Street	OUT	1837	1220	482	655	475	630	1.0	0.3
RSI6	Avon Street	OUT	1591	1769	115	132	151	169	3.0	3.1
I8	Station Approach Rd	OUT	1480	1482	287	358	304	414	2.9	1.0
RSI7	Feeder Road	OUT	1574	1286	169	189	94	138	4.0	6.5
RSI8	A4 Bath Road	OUT	1572	1189	978	1210	1082	1362	4.3	3.2
RSI9	St Lukes Road	OUT	1191	2163	165	169	212	230	4.3	3.4
I1_I2	Whitehouse/Spring Street	OUT	8250	2164	190	199	213	217	1.3	1.6
RSI10	Bedminster Parade	OUT	2161	4022	249	316	246	327	0.6	0.2
RSI11	A370 Coronation Road	OUT	1558	1489	550	630	666	730	3.8	4.7
RSI12	Cumberland Road	OUT	1711	2668	510	535	419	433	4.7	4.2
RSI13	Hotwell Road	OUT	2593	1521	1395	1614	1452	1604	0.3	1.5
I4	Constitution Hill	OUT	2559	2558	184	191	187	193	0.2	0.2
E1	A4174	IN	9961	9960	1597	1888	1866	2018	3.0	6.5
E2	Downend Rd	IN	2385	1066	484	524	493	548	1.1	0.4
E3	Staplehill Rd	IN	2383	1071	479	525	439	505	0.9	1.9
E4	Lodge Hill	IN	1079	1078	284	376	303	332	2.3	1.1
E5	Two Mile Hill Rd	IN	1255	2049	306	341	275	326	0.8	1.8

E6	Nags Head Hill	IN	2053	1276	633	678	705	738	2.3	2.8
E7	Crews Hole Road	IN	1999	1293	671	687	521	541	5.9	6.2
E9	Bath Rd	IN	8053	1406	1347	1593	1352	1460	3.4	0.1
E1	A4174	OUT	9960	9961	1484	1754	1539	1695	1.4	1.4
E2	Downend Rd	OUT	1066	2385	315	348	303	364	0.8	0.7
E3	Staplehill Rd	OUT	1071	2383	298	330	324	360	1.6	1.5
E4	Lodge Hill	OUT	1078	1079	136	184	116	147	2.9	1.8
E5	Two Mile Hill Rd	OUT	2049	1255	410	462	423	472	0.5	0.6
E6	Nags Head Hill	OUT	1276	2053	477	517	491	540	1.0	0.6
E7	Crews Hole Road	OUT	1293	1999	92	100	140	141	3.8	4.4
E9	Bath Rd	OUT	1406	8053	1072	1268	974	1101	4.8	3.0
NWI2	Shirehampton Rd	IN	3338	3339	289	342	300	357	0.8	0.6
NWI3	Henbury Rd	IN	8069	3329	142	144	146	157	1.0	0.3
NWI4	A4018 Passage Rd	IN	2261	3584	888	1050	970	1035	0.5	2.7
NWI5	Grey Stoke Av	IN	2259	4340	556	657	509	516	5.8	2.0
NWI7	Southmead Rd	IN	2265	3586	485	522	502	574	2.2	0.8
NWI8	Kellaway Av	IN	1026	1025	359	424	408	428	0.2	2.5
NWI9	Gloucester Rd	IN	1027	1028	516	617	566	720	4.0	2.1
NWI10	Muller Rd	IN	1058	1059	839	955	799	867	2.9	1.4
NWI11	Coldhabour Lane	IN	1663	1093	320	346	315	353	0.4	0.3
NWI12	Filton Rd	IN	3451	3490	1922	2272	1879	2124	3.2	1.0
NWI13	Hambrook Rd	IN	1941	3539	36	43	25	31	2.0	2.0
NWI14	Winterbourne Rd	IN	3529	3528	795	940	793	920	0.6	0.1
NWI15	M4	IN	3157	3901	4330	5120	3874	4949	2.4	7.1
NWI2	Shirehampton Rd	OUT	3339	3338	251	297	287	437	7.3	2.2
NWI3	Henbury Rd	OUT	3329	8069	134	135	131	141	0.5	0.2
NWI4	A4018 Passage Rd	OUT	3584	2261	800	946	799	877	2.3	0.1
NWI5	Grey Stoke Av	OUT	4340	2259	341	403	316	345	3.0	1.4
NWI7	Southmead Rd	OUT	3586	2265	370	430	395	430	0.0	1.3
NWI8	Kellaway Av	OUT	1025	1026	449	531	455	494	1.6	0.3
NWI9	Gloucester Rd	OUT	1028	1027	582	682	597	721	1.5	0.6
NWI10	Muller Rd	OUT	1059	1058	854	938	889	1004	2.1	1.2
NWI11	Coldhabour Lane	OUT	1093	1663	897	949	1001	1066	3.7	3.4
NWI12	Filton Rd	OUT	3490	3451	985	1165	1051	1209	1.3	2.1
NWI13	Hambrook Rd	OUT	1941	2365	463	548	499	546	0.1	1.6
NWI14	Winterbourne Rd	OUT	3528	3529	1452	1716	1392	1500	5.4	1.6
NWI15	M4	OUT	3910	3138	4039	4776	4072	4984	3.0	0.5
S1	Bridgewater Rd	IN	3635	2459	438	519	401	436	3.8	1.8
S2	Bishopsworth Rd	IN	2463	2195	388	458	345	387	3.5	2.3
S3	St Peters Rise	IN	1357	2523	219	233	237	281	2.9	1.2
S4	Hengrove Way	IN	1359	1360	777	830	768	850	0.7	0.3
S5	Hawkfield Rd	IN	1365	2519	414	428	401	507	3.7	0.6
S6	Whitchurch Lane	IN	7178	1376	620	739	570	615	4.8	2.1
S7	Bamfield	IN	2433	3644	153	162	179	200	2.8	2.0
S8	Wells Rd	IN	1380	1430	659	821	650	714	3.9	0.4
S9	Bath Rd	IN	1311	4044	1056	1249	1364	1527	7.5	8.9
S10	School Road	IN	1307	2121	338	360	352	375	0.8	0.8
S11	Allison Rd	IN	1307	2117	233	264	189	210	3.5	3.0
S1	Bridgewater Rd	OUT	2459	3635	533	604	510	553	2.1	1.0
S2	Bishopsworth Rd	OUT	2195	2463	467	552	393	464	3.9	3.5
S3	St Peters Rise	OUT	2523	1357	115	136	208	223	6.5	7.4

S4	Hengrove Way	OUT	1360	1359	846	904	775	808	3.3	2.5
S5	Hawkfield Rd	OUT	2519	1365	505	520	451	546	1.1	2.5
S6	Whitchurch Lane	OUT	7013	1376	572	665	733	812	5.4	6.3
S7	Bamfield	OUT	3644	2433	318	321	311	321	0.0	0.4
S8	Wells Rd	OUT	1430	1380	392	511	357	533	1.0	1.8
S9	Bath Rd	OUT	1490	4046	762	902	809	882	0.6	1.7
S10	School Road	OUT	2121	1307	494	560	546	630	2.9	2.3
S11	Allison Rd	OUT	2117	1307	346	369	300	325	2.4	2.5
R1	M5	IN	3213	3928	3173	3752	3117	3821	1.1	1.0
R3	A3029 Brunel Way (N)	IN	1165	1513	1649	1908	1937	2151	5.4	6.8
R4	A3029 Brunel Way (S)	IN	1513	1166	1959	2242	2056	2277	0.7	2.2
R5	Princes Street Bridge	IN	1436	1777	523	528	289	424	4.8	11.6
R6	Bedminster Bridge	IN	1477	1319	760	957	781	906	1.7	0.8
R7	Redcliffe Way	IN	2651	1203	177	333	318	367	1.8	9.0
R8	Bristol Bridge, Victoria Street	IN	1233	2547	497	620	511	756	5.2	0.6
R9	Passager Street	IN	1247	1594	392	463	495	495	1.5	4.9
R10	Temple Way	IN	1591	1593	1500	1716	1387	1571	3.6	3.0
R11	Bath Bridge	IN	1485	1210	1697	2107	1748	2085	0.5	1.2
R12	Avon Street	IN	1592	1286	273	298	292	352	3.0	1.1
R13	Albert Road	IN	1288	1301	274	384	273	344	2.1	0.1
R15	St PhillAMs Causeway	IN	1290	1302	856	1005	923	990	0.5	2.3
R16	Marsh Lane	IN	2011	3631	220	253	257	278	1.6	2.4
R17	Nethan Road	IN	2013	1425	920	992	734	788	6.8	6.4
R18	Feeder Road	IN	1426	2599	569	617	555	602	0.6	0.6
R1	M5	OUT	3927	3204	4639	5485	4621	5315	2.3	0.3
R3	A3029 Brunel Way (N)	OUT	1525	1524	2493	2884	2551	2795	1.7	1.1
R4	A3029 Brunel Way (S)	OUT	1527	1526	2861	3134	2691	2950	3.3	3.2
R5	Princes Street Bridge	OUT	1777	1436	232	237	170	200	2.5	4.4
R6	Bedminster Bridge	OUT	1474	1318	1859	2189	1827	1988	4.4	0.8
R7	Redcliffe Way	OUT	1204	2651	399	512	403	453	2.7	0.2
R8	Bristol Bridge, Victoria Street	OUT	2547	1233	586	690	664	762	2.7	3.1
R9	Passage Street	OUT	1594	1247	429	507	290	397	5.2	7.3
R10	Temple Way	OUT	1593	1207	1425	1605	1576	1691	2.1	3.9
R11	Bath Bridge	OUT	1483	1484	1698	2049	1871	2032	0.4	4.1
R12	Avon Street	OUT	1286	1592	539	586	401	503	3.5	6.4
R13	Albert Road	OUT	1301	1288	339	373	345	414	2.1	0.3
R15	St PhillAMs Causeway	OUT	1302	1290	1420	1715	1300	1481	5.9	3.3
R16	Marsh Lane	OUT	3631	2011	220	241	239	265	1.5	1.2
R17	Nethan Road	OUT	1425	2013	564	611	613	646	1.4	2.0
R18	Feeder Road	OUT	2599	1426	768	824	812	878	1.8	1.6
RW1	A4176 Portway	IN	1052	1162	989	1262	941	1121	4.1	1.5
RW5	Clifton Down	IN	1041	1161	675	716	534	555	6.4	5.7
RW22	Kingsland Road	IN	1733	1285	212	238	210	255	1.1	0.1
RW2	Avon Street	IN	1769	1592	115	132	177	210	5.9	5.1
RW26	B3021 St Johns Lane	IN	1181	1180	939	1018	871	923	3.0	2.2
RW27	A38 Parsons Street	IN	1173	1579	1248	1449	1222	1387	1.6	0.8
RW28	A38 Bedminster Down Road	IN	1433	2746	1747	2067	1663	1825	5.5	2.0
RW30	Whitby Road	IN	2599	1302	521	528	487	546	0.8	1.5
RW34	A4174	IN	2937	3612	1426	1686	1389	1510	4.4	1.0
RW35	A4175 Keynsham Road	IN	1394	1393	509	538	543	563	1.1	1.5
RW36	Muller Road	IN	1058	2335	703	744	747	839	3.4	1.6

RW37	Lockleaze Road	IN	2327	1486	177	189	145	162	2.1	2.5
RW38	Bonnington Walk	IN	2315	2305	173	188	170	197	0.7	0.2
RW39	A4174 Station Road	IN	3693	3471	1337	1581	1393	1616	0.9	1.5
RW40	GAMsy Patch Lane	IN	3234	1945	877	1037	911	957	2.5	1.2
RW41	A38 Gloucester Road	IN	3427	3307	1473	1880	1517	1748	3.1	1.1
RW42	M5	IN	3174	3181	3663	4331	3709	4331	0.0	0.8
RW1	A4176 Portway	OUT	1162	1052	934	1159	904	1048	3.3	1.0
RW5	Clifton Down	OUT	1161	1041	785	820	717	775	1.6	2.5
RW22	Kingsland Road	OUT	1285	1733	140	187	197	223	2.5	4.4
RW2	Avon Street	OUT	1592	1769	301	323	282	314	0.5	1.1
RW26	B3021 St Johns Lane	OUT	1180	1181	420	444	410	451	0.3	0.5
RW30	Whitby Road	OUT	1302	2599	373	396	181	205	11.0	11.5
RW35	A4175 Keynsham Road	OUT	1393	1394	482	510	466	508	0.1	0.8
RW36	Muller Road	OUT	2335	1058	567	607	611	650	1.7	1.8
RW37	Lockleaze Road	OUT	1486	2327	162	185	163	178	0.5	0.1
RW38	Bonnington Walk	OUT	2305	2315	178	184	160	205	1.4	1.4
RW39	A4174 Station Road	OUT	3471	3693	1827	2161	2026	2257	2.0	4.5
RW40	GAMsy Patch Lane	OUT	1945	3234	651	770	658	757	0.5	0.3
RW41	A38 Gloucester Road	OUT	3310	3313	711	859	756	824	1.2	1.6
M5 J19	Docks	IN	1619	3926	192	440	240	354	4.3	3.2
	Docks	OUT	7025	1619	383	631	431	566	2.6	2.4
	Gordano Services	IN	4336	7027	149	224	150	190	2.4	0.1
	Gordano Services	OUT	7027	4336	150	215	148	185	2.1	0.2
	A369 Martcombe Rd East	IN	3706	3705	721	764	765	789	0.9	1.6
	A369 Martcombe Rd East	OUT	3705	3706	1024	1102	714	799	9.8	10.5
	St George's Hill - Pill	IN	3705	7019	159	174	163	202	2.0	0.4
	St George's Hill - Pill	OUT	7019	3705	273	290	235	288	0.1	2.4
	Portbury High st	IN	7035	7036	243	256	221	260	0.3	1.5
	Portbury High st	OUT	7036	7035	505	510	418	474	1.6	4.1
	The Portbury Hundred	IN	3789	3703	1459	1522	1335	1420	2.7	3.3
	The Portbury Hundred	OUT	3703	3789	886	974	1183	1272	8.9	9.2
Temple Circus roundabout	A4044 Temple Way (N)	IN	1610	1206	1313	1523	945	1115	11.2	11.0
	Friary (E)	IN	1565	1508	41	60	4	10	8.4	7.8
	Redcliffe Way (S)	IN	1510	1506	1763	2170	2023	2281	2.3	6.0
	Victoria Street (NW)	IN	1562	1205	279	420	425	566	6.6	7.8
	A4044 Temple Way (N)	OUT	1205	1563	1339	1597	1624	1735	3.4	7.4
	Friary (E)	OUT	1206	1564	185	199	213	227	1.9	2.0
	A4 Temple Gate (SE)	OUT	1508	1507	1464	1844	1038	1385	11.4	12.0
	Victoria Street (NW)	OUT	1506	1561	408	534	527	624	3.8	5.5
	A4 Temple Gate (E)	IN	2647	2556	1513	1867	1461	1680	4.4	1.4
	Redcliff Mead Lane (S)	IN	2740	2556	155	158	31	35	12.5	12.9
	Redcliffe Way (W)	IN	1717	1605	511	649	787	799	5.6	10.8
	Redcliffe Way (W)	OUT	1604	1606	312	379	198	229	8.5	7.2
Bath Bridge	A4 Temple Gate (N)	IN	1480	1485	1146	1442	793	1050	11.1	11.3
	Cattle market Road (NE)	IN	1574	1485	297	357	335	372	0.8	2.1
	A4 Bath Road (SE)	IN	1572	1190	1287	1635	1353	1474	4.1	1.8
	A370 York Road (SW)	IN	1570	1483	348	358	363	375	0.9	0.8
	Clarence Road (W)	IN	1573	1484	567	675	591	656	0.7	1.0
	A4 Temple Gate (N)	OUT	1484	1480	1492	1830	1371	1484	8.5	3.2
	Cattle market Road (NE)	OUT	1485	1574	194	219	94	138	6.1	8.3
	A4 Bath Road (SE)	OUT	1210	1571	979	1286	1082	1362	2.1	3.2

	A370 York Road (SW)	OUT	1190	1570	496	587	510	539	2.0	0.6
	Clarence Road (W)	OUT	1484	1573	484	546	376	404	6.5	5.2
Bedminster Bridge roundabout	Redcliff Hill (N)	IN	1479	1476	340	473	359	447	1.2	1.0
	Clarence Road (NE)	IN	1554	1477	369	425	312	333	4.7	3.1
	A370 York Road (SE)	IN	1555	1478	634	718	471	486	9.4	7.0
	Bedminster Parade (S)	IN	1557	1192	657	815	498	597	8.2	6.6
	A370 Coronation Road (SW)	IN	1558	1474	697	823	1129	1185	11.4	14.3
	Commerical Road (NW)	IN	1559	1475	413	459	649	686	9.5	10.3
	Redcliff Hill (N)	OUT	1475	1552	795	1008	1470	1545	15.0	20.1
	Clarence Road (NE)	OUT	1476	1554	741	856	643	717	5.0	3.7
	A370 York Road (SE)	OUT	1319	1555	149	152	179	180	2.2	2.3
	Bedminster Parade (S)	OUT	1478	1556	292	402	244	322	4.2	2.9
	A370 Coronation Road (SW)	OUT	1553	1558	548	656	630	683	1.0	3.4
	Commerical Road (NW)	OUT	1560	1559	585	639	248	282	16.6	16.5
Redcliffe Way roundabout	Redcliff Street (N)	IN	2546	1204	245	280	271	275	0.3	1.6
	Redcliffe Way (E)	IN	2550	1204	334	398	198	230	9.5	8.4
	Redcliff Hill (S)	IN	1552	1204	905	1067	1470	1545	13.2	16.4
	Redcliff Street (N)	OUT	1204	2546	334	354	411	415	3.1	4.0
	Redcliffe Way (E)	OUT	1204	2550	605	741	992	1061	10.7	13.7
	Redcliff Hill (S)	OUT	1204	4021	326	474	382	469	0.2	3.0
Jacob Wells Road roundabout	Jacobs Wells Road (N)	IN	1198	9994	467	510	602	631	5.1	5.8
	St Georges Street (NE)	IN	9997	9995	150	160	124	136	2.0	2.2
	A4 Anchor Road €	IN	9998	9996	438	572	503	541	1.3	3.0
	A4 Hotwells Road (W)	IN	1618	9993	1392	1630	1363	1490	3.5	0.8
	Jacobs Wells Road (N)	OUT	1198	2559	531	606	492	498	4.6	1.7
	St Georges Street (NE)	OUT	9997	2671	390	398	177	179	12.9	12.7
	A4 Anchor Road €	OUT	9998	9999	785	960	1080	1156	6.0	9.7
	A4 Hotwells Road (W)	OUT	1618	1707	741	908	843	967	1.9	3.6
The Triangle	A4018 Queens Road (N)	IN	1817	1488	1184	1395	968	1104	8.2	6.6
	Triangle (W) circulatory		1229	4053	1328	1612	1151	1280	8.7	5.0
	A4018 Queens Road (N)	OUT	4053	4054	992	1232	742	864	11.4	8.5
	Triangle (W) circulatory		4053	1488	336	380	409	416	1.8	3.8
	University Road	OUT	2708	4060	90	101	124	124	2.2	3.3
	Park Row (E)	IN	2710	1228	979	1167	799	900	8.3	6.0
	Park Row (E)	OUT	2709	2708	1117	1324	1058	1168	4.4	1.8
	Triangle (E) circulatory		2709	1228	382	426	319	353	3.7	3.4
	Park Row (E)	OUT	2708	2710	1027	1224	935	1043	5.4	3.0
	Berkeley Place (S)	IN	2673	1229	561	636	608	620	0.6	1.9
	Berkeley Place (S)	OUT	1229	2673	459	495	818	856	13.9	14.2
Lawrence Hill Rbt	A4320 Easton Way (N)	IN	1611	1244	2011	2301	1726	1784	11.4	6.6
	Lawrence Hill (E)	IN	4036	1245	981	1135	1388	1517	10.5	11.8
	A4320 St Phillips Causeway (S)	IN	1284	1246	1141	1449	1267	1514	1.7	3.6
	Lawrence Hill (W)	IN	1249	1248	495	615	689	761	5.6	8.0
	A4320 Easton Way (N)	OUT	1248	1620	1362	1670	1398	1602	1.7	1.0
	Lawrence Hill (E)	OUT	1244	4092	585	749	665	785	1.3	3.2
	A4320 St Phillips Causeway (S)	OUT	1245	1284	1376	1622	1382	1438	4.7	0.2
	Lawrence Hill (W)	OUT	1246	1249	1305	1458	1912	2037	13.9	15.1
M32 Junction 3	M32 (North)	IN	3597	3973	2314	2664	1996	2124	11.0	6.9
	A4320 (E)	IN	2571	3974	1505	1848	1402	1629	5.3	2.7
	M32 (South)	IN	3977	3978	335	374	77	81	19.4	18.0
	B4051 (W)	IN	3578	3979	795	823	820	839	0.6	0.9

	M32 (North)	OUT	3979	3986	1375	1690	1284	1474	5.4	2.5
	A4320 (E)	OUT	3973	3577	1931	2196	1586	1694	11.4	8.2
	M32 (South)	OUT	3974	3975	631	699	180	185	24.4	22.4
	B4051 (W)	OUT	3978	3578	1012	1124	1313	1386	7.4	8.8
M32 / Cabot circus	A4032 Newfoundland Way	IN	3982	1471	1979	2191	1862	1947	5.4	2.7
	Houlton Street	IN	9972	1471	137	173	111	132	3.3	2.4
	Car Park	IN	2628	9974	12	12	41	41	5.7	5.7
	A4044 Temple Way	IN	9985	9967	1688	2169	1825	2116	1.1	3.3
	A4044 Newfoundland Street	IN	9970	1209	1912	2164	2166	2282	2.5	5.6
	A4032 Newfoundland Way	OUT	1221	9981	2151	2456	2311	2428	0.6	3.4
	Houlton Street	OUT	1471	9972	334	352	313	316	1.9	1.2
	Car Park	OUT	9974	2628	134	134	146	146	1.0	1.0
	A4044 Temple Way	OUT	9967	9985	1088	1239	1477	1604	9.7	10.9
	A4044 Newfoundland Street	OUT	1209	9970	1875	2376	1658	1901	10.3	5.2
	St Paul Street	OUT	1209	9975	146	154	113	121	2.8	2.9
Hambrook	Bristol Rd (N) to A4174 (W)	N to W	3487	3560	296	350	609	615	12.1	14.7
	Bristol Rd (N) to (S)	N to S	3487	3560	147	174	186	204	2.2	3.0
	Bristol Rd (N) to A4174 (E)	N to E	3487	3560	112	133	50	54	8.2	6.9
	A4174 (W) to Bristol Rd (N)	W to N	3499	3560	519	614	491	559	2.3	1.3
	A4174 (W) to Bristol Rd (S)	W to S	3499	3560	307	363	258	285	4.3	2.9
	A4174 (W) to (E)	W to E	3499	3560	1296	1533	1459	1596	1.6	4.4
	Bristol Rd (S) to (N)	S to N	3473	3560	283	334	179	202	8.1	6.8
	Bristol Rd (S) to A4174 (W)	S to W	3473	3560	306	362	643	738	16.1	15.5
	Bristol Rd (S) to A4174 (E)	S to E	3473	3560	62	73	29	45	3.7	4.8
	A4174 (E) to Bristol Rd (N)	E to N	9960	3560	287	340	238	239	5.9	3.1
	A4174 (E) to (W)	E to W	9960	3560	1307	1545	1539	1651	2.6	6.1
	A4174 (E) to Bristol Rd (S)	E to S	9960	3473	123	145	82	121	2.1	4.0
M32 J1	M32 (N) to A4174 (E)	N to E	3900	3952	757	998	760	778	7.3	0.1
	M32 (N) to A4174 (W)	N to W	3952	3953	854	895	811	995	3.3	1.5
	A4174 (E) to M32 (S)	E to S	3561	3953	596	658	1141	1162	16.7	18.5
	A4174 (E) to M32 (N)	E to N	3953	3957	650	845	682	812	1.2	1.2
	A4174 (E) to (W)	E to W	3561	3953	499	576	837	1029	16.0	13.1
	M32 (S) to A4174 (W)	S to W	9916	3957	708	779	236	244	23.7	21.7
	M32 (S) to A4174 (E)	S to E	3957	3958	758	806	775	930	4.2	0.6
	A4174 (W) to M32 (N)	W to N	3562	3958	238	268	101	187	5.3	10.6
	A4174 (W) to (E)	W to E	3562	3958	543	598	659	730	5.1	4.7
	A4174 (W) to M32 (S)	W to S	3958	3952	302	354	280	291	3.5	1.3

TABLE E2

Morning Peak Traffic Flow Validation Comparison

Ref No.	Road	Dir	A node	B node	Obs LV	Obs Total PCUs	Model LV	Model Total PCUs	GEH PCUs	GEH LVs
O1	A38 Bridgewater Road	IN	7147	3635	862	1019	880	918	3.3	0.6
O2	A370 Long Ashton Bypass	IN	2703	1355	1133	1281	1268	1348	1.8	3.9
O3	B3128 Ashton Road	IN	1148	1149	808	930	963	1002	2.3	5.2
O4	A369 Clanage Road	IN	1158	2471	417	491	405	453	1.8	0.6
O5	B3129 Clifton Suspension Bridge	IN	1159	1160	681	752	587	587	6.4	3.8
O6	A4 Portway	IN	3348	3591	736	1251	859	1055	5.8	4.4
O7	B4054 Shirehampton Road	IN	2223	3340	390	450	357	426	1.1	1.7
O8	Kings Weston Lane	IN	3389	3342	105	117	79	84	3.2	2.7
O9	Hallen Road	IN	3362	3363	143	162	140	157	0.4	0.3
O10	A4018 Cribbs Causeway	IN	3197	3324	1010	1194	1166	1212	0.5	4.7
O11	Merlin Road	IN	3193	3198	954	1129	1022	1167	1.1	2.1
O12	Highwood Lane	IN	3191	3195	427	505	363	401	4.9	3.2
O13	A38 Gloucester Rd	IN	3162	3410	3126	3495	3439	3785	4.8	5.5
O14	B4427 Old Gloucester Road	IN	3030	3526	384	454	365	392	3.0	1.0
O15	B4057 Beacon Lane	IN	3037	3528	1040	1229	1066	1110	3.5	0.8
O16	M32	IN	3907	3951	3646	4481	3837	4304	2.7	3.1
O17	B4058 Bristol Road	IN	2371	3550	564	667	721	777	4.1	6.2
O18	A432 Badminton Road	IN	4236	3047	671	794	791	935	4.8	4.4
O19	Westerleigh Road	IN	4237	3685	658	778	658	720	2.1	0.0
O20	Shortwood Road	IN	1125	3055	361	427	336	397	1.5	1.3
O21	A420 London Rd	IN	3761	3760	449	531	544	630	4.1	4.2
O22	A431 Bath Road	IN	3798	3772	358	424	506	549	5.7	7.1
O23	A4 Bath Road	IN	1408	1407	1031	1161	954	1030	3.9	2.5
O24	B3116 Wellsway	IN	3767	1404	658	710	528	618	3.6	5.3
O25	A37 Bristol Road	IN	3645	8052	615	727	629	682	1.7	0.6
O26	Queens Rd	IN	3636	7115	348	367	319	320	2.5	1.6
O1	A38 Bridgewater Road	OUT	3635	7147	705	834	840	891	2.0	4.9
O2	A370 Long Ashton Bypass	OUT	1355	2703	526	622	574	631	0.3	2.0
O3	B3128 Ashton Road	OUT	1149	1148	329	389	268	366	1.2	3.5
O4	A369 Clanage Road	OUT	2471	1158	436	451	472	492	1.9	1.7
O5	B3129 Clifton Suspension Bridge	OUT	1160	1159	419	495	280	280	10.9	7.4
O6	A4 Portway	OUT	3591	3348	868	1135	1020	1095	1.2	4.9
O7	B4054 Shirehampton Road	OUT	3340	2223	359	386	389	478	4.4	1.5
O8	Kings Weston Lane	OUT	3342	3389	339	345	337	393	2.5	0.1
O9	Hallen Road	OUT	3363	3362	135	144	152	158	1.1	1.4
O10	A4018 Cribbs Causeway	OUT	3324	3197	978	1156	1014	1091	1.9	1.2
O11	Merlin Road	OUT	3198	3193	319	377	378	416	2.0	3.2
O12	Highwood Lane	OUT	3195	3193	202	239	230	259	1.3	1.9
O13	A38 Gloucester Rd	OUT	3410	3162	1315	1466	1206	1320	3.9	3.1
O14	B4427 Old Gloucester Road	OUT	3526	3030	204	241	259	315	4.4	3.6
O15	B4057 Beacon Lane	OUT	3528	3037	657	776	557	675	3.8	4.1
O16	M32	OUT	3960	3908	2765	3398	2883	3354	0.7	2.2
O17	B4058 Bristol Road	OUT	3550	2371	297	351	304	331	1.1	0.4
O18	A432 Badminton Road	OUT	3047	4236	1075	1271	999	1212	1.7	2.4
O19	Westerleigh Road	OUT	3685	4237	715	846	696	829	0.6	0.7

O20	Shortwood Road	OUT	3055	1125	457	540	555	590	2.1	4.4
O21	A420 London Rd	OUT	3760	3761	880	1040	906	1089	1.5	0.9
O22	A431 Bath Road	OUT	3772	3798	789	894	896	987	3.0	3.7
O23	A4 Bath Road	OUT	1407	1408	859	1000	791	908	3.0	2.4
O24	B3116 Wellsway	OUT	1404	3767	529	570	450	581	0.5	3.6
O25	A37 Bristol Road	OUT	8052	3645	418	484	452	562	3.4	1.6
O26	Queens Rd	OUT	7115	3636	201	210	178	187	1.6	1.7
M2	A4176 Portway	IN	1162	1582	1462	1769	1470	1653	2.8	0.2
M4	College Road	IN	1801	1160	211	264	195	224	2.6	1.2
M5	Pembroke Road	IN	1041	1803	240	261	228	248	0.8	0.8
M7	Whiteladies Road	IN	1809	1238	844	953	846	940	0.4	0.1
M8	Hampton Road	IN	1015	1881	494	499	592	599	4.3	4.2
M9	Redland Grove	IN	1659	1853	627	651	568	605	1.8	2.4
M10	Redland Road	IN	1034	1855	262	262	251	251	0.7	0.7
M11	A38 Cheltenham Road	IN	1030	1031	512	751	720	847	3.4	8.4
M12	North Road	IN	1146	1031	353	374	319	330	2.3	1.8
RW14	Ashley Hill	IN	1036	1917	817	833	788	845	0.4	1.0
MM12	Glenfrome Road	IN	1107	1919	430	508	487	516	0.4	2.6
M13	M32	IN	3971	3972	3397	3731	3257	3460	4.5	2.4
M14	Stapleton Road	IN	1437	1440	572	675	823	881	7.4	9.5
M15	Easton Road	IN	2005	1995	481	487	392	403	4.0	4.3
M16	A420 Lawrence Hill	IN	1251	1466	1162	1312	1211	1303	0.2	1.4
M17	Ducie Road	IN	1763	1250	201	238	150	179	4.1	3.8
M18	Barrow Road	IN	1283	1747	248	258	250	261	0.2	0.1
M19	A4320 St Phillips Causeway	IN	1290	1549	877	1287	1104	1347	1.6	7.2
M20	Feeder Road	IN	1751	1741	805	883	784	957	2.4	0.7
M21	Albert Road	IN	1290	1755	465	630	502	573	2.3	1.7
M22	Bath Road	IN	2087	4038	475	571	607	660	3.6	5.7
M23	Wells Road	IN	2131	2085	579	716	494	532	7.4	3.7
MM23	Redcatch Road	IN	1185	2125	562	595	630	661	2.6	2.8
M24	Wedmore Vale	IN	2213	2159	416	426	431	470	2.1	0.7
M25	Novers Hill	IN	2469	2211	472	484	429	465	0.9	2.0
M26	A4174 Hartcliffe Way	IN	2728	1361	782	920	826	951	1.0	1.5
M27	A38 Bedminster Down Road	IN	1183	1433	856	979	751	829	5.0	3.7
M28	South Liberty Lane	IN	7166	3607	118	157	159	173	1.3	3.5
M29	Ashton Drive	IN	10005	4082	273	319	282	299	1.1	0.5
M30	A370 Ashton Road	IN	1153	1154	1683	1993	1791	1937	1.3	2.6
M2	A4176 Portway	OUT	1582	1162	1347	1628	1408	1584	1.1	1.6
M4	College Road	OUT	1160	1801	213	266	217	236	1.9	0.2
M5	Pembroke Road	OUT	1803	1041	177	193	168	182	0.8	0.7
M7	Whiteladies Road	OUT	1238	1809	638	771	545	684	3.2	3.8
M8	Hampton Road	OUT	1881	1015	281	292	354	368	4.2	4.0
M9	Redland Grove	OUT	1853	1659	321	342	343	410	3.5	1.2
M10	Redland Road	OUT	1855	1034	83	83	113	113	3.0	3.0
M11	A38 Cheltenham Road	OUT	1031	1030	450	830	560	676	5.6	4.9
M12	North Road	OUT	1031	1146	30	40	33	44	0.7	0.6
RW14	Ashley Hill	OUT	1917	1036	771	784	928	961	6.0	5.4
MM12	Glenfrome Road	OUT	1919	1107	467	552	526	556	0.2	2.6
M13	M32	OUT	3981	3965	3192	3660	3486	3795	2.2	5.1
M14	Stapleton Road	OUT	1440	1437	267	325	296	377	2.8	1.7
M15	Easton Road	OUT	1995	2005	100	106	110	115	0.9	1.1

M16	A420 Lawrence Hill	OUT	1466	1251	564	625	523	588	1.5	1.8
M17	Ducie Road	OUT	1250	1763	12	14	19	27	2.7	1.8
M18	Barrow Road	OUT	1747	1283	350	395	301	350	2.3	2.7
M19	A4320 St Phillips Causeway	OUT	1549	1290	829	1120	1083	1188	2.0	8.2
M20	Feeder Road	OUT	1741	1751	374	451	390	444	0.3	0.8
M21	Albert Road	OUT	1755	1290	183	351	276	444	4.7	6.1
M22	Bath Road	OUT	4038	2087	401	507	440	492	0.7	1.9
M23	Wells Road	OUT	2085	2131	527	687	450	642	1.7	3.5
MM23	Redcatch Road	OUT	2125	1185	339	366	392	423	2.9	2.7
M24	Wedmore Vale	OUT	2159	2213	155	180	126	155	1.9	2.5
M25	Novers Hill	OUT	2211	2469	179	187	241	241	3.7	4.3
M26	A4174 Hartcliffe Way	OUT	1361	2728	633	769	722	809	1.4	3.4
M27	A38 Bedminster Down Road	OUT	1433	1183	882	1075	808	909	5.3	2.5
M28	South Liberty Lane	OUT	3607	7166	139	166	119	125	3.4	1.8
M29	Ashton Drive	OUT	4082	10005	192	198	129	150	3.7	4.9
M30	A370 Ashton Road	OUT	1530	1531	907	1091	901	1072	0.6	0.2
NWO1	M5	IN	3192	3201	3119	3833	3305	3935	1.6	3.3
NWO2	A4018 Cribbs Causeway	IN	4351	3347	1056	1248	1214	1315	1.9	4.7
NWO4	Gloucester Rd North	IN	3496	1651	1507	1793	1697	1963	3.9	4.8
NWO5	Great Stoke Way	IN	3488	4386	867	1025	963	1068	1.3	3.2
NWO6	M32	IN	3951	3954	1927	2335	2256	2522	3.8	7.2
NWO7	Bristol Rd	IN	3487	3560	610	702	838	864	5.8	8.5
NWO1	M5	OUT	3216	3183	3981	4823	3926	4756	1.0	0.9
NWO2	A4018 Cribbs Causeway	OUT	3347	4351	1218	1440	1303	1434	0.1	2.4
NWO4	Gloucester Rd North	OUT	1651	3496	1044	1234	963	1117	3.4	2.5
NWO5	Great Stoke Way	OUT	4386	3488	780	892	704	754	4.8	2.8
NWO6	M32	OUT	3956	3959	1845	2235	2101	2357	2.5	5.8
NWO7	Bristol Rd	OUT	3560	3487	952	1010	907	1000	0.3	1.5
NE1	Frenchay park Rd	IN	2355	1094	797	863	716	778	2.9	2.9
NE2	Blackberry Hill	IN	1094	2393	456	498	485	507	0.4	1.3
NE3	Fishponds Road	IN	1985	1062	384	498	315	422	3.5	3.7
NE4	Berkley Rd	IN	1077	2025	507	600	486	503	4.1	0.9
NE5	Charlton Road	IN	2027	1098	361	380	353	477	4.7	0.4
NE6	Lodge Rd	IN	1097	1080	302	313	220	232	4.9	5.0
NE7	Downend Rd	IN	1612	2724	285	301	316	336	2.0	1.8
NE8	Syston Way	IN	1541	2031	401	419	531	564	6.5	6.0
NE9	Lees Hill	IN	2490	2409	202	210	232	236	1.8	2.0
NE10	Pound Rd	IN	2405	1685	138	143	127	156	1.1	1.0
NE12	Station Rd	IN	1089	1087	516	610	546	574	1.5	1.3
NE1	Frenchay park Rd	OUT	1094	2355	845	962	1048	1097	4.2	6.6
NE2	Blackberry Hill	OUT	2393	1094	674	745	677	711	1.3	0.1
NE3	Fishponds Road	OUT	1062	1985	664	737	636	762	0.9	1.1
NE4	Berkley Rd	OUT	2025	1077	497	572	442	482	3.9	2.6
NE5	Charlton Road	OUT	1098	2027	598	620	484	562	2.3	4.9
NE6	Lodge Rd	OUT	1080	1097	318	329	331	371	2.2	0.7
NE7	Downend Rd	OUT	2724	1612	210	224	251	281	3.5	2.7
NE8	Syston Way	OUT	2031	1541	301	339	321	343	0.2	1.2
NE9	Lees Hill	OUT	2409	2490	220	229	281	284	3.4	3.9
NE10	Pound Rd	OUT	1685	2405	264	268	227	241	1.7	2.4
NE12	Station Rd	OUT	1087	1089	348	412	365	382	1.5	0.9

TABLE E3
Inter Peak Traffic Flow Calibration Comparison

Ref No.	Road	Dir	A node	B node	Obs LV	Obs Total PCUs	Model LV	Model Total PCUs	GEH PCUs	GEH LVs
RSI1	A4018 Whiteladies Road	IN	1488	2709	901	1068	904	1008	1.9	0.1
I5	Woodland Rd	IN	2557	1226	101	150	90	95	4.9	1.1
RSI2	Horfield Road	IN	1863	1539	210	222	220	225	0.2	0.7
RSI3	A38 North Road	IN	1504	1566	440	543	396	509	1.5	2.1
I6	York Street	IN	2624	2625	47	50	40	42	1.2	1.1
RSI4	A4032 Newfoundland Street	IN	3976	3982	1560	1793	1644	1898	2.4	2.1
RSI5	A420 Old Market Street	IN	4034	1219	752	912	744	903	0.3	0.3
RSI6	Avon Street	IN	1769	1591	92	98	91	102	0.4	0.1
I8	Station Approach Rd	IN	1482	1480	278	418	213	312	5.5	4.1
RSI7	Feeder Road	IN	1286	1574	264	283	271	311	1.6	0.4
RSI8	A4 Bath Road	IN	1189	1572	970	1239	671	943	9.0	10.4
RSI9	St Lukes Road	IN	2163	1191	252	257	252	257	0.0	0.0
I1_I2	Whitehouse/Spring Street	IN	2164	8250	184	191	121	128	5.0	5.1
RSI10	Bedminster Parade	IN	4022	2161	497	615	339	461	6.6	7.7
RSI11	A370 Coronation Road	IN	1489	1558	587	709	853	971	9.0	9.9
RSI12	Cumberland Road	IN	2668	1711	362	407	346	352	2.8	0.9
RSI13	Hotwell Road	IN	1164	1705	981	1147	951	1102	1.4	1.0
I4	Constitution Hill	IN	2558	2559	84	89	86	88	0.1	0.2
I3	Lower Clifton Hill (one way)	IN	2558	2560	21	23	6	13	2.4	4.2
RSI1	A4018 Whiteladies Road	OUT	1228	1229	1067	1279	912	1046	6.8	4.9
I5	Woodland Rd	OUT	1226	2557	96	108	84	84	2.5	1.3
RSI2	Horfield Road	OUT	1539	1863	117	136	114	127	0.8	0.3
RSI3	A38 North Road	OUT	1607	1504	328	465	216	324	7.1	6.8
I6	York Street	OUT	2625	2624	59	62	24	54	1.2	5.3
RSI4	A4032 Newfoundland Street	OUT	1470	3977	1786	2042	1828	2084	0.9	1.0
RSI5	A420 Old Market Street	OUT	1837	1220	570	730	516	633	3.7	2.3
RSI6	Avon Street	OUT	1591	1769	99	113	153	156	3.6	4.8
I8	Station Approach Rd	OUT	1480	1482	287	356	287	385	1.5	0.0
RSI7	Feeder Road	OUT	1574	1286	180	204	117	178	1.8	5.1
RSI8	A4 Bath Road	OUT	1572	1189	1133	1448	1169	1554	2.7	1.1
RSI9	St Lukes Road	OUT	1191	2163	329	335	412	439	5.3	4.3
I1_I2	Whitehouse/Spring Street	OUT	8250	2164	181	188	182	217	2.1	0.1
RSI10	Bedminster Parade	OUT	2161	4022	346	445	341	434	0.5	0.2
RSI11	A370 Coronation Road	OUT	1558	1489	786	893	786	850	1.4	0.0
RSI12	Cumberland Road	OUT	1711	2668	309	331	259	266	3.7	3.0
RSI13	Hotwell Road	OUT	2593	1521	1081	1215	1084	1199	0.5	0.1
I4	Constitution Hill	OUT	2559	2558	108	112	159	178	5.5	4.4
E1	A4174	IN	9961	9960	1369	1764	1438	1643	2.9	1.8
E2	Downend Rd	IN	2385	1066	333	361	347	383	1.1	0.8
E3	Staplehill Rd	IN	2383	1071	336	376	246	386	0.5	5.3
E4	Lodge Hill	IN	1079	1078	199	268	97	202	4.3	8.4
E5	Two Mile Hill Rd	IN	1255	2049	278	308	245	341	1.8	2.1
E6	Nags Head Hill	IN	2053	1276	396	428	406	437	0.4	0.5
E7	Crews Hole Road	IN	1999	1293	122	136	126	128	0.7	0.4
E9	Bath Rd	IN	8053	1406	1096	1412	1016	1150	7.3	2.4
E1	A4174	OUT	9960	9961	1556	2005	1613	1858	3.3	1.4

E2	Downend Rd	OUT	1066	2385	331	361	329	353	0.4	0.1
E3	Staplehill Rd	OUT	1071	2383	330	364	331	417	2.7	0.1
E4	Lodge Hill	OUT	1078	1079	163	220	122	188	2.3	3.5
E5	Two Mile Hill Rd	OUT	2049	1255	347	386	340	394	0.4	0.4
E6	Nags Head Hill	OUT	1276	2053	448	489	446	480	0.4	0.1
E7	Crews Hole Road	OUT	1293	1999	211	229	249	283	3.4	2.5
E9	Bath Rd	OUT	1406	8053	1087	1401	1054	1207	5.4	1.0
NWI2	Shirehampton Rd	IN	3338	3339	283	365	365	443	3.9	4.5
NWI3	Henbury Rd	IN	8069	3329	68	70	82	105	3.8	1.6
NWI4	A4018 Passage Rd	IN	2261	3584	692	892	700	746	5.1	0.3
NWI5	Grey Stoke Av	IN	2259	4340	371	478	371	428	2.4	0.0
NWI7	Southmead Rd	IN	2265	3586	532	569	531	595	1.1	0.0
NWI8	Kellaway Av	IN	1026	1025	444	572	452	503	2.9	0.4
NWI9	Gloucester Rd	IN	1027	1028	424	522	425	525	0.1	0.0
NWI10	Muller Rd	IN	1058	1059	778	867	789	930	2.1	0.4
NWI11	Coldhabour Lane	IN	1663	1093	353	384	345	443	2.9	0.4
NWI12	Filton Rd	IN	3451	3490	876	1129	883	989	4.3	0.2
NWI13	Hambrook Rd	IN	1941	3539	73	94	71	86	0.8	0.2
NWI14	Winterbourne Rd	IN	3529	3528	880	1134	866	989	4.5	0.5
NWI15	M4	IN	3157	3901	3195	4116	3150	4223	1.6	0.8
NWI2	Shirehampton Rd	OUT	3339	3338	259	334	289	389	2.9	1.8
NWI3	Henbury Rd	OUT	3329	8069	72	73	89	110	3.8	1.8
NWI4	A4018 Passage Rd	OUT	3584	2261	648	834	646	754	2.8	0.1
NWI5	Grey Stoke Av	OUT	4340	2259	342	441	338	385	2.7	0.2
NWI7	Southmead Rd	OUT	3586	2265	520	576	522	571	0.2	0.1
NWI8	Kellaway Av	OUT	1025	1026	442	570	441	482	3.8	0.1
NWI9	Gloucester Rd	OUT	1028	1027	484	577	473	566	0.5	0.5
NWI10	Muller Rd	OUT	1059	1058	772	829	774	883	1.8	0.0
NWI11	Coldhabour Lane	OUT	1093	1663	307	339	303	413	3.8	0.2
NWI12	Filton Rd	OUT	3490	3451	1196	1542	1184	1372	4.4	0.3
NWI13	Hambrook Rd	OUT	1941	2365	75	97	61	64	3.6	1.6
NWI14	Winterbourne Rd	OUT	3528	3529	929	1197	928	1075	3.6	0.0
NWI15	M4	OUT	3910	3138	3093	3985	3141	4203	3.4	0.9
S1	Bridgewater Rd	IN	3635	2459	453	539	449	496	1.9	0.2
S2	Bishopsworth Rd	IN	2463	2195	432	557	423	505	2.3	0.4
S3	St Peters Rise	IN	1357	2523	129	146	146	178	2.5	1.5
S4	Hengrove Way	IN	1359	1360	696	735	681	736	0.0	0.6
S5	Hawkfield Rd	IN	1365	2519	427	444	352	436	0.4	3.8
S6	Whitchurch Lane	IN	7178	1376	507	614	483	600	0.6	1.1
S7	Bamfield	IN	2433	3644	166	169	152	155	1.1	1.1
S8	Wells Rd	IN	1380	1430	547	690	572	741	1.9	1.1
S9	Bath Rd	IN	1311	4044	987	1272	1163	1388	3.2	5.4
S10	School Road	IN	1307	2121	257	279	208	266	0.8	3.2
S11	Allison Rd	IN	1307	2117	170	209	171	184	1.8	0.1
S1	Bridgewater Rd	OUT	2459	3635	478	559	475	577	0.8	0.2
S2	Bishopsworth Rd	OUT	2195	2463	454	584	460	548	1.5	0.3
S3	St Peters Rise	OUT	2523	1357	145	166	156	180	1.0	0.9
S4	Hengrove Way	OUT	1360	1359	734	773	687	730	1.6	1.8
S5	Hawkfield Rd	OUT	2519	1365	414	426	369	454	1.3	2.2
S6	Whitchurch Lane	OUT	7013	1376	497	583	551	653	2.8	2.4
S7	Bamfield	OUT	3644	2433	161	170	188	203	2.4	2.1

S8	Wells Rd	OUT	1430	1380	522	661	585	730	2.6	2.7
S9	Bath Rd	OUT	1490	4046	926	1193	962	1126	2.0	1.2
S10	School Road	OUT	2121	1307	357	389	326	386	0.2	1.7
S11	Allison Rd	OUT	2117	1307	174	199	155	165	2.5	1.5
R1	M5	IN	3213	3928	2925	3769	2938	3591	2.9	0.2
R3	A3029 Brunel Way (N)	IN	1165	1513	1459	1772	1291	1619	3.7	4.5
R4	A3029 Brunel Way (S)	IN	1513	1166	1614	1901	1746	2086	4.1	3.2
R5	Princes Street Bridge	IN	1436	1777	138	145	96	96	4.5	3.9
R6	Bedminster Bridge	IN	1477	1319	777	988	1135	1307	9.4	11.6
R7	Redcliffe Way	IN	2651	1203	189	335	239	296	2.2	3.4
R8	Bristol Bridge, Victoria Street	IN	1233	2547	542	694	508	766	2.7	1.5
R9	Passager Street	IN	1247	1594	210	271	277	281	0.6	4.3
R10	Temple Way	IN	1591	1593	1198	1517	1097	1360	4.1	3.0
R11	Bath Bridge	IN	1485	1210	1990	2453	1867	2342	2.3	2.8
R12	Avon Street	IN	1592	1286	324	350	331	386	1.9	0.4
R13	Albert Road	IN	1288	1301	384	484	393	451	1.6	0.4
R15	St Phillips Causeway	IN	1290	1302	939	1091	840	937	4.8	3.3
R16	Marsh Lane	IN	2011	3631	199	243	132	134	8.0	5.2
R17	Nethan Road	IN	2013	1425	569	643	613	630	0.5	1.8
R18	Feeder Road	IN	1426	2599	552	623	521	558	2.7	1.3
R1	M5	OUT	3927	3204	3193	4114	3179	4085	0.5	0.3
R3	A3029 Brunel Way (N)	OUT	1525	1524	1503	1914	1530	1888	0.6	0.7
R4	A3029 Brunel Way (S)	OUT	1527	1526	1642	1941	1591	1949	0.2	1.3
R5	Princes Street Bridge	OUT	1777	1436	192	200	130	153	3.5	4.9
R6	Bedminster Bridge	OUT	1474	1318	1328	1657	1343	1575	2.0	0.4
R7	Redcliffe Way	OUT	1204	2651	287	405	252	304	5.3	2.2
R8	Bristol Bridge, Victoria Street	OUT	2547	1233	538	684	552	679	0.2	0.6
R9	Passage Street	OUT	1594	1247	268	346	131	245	5.8	9.7
R10	Temple Way	OUT	1593	1207	1161	1385	1192	1427	1.1	0.9
R11	Bath Bridge	OUT	1483	1484	1195	1549	1225	1551	0.0	0.9
R12	Avon Street	OUT	1286	1592	259	286	265	303	1.0	0.4
R13	Albert Road	OUT	1301	1288	294	374	154	263	6.2	9.4
R15	St Phillips Causeway	OUT	1302	1290	1006	1211	971	1070	4.2	1.1
R16	Marsh Lane	OUT	3631	2011	188	212	289	318	6.5	6.5
R17	Nethan Road	OUT	1425	2013	625	695	637	698	0.1	0.5
R18	Feeder Road	OUT	2599	1426	593	666	622	673	0.3	1.2
RW1	A4176 Portway	IN	1052	1162	689	965	616	853	3.7	2.9
RW5	Clifton Down	IN	1041	1161	555	597	568	612	0.6	0.5
RW22	Kingsland Road	IN	1733	1285	191	201	199	222	1.4	0.5
RW2	Avon Street	IN	1769	1592	99	113	178	181	5.5	6.7
RW26	B3021 St Johns Lane	IN	1181	1180	612	694	629	721	1.0	0.7
RW27	A38 Parsons Street	IN	1173	1579	1397	1632	1395	1605	0.7	0.1
RW28	A38 Bedminster Down Road	IN	1433	2746	1386	1661	1350	1612	1.2	1.0
RW30	Whitby Road	IN	2599	1302	332	339	324	341	0.1	0.4
RW34	A4174	IN	2937	3612	1142	1320	1124	1200	3.4	0.5
RW35	A4175 Keynsham Road	IN	1394	1393	377	399	357	421	1.0	1.1
RW36	Muller Road	IN	1058	2335	632	658	634	692	1.3	0.1
RW37	Lockleaze Road	IN	2327	1486	113	131	114	153	1.8	0.1
RW38	Bonnington Walk	IN	2315	2305	139	148	107	120	2.4	2.9
RW39	A4174 Station Road	IN	3693	3471	1116	1438	1118	1324	3.1	0.1
RW40	Gipsy Patch Lane	IN	3234	1945	668	861	667	722	4.9	0.0

RW41	A38 Gloucester Road	IN	3427	3307	964	1158	910	1011	4.5	1.7
RW42	M5	IN	3174	3181	2946	3796	2962	3660	2.2	0.3
RW1	A4176 Portway	OUT	1162	1052	669	932	527	731	7.0	5.8
RW5	Clifton Down	OUT	1161	1041	697	725	681	725	0.0	0.6
RW22	Kingsland Road	OUT	1285	1733	125	145	182	224	5.8	4.6
RW2	Avon Street	OUT	1592	1769	92	98	96	109	1.0	0.4
RW26	B3021 St Johns Lane	OUT	1180	1181	672	711	633	706	0.2	1.5
RW30	Whitby Road	OUT	1302	2599	409	458	271	319	7.1	7.5
RW35	A4175 Keynsham Road	OUT	1393	1394	382	404	401	489	4.0	0.9
RW36	Muller Road	OUT	2335	1058	617	666	642	747	3.0	1.0
RW37	Lockleaze Road	OUT	1486	2327	133	148	132	176	2.2	0.1
RW38	Bonnington Walk	OUT	2305	2315	129	139	104	119	1.8	2.3
RW39	A4174 Station Road	OUT	3471	3693	1213	1563	1172	1396	4.3	1.2
RW40	Gipsy Patch Lane	OUT	1945	3234	649	836	631	656	6.6	0.7
RW41	A38 Gloucester Road	OUT	3310	3313	694	820	684	803	0.6	0.4
M5 J19	Docks	IN	1619	3926	0	0	127	299		
	Docks	OUT	7025	1619	0	0	88	138		
	Gordano Services	IN	4336	7027	0	0	68	161		
	Gordano Services	OUT	7027	4336	0	0	56	66		
	A369 Martcombe Rd East	IN	3706	3705	0	0	378	405		
	A369 Martcombe Rd East	OUT	3705	3706	0	0	484	512		
	St George's Hill - Pill	IN	3705	7019	0	0	180	203		
	St George's Hill - Pill	OUT	7019	3705	0	0	123	165		
	Portbury High st	IN	7035	7036	0	0	58	70		
	Portbury High st	OUT	7036	7035	0	0	42	54		
	The Portbury Hundred	IN	3789	3703	0	0	1128	1216		
	The Portbury Hundred	OUT	3703	3789	0	0	964	1027		
Temple Circus roundabout	A4044 Temple Way (N)	IN	1610	1206	1149	1455	1011	1272	5.0	4.2
	Friary (E)	IN	1565	1508	61	103	52	58	5.1	1.3
	Redcliffe Way (S)	IN	1510	1506	1395	1873	1416	1840	0.8	0.6
	Victoria Street (NW)	IN	1562	1205	340	484	413	615	5.6	3.7
	A4044 Temple Way (N)	OUT	1205	1563	1054	1368	1087	1318	1.4	1.0
	Friary (E)	OUT	1206	1564	56	93	45	72	2.3	1.5
	A4 Temple Gate (SE)	OUT	1508	1507	1566	2069	1345	1824	5.5	5.8
	Victoria Street (NW)	OUT	1506	1561	271	387	415	571	8.4	7.8
	A4 Temple Gate (E)	IN	2647	2556	1126	1546	816	1154	10.7	9.9
	Redcliff Mead Lane (S)	IN	2740	2556	57	60	59	81	2.5	0.3
	Redcliffe Way (W)	IN	1717	1605	420	564	707	776	8.2	12.1
	Redcliffe Way (W)	OUT	1604	1606	184	253	76	102	11.3	9.5
Bath Bridge	A4 Temple Gate (N)	IN	1480	1485	1361	1719	1131	1513	5.1	6.5
	Cattle market Road (NE)	IN	1574	1485	264	315	271	311	0.2	0.4
	A4 Bath Road (SE)	IN	1572	1190	1000	1345	672	943	11.9	11.4
	A370 York Road (SW)	IN	1570	1483	296	328	318	328	0.0	1.3
	Clarence Road (W)	IN	1573	1484	459	616	459	549	2.8	0.0
	A4 Temple Gate (N)	OUT	1484	1480	960	1267	675	931	10.1	9.9
	Cattle market Road (NE)	OUT	1485	1574	188	228	117	178	3.4	5.8
	A4 Bath Road (SE)	OUT	1210	1571	1172	1568	1169	1554	0.4	0.1
	A370 York Road (SW)	OUT	1190	1570	768	896	463	509	14.6	12.3
	Clarence Road (W)	OUT	1484	1573	293	364	426	472	5.3	7.0
Bedminster Bridge roundabout	Redcliff Hill (N)	IN	1479	1476	424	567	698	807	9.2	11.5
	Clarence Road (NE)	IN	1554	1477	262	334	405	452	6.0	7.9

	A370 York Road (SE)	IN	1555	1478	575	705	23	23	35.7	31.9
	Bedminster Parade (S)	IN	1557	1192	559	731	489	598	5.1	3.0
	A370 Coronation Road (SW)	IN	1558	1474	525	684	853	971	10.0	12.5
	Commerical Road (NW)	IN	1559	1475	336	394	301	313	4.3	2.0
	Redcliff Hill (N)	OUT	1475	1552	615	803	1015	1117	10.1	14.0
	Clarence Road (NE)	OUT	1476	1554	522	688	484	569	4.7	1.7
	A370 York Road (SE)	OUT	1319	1555	187	203	98	114	7.1	7.4
	Bedminster Parade (S)	OUT	1478	1556	349	494	321	411	3.9	1.5
	A370 Coronation Road (SW)	OUT	1553	1558	744	909	738	800	3.7	0.2
	Commerical Road (NW)	OUT	1560	1559	265	317	113	153	10.7	11.1
Redcliffe Way roundabout	Redcliff Street (N)	IN	2546	1204	317	346	313	354	0.4	0.2
	Redcliffe Way (E)	IN	2550	1204	184	250	92	120	9.6	7.8
	Redcliff Hill (S)	IN	1552	1204	686	874	1015	1117	7.7	11.3
	Redcliff Street (N)	OUT	1204	2546	279	304	243	243	3.7	2.2
	Redcliffe Way (E)	OUT	1204	2550	433	581	721	825	9.2	12.0
	Redcliff Hill (S)	OUT	1204	4021	379	516	659	756	9.5	12.3
Jacob Wells Road roundabout	Jacobs Wells Road (N)	IN	1198	9994	373	434	337	343	4.6	1.9
	St Georges Street (NE)	IN	9997	9995	156	165	137	138	2.2	1.6
	A4 Anchor Road €	IN	9998	9996	402	595	563	584	0.4	7.3
	A4 Hotwells Road (W)	IN	1618	9993	772	964	762	875	2.9	0.4
	Jacobs Wells Road (N)	OUT	1198	2559	342	399	231	240	8.9	6.5
	St Georges Street (NE)	OUT	9997	2671	176	192	90	90	8.6	7.4
	A4 Anchor Road €	OUT	9998	9999	446	601	729	746	5.6	11.7
	A4 Hotwells Road (W)	OUT	1618	1707	739	965	748	851	3.8	0.3
The Triangle	A4018 Queens Road (N)	IN	1817	1488	791	1060	670	765	9.8	4.5
	Triangle (W) circulatory		1229	4053	1134	1407	717	849	16.6	13.7
	A4018 Queens Road (N)	OUT	4053	4054	815	1046	483	606	15.3	13.0
	Triangle (W) circulatory		4053	1488	352	416	234	243	9.5	6.9
	University Road	OUT	2708	4060	58	63	91	92	3.2	3.9
	Park Row (E)	IN	2710	1228	886	1102	532	654	15.1	13.3
	Park Row (E)	OUT	2709	2708	823	5658	666	757	86.5	5.8
	Triangle (E) circulatory		2709	1228	195	237	239	250	0.9	3.0
	Park Row (E)	OUT	2708	2710	788	1046	574	665	13.0	8.2
	Berkeley Place (S)	IN	2673	1229	388	462	285	304	8.1	5.6
Lawrence Hill Rbt	A4320 Easton Way (N)	IN	1611	1244	1374	1680	1362	1479	5.1	0.3
	Lawrence Hill (E)	IN	4036	1245	654	792	891	1026	7.7	8.5
	A4320 St Phillips Causeway (S)	IN	1284	1246	979	1215	1086	1227	0.3	3.3
	Lawrence Hill (W)	IN	1249	1248	693	816	668	743	2.6	0.9
	A4320 Easton Way (N)	OUT	1248	1620	1206	1438	1323	1482	1.1	3.3
	Lawrence Hill (E)	OUT	1244	4092	699	845	852	925	2.7	5.5
	A4320 St Phillips Causeway (S)	OUT	1245	1284	1181	1471	880	978	14.1	9.4
	Lawrence Hill (W)	OUT	1246	1249	616	749	645	748	0.0	1.2
M32 Junction 3	M32 (North)	IN	3597	3973	1067	1334	1240	1413	2.1	5.1
	A4320 (E)	IN	2571	3974	1231	1500	1184	1365	3.6	1.3
	M32 (South)	IN	3977	3978	382	430	259	274	8.3	6.8
	B4051 (W)	IN	3578	3979	689	768	862	885	4.0	6.2
	M32 (North)	OUT	3979	3986	1108	1372	858	1031	9.8	8.0
	A4320 (E)	OUT	3973	3577	1396	1695	1587	1734	0.9	4.9
	M32 (South)	OUT	3974	3975	206	236	142	159	5.4	4.8
	B4051 (W)	OUT	3978	3578	659	730	959	1012	9.6	10.5

M32 / Cabot circus	A4032 Newfoundland Way	IN	3982	1471	1724	2037	1644	1898	3.1	2.0
	Houlton Street	IN	9972	1471	88	103	37	38	7.7	6.5
	Car Park	IN	2628	9974	70	70	107	107	4.0	4.0
	A4044 Temple Way	IN	9985	9967	1404	1974	1470	1848	2.9	1.7
	A4044 Newfoundland Street	IN	9970	1209	1590	1870	1718	1927	1.3	3.1
	A4032 Newfoundland Way	OUT	1221	9981	1940	2279	1828	2084	4.2	2.6
	Houlton Street	OUT	1471	9972	323	346	194	216	7.8	8.1
	Car Park	OUT	9974	2628	270	273	346	346	4.2	4.4
	A4044 Temple Way	OUT	9967	9985	777	1057	1175	1386	9.4	12.8
	A4044 Newfoundland Street	OUT	1209	9970	1463	1993	1339	1672	7.5	3.3
	St Paul Street	OUT	1209	9975	105	107	94	114	0.7	1.1
Hambrook	Bristol Rd (N) to A4174 (W)	N to W	3487	3560	218	281	227	280	0.1	0.6
	Bristol Rd (N) to (S)	N to S	3487	3560	143	184	326	361	10.7	12.0
	Bristol Rd (N) to A4174 (E)	N to E	3487	3560	297	383	69	80	19.9	16.8
	A4174 (W) to Bristol Rd (N)	W to N	3499	3560	269	347	370	464	5.9	5.6
	A4174 (W) to Bristol Rd (S)	W to S	3499	3560	211	272	70	137	9.5	11.9
	A4174 (W) to (E)	W to E	3499	3560	1086	1399	1484	1699	7.6	11.1
	Bristol Rd (S) to (N)	S to N	3473	3560	146	188	190	211	1.6	3.4
	Bristol Rd (S) to A4174 (W)	S to W	3473	3560	203	262	96	174	5.9	8.8
	Bristol Rd (S) to A4174 (E)	S to E	3473	3560	116	150	60	79	6.7	6.1
	A4174 (E) to Bristol Rd (N)	E to N	9960	3560	227	293	223	225	4.2	0.3
	A4174 (E) to (W)	E to W	9960	3560	966	1244	1126	1321	2.1	5.0
	A4174 (E) to Bristol Rd (S)	E to S	9960	3473	128	165	83	92	6.5	4.4
M32 J1	M32 (N) to A4174 (E)	N to E	3900	3952	523	760	705	871	3.9	7.4
	M32 (N) to A4174 (W)	N to W	3952	3953	220	253	179	206	3.1	2.9
	A4174 (E) to M32 (S)	E to S	3561	3953	460	532	423	516	0.7	1.7
	A4174 (E) to M32 (N)	E to N	3953	3957	524	771	544	709	2.3	0.9
	A4174 (E) to (W)	E to W	3561	3953	375	437	322	554	5.3	2.8
	M32 (S) to A4174 (W)	S to W	9916	3957	280	331	252	288	2.5	1.7
	M32 (S) to A4174 (E)	S to E	3957	3958	521	602	467	586	0.7	2.4
	A4174 (W) to M32 (N)	W to N	3562	3958	288	322	133	179	9.0	10.7
	A4174 (W) to (E)	W to E	3562	3958	549	624	702	844	8.1	6.1
	A4174 (W) to M32 (S)	W to S	3958	3952	300	364	300	349	0.8	0.0

TABLE E4

Inter Peak Traffic Flow Validation Comparison

Ref No.	Road	Dir	A node	B node	Obs LV	Obs Total PCUs	Model LV	Model Total PCUs	GEH PCUs	GEH LVs
O1	A38 Bridgewater Road	IN	7147	3635	564	727	610	662	2.5	1.9
O2	A370 Long Ashton Bypass	IN	2703	1355	499	644	533	555	3.6	1.5
O3	B3128 Ashton Road	IN	1148	1149	353	455	295	474	0.9	3.2
O4	A369 Clanage Road	IN	1158	2471	417	453	334	366	4.3	4.3
O5	B3129 Clifton Suspension Bridge	IN	1159	1160	292	376	321	321	3.0	1.6
O6	A4 Portway	IN	3348	3591	514	868	629	759	3.8	4.8
O7	B4054 Shirehampton Road	IN	2223	3340	270	308	243	278	1.8	1.7
O8	Kings Weston Lane	IN	3389	3342	195	208	144	196	0.8	4.0
O9	Hallen Road	IN	3362	3363	132	139	120	130	0.8	1.1
O10	A4018 Cribbs Causeway	IN	3197	3324	553	713	541	608	4.1	0.5
O11	Merlin Road	IN	3193	3198	740	954	822	901	1.7	2.9
O12	Highwood Lane	IN	3191	3195	565	728	599	716	0.4	1.4
O13	A38 Gloucester Rd	IN	3162	3410	1010	1302	1100	1292	0.3	2.8
O14	B4427 Old Gloucester Road	IN	3030	3526	172	221	209	224	0.2	2.7
O15	B4057 Beacon Lane	IN	3037	3528	478	616	441	554	2.6	1.7
O16	M32	IN	3907	3951	2229	2739	2197	2677	1.2	0.7
O17	B4058 Bristol Road	IN	2371	3550	268	346	254	325	1.1	0.9
O18	A432 Badminton Road	IN	4236	3047	594	766	583	681	3.2	0.5
O19	Westerleigh Road	IN	4237	3685	377	486	334	459	1.3	2.3
O20	Shortwood Road	IN	1125	3055	230	296	258	319	1.4	1.8
O21	A420 London Rd	IN	3761	3760	386	497	365	508	0.5	1.1
O22	A431 Bath Road	IN	3798	3772	268	345	286	321	1.3	1.1
O23	A4 Bath Road	IN	1408	1407	823	929	728	848	2.7	3.4
O24	B3116 Wellsway	IN	3767	1404	425	455	394	441	0.7	1.5
O25	A37 Bristol Road	IN	3645	8052	435	560	443	615	2.3	0.4
O26	Queens Rd	IN	3636	7115	145	151	156	194	3.3	0.9
O1	A38 Bridgewater Road	OUT	3635	7147	583	751	695	828	2.7	4.4
O2	A370 Long Ashton Bypass	OUT	1355	2703	576	742	563	612	5.0	0.5
O3	B3128 Ashton Road	OUT	1149	1148	398	513	415	577	2.8	0.8
O4	A369 Clanage Road	OUT	2471	1158	365	385	308	346	2.0	3.1
O5	B3129 Clifton Suspension Bridge	OUT	1160	1159	327	421	356	356	3.3	1.6
O6	A4 Portway	OUT	3591	3348	614	859	557	773	3.0	2.4
O7	B4054 Shirehampton Road	OUT	3340	2223	257	292	171	223	4.3	5.9
O8	Kings Weston Lane	OUT	3342	3389	182	193	137	182	0.8	3.5
O9	Hallen Road	OUT	3363	3362	104	112	85	106	0.6	1.9
O10	A4018 Cribbs Causeway	OUT	3324	3197	620	798	547	684	4.2	3.0
O11	Merlin Road	OUT	3198	3193	565	727	727	761	1.2	6.4
O12	Highwood Lane	OUT	3195	3193	406	523	494	612	3.7	4.1
O13	A38 Gloucester Rd	OUT	3410	3162	1185	1527	1261	1453	1.9	2.2
O14	B4427 Old Gloucester Road	OUT	3526	3030	129	166	182	188	1.7	4.2
O15	B4057 Beacon Lane	OUT	3528	3037	479	617	483	590	1.1	0.2
O16	M32	OUT	3960	3908	2034	2500	1855	2385	2.3	4.1
O17	B4058 Bristol Road	OUT	3550	2371	284	366	289	371	0.3	0.3
O18	A432 Badminton Road	OUT	3047	4236	609	785	520	629	5.9	3.8

O19	Westerleigh Road	OUT	3685	4237	349	449	394	489	1.8	2.3
O20	Shortwood Road	OUT	3055	1125	249	321	265	312	0.5	1.0
O21	A420 London Rd	OUT	3760	3761	357	460	362	527	3.0	0.3
O22	A431 Bath Road	OUT	3772	3798	239	308	268	322	0.8	1.8
O23	A4 Bath Road	OUT	1407	1408	853	916	861	1000	2.7	0.3
O24	B3116 Wellsway	OUT	1404	3767	445	478	367	408	3.3	3.9
O25	A37 Bristol Road	OUT	8052	3645	361	466	352	530	2.9	0.5
O26	Queens Rd	OUT	7115	3636	140	149	172	206	4.3	2.6
M2	A4176 Portway	IN	1162	1582	1105	1421	1070	1317	2.8	1.1
M4	College Road	IN	1801	1160	313	351	327	353	0.1	0.8
M5	Pembroke Road	IN	1041	1803	139	159	179	196	2.8	3.2
M7	Whiteladies Road	IN	1809	1238	711	851	715	801	1.8	0.2
M8	Hampton Road	IN	1015	1881	204	210	208	211	0.0	0.2
M9	Redland Grove	IN	1659	1853	191	210	115	136	5.7	6.1
M10	Redland Road	IN	1034	1855	130	133	172	173	3.2	3.4
M11	A38 Cheltenham Road	IN	1030	1031	427	645	454	538	4.4	1.3
M12	North Road	IN	1146	1031	239	249	186	197	3.5	3.7
RW14	Ashley Hill	IN	1036	1917	498	514	530	543	1.2	1.4
MM12	Glenfrome Road	IN	1107	1919	350	451	301	319	6.8	2.7
M13	M32	IN	3971	3972	2290	2666	2395	2783	2.3	2.2
M14	Stapleton Road	IN	1437	1440	413	476	354	432	2.0	3.1
M15	Easton Road	IN	2005	1995	261	270	75	81	14.3	14.4
M16	A420 Lawrence Hill	IN	1251	1466	738	829	815	950	4.1	2.8
M17	Ducie Road	IN	1763	1250	68	88	87	115	2.8	2.2
M18	Barrow Road	IN	1283	1747	307	327	284	344	0.9	1.4
M19	A4320 St Phillips Causeway	IN	1290	1549	961	1164	1033	1169	0.2	2.3
M20	Feeder Road	IN	1751	1741	482	581	421	461	5.2	2.8
M21	Albert Road	IN	1290	1755	358	574	349	446	5.7	0.5
M22	Bath Road	IN	2087	4038	519	625	420	505	5.0	4.6
M23	Wells Road	IN	2131	2085	469	583	345	497	3.7	6.1
MM23	Redcatch Road	IN	1185	2125	244	275	301	331	3.2	3.5
M24	Wedmore Vale	IN	2213	2159	184	188	163	206	1.3	1.5
M25	Novers Hill	IN	2469	2211	220	239	222	223	1.1	0.2
M26	A4174 Hartcliffe Way	IN	2728	1361	802	906	749	945	1.3	1.9
M27	A38 Bedminster Down Road	IN	1183	1433	905	1022	809	939	2.7	3.3
M28	South Liberty Lane	IN	7166	3607	120	156	113	126	2.5	0.6
M29	Ashton Drive	IN	10005	4082	181	208	144	161	3.5	2.9
M30	A370 Ashton Road	IN	1153	1154	894	1054	796	1007	1.5	3.4
M2	A4176 Portway	OUT	1582	1162	1071	1382	970	1200	5.1	3.2
M4	College Road	OUT	1160	1801	238	249	253	267	1.1	1.0
M5	Pembroke Road	OUT	1803	1041	147	167	164	181	1.1	1.4
M7	Whiteladies Road	OUT	1238	1809	663	817	578	659	5.8	3.4
M8	Hampton Road	OUT	1881	1015	272	280	295	295	0.9	1.3
M9	Redland Grove	OUT	1853	1659	189	211	129	149	4.6	4.8
M10	Redland Road	OUT	1855	1034	90	92	115	116	2.4	2.4
M11	A38 Cheltenham Road	OUT	1031	1030	430	640	497	588	2.1	3.1
M12	North Road	OUT	1031	1146	25	35	24	32	0.5	0.3
RW14	Ashley Hill	OUT	1917	1036	536	551	585	591	1.7	2.1
MM12	Glenfrome Road	OUT	1919	1107	325	419	319	337	4.2	0.3
M13	M32	OUT	3981	3965	2454	2906	2406	2829	1.4	1.0
M14	Stapleton Road	OUT	1440	1437	424	498	369	418	3.8	2.7

M15	Easton Road	OUT	1995	2005	189	198	218	230	2.2	2.0
M16	A420 Lawrence Hill	OUT	1466	1251	659	754	704	757	0.1	1.7
M17	Ducie Road	OUT	1250	1763	27	34	55	84	6.5	4.5
M18	Barrow Road	OUT	1747	1283	229	264	210	246	1.1	1.3
M19	A4320 St Phillips Causeway	OUT	1549	1290	785	1074	784	875	6.4	0.0
M20	Feeder Road	OUT	1741	1751	487	577	450	562	0.6	1.7
M21	Albert Road	OUT	1755	1290	293	443	356	502	2.7	3.5
M22	Bath Road	OUT	4038	2087	526	647	594	722	2.9	2.8
M23	Wells Road	OUT	2085	2131	567	712	482	621	3.5	3.7
MM23	Redcatch Road	OUT	2125	1185	356	393	350	377	0.8	0.3
M24	Wedmore Vale	OUT	2159	2213	165	185	231	257	4.8	4.6
M25	Novers Hill	OUT	2211	2469	309	327	293	305	1.3	1.0
M26	A4174 Hartcliffe Way	OUT	1361	2728	780	953	710	841	3.7	2.6
M27	A38 Bedminster Down Road	OUT	1433	1183	854	988	914	1104	3.6	2.0
M28	South Liberty Lane	OUT	3607	7166	109	149	92	119	2.6	1.6
M29	Ashton Drive	OUT	4082	10005	191	202	178	201	0.1	1.0
M30	A370 Ashton Road	OUT	1530	1531	1004	1210	916	1132	2.3	2.9
NWO1	M5	IN	3192	3201	2543	3125	2836	3496	6.5	5.7
NWO2	A4018 Cribbs Causeway	IN	4351	3347	913	1176	969	1052	3.7	1.8
NWO4	Gloucester Rd North	IN	3496	1651	886	1142	994	1144	0.1	3.5
NWO5	Great Stoke Way	IN	3488	4386	723	931	725	992	2.0	0.1
NWO6	M32	IN	3951	3954	1348	1657	1320	1621	0.9	0.8
NWO7	Bristol Rd	IN	3487	3560	650	713	622	721	0.3	1.1
NWO1	M5	OUT	3216	3183	2787	3425	2910	3763	5.6	2.3
NWO2	A4018 Cribbs Causeway	OUT	3347	4351	947	1220	954	1096	3.6	0.2
NWO4	Gloucester Rd North	OUT	1651	3496	984	1268	1110	1239	0.8	3.9
NWO5	Great Stoke Way	OUT	4386	3488	626	807	700	784	0.8	2.9
NWO6	M32	OUT	3956	3959	1245	1531	1179	1497	0.9	1.9
NWO7	Bristol Rd	OUT	3560	3487	711	755	783	901	5.1	2.7
NE1	Frenchay park Rd	IN	2355	1094	580	617	626	694	3.0	1.9
NE2	Blackberry Hill	IN	1094	2393	494	533	594	650	4.8	4.3
NE3	Fishponds Road	IN	1985	1062	649	750	509	734	0.6	5.8
NE4	Berkley Rd	IN	1077	2025	308	396	341	362	1.8	1.9
NE5	Charlton Road	IN	2027	1098	298	310	303	327	0.9	0.3
NE6	Lodge Rd	IN	1097	1080	242	254	115	212	2.7	9.5
NE7	Downend Rd	IN	1612	2724	330	346	292	306	2.2	2.1
NE8	Syston Way	IN	1541	2031	259	275	298	361	4.8	2.4
NE9	Lees Hill	IN	2490	2409	131	140	107	110	2.7	2.2
NE10	Pound Rd	IN	2405	1685	119	122	108	130	0.7	1.0
NE12	Station Rd	IN	1089	1087	338	435	459	467	1.5	6.1
NE1	Frenchay park Rd	OUT	1094	2355	498	527	499	599	3.0	0.0
NE2	Blackberry Hill	OUT	2393	1094	504	548	516	590	1.8	0.5
NE3	Fishponds Road	OUT	1062	1985	652	764	521	652	4.2	5.4
NE4	Berkley Rd	OUT	2025	1077	352	453	294	355	4.9	3.2
NE5	Charlton Road	OUT	1098	2027	329	342	350	367	1.3	1.1
NE6	Lodge Rd	OUT	1080	1097	212	223	129	269	2.9	6.3
NE7	Downend Rd	OUT	2724	1612	228	241	202	236	0.4	1.8
NE8	Syston Way	OUT	2031	1541	277	310	279	364	2.9	0.1
NE9	Lees Hill	OUT	2409	2490	174	184	205	224	2.8	2.3
NE10	Pound Rd	OUT	1685	2405	158	161	154	185	1.8	0.3
NE12	Station Rd	OUT	1087	1089	282	363	323	348	0.8	2.4

TABLE E5
Evening Peak Traffic Flow Calibration Comparison

Ref No.	Road	Dir	A node	B node	Obs LV	Obs Total PCUs	Model LV	Model Total PCUs	GEH PCUs	GEH LVs
RSI1	A4018 Whiteladies Road	IN	1488	2709	1024	1111	1120	1210	2.9	3.0
I5	Woodland Rd	IN	2557	1226	127	186	109	110	6.2	1.7
RSI2	Horfield Road	IN	1863	1539	198	215	280	286	4.5	5.3
RSI3	A38 North Road	IN	1504	1566	504	661	520	617	1.7	0.7
I6	York Street	IN	2624	2625	76	77	39	43	4.4	4.8
RSI4	A4032 Newfoundland Street	IN	3976	3982	1547	1646	1671	1758	2.7	3.1
RSI5	A420 Old Market Street	IN	4034	1219	878	980	964	1050	2.2	2.8
RSI6	Avon Street	IN	1769	1591	124	132	115	122	0.9	0.8
I8	Station Approach Rd	IN	1482	1480	298	426	234	386	2.0	3.9
RSI7	Feeder Road	IN	1286	1574	295	325	339	373	2.6	2.5
RSI8	A4 Bath Road	IN	1189	1572	1033	1189	917	1049	4.2	3.7
RSI9	St Lukes Road	IN	2163	1191	259	259	273	274	0.9	0.8
I1_I2	Whitehouse/Spring Street	IN	2164	8250	205	224	192	259	2.2	0.9
RSI10	Bedminster Parade	IN	4022	2161	597	695	403	469	9.4	8.7
RSI11	A370 Coronation Road	IN	1489	1558	664	729	902	936	7.2	8.5
RSI12	Cumberland Road	IN	2668	1711	656	669	608	629	1.6	1.9
RSI13	Hotwell Road	IN	1164	1705	1238	1375	1315	1401	0.7	2.1
I4	Constitution Hill	IN	2558	2559	99	101	114	115	1.4	1.4
I3	Lower Clifton Hill (one way)	IN	2558	2560	27	31	10	10	4.5	3.9
RSI1	A4018 Whiteladies Road	OUT	1228	1229	1271	1392	1426	1554	4.2	4.2
I5	Woodland Rd	OUT	1226	2557	140	188	156	156	2.4	1.3
RSI2	Horfield Road	OUT	1539	1863	127	144	100	119	2.2	2.6
RSI3	A38 North Road	OUT	1607	1504	453	561	330	419	6.4	6.3
I6	York Street	OUT	2625	2624	65	68	15	15	8.1	7.9
RSI4	A4032 Newfoundland Street	OUT	1470	3977	2642	2787	2751	2783	0.1	2.1
RSI5	A420 Old Market Street	OUT	1837	1220	992	1117	841	951	5.2	5.0
RSI6	Avon Street	OUT	1591	1769	253	258	271	278	1.3	1.1
I8	Station Approach Rd	OUT	1480	1482	285	353	292	417	3.3	0.4
RSI7	Feeder Road	OUT	1574	1286	265	276	77	151	8.6	14.3
RSI8	A4 Bath Road	OUT	1572	1189	1499	1653	1606	1749	2.3	2.7
RSI9	St Lukes Road	OUT	1191	2163	516	525	737	744	8.7	8.8
I1_I2	Whitehouse/Spring Street	OUT	8250	2164	207	213	216	220	0.5	0.6
RSI10	Bedminster Parade	OUT	2161	4022	429	585	453	514	3.0	1.1
RSI11	A370 Coronation Road	OUT	1558	1489	1125	1177	1061	1143	1.0	1.9
RSI12	Cumberland Road	OUT	1711	2668	747	817	534	612	7.7	8.4
RSI13	Hotwell Road	OUT	2593	1521	1902	2216	2030	2196	0.4	2.9
I4	Constitution Hill	OUT	2559	2558	196	198	238	239	2.8	2.8
E1	A4174	IN	9961	9960	1648	1841	1678	1754	2.1	0.7
E2	Downend Rd	IN	2385	1066	358	375	360	406	1.6	0.1
E3	Staplehill Rd	IN	2383	1071	403	435	378	404	1.5	1.3
E4	Lodge Hill	IN	1079	1078	234	309	270	285	1.3	2.2

E5	Two Mile Hill Rd	IN	1255	2049	361	384	279	317	3.6	4.6
E6	Nags Head Hill	IN	2053	1276	471	493	480	508	0.7	0.4
E7	Crews Hole Road	IN	1999	1293	96	101	113	114	1.2	1.6
E9	Bath Rd	IN	8053	1406	1257	1404	1231	1277	3.5	0.7
E1	A4174	OUT	9960	9961	2563	2863	2808	2899	0.7	4.7
E2	Downend Rd	OUT	1066	2385	405	431	412	452	1.0	0.4
E3	Staplehill Rd	OUT	1071	2383	500	548	450	470	3.4	2.3
E4	Lodge Hill	OUT	1078	1079	245	325	223	229	5.7	1.4
E5	Two Mile Hill Rd	OUT	2049	1255	519	573	515	553	0.8	0.2
E6	Nags Head Hill	OUT	1276	2053	677	744	771	796	1.9	3.5
E7	Crews Hole Road	OUT	1293	1999	648	648	653	660	0.5	0.2
E9	Bath Rd	OUT	1406	8053	1598	1785	1584	1630	3.8	0.4
NWI2	Shirehampton Rd	IN	3338	3339	391	437	386	476	1.9	0.3
NWI3	Henbury Rd	IN	8069	3329	109	109	125	129	1.8	1.5
NWI4	A4018 Passage Rd	IN	2261	3584	984	1100	939	966	4.2	1.5
NWI5	Grey Stoke Av	IN	2259	4340	416	464	484	495	1.4	3.2
NWI7	Southmead Rd	IN	2265	3586	677	730	693	726	0.2	0.6
NWI8	Kellaway Av	IN	1026	1025	560	626	591	597	1.2	1.3
NWI9	Gloucester Rd	IN	1027	1028	622	687	313	387	13.0	14.3
NWI10	Muller Rd	IN	1058	1059	820	918	764	817	3.4	2.0
NWI11	Coldhabour Lane	IN	1663	1093	584	620	571	610	0.4	0.5
NWI12	Filton Rd	IN	3451	3490	959	1072	803	871	6.4	5.3
NWI13	Hambrook Rd	IN	1941	3539	137	153	187	192	3.0	3.9
NWI14	Winterbourne Rd	IN	3529	3528	1237	1382	1303	1342	1.1	1.9
NWI15	M4	IN	3157	3901	4645	5190	4702	5345	2.1	0.8
NWI2	Shirehampton Rd	OUT	3339	3338	336	375	385	423	2.4	2.6
NWI3	Henbury Rd	OUT	3329	8069	134	136	131	138	0.2	0.3
NWI4	A4018 Passage Rd	OUT	3584	2261	851	950	909	941	0.3	2.0
NWI5	Grey Stoke Av	OUT	4340	2259	595	665	510	562	4.2	3.6
NWI7	Southmead Rd	OUT	3586	2265	564	613	623	724	4.3	2.5
NWI8	Kellaway Av	OUT	1025	1026	591	660	474	487	7.2	5.1
NWI9	Gloucester Rd	OUT	1028	1027	555	626	486	573	2.2	3.0
NWI10	Muller Rd	OUT	1059	1058	989	1050	904	931	3.8	2.8
NWI11	Coldhabour Lane	OUT	1093	1663	352	382	329	384	0.1	1.2
NWI12	Filton Rd	OUT	3490	3451	2080	2324	2188	2402	1.6	2.3
NWI13	Hambrook Rd	OUT	1941	2365	94	105	94	96	0.9	0.0
NWI14	Winterbourne Rd	OUT	3528	3529	1373	1534	1372	1420	3.0	0.0
NWI15	M4	OUT	3910	3138	4801	5364	4812	5450	1.2	0.2
S1	Bridgewater Rd	IN	3635	2459	548	605	624	647	1.7	3.1
S2	Bishopsworth Rd	IN	2463	2195	438	489	460	479	0.5	1.0
S3	St Peters Rise	IN	1357	2523	132	144	157	172	2.2	2.1
S4	Hengrove Way	IN	1359	1360	814	846	721	742	3.7	3.4
S5	Hawkfield Rd	IN	1365	2519	554	570	551	596	1.1	0.1
S6	Whitchurch Lane	IN	7178	1376	632	735	687	742	0.3	2.2
S7	Bamfield	IN	2433	3644	299	299	238	248	3.1	3.7
S8	Wells Rd	IN	1380	1430	560	675	581	662	0.5	0.9
S9	Bath Rd	IN	1311	4044	1102	1231	1222	1302	2.0	3.5
S10	School Road	IN	1307	2121	389	410	424	427	0.8	1.7
S11	Allison Rd	IN	1307	2117	284	318	313	338	1.1	1.7
S1	Bridgewater Rd	OUT	2459	3635	578	630	694	716	3.3	4.6
S2	Bishopsworth Rd	OUT	2195	2463	705	787	692	710	2.8	0.5

S3	St Peters Rise	OUT	2523	1357	203	220	209	222	0.1	0.5
S4	Hengrove Way	OUT	1360	1359	884	900	892	906	0.2	0.3
S5	Hawkfield Rd	OUT	2519	1365	432	442	446	527	3.8	0.6
S6	Whitchurch Lane	OUT	7013	1376	692	760	689	729	1.1	0.1
S7	Bamfield	OUT	3644	2433	245	248	280	300	3.1	2.2
S8	Wells Rd	OUT	1430	1380	638	775	703	772	0.1	2.5
S9	Bath Rd	OUT	1490	4046	1058	1182	1585	1639	12.2	14.5
S10	School Road	OUT	2121	1307	543	596	389	390	9.3	7.1
S11	Allison Rd	OUT	2117	1307	278	295	313	328	1.9	2.0
R1	M5	IN	3213	3928	4471	4995	4424	4897	1.4	0.7
R3	A3029 Brunel Way (N)	IN	1165	1513	2575	2689	2757	2915	4.3	3.5
R4	A3029 Brunel Way (S)	IN	1513	1166	2912	3047	3126	3295	4.4	3.9
R5	Princes Street Bridge	IN	1436	1777	157	162	196	202	2.9	3.0
R6	Bedminster Bridge	IN	1477	1319	1258	1443	1303	1427	0.4	1.3
R7	Redcliffe Way	IN	2651	1203	324	475	325	395	3.8	0.1
R8	Bristol Bridge, Victoria Street	IN	1233	2547	620	736	701	810	2.6	3.2
R9	Passager Street	IN	1247	1594	323	361	364	372	0.6	2.2
R10	Temple Way	IN	1591	1593	1128	1292	1136	1227	1.8	0.3
R11	Bath Bridge	IN	1485	1210	2432	2825	2648	2857	0.6	4.3
R12	Avon Street	IN	1592	1286	575	605	564	589	0.7	0.5
R13	Albert Road	IN	1288	1301	361	382	433	447	3.2	3.6
R15	St Phillips Causeway	IN	1290	1302	1329	1405	1551	1618	5.5	5.8
R16	Marsh Lane	IN	2011	3631	260	278	221	224	3.4	2.5
R17	Nethan Road	IN	2013	1425	644	675	702	726	1.9	2.2
R18	Feeder Road	IN	1426	2599	791	847	839	868	0.7	1.7
R1	M5	OUT	3927	3204	3866	4319	3831	4665	5.2	0.6
R3	A3029 Brunel Way (N)	OUT	1525	1524	1944	2087	2277	2411	6.8	7.2
R4	A3029 Brunel Way (S)	OUT	1527	1526	2122	2266	2362	2497	4.8	5.1
R5	Princes Street Bridge	OUT	1777	1436	683	683	412	433	10.6	11.6
R6	Bedminster Bridge	OUT	1474	1318	1500	1744	1644	1821	1.8	3.6
R7	Redcliffe Way	OUT	1204	2651	329	435	269	342	4.7	3.5
R8	Bristol Bridge, Victoria Street	OUT	2547	1233	727	842	736	826	0.6	0.4
R9	Passage Street	OUT	1594	1247	372	416	353	354	3.2	1.0
R10	Temple Way	OUT	1593	1207	1187	1344	1670	1764	10.7	12.8
R11	Bath Bridge	OUT	1483	1484	1330	1617	1345	1537	2.0	0.4
R12	Avon Street	OUT	1286	1592	252	276	267	308	1.9	0.9
R13	Albert Road	OUT	1301	1288	287	305	216	230	4.6	4.5
R15	St Phillips Causeway	OUT	1302	1290	1117	1160	1136	1189	0.8	0.6
R16	Marsh Lane	OUT	3631	2011	268	270	291	302	1.9	1.4
R17	Nethan Road	OUT	1425	2013	1187	1216	731	778	13.9	14.7
R18	Feeder Road	OUT	2599	1426	761	800	774	793	0.2	0.5
RW1	A4176 Portway	IN	1052	1162	969	1073	1098	1139	2.0	4.0
RW5	Clifton Down	IN	1041	1161	708	733	659	679	2.0	1.9
RW22	Kingsland Road	IN	1733	1285	252	264	315	344	4.6	3.8
RW2	Avon Street	IN	1769	1592	253	258	305	314	3.3	3.1
RW26	B3021 St Johns Lane	IN	1181	1180	611	651	610	634	0.7	0.0
RW27	A38 Parsons Street	IN	1173	1579	1889	1987	2050	2219	5.1	3.6
RW28	A38 Bedminster Down Road	IN	1433	2746	1923	2049	2004	2106	1.2	1.8
RW30	Whitby Road	IN	2599	1302	271	276	301	305	1.7	1.8

RW34	A4174	IN	2937	3612	1861	2079	1834	1857	5.0	0.6
RW35	A4175 Keynsham Road	IN	1394	1393	569	590	600	624	1.4	1.3
RW36	Muller Road	IN	1058	2335	746	766	752	774	0.3	0.2
RW37	Lockleaze Road	IN	2327	1486	148	158	166	175	1.3	1.4
RW38	Bonnington Walk	IN	2315	2305	245	255	248	268	0.8	0.2
RW39	A4174 Station Road	IN	3693	3471	1573	1758	1593	1718	0.9	0.5
RW40	Gipsy Patch Lane	IN	3234	1945	710	793	717	738	2.0	0.3
RW41	A38 Gloucester Road	IN	3427	3307	1164	1417	1217	1281	3.7	1.5
RW42	M5	IN	3174	3181	4206	4699	4153	4547	2.2	0.8
RW1	A4176 Portway	OUT	1162	1052	1081	1216	1104	1164	1.5	0.7
RW5	Clifton Down	OUT	1161	1041	826	858	713	732	4.5	4.1
RW22	Kingsland Road	OUT	1285	1733	167	205	206	222	1.1	2.9
RW2	Avon Street	OUT	1592	1769	124	132	127	135	0.2	0.3
RW26	B3021 St Johns Lane	OUT	1180	1181	915	993	778	808	6.2	4.7
RW30	Whitby Road	OUT	1302	2599	307	325	131	139	12.2	11.9
RW35	A4175 Keynsham Road	OUT	1393	1394	606	622	608	639	0.7	0.1
RW36	Muller Road	OUT	2335	1058	579	639	601	640	0.1	0.9
RW37	Lockleaze Road	OUT	1486	2327	209	228	208	221	0.4	0.0
RW38	Bonnington Walk	OUT	2305	2315	183	203	148	175	2.0	2.7
RW39	A4174 Station Road	OUT	3471	3693	1371	1532	1483	1740	5.1	2.9
RW40	Gipsy Patch Lane	OUT	1945	3234	852	952	894	907	1.5	1.4
RW41	A38 Gloucester Road	OUT	3310	3313	513	581	533	574	0.3	0.9
M5 J19	Docks	IN	1619	3926	528	770	529	723	1.7	0.0
	Docks	OUT	7025	1619	87	330	161	205	7.6	6.6
	Gordano Services	IN	4336	7027	203	262	49	96	12.4	13.8
	Gordano Services	OUT	7027	4336	164	228	166	215	0.9	0.2
	A369 Martcombe Rd East	IN	3706	3705	770	780	956	984	6.9	6.3
	A369 Martcombe Rd East	OUT	3705	3706	857	869	846	870	0.1	0.4
	St George's Hill - Pill	IN	3705	7019	248	259	244	260	0.1	0.2
	St George's Hill - Pill	OUT	7019	3705	277	280	93	192	5.7	13.5
	Portbury High st	IN	7035	7036	487	491	533	538	2.1	2.0
	Portbury High st	OUT	7036	7035	300	300	300	336	2.1	0.0
	The Portbury Hundred	IN	3789	3703	1013	1028	1016	1121	2.8	0.1
	The Portbury Hundred	OUT	3703	3789	1480	1503	1590	1646	3.6	2.8
Temple Circus roundabout	A4044 Temple Way (N)	IN	1610	1206	1134	1297	1061	1151	4.2	2.2
	Friary (E)	IN	1565	1508	165	180	89	110	5.8	6.8
	Redcliffe Way (S)	IN	1510	1506	1567	1924	1565	1834	2.1	0.1
	Victoria Street (NW)	IN	1562	1205	477	586	797	900	11.5	12.7
	A4044 Temple Way (N)	OUT	1205	1563	1230	1449	1455	1548	2.6	6.1
	Friary (E)	OUT	1206	1564	49	64	25	32	4.6	4.0
	A4 Temple Gate (SE)	OUT	1508	1507	1839	2174	1899	2192	0.4	1.4
	Victoria Street (NW)	OUT	1506	1561	225	300	133	222	4.8	6.9
	A4 Temple Gate (E)	IN	2647	2556	1208	1525	1060	1305	5.9	4.4
	Redcliff Mead Lane (S)	IN	2740	2556	129	129	74	85	4.3	5.4
	Redcliffe Way (W)	IN	1717	1605	582	682	776	789	3.9	7.4
	Redcliffe Way (W)	OUT	1604	1606	277	343	211	247	5.5	4.3
Bath Bridge	A4 Temple Gate (N)	IN	1480	1485	1785	2010	1639	1866	3.3	3.5
	Cattle market Road (NE)	IN	1574	1485	325	338	339	373	1.9	0.8
	A4 Bath Road (SE)	IN	1572	1190	1046	1235	917	1049	5.5	4.1
	A370 York Road (SW)	IN	1570	1483	413	436	394	431	0.2	0.9
	Clarence Road (W)	IN	1573	1484	565	633	597	620	0.5	1.3

	A4 Temple Gate (N)	OUT	1484	1480	977	1167	858	1009	4.8	3.9
	Cattle market Road (NE)	OUT	1485	1574	304	334	77	151	11.8	16.4
	A4 Bath Road (SE)	OUT	1210	1571	1462	1686	1606	1749	1.5	3.7
	A370 York Road (SW)	OUT	1190	1570	1015	1080	1008	1051	0.9	0.2
	Clarence Road (W)	OUT	1484	1573	376	385	309	349	1.8	3.6
Bedminster Bridge roundabout	Redcliff Hill (N)	IN	1479	1476	585	694	691	786	3.4	4.2
	Clarence Road (NE)	IN	1554	1477	379	403	319	347	2.9	3.2
	A370 York Road (SE)	IN	1555	1478	780	818	512	576	9.2	10.6
	Bedminster Parade (S)	IN	1557	1192	532	625	524	619	0.2	0.4
	A370 Coronation Road (SW)	IN	1558	1474	641	700	902	936	8.2	9.4
	Commerical Road (NW)	IN	1559	1475	736	770	702	722	1.8	1.3
	Redcliff Hill (N)	OUT	1475	1552	668	789	1244	1325	16.5	18.6
	Clarence Road (NE)	OUT	1476	1554	682	738	538	564	6.8	5.8
	A370 York Road (SE)	OUT	1319	1555	432	440	386	388	2.5	2.3
	Bedminster Parade (S)	OUT	1478	1556	445	560	432	493	2.9	0.6
	A370 Coronation Road (SW)	OUT	1553	1558	1041	1088	779	854	7.5	8.7
	Commerical Road (NW)	OUT	1560	1559	385	396	269	357	2.0	6.4
Redcliffe Way roundabout	Redcliff Street (N)	IN	2546	1204	280	290	273	294	0.2	0.4
	Redcliffe Way (E)	IN	2550	1204	263	326	232	269	3.3	2.0
	Redcliff Hill (S)	IN	1552	1204	772	903	1244	1324	12.6	14.9
	Redcliff Street (N)	OUT	1204	2546	299	320	361	366	2.5	3.4
	Redcliffe Way (E)	OUT	1204	2550	551	656	962	1026	12.8	14.9
	Redcliff Hill (S)	OUT	1204	4021	460	583	585	682	3.9	5.5
Jacob Wells Road roundabout	Jacobs Wells Road (N)	IN	1198	9994	488	510	715	754	9.7	9.3
	St Georges Street (NE)	IN	9997	9995	192	195	110	112	6.6	6.7
	A4 Anchor Road €	IN	9998	9996	711	850	873	892	1.4	5.8
	A4 Hotwells Road (W)	IN	1618	9993	738	854	666	736	4.2	2.7
	Jacobs Wells Road (N)	OUT	1198	2559	395	421	375	381	2.0	1.0
	St Georges Street (NE)	OUT	9997	2671	226	229	175	175	3.7	3.6
	A4 Anchor Road €	OUT	9998	9999	320	419	383	385	1.7	3.4
	A4 Hotwells Road (W)	OUT	1618	1707	1188	1339	1429	1549	5.5	6.7
The Triangle	A4018 Queens Road (N)	IN	1817	1488	606	759	863	953	6.6	9.5
	Triangle (W) circulatory		1229	4053	1442	1546	1049	1145	10.9	11.1
	A4018 Queens Road (N)	OUT	4053	4054	1144	1226	792	887	10.4	11.3
	Triangle (W) circulatory		4053	1488	298	353	257	257	5.5	2.4
	University Road	OUT	2708	4060	54	54	19	19	5.8	5.8
	Park Row (E)	IN	2710	1228	1140	1210	815	925	8.7	10.4
	Park Row (E)	OUT	2709	2708	649	854	733	808	1.6	3.2
	Triangle (E) circulatory		2709	1228	209	265	387	403	7.6	10.3
	Park Row (E)	OUT	2708	2710	595	778	714	789	0.4	4.6
	Berkeley Place (S)	IN	2673	1229	505	557	460	466	4.0	2.1
Lawrence Hill Rbt	Berkeley Place (S)	OUT	1229	2673	559	582	837	875	10.9	10.5
	A4320 Easton Way (N)	IN	1611	1244	1490	1581	1962	2011	10.1	11.4
	Lawrence Hill (E)	IN	4036	1245	645	711	1002	1084	12.4	12.4
	A4320 St Phillips Causeway (S)	IN	1284	1246	920	1003	1318	1359	10.4	11.9
	Lawrence Hill (W)	IN	1249	1248	749	832	906	970	4.6	5.4
	A4320 Easton Way (N)	OUT	1248	1620	1174	1230	1365	1392	4.5	5.4
	Lawrence Hill (E)	OUT	1244	4092	805	920	1279	1364	13.1	14.7

	A4320 St Phillips Causeway (S)	OUT	1245	1284	1255	1346	1986	2060	17.3	18.2
	Lawrence Hill (W)	OUT	1246	1249	570	631	980	1029	13.8	14.7
M32 Junction 3	M32 (North)	IN	3597	3973	1735	1862	1531	1595	6.4	5.0
	A4320 (E)	IN	2571	3974	1994	2078	1233	1271	19.7	18.9
	M32 (South)	IN	3977	3978	467	472	270	276	10.2	10.2
	B4051 (W)	IN	3578	3979	751	769	808	819	1.8	2.0
	M32 (North)	OUT	3979	3986	1810	1891	1019	1082	21.0	21.0
	A4320 (E)	OUT	3973	3577	1940	2067	1767	1814	5.8	4.0
	M32 (South)	OUT	3974	3975	167	170	49	52	11.2	11.3
	B4051 (W)	OUT	3978	3578	1030	1053	1025	1032	0.6	0.2
M32 / Cabot circus	A4032 Newfoundland Way	IN	3982	1471	1548	1661	1671	1758	2.4	3.1
	Houlton Street	IN	9972	1471	116	122	97	107	1.4	1.8
	Car Park	IN	2628	9974	81	81	72	72	1.1	1.1
	A4044 Temple Way	IN	9985	9967	1838	2242	2030	2203	0.8	4.4
	A4044 Newfoundland Street	IN	9970	1209	2321	2517	2275	2332	3.7	1.0
	A4032 Newfoundland Way	OUT	1221	9981	2957	3181	2751	2783	7.3	3.9
	Houlton Street	OUT	1471	9972	441	461	221	225	12.7	12.1
	Car Park	OUT	9974	2628	223	223	201	201	1.5	1.5
	A4044 Temple Way	OUT	9967	9985	564	647	1370	1454	24.9	25.9
	A4044 Newfoundland Street	OUT	1209	9970	1625	2016	1527	1730	6.6	2.5
	St Paul Street	OUT	1209	9975	94	94	76	77	1.9	2.0
Hambrook	Bristol Rd (N) to A4174 (W)	N to W	3487	3560	284	317	311	323	0.3	1.6
	Bristol Rd (N) to (S)	N to S	3487	3560	113	144	201	206	4.6	7.0
	Bristol Rd (N) to A4174 (E)	N to E	3487	3560	308	344	268	273	4.1	2.4
	A4174 (W) to Bristol Rd (N)	W to N	3499	3560	712	795	605	629	6.2	4.1
	A4174 (W) to Bristol Rd (S)	W to S	3499	3560	240	268	159	169	6.7	5.7
	A4174 (W) to (E)	W to E	3499	3560	2254	2518	2477	2540	0.4	4.6
	Bristol Rd (S) to (N)	S to N	3473	3560	217	242	221	231	0.7	0.3
	Bristol Rd (S) to A4174 (W)	S to W	3473	3560	321	359	230	244	6.6	5.5
	Bristol Rd (S) to A4174 (E)	S to E	3473	3560	135	151	79	104	4.2	5.4
	A4174 (E) to Bristol Rd (N)	E to N	9960	3560	382	426	216	217	11.7	9.6
	A4174 (E) to (W)	E to W	9960	3560	1290	1441	1342	1403	1.0	1.4
	A4174 (E) to Bristol Rd (S)	E to S	9960	3473	118	132	117	132	0.0	0.1
M32 J1	M32 (N) to A4174 (E)	N to E	3900	3952	1256	1415	1291	1317	2.6	1.0
	M32 (N) to A4174 (W)	N to W	3952	3953	226	234	195	220	1.0	2.2
	A4174 (E) to M32 (S)	E to S	3561	3953	581	607	610	632	1.0	1.2
	A4174 (E) to M32 (N)	E to N	3953	3957	682	802	837	862	2.1	5.6
	A4174 (E) to (W)	E to W	3561	3953	365	375	415	478	5.0	2.5
	M32 (S) to A4174 (W)	S to W	9916	3957	304	335	197	202	8.1	6.7
	M32 (S) to A4174 (E)	S to E	3957	3958	889	936	971	999	2.0	2.7
	A4174 (W) to M32 (N)	W to N	3562	3958	947	966	812	977	0.4	4.6
	A4174 (W) to (E)	W to E	3562	3958	745	763	952	1001	8.0	7.1
	A4174 (W) to M32 (S)	W to S	3958	3952	469	496	419	425	3.3	2.4

TABLE E6

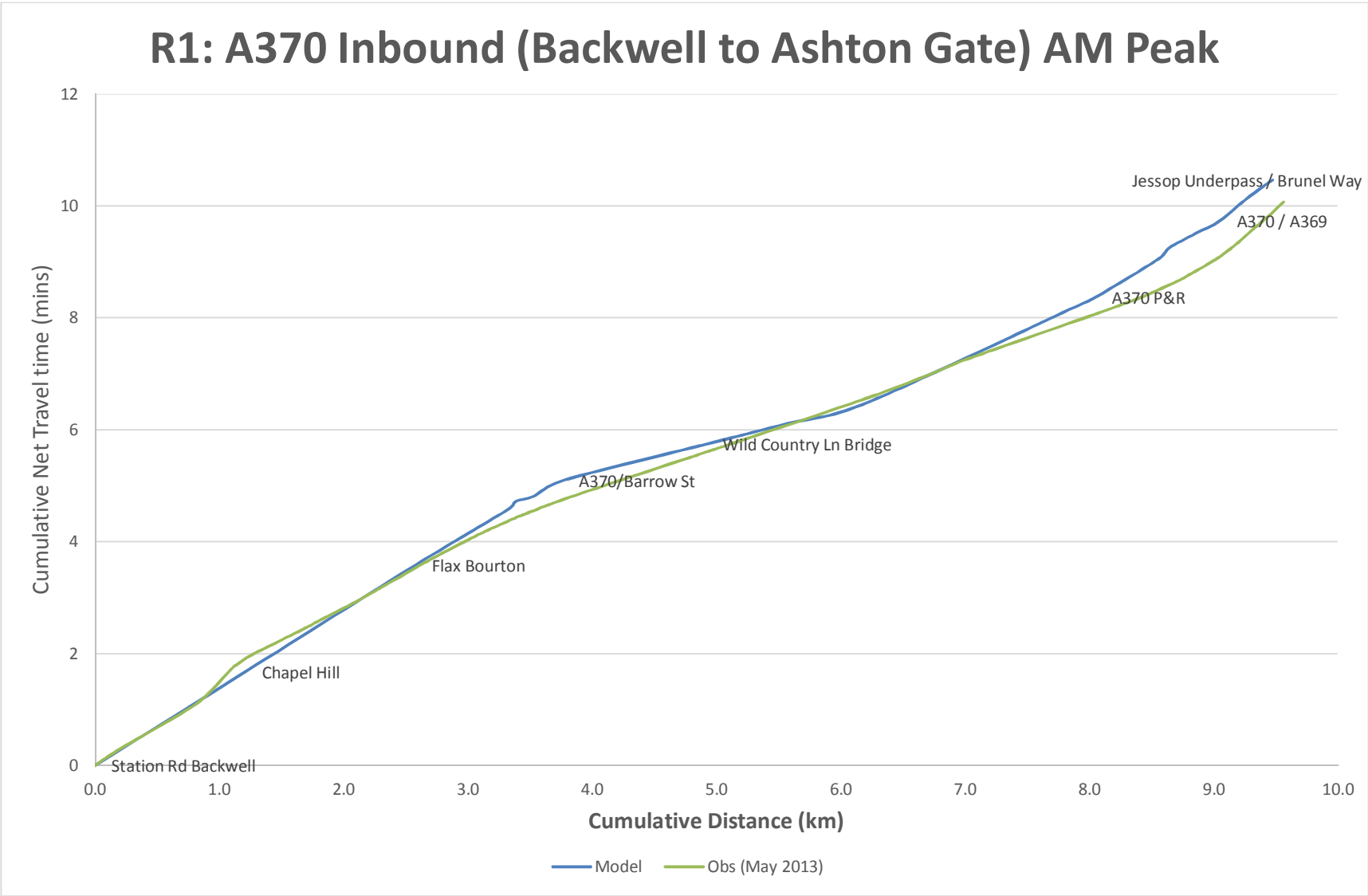
Evening Peak Traffic Flow Validation Comparison

Ref No.	Road	Dir	A node	B node	Obs LV	Obs Total PCUs	Model LV	Model Total PCUs	GEH PCUs	GEH LVs
O1	A38 Bridgewater Road	IN	7147	3635	820	916	793	820	3.2	0.9
O2	A370 Long Ashton Bypass	IN	2703	1355	641	700	597	617	3.2	1.8
O3	B3128 Ashton Road	IN	1148	1149	413	491	401	427	3.0	0.6
O4	A369 Clanage Road	IN	1158	2471	534	572	628	663	3.7	3.9
O5	B3129 Clifton Suspension Bridge	IN	1159	1160	417	435	410	410	1.2	0.4
O6	A4 Portway	IN	3348	3591	754	1089	932	1052	1.1	6.1
O7	B4054 Shirehampton Road	IN	2223	3340	403	427	325	399	1.4	4.1
O8	Kings Weston Lane	IN	3389	3342	434	439	344	362	3.9	4.5
O9	Hallen Road	IN	3362	3363	307	310	269	276	2.0	2.2
O10	A4018 Cribbs Causeway	IN	3197	3324	887	926	929	933	0.2	1.4
O11	Merlin Road	IN	3193	3198	847	943	1073	1141	6.1	7.3
O12	Highwood Lane	IN	3191	3195	506	566	552	587	0.9	2.0
O13	A38 Gloucester Rd	IN	3162	3410	1512	1600	1747	1794	4.7	5.8
O14	B4427 Old Gloucester Road	IN	3030	3526	144	161	160	164	0.3	1.3
O15	B4057 Beacon Lane	IN	3037	3528	670	748	644	672	2.9	1.0
O16	M32	IN	3907	3951	3240	3926	3593	3823	1.7	6.0
O17	B4058 Bristol Road	IN	2371	3550	441	476	375	390	4.1	3.3
O18	A432 Badminton Road	IN	4236	3047	648	691	754	797	3.9	4.0
O19	Westerleigh Road	IN	4237	3685	740	818	630	710	3.9	4.2
O20	Shortwood Road	IN	1125	3055	530	592	506	575	0.7	1.1
O21	A420 London Rd	IN	3761	3760	862	900	798	932	1.1	2.2
O22	A431 Bath Road	IN	3798	3772	772	863	723	801	2.2	1.8
O23	A4 Bath Road	IN	1408	1407	1003	1086	1137	1159	2.2	4.1
O24	B3116 Wellsway	IN	3767	1404	545	609	456	551	2.4	3.9
O25	A37 Bristol Road	IN	3645	8052	687	767	638	700	2.5	1.9
O26	Queens Rd	IN	3636	7115	180	188	176	191	0.2	0.3
O1	A38 Bridgewater Road	OUT	3635	7147	977	1091	1106	1133	1.2	4.0
O2	A370 Long Ashton Bypass	OUT	1355	2703	1295	1388	1535	1615	5.9	6.4
O3	B3128 Ashton Road	OUT	1149	1148	919	1003	1108	1150	4.5	5.9
O4	A369 Clanage Road	OUT	2471	1158	560	588	623	651	2.5	2.6
O5	B3129 Clifton Suspension Bridge	OUT	1160	1159	642	670	721	721	1.9	3.0
O6	A4 Portway	OUT	3591	3348	886	1060	972	1022	1.2	2.8
O7	B4054 Shirehampton Road	OUT	3340	2223	359	375	309	334	2.1	2.8
O8	Kings Weston Lane	OUT	3342	3389	105	107	84	98	0.8	2.1
O9	Hallen Road	OUT	3363	3362	112	116	82	94	2.1	3.0
O10	A4018 Cribbs Causeway	OUT	3324	3197	1297	1354	1239	1261	2.6	1.6
O11	Merlin Road	OUT	3198	3193	1174	1312	1105	1155	4.5	2.1
O12	Highwood Lane	OUT	3195	3193	512	572	545	580	0.3	1.4
O13	A38 Gloucester Rd	OUT	3410	3162	2038	2276	2204	2299	0.5	3.6
O14	B4427 Old Gloucester Road	OUT	3526	3030	660	738	637	656	3.1	0.9
O15	B4057 Beacon Lane	OUT	3528	3037	888	993	1009	1043	1.6	3.9
O16	M32	OUT	3960	3908	3522	4319	3602	3963	5.5	1.3
O17	B4058 Bristol Road	OUT	3550	2371	490	534	356	373	7.5	6.5
O18	A432 Badminton Road	OUT	3047	4236	919	981	1058	1084	3.2	4.4
O19	Westerleigh Road	OUT	3685	4237	829	926	740	824	3.4	3.2
O20	Shortwood Road	OUT	3055	1125	415	463	465	481	0.8	2.4

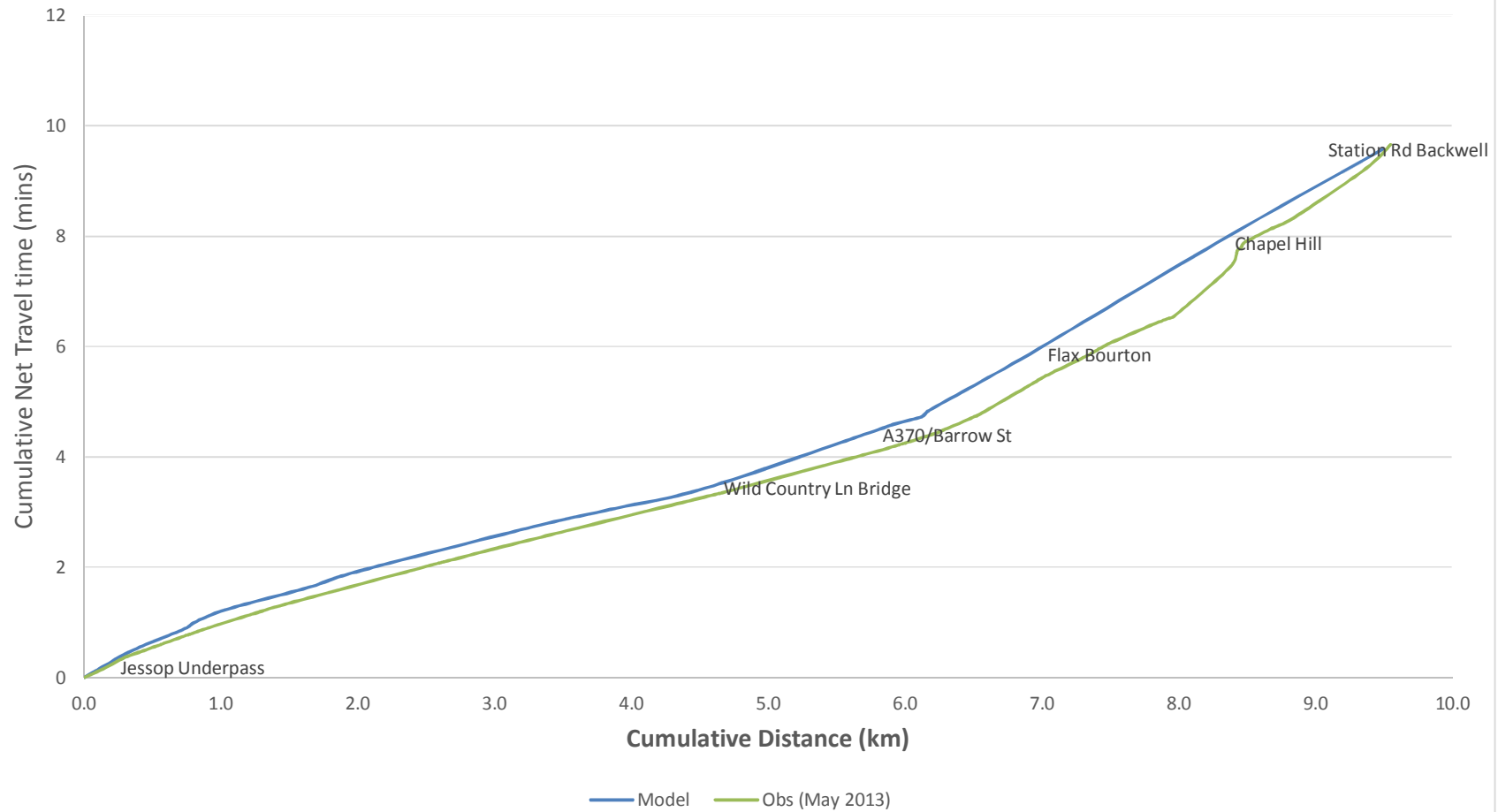
O21	A420 London Rd	OUT	3760	3761	614	656	483	540	4.8	5.6
O22	A431 Bath Road	OUT	3772	3798	306	342	357	385	2.3	2.8
O23	A4 Bath Road	OUT	1407	1408	1138	1186	1049	1074	3.3	2.7
O24	B3116 Wellsway	OUT	1404	3767	762	782	702	725	2.1	2.2
O25	A37 Bristol Road	OUT	8052	3645	616	688	662	721	1.3	1.8
O26	Queens Rd	OUT	7115	3636	305	309	296	297	0.7	0.6
M2	A4176 Portway	IN	1162	1582	1542	1659	1551	1593	1.6	0.2
M4	College Road	IN	1801	1160	470	515	512	530	0.7	1.9
M5	Pembroke Road	IN	1041	1803	183	200	177	189	0.8	0.4
M7	Whiteladies Road	IN	1809	1238	692	790	689	769	0.8	0.1
M8	Hampton Road	IN	1015	1881	235	235	245	246	0.7	0.7
M9	Redland Grove	IN	1659	1853	268	283	211	241	2.6	3.7
M10	Redland Road	IN	1034	1855	180	182	236	236	3.7	3.9
M11	A38 Cheltenham Road	IN	1030	1031	504	671	524	599	2.9	0.9
M12	North Road	IN	1146	1031	283	292	218	233	3.6	4.1
RW14	Ashley Hill	IN	1036	1917	572	572	581	585	0.5	0.4
MM12	Glenfrome Road	IN	1107	1919	506	565	429	446	5.3	3.6
M13	M32	IN	3971	3972	3048	3193	2763	2896	5.4	5.3
M14	Stapleton Road	IN	1437	1440	457	577	573	618	1.7	5.1
M15	Easton Road	IN	2005	1995	267	276	270	275	0.0	0.1
M16	A420 Lawrence Hill	IN	1251	1466	801	850	798	855	0.2	0.1
M17	Ducie Road	IN	1763	1250	86	98	139	151	4.7	5.0
M18	Barrow Road	IN	1283	1747	663	684	756	826	5.2	3.5
M19	A4320 St Phillips Causeway	IN	1290	1549	1111	1334	1323	1393	1.6	6.1
M20	Feeder Road	IN	1751	1741	404	423	484	499	3.5	3.8
M21	Albert Road	IN	1290	1755	444	513	392	456	2.6	2.5
M22	Bath Road	IN	2087	4038	575	663	581	649	0.5	0.2
M23	Wells Road	IN	2131	2085	455	534	427	481	2.4	1.4
MM23	Redcatch Road	IN	1185	2125	351	373	411	417	2.2	3.1
M24	Wedmore Vale	IN	2213	2159	236	243	184	201	2.8	3.6
M25	Novers Hill	IN	2469	2211	172	176	134	135	3.2	3.1
M26	A4174 Hartcliffe Way	IN	2728	1361	824	904	949	1018	3.7	4.2
M27	A38 Bedminster Down Road	IN	1183	1433	1222	1332	1101	1147	5.3	3.6
M28	South Liberty Lane	IN	7166	3607	153	167	185	230	4.5	2.4
M29	Ashton Drive	IN	10005	4082	219	285	261	274	0.6	2.7
M30	A370 Ashton Road	IN	1153	1154	1065	1189	1057	1116	2.2	0.2
M2	A4176 Portway	OUT	1582	1162	1560	1713	1508	1592	3.0	1.3
M4	College Road	OUT	1160	1801	159	159	143	166	0.6	1.2
M5	Pembroke Road	OUT	1803	1041	251	265	232	244	1.3	1.2
M7	Whiteladies Road	OUT	1238	1809	759	834	721	803	1.1	1.4
M8	Hampton Road	OUT	1881	1015	554	557	543	555	0.1	0.5
M9	Redland Grove	OUT	1853	1659	464	473	448	477	0.2	0.8
M10	Redland Road	OUT	1855	1034	137	140	199	199	4.5	4.8
M11	A38 Cheltenham Road	OUT	1031	1030	515	635	607	686	2.0	3.9
M12	North Road	OUT	1031	1146	37	49	28	39	1.4	1.7
RW14	Ashley Hill	OUT	1917	1036	836	839	946	947	3.6	3.7
MM12	Glenfrome Road	OUT	1919	1107	382	427	345	363	3.2	1.9
M13	M32	OUT	3981	3965	3882	4088	3462	3552	8.7	6.9
M14	Stapleton Road	OUT	1440	1437	548	602	502	558	1.8	2.0
M15	Easton Road	OUT	1995	2005	403	412	411	432	1.0	0.4
M16	A420 Lawrence Hill	OUT	1466	1251	924	1078	1170	1235	4.6	7.6

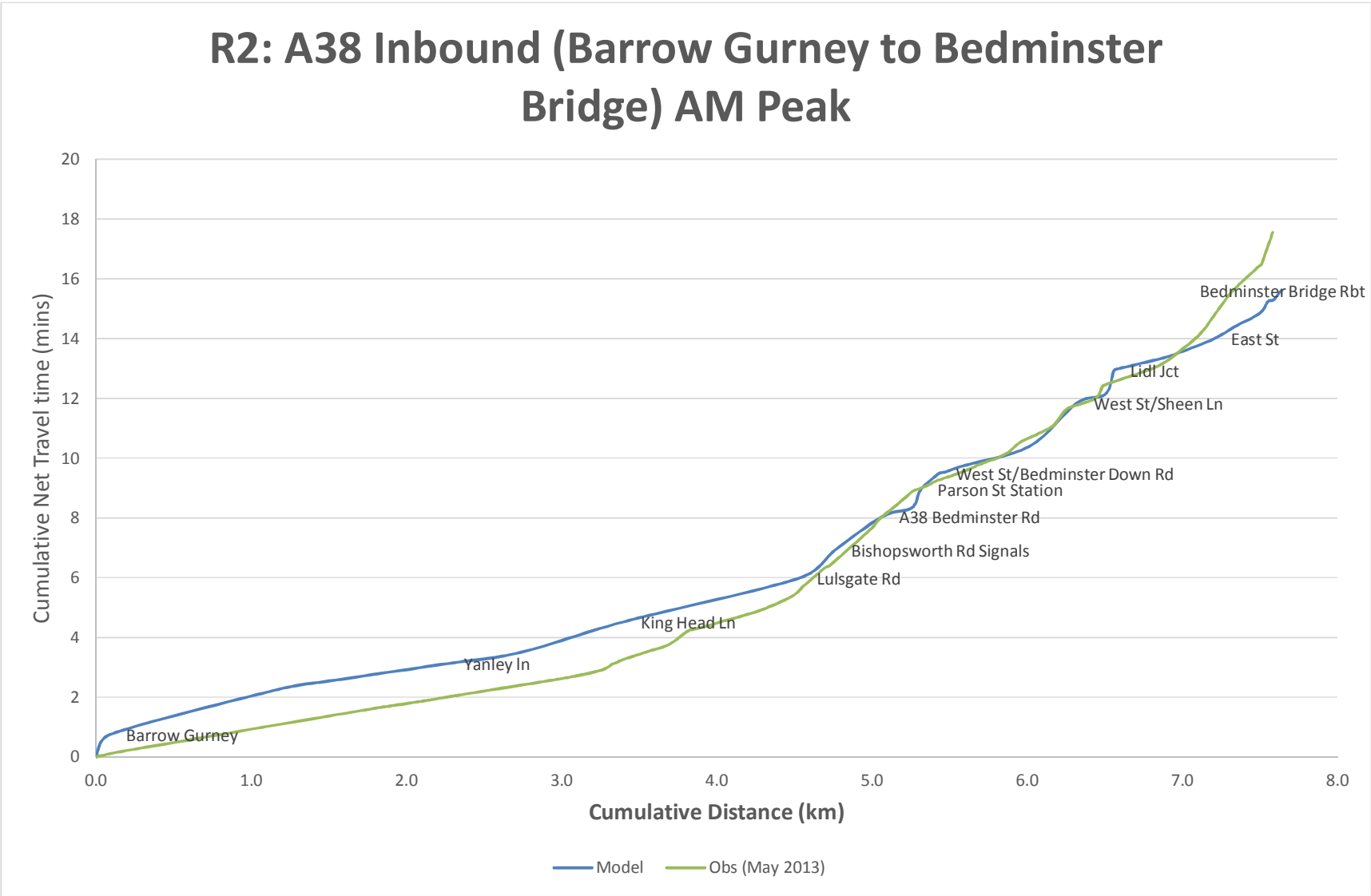
M17	Ducie Road	OUT	1250	1763	19	43	29	41	0.2	2.0
M18	Barrow Road	OUT	1747	1283	210	235	189	218	1.1	1.5
M19	A4320 St Phillips Causeway	OUT	1549	1290	1011	1394	1676	1744	8.8	18.1
M20	Feeder Road	OUT	1741	1751	775	801	625	706	3.4	5.7
M21	Albert Road	OUT	1755	1290	418	440	444	482	1.9	1.3
M22	Bath Road	OUT	4038	2087	654	826	829	884	2.0	6.4
M23	Wells Road	OUT	2085	2131	828	909	856	922	0.4	1.0
MM23	Redcatch Road	OUT	2125	1185	614	641	532	561	3.3	3.4
M24	Wedmore Vale	OUT	2159	2213	313	346	282	317	1.6	1.8
M25	Novers Hill	OUT	2211	2469	374	374	321	366	0.4	2.8
M26	A4174 Hartcliffe Way	OUT	1361	2728	970	1190	1271	1338	4.2	9.0
M27	A38 Bedminster Down Road	OUT	1433	1183	855	1014	1259	1299	8.4	12.4
M28	South Liberty Lane	OUT	3607	7166	95	120	97	101	1.7	0.2
M29	Ashton Drive	OUT	4082	10005	237	249	127	147	7.2	8.2
M30	A370 Ashton Road	OUT	1530	1531	1960	2272	2161	2297	0.5	4.4
NWO1	M5	IN	3192	3201	4206	5104	4323	4708	5.6	1.8
NWO2	A4018 Cribbs Causeway	IN	4351	3347	1347	1505	1318	1373	3.5	0.8
NWO4	Gloucester Rd North	IN	3496	1651	1184	1365	1562	1623	6.7	10.2
NWO5	Great Stoke Way	IN	3488	4386	778	869	719	775	3.3	2.1
NWO6	M32	IN	3951	3954	1936	2379	2107	2286	1.9	3.8
NWO7	Bristol Rd	IN	3487	3560	726	860	779	801	2.1	1.9
NWO1	M5	OUT	3216	3183	3627	4458	3885	4564	1.6	4.2
NWO2	A4018 Cribbs Causeway	OUT	3347	4351	1427	1625	1636	1708	2.0	5.4
NWO4	Gloucester Rd North	OUT	1651	3496	1419	1585	1546	1640	1.4	3.3
NWO5	Great Stoke Way	OUT	4386	3488	686	766	770	810	1.6	3.1
NWO6	M32	OUT	3956	3959	2119	2211	1952	2123	1.9	3.7
NWO7	Bristol Rd	OUT	3560	3487	971	1022	1042	1076	1.7	2.2
NE1	Frenchay park Rd	IN	2355	1094	853	935	922	961	0.8	2.3
NE2	Blackberry Hill	IN	1094	2393	576	661	643	674	0.5	2.7
NE3	Fishponds Road	IN	1985	1062	743	808	676	751	2.1	2.5
NE4	Berkley Rd	IN	1077	2025	391	437	358	366	3.5	1.7
NE5	Charlton Road	IN	2027	1098	423	436	383	391	2.2	2.0
NE6	Lodge Rd	IN	1097	1080	339	368	252	273	5.3	5.1
NE7	Downend Rd	IN	1612	2724	314	324	361	377	2.8	2.5
NE8	Syston Way	IN	1541	2031	363	375	358	384	0.5	0.2
NE9	Lees Hill	IN	2490	2409	193	204	133	142	4.7	4.7
NE10	Pound Rd	IN	2405	1685	214	218	219	226	0.6	0.4
NE12	Station Rd	IN	1089	1087	455	508	521	546	1.6	3.0
NE1	Frenchay park Rd	OUT	1094	2355	491	519	481	536	0.7	0.5
NE2	Blackberry Hill	OUT	2393	1094	572	593	611	656	2.5	1.6
NE3	Fishponds Road	OUT	1062	1985	800	877	795	856	0.7	0.2
NE4	Berkley Rd	OUT	2025	1077	554	593	420	445	6.5	6.1
NE5	Charlton Road	OUT	1098	2027	401	417	308	348	3.5	4.9
NE6	Lodge Rd	OUT	1080	1097	263	269	316	350	4.6	3.2
NE7	Downend Rd	OUT	2724	1612	239	246	179	191	3.7	4.1
NE8	Syston Way	OUT	2031	1541	420	444	490	512	3.1	3.2
NE9	Lees Hill	OUT	2409	2490	229	239	225	229	0.6	0.3
NE10	Pound Rd	OUT	1685	2405	221	228	91	167	4.3	10.5
NE12	Station Rd	OUT	1087	1089	444	496	481	502	0.2	1.7

Appendix F: Distance-Travel Time Graphs

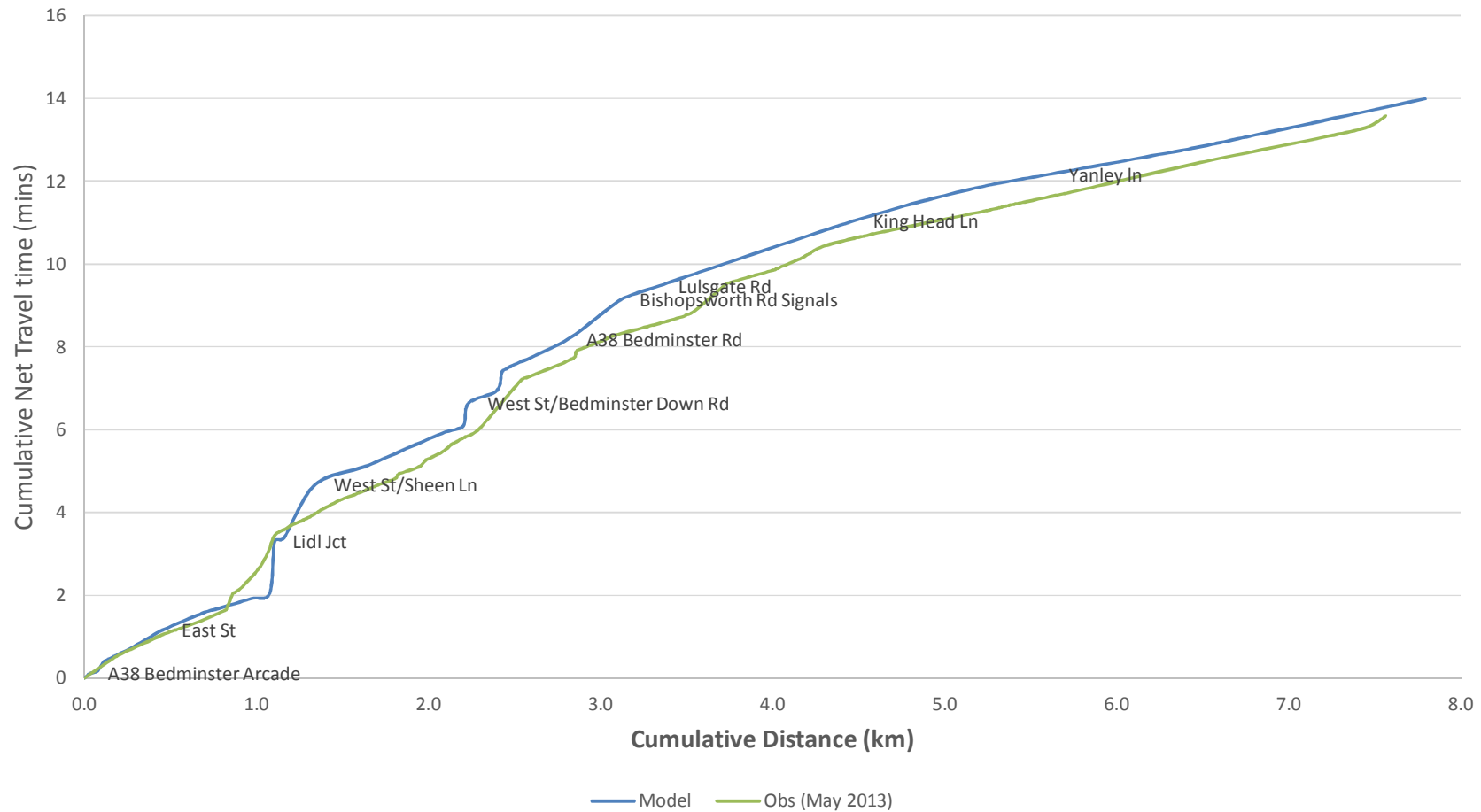


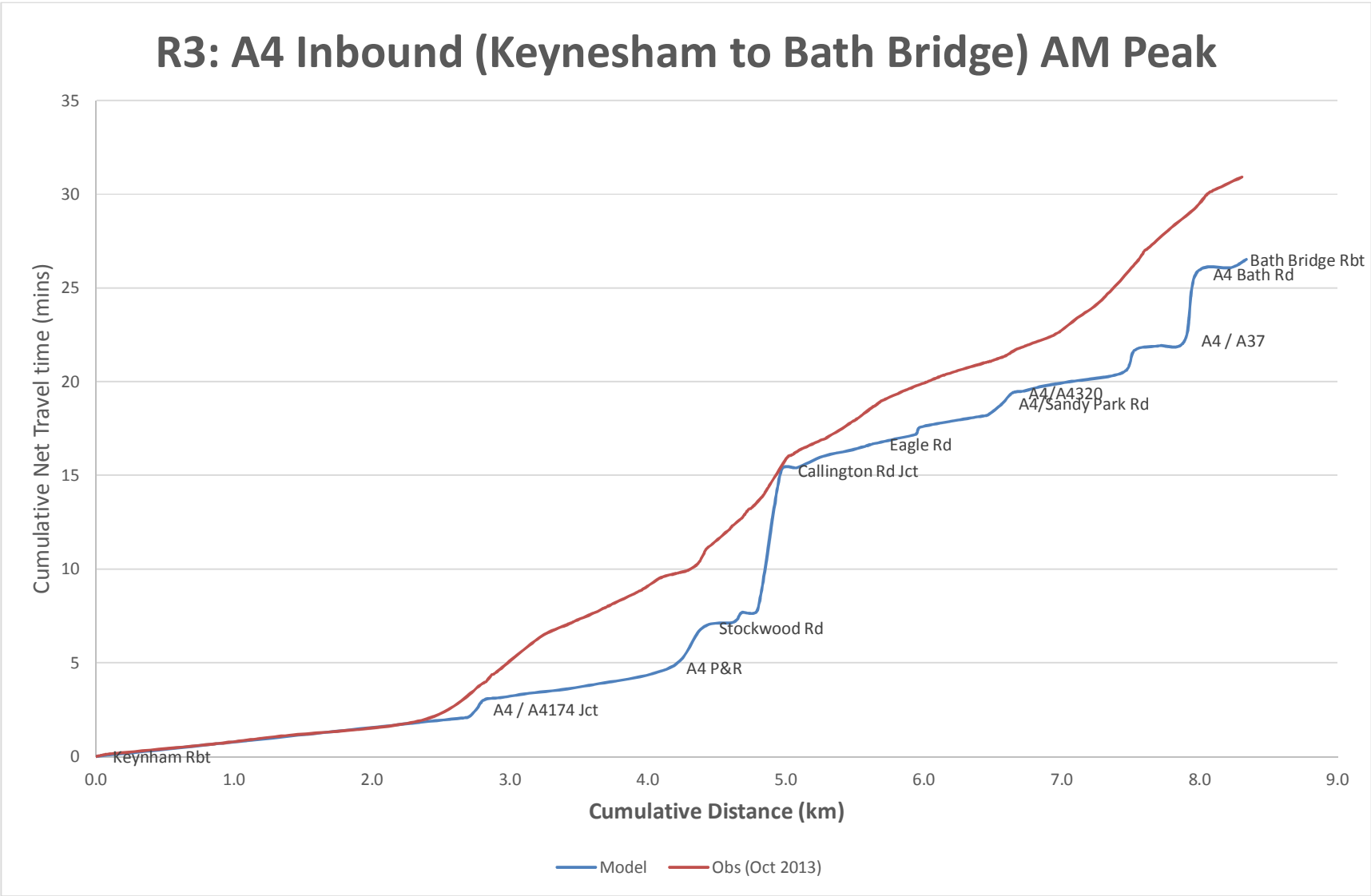
R1: A370 Outbound (Ashton Gate to Backwell) AM Peak



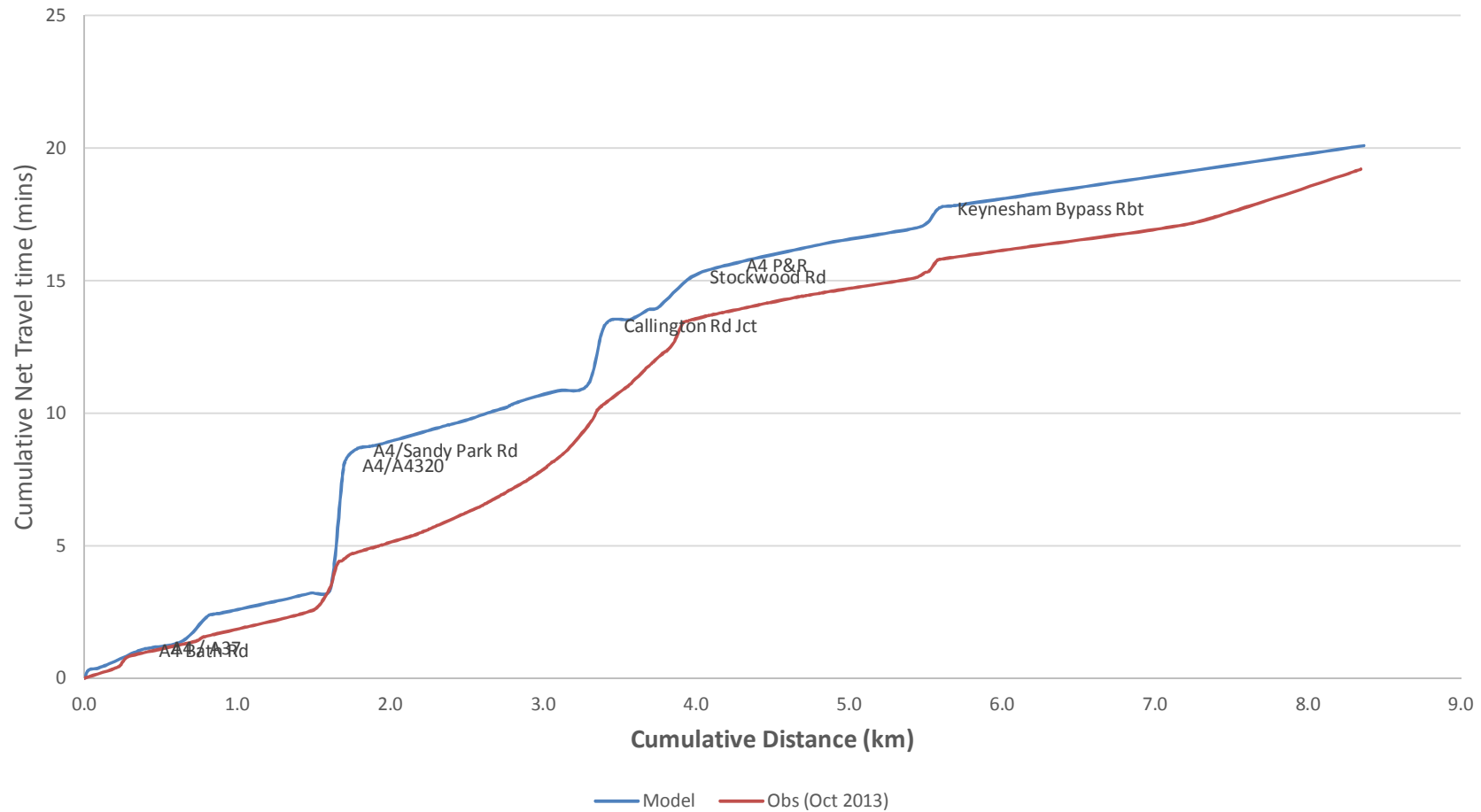


R2: A38 Outbound (Bedminster Bridge to Barrow Gurney) AM Peak

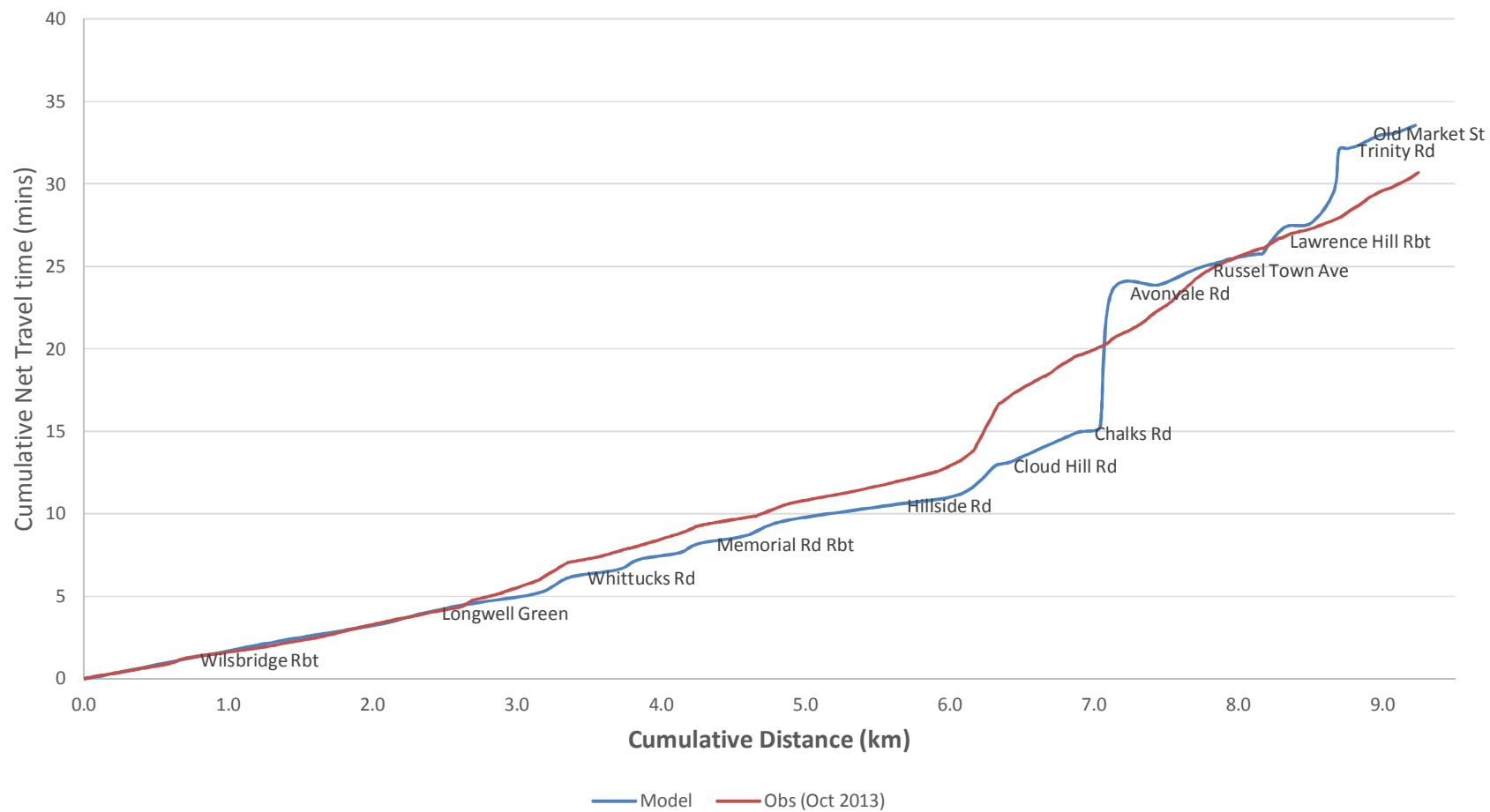




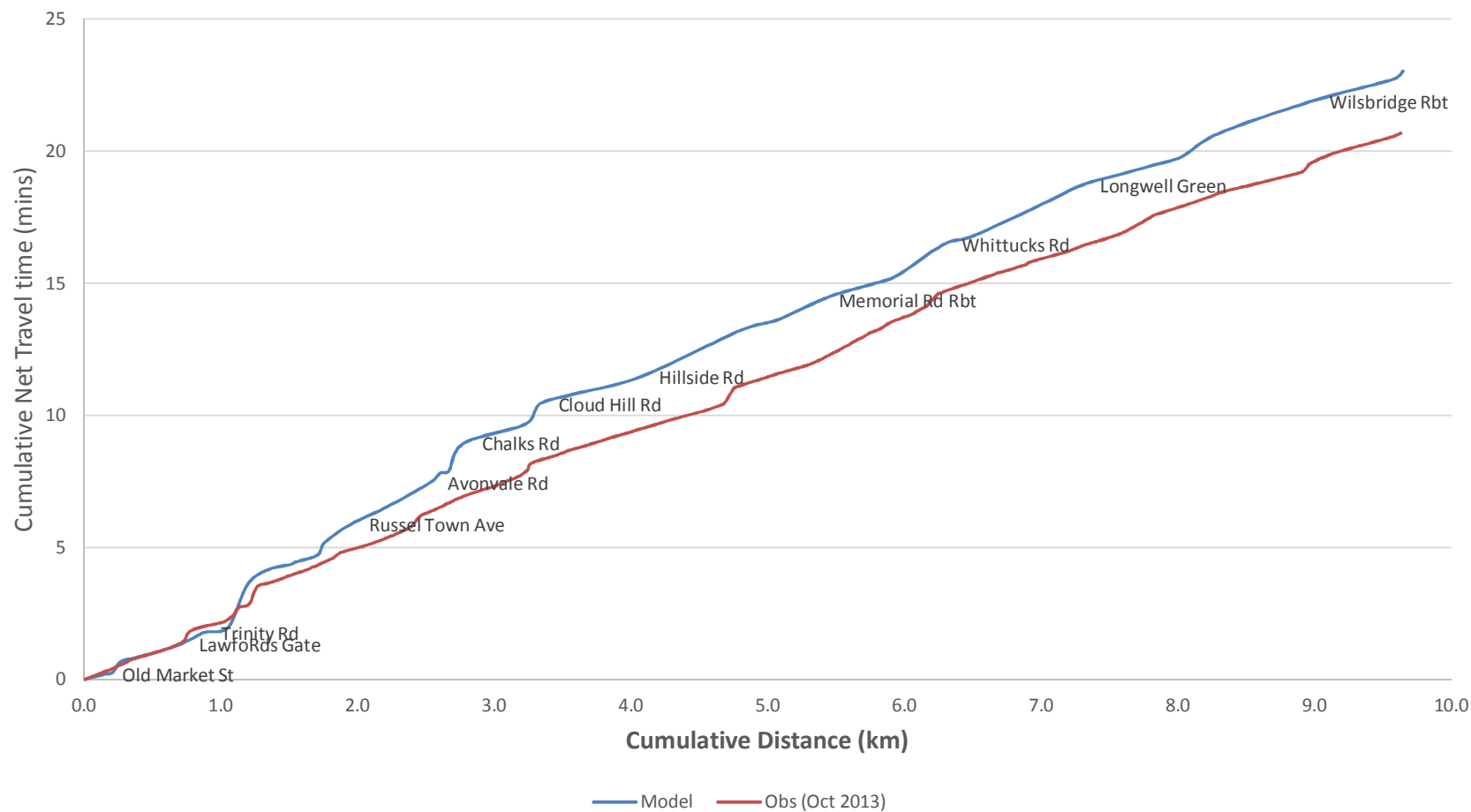
R3: A4 Outbound (Bath Bridge to Keynesham) AM Peak



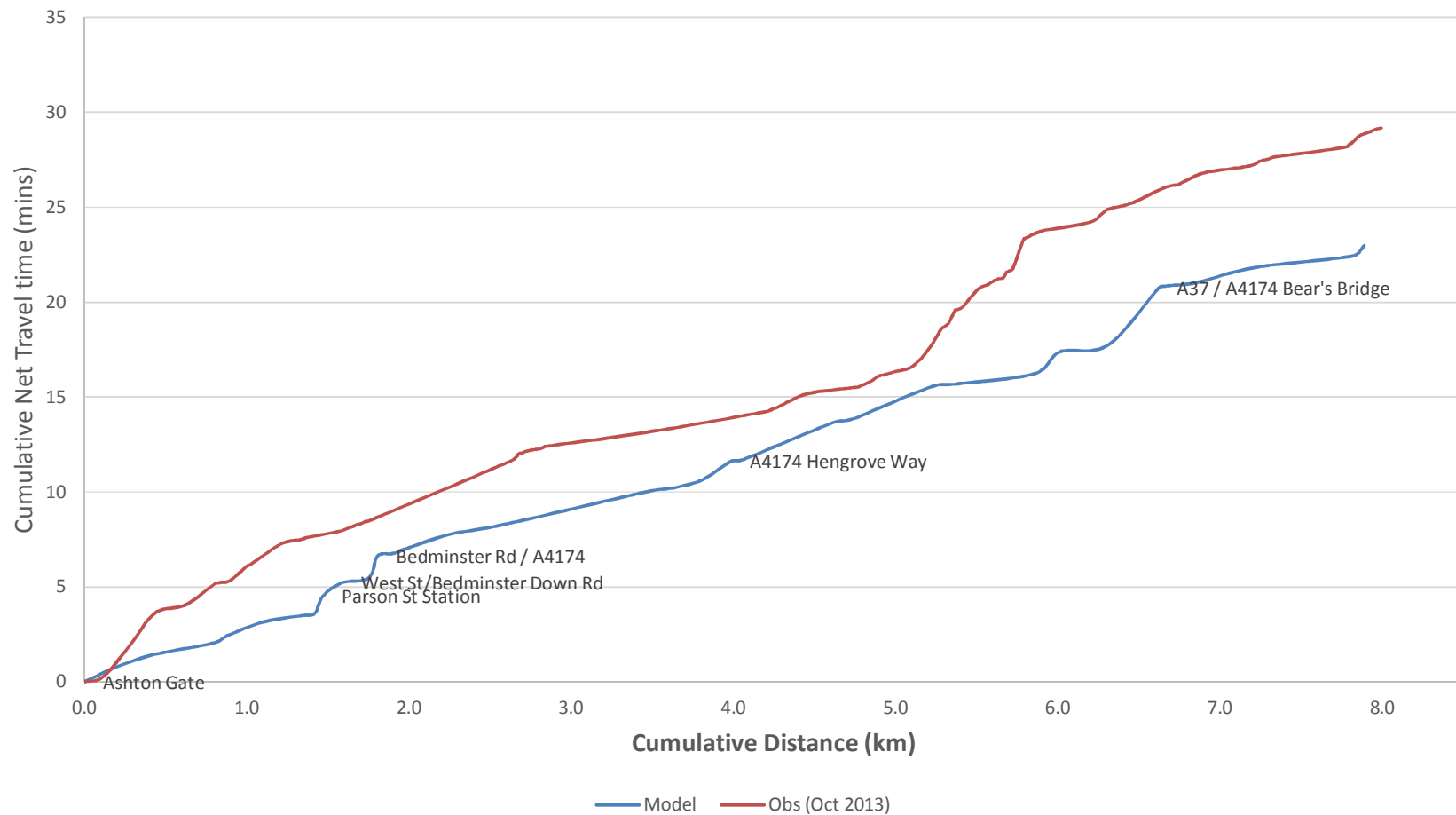
R4: A431 Inbound (Willsbridge to Old Market St) AM Peak



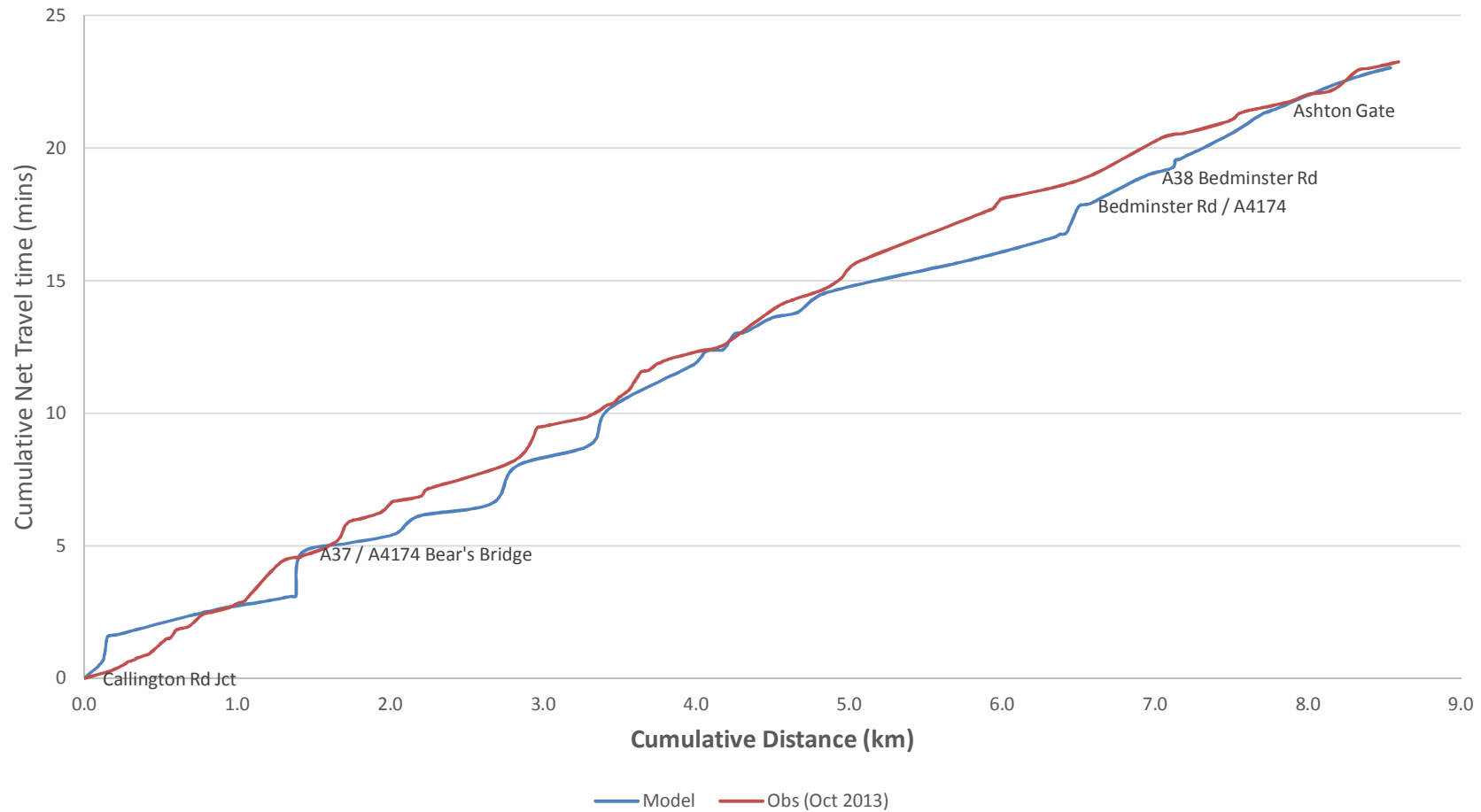
R4: A431 Outbound (Old Market St Jct to Willsbridge) AM Peak



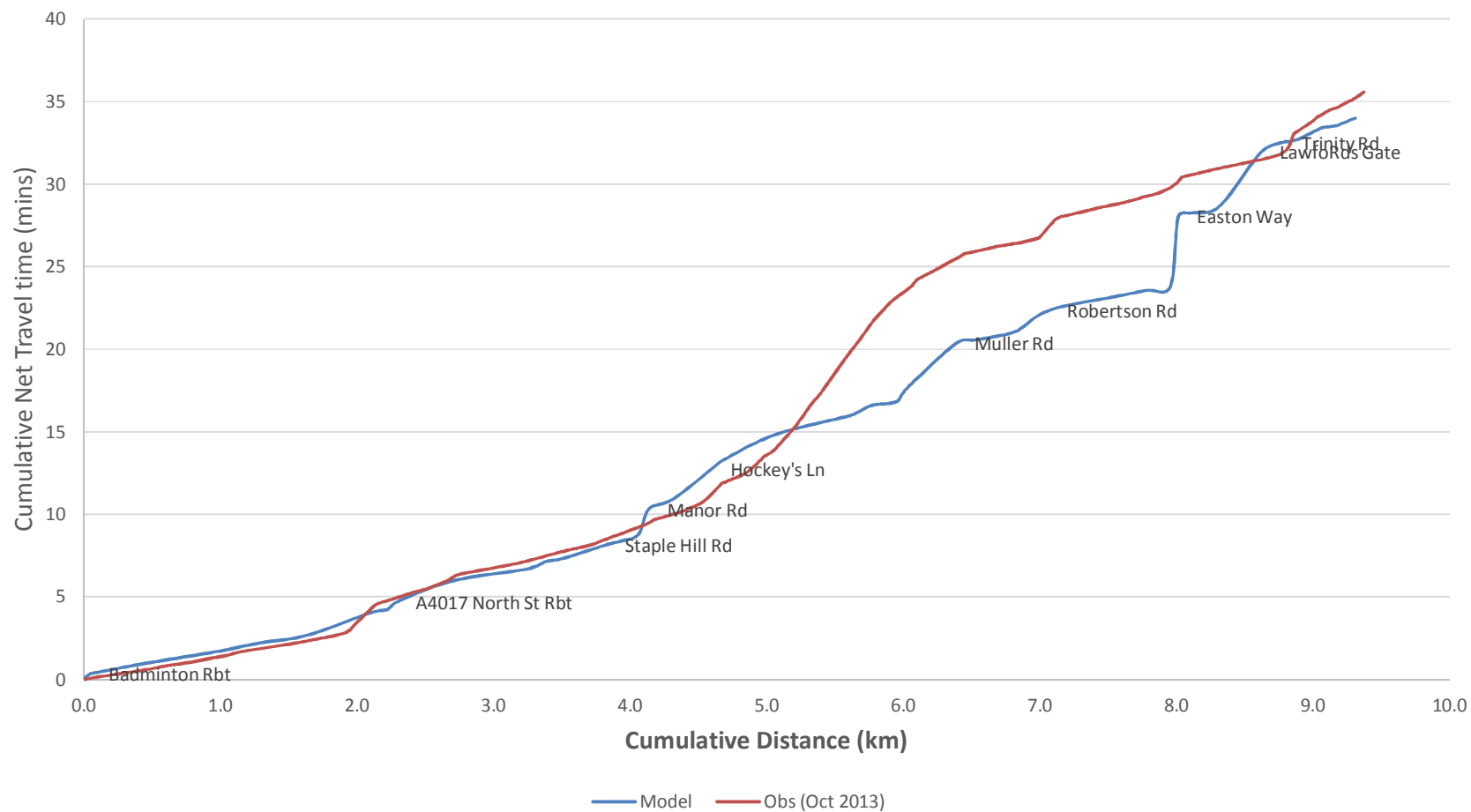
R5: A38 Eastbound (Ashton Gate to Brislington {via Hengrove}) AM Peak



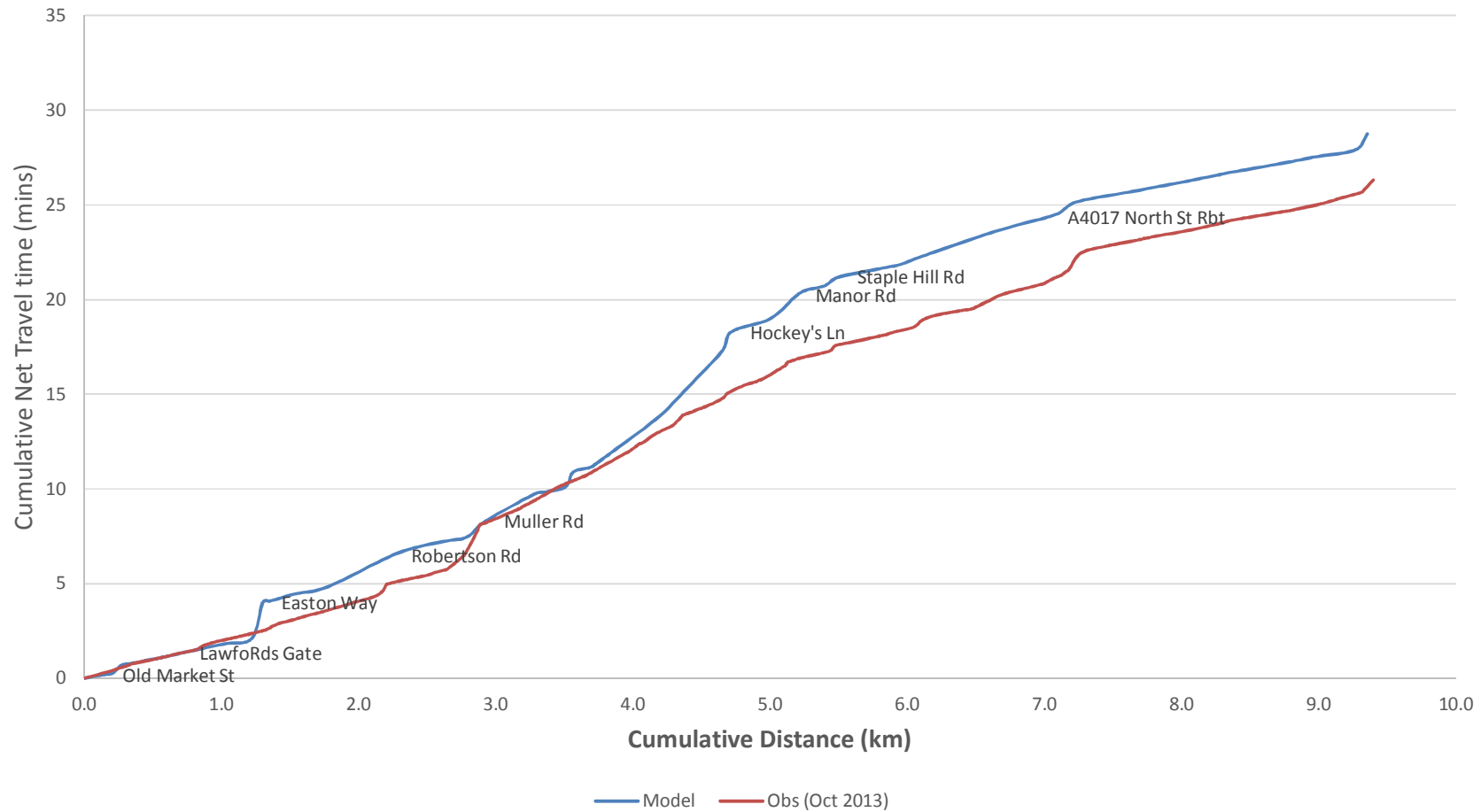
R5: A38 Westbound (Brislington to Ashton Gate {via Hengrove}) AM Peak

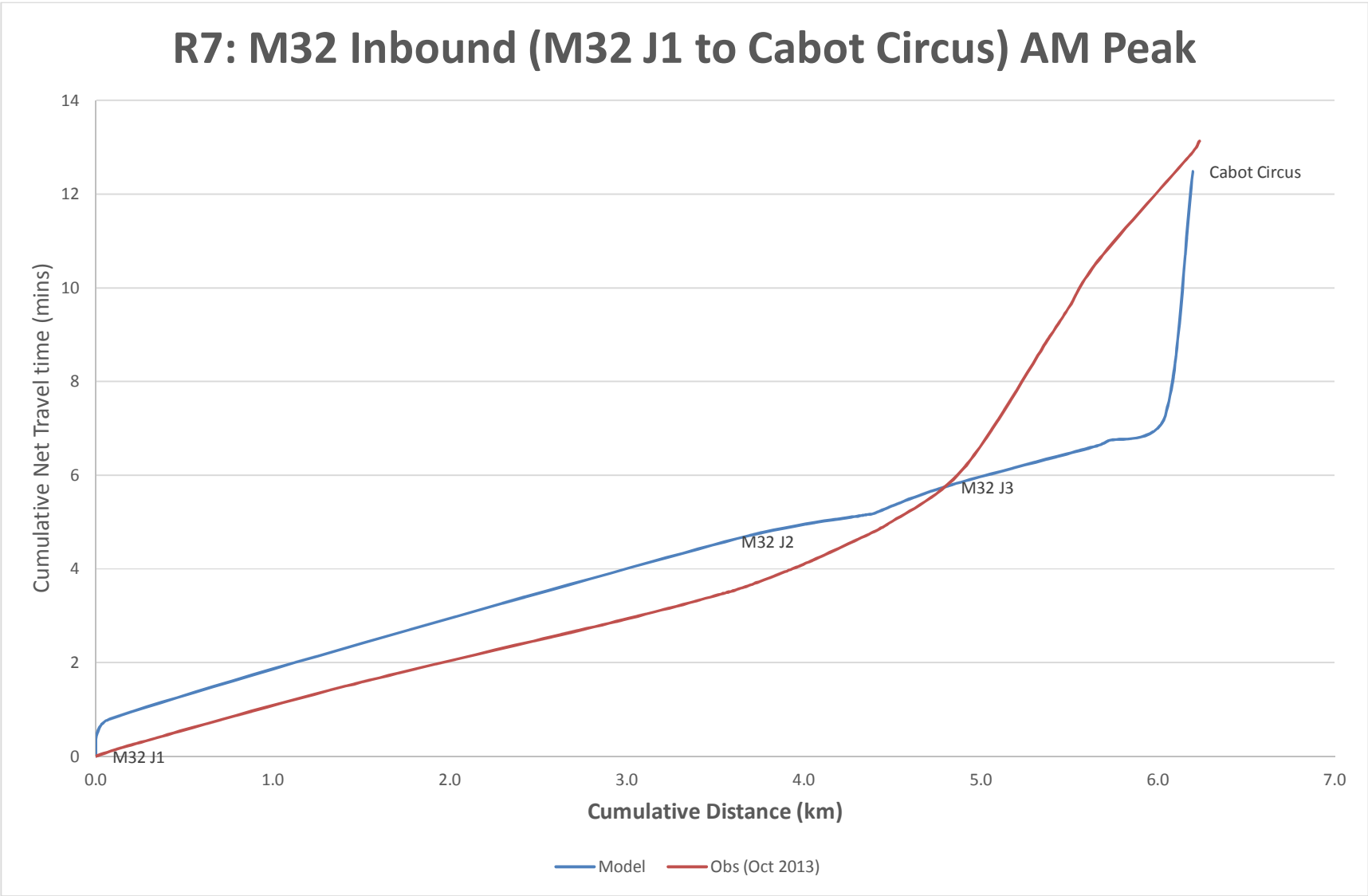


R6: A432 Inbound (A4174 Badminton Rbt to Old Market St) AM Peak

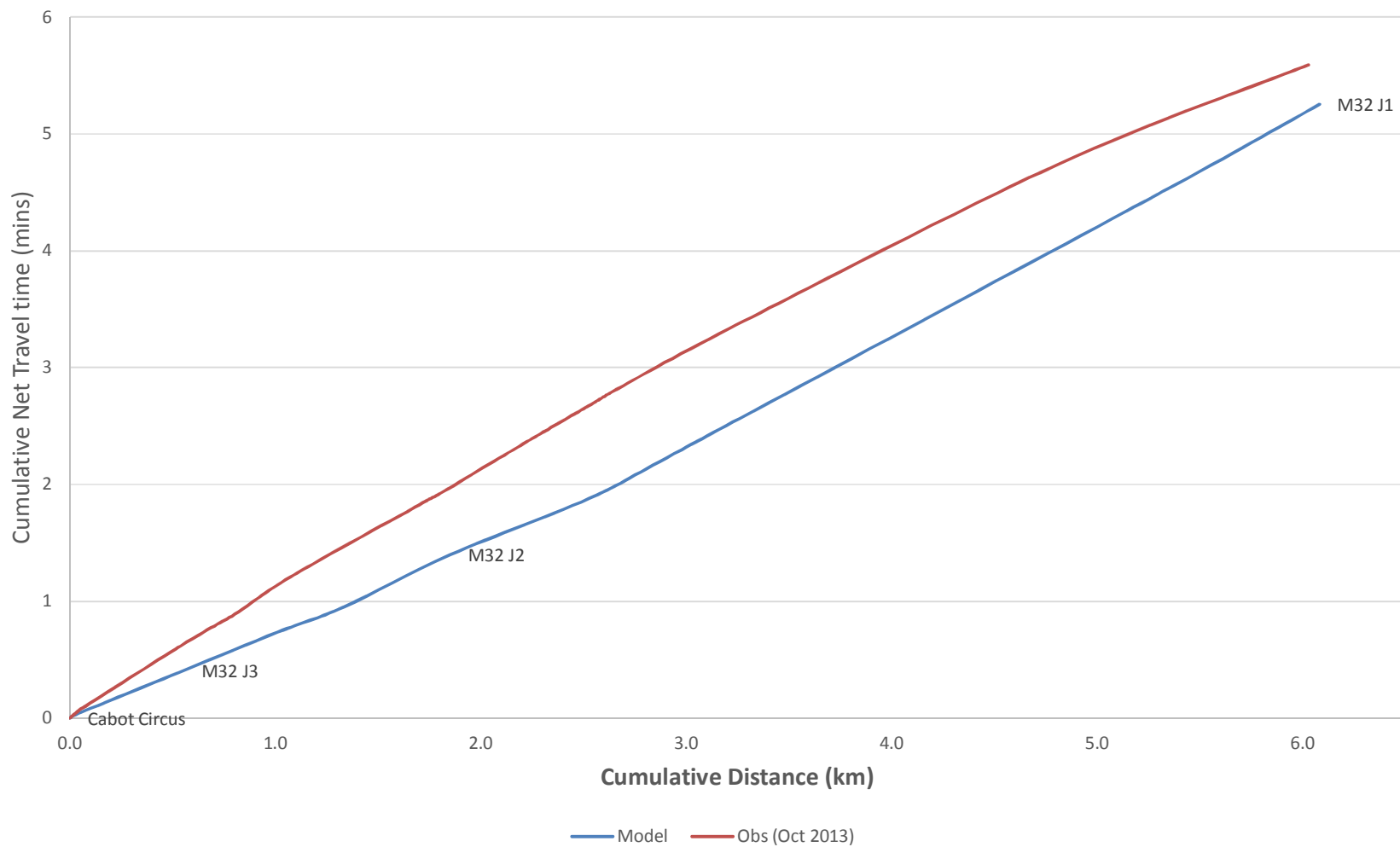


R6: A432 Outbound (West St to A4174 Badminton Rbt) AM Peak

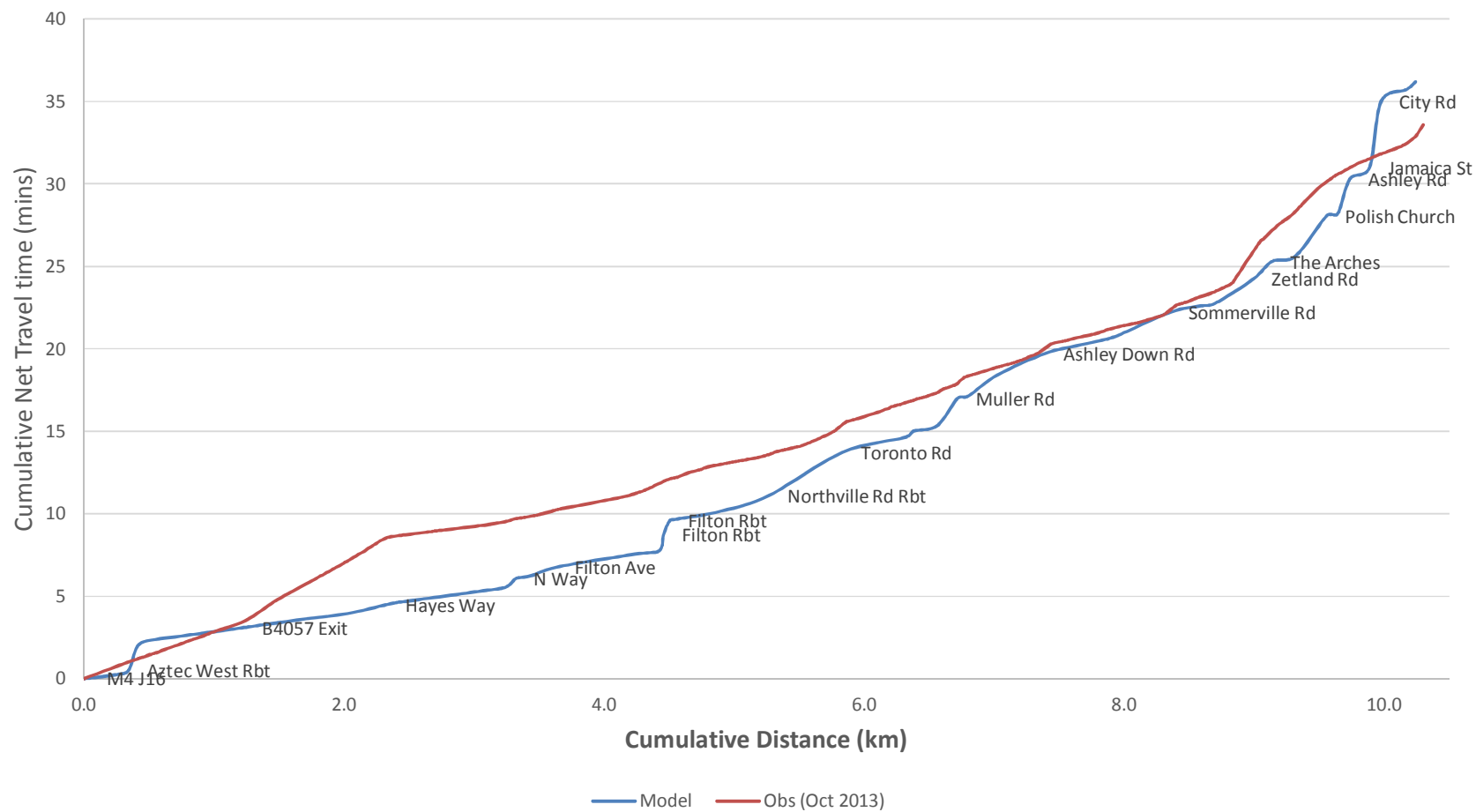




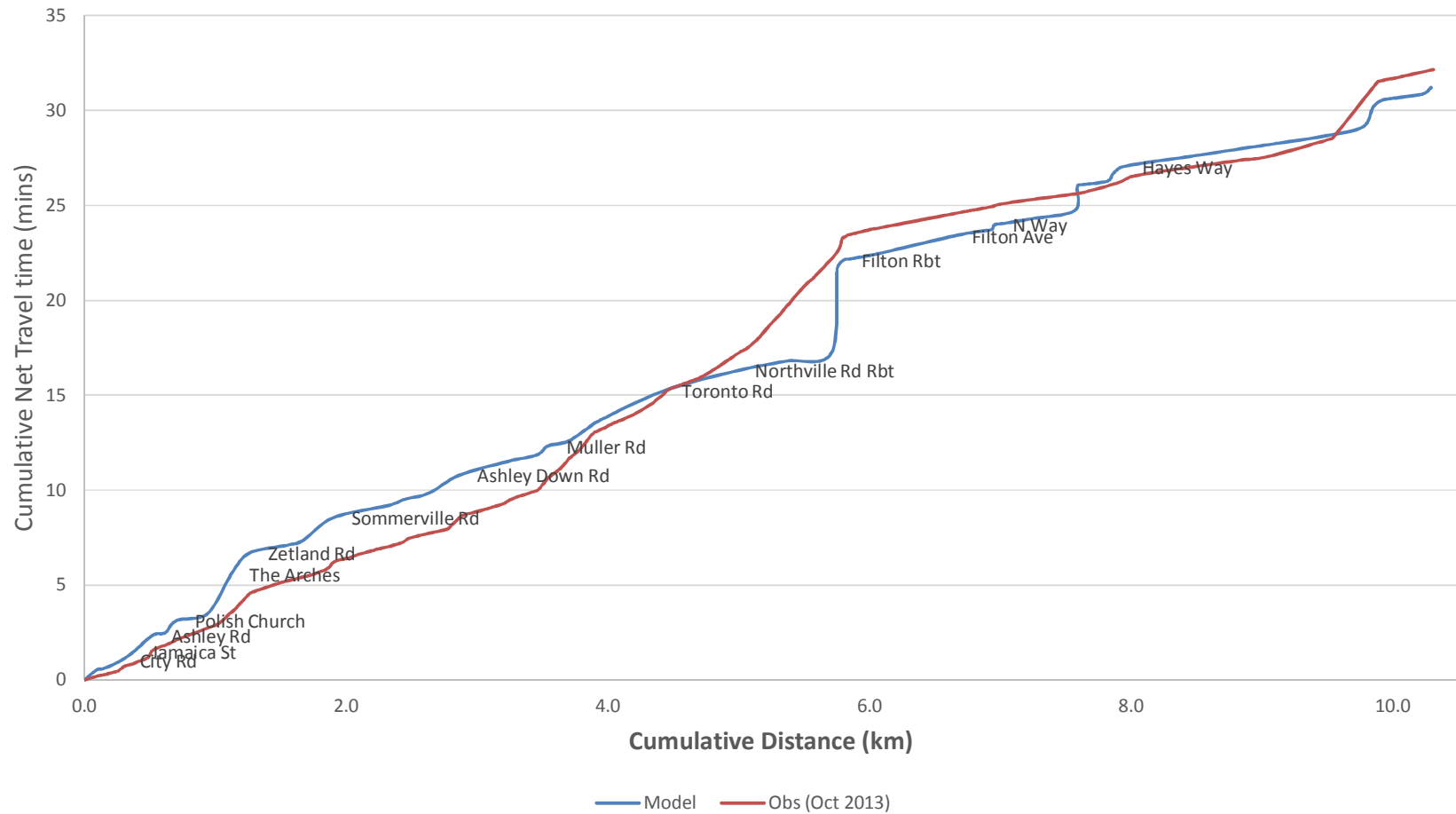
R7: M32 Outbound (Cabot Circus to M32 J1) AM Peak



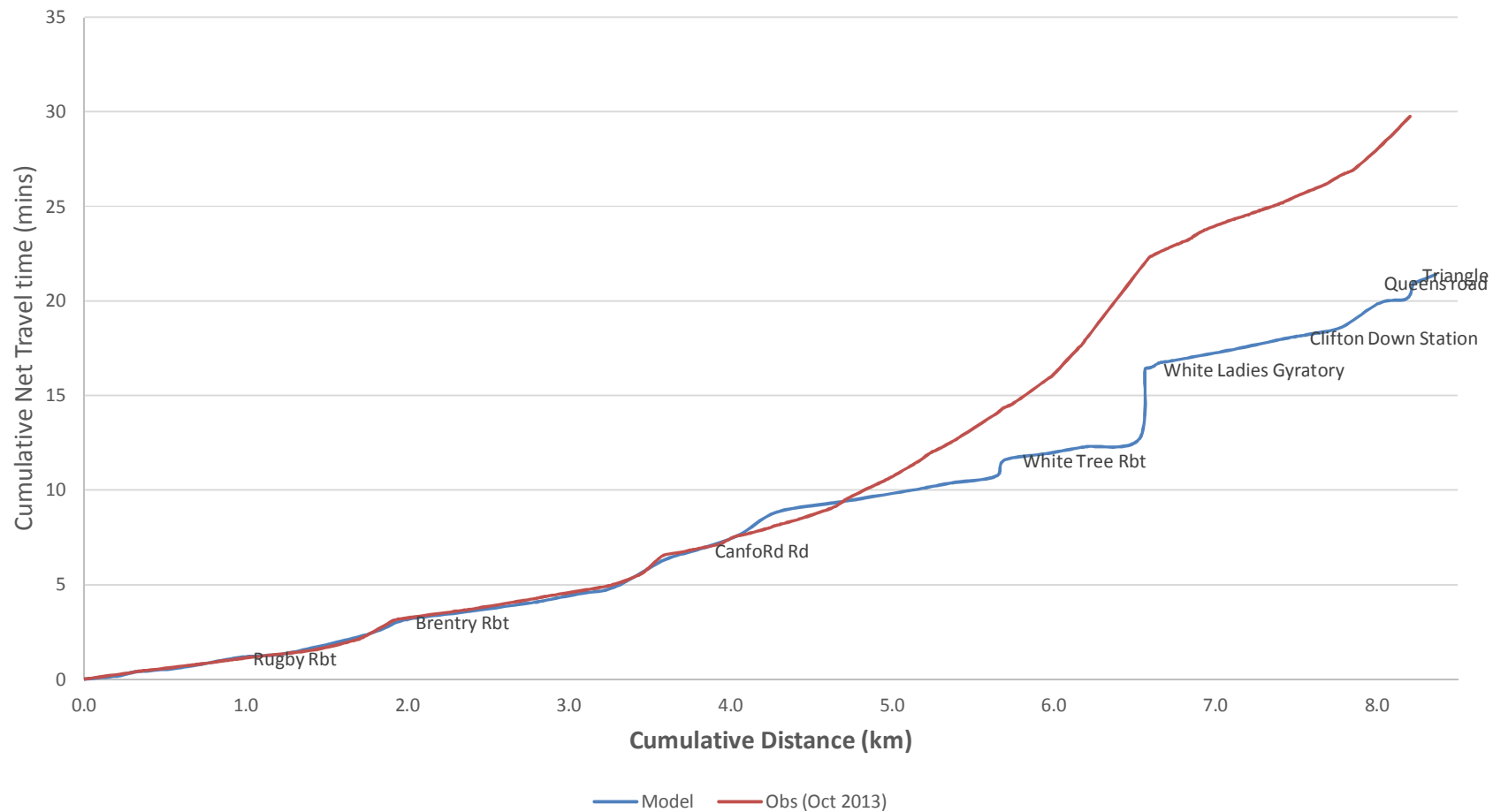
R8: A38 Inbound (M5 J16 to St James Barton Rbt) AM Peak



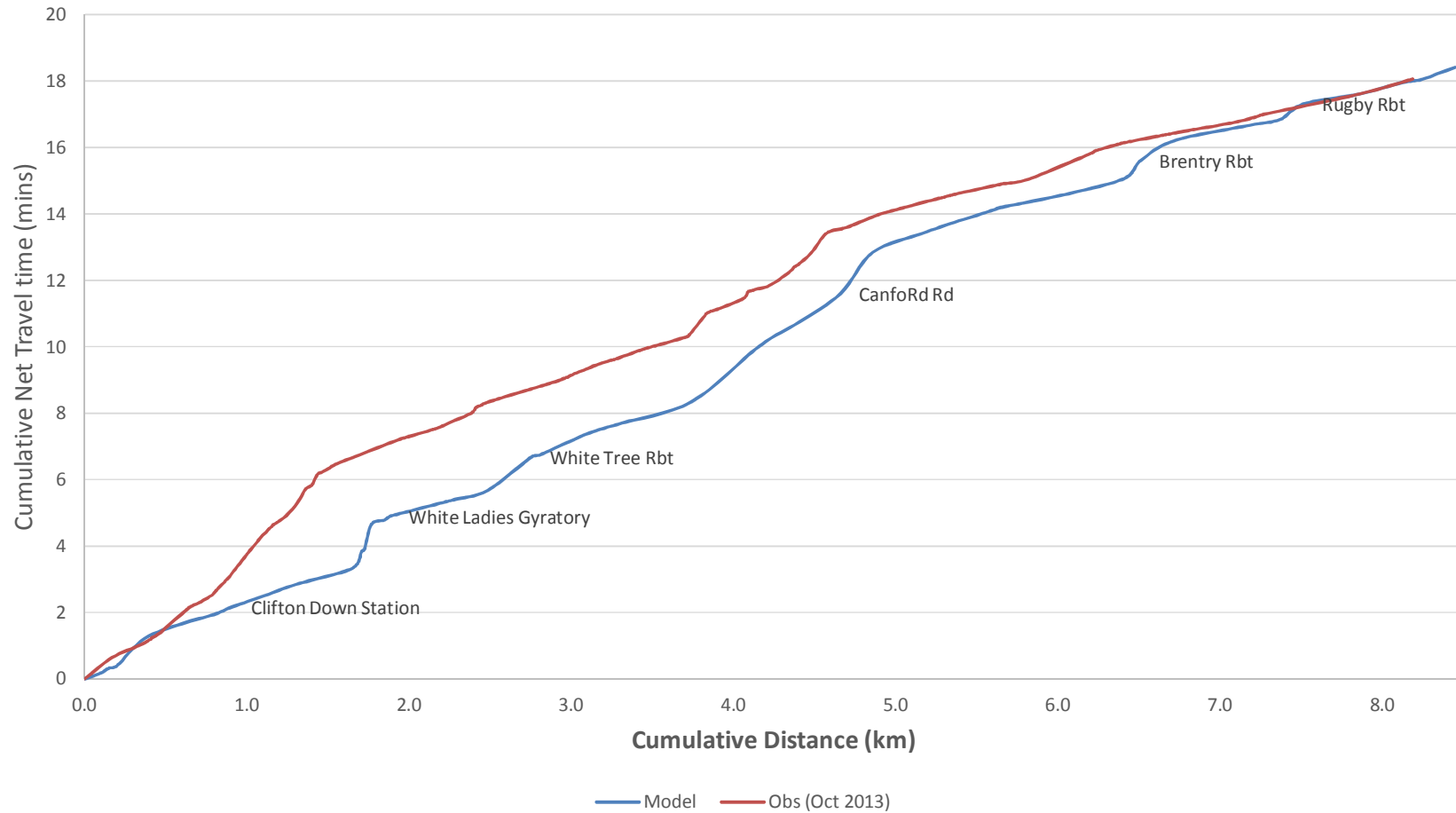
R8: A38 Outbound (St James Barton Rbt to M5 J16) AM Peak



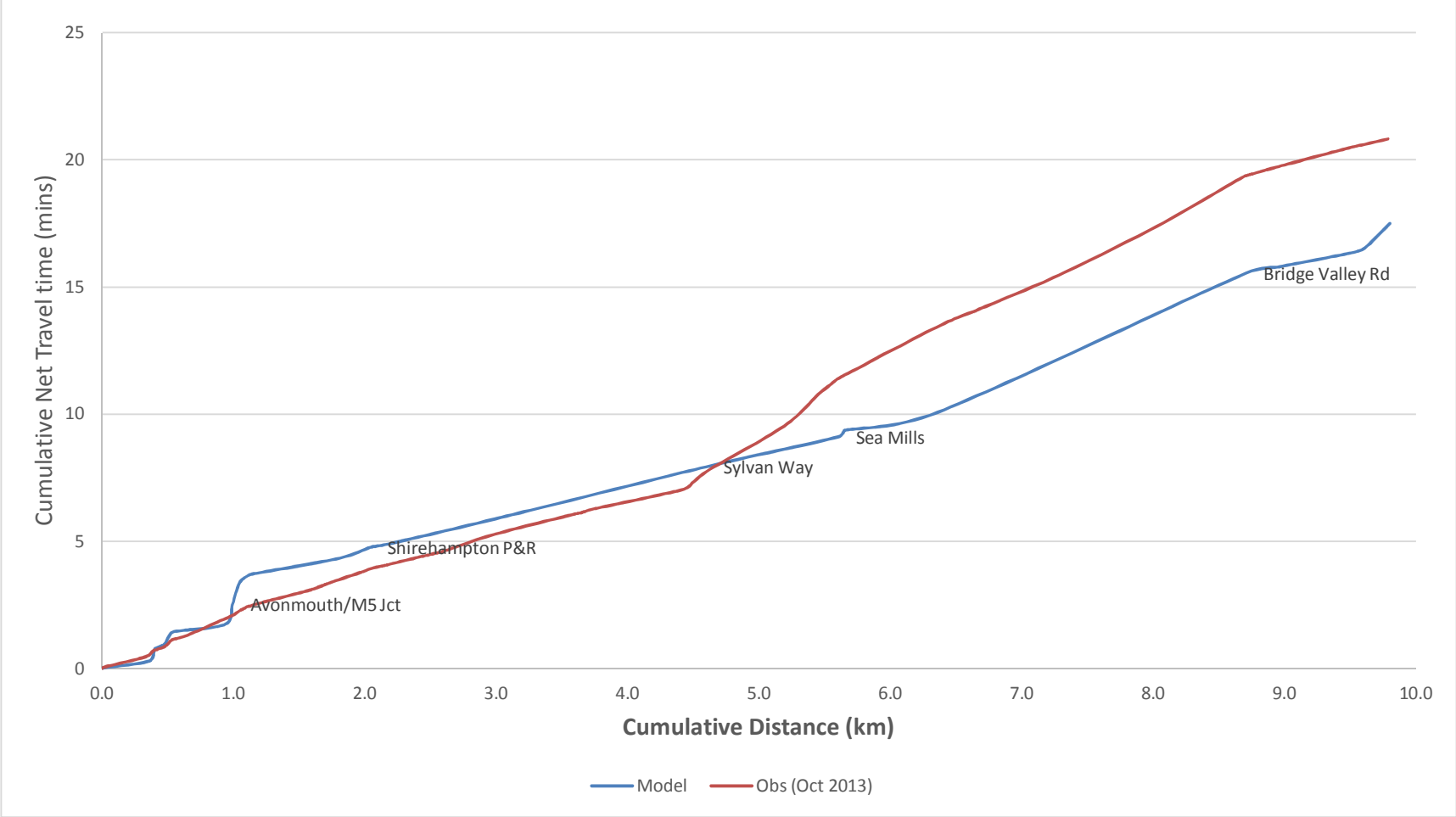
R9: A4018 Inbound (M5 J17 Cribbs to Clifton Triangle) AM Peak



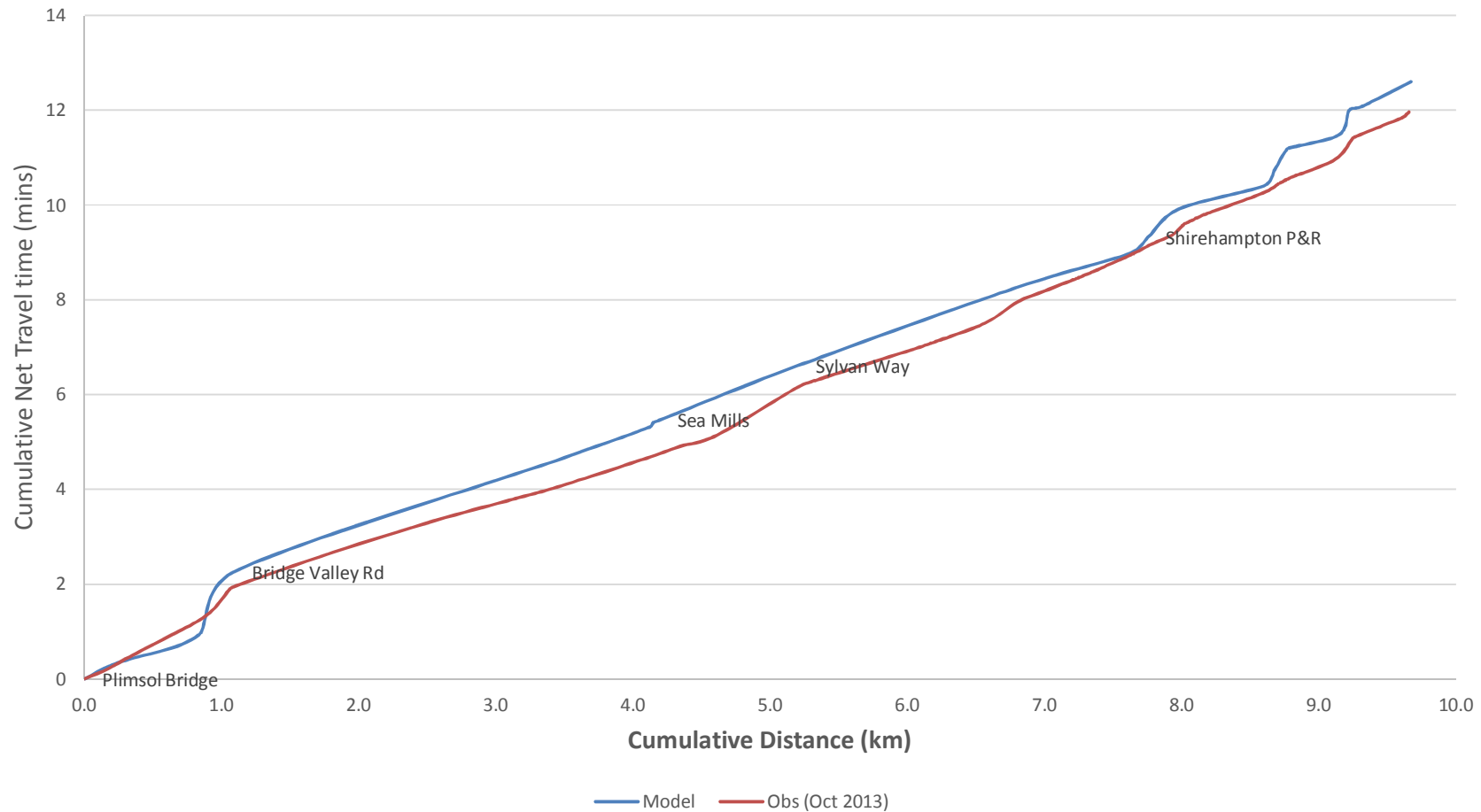
R9: A4018 Outbound (College Green to M5 J17 Cribbs) AM Peak



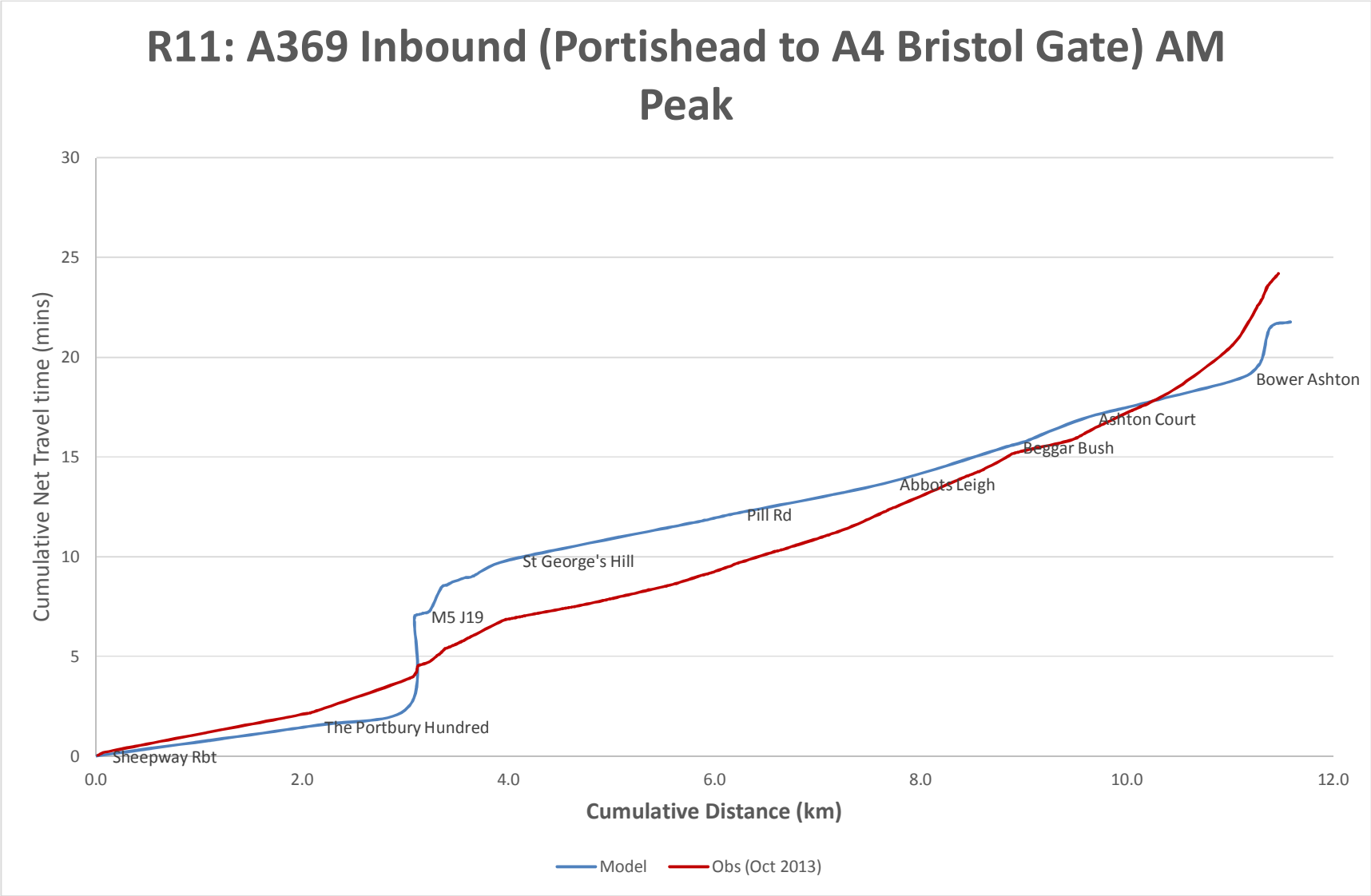
R10: A4 Portway Inbound (Avonmouth to Hotwells) AM Peak



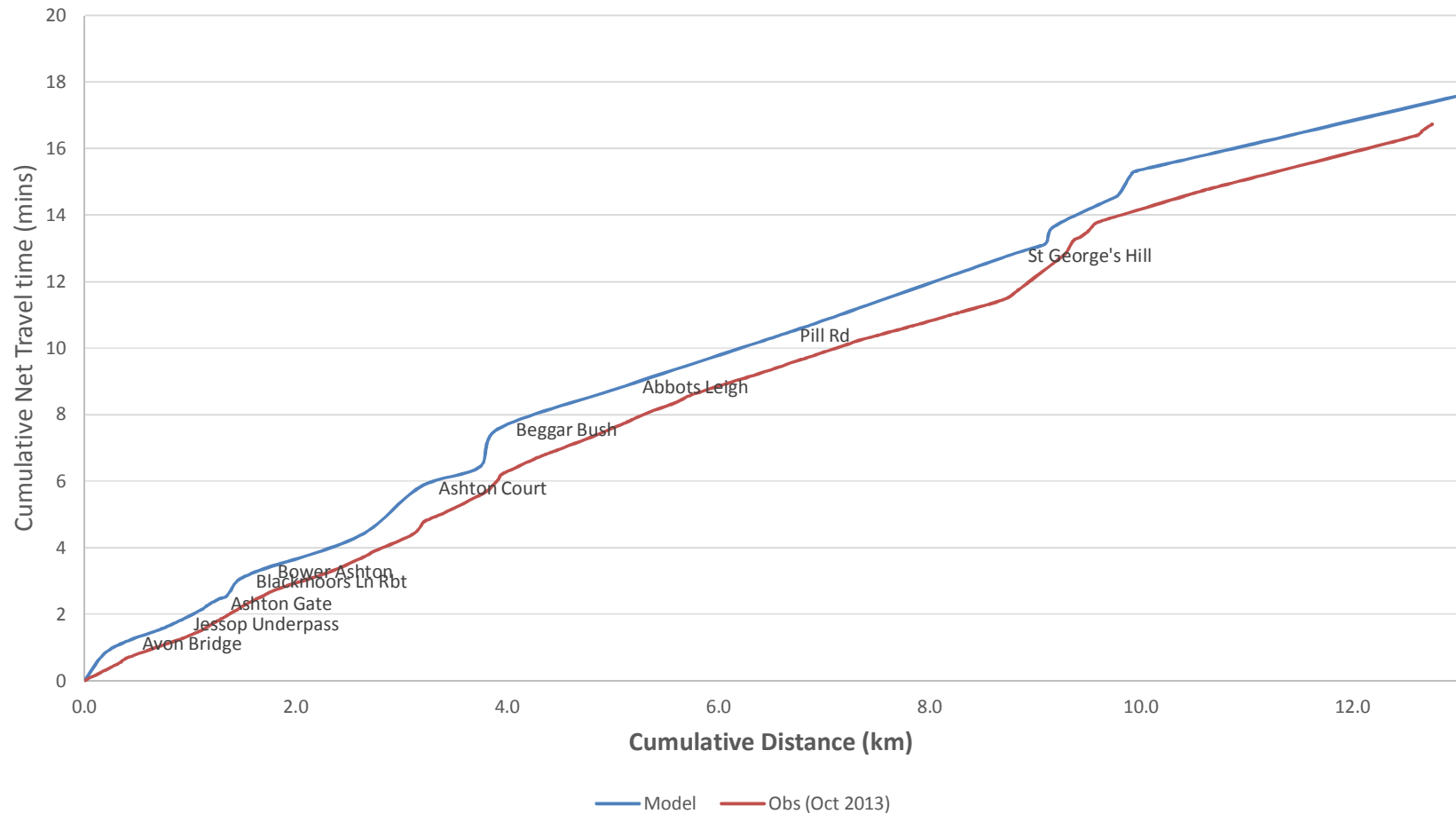
R10: A4 Portway Outbound (Hotwells to Avonmouth) AM Peak

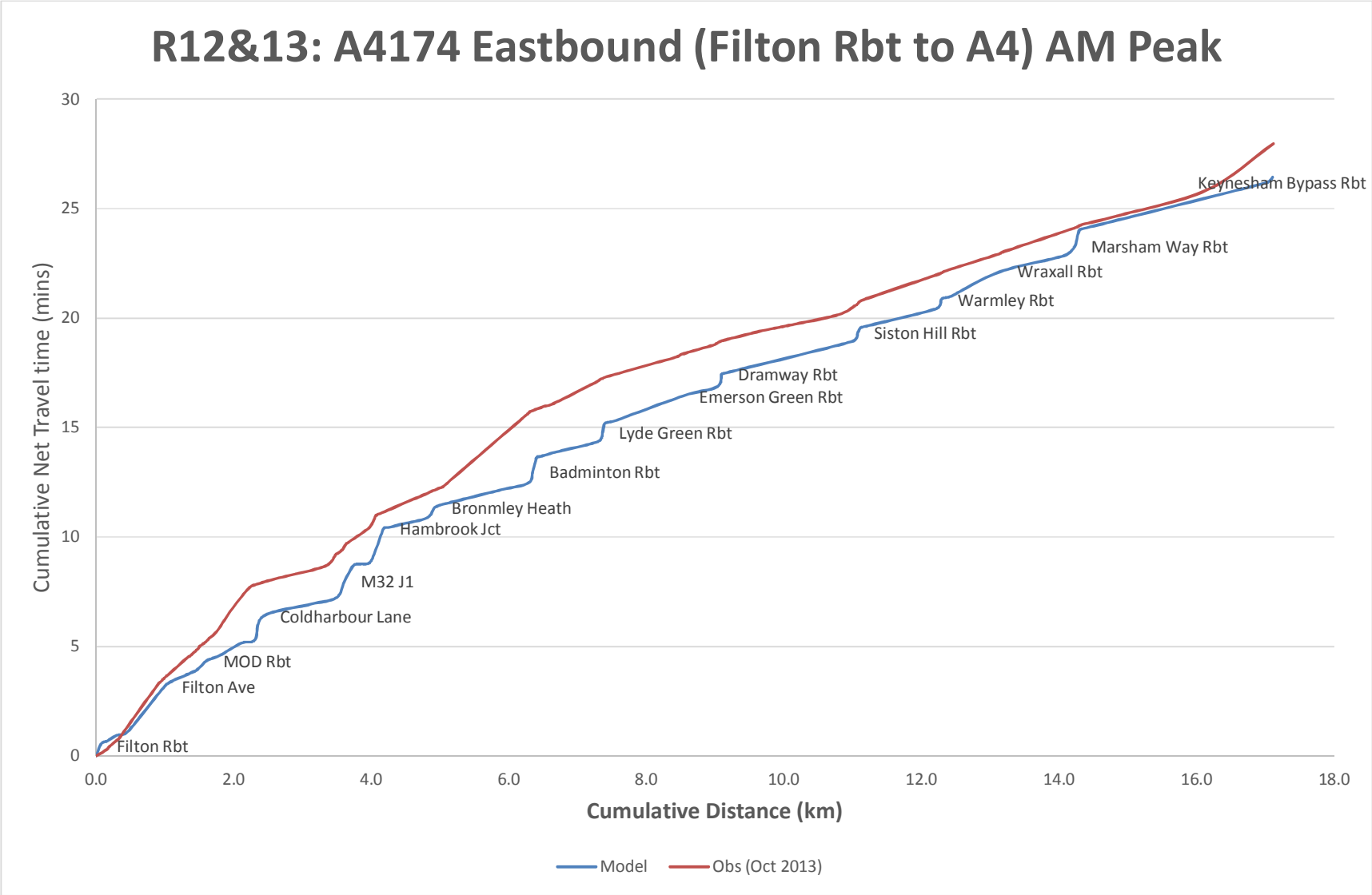


R11: A369 Inbound (Portishead to A4 Bristol Gate) AM Peak

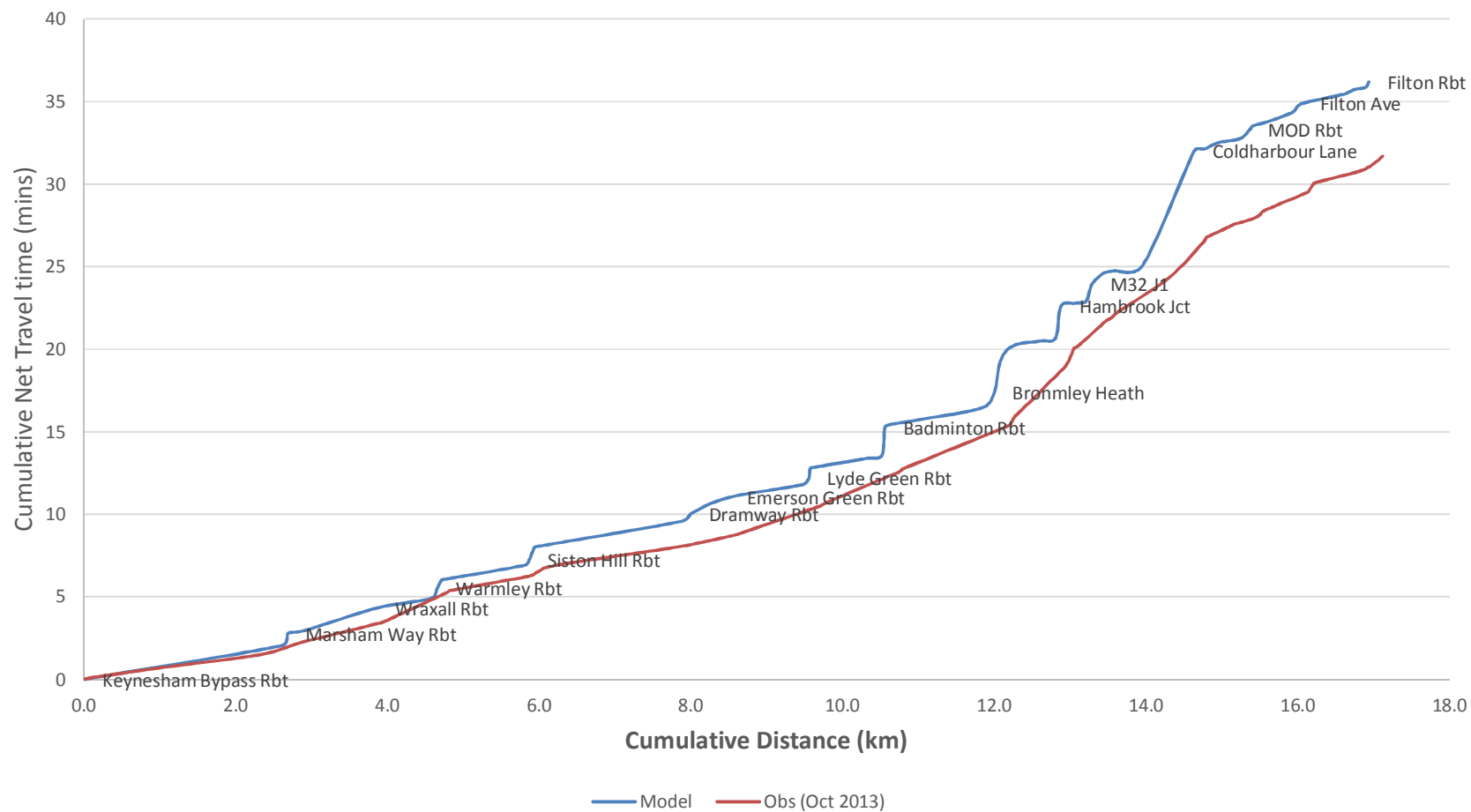


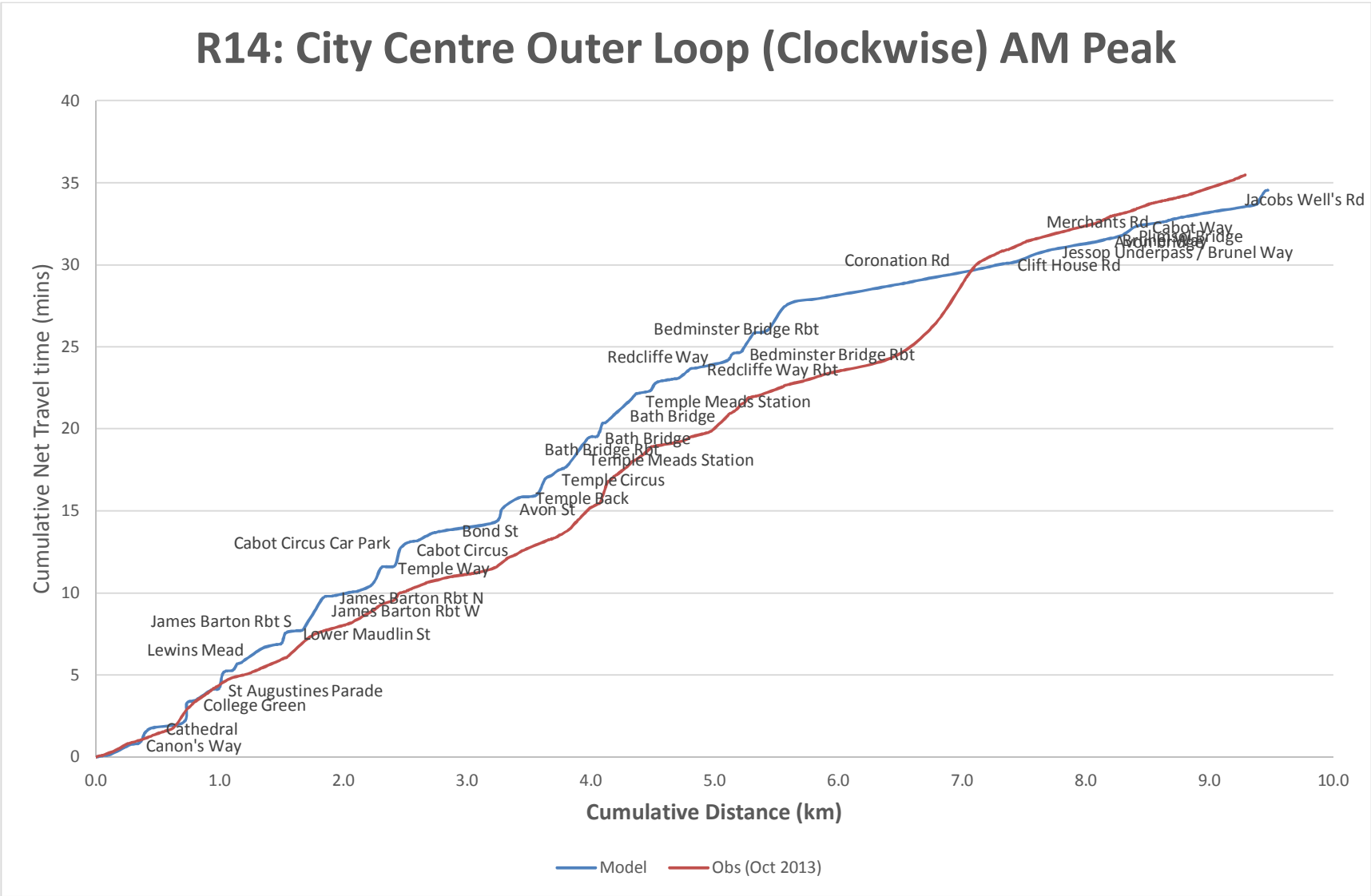
R11: A369 Outbound (A4 Bristol Gate to Portishead) AM Peak



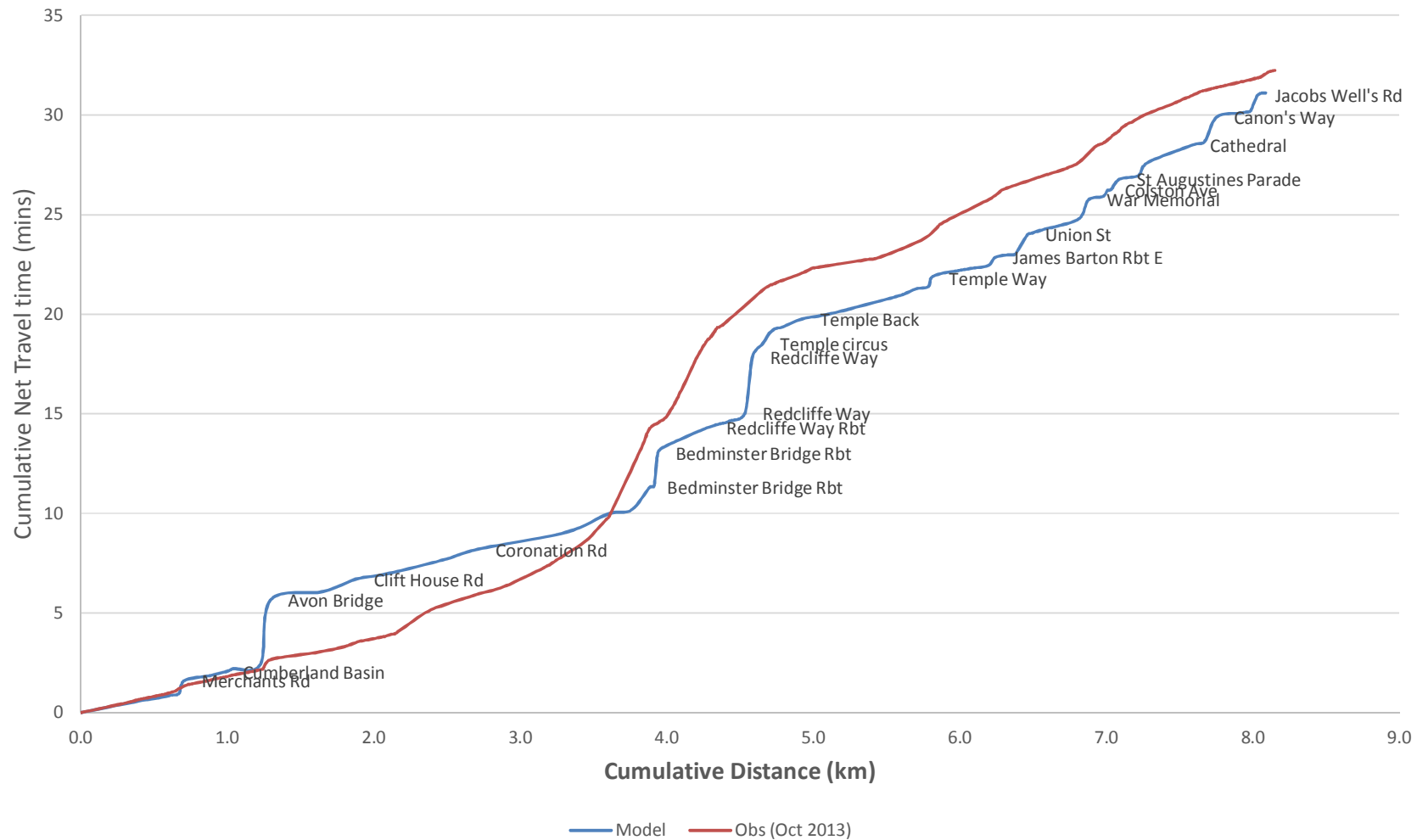


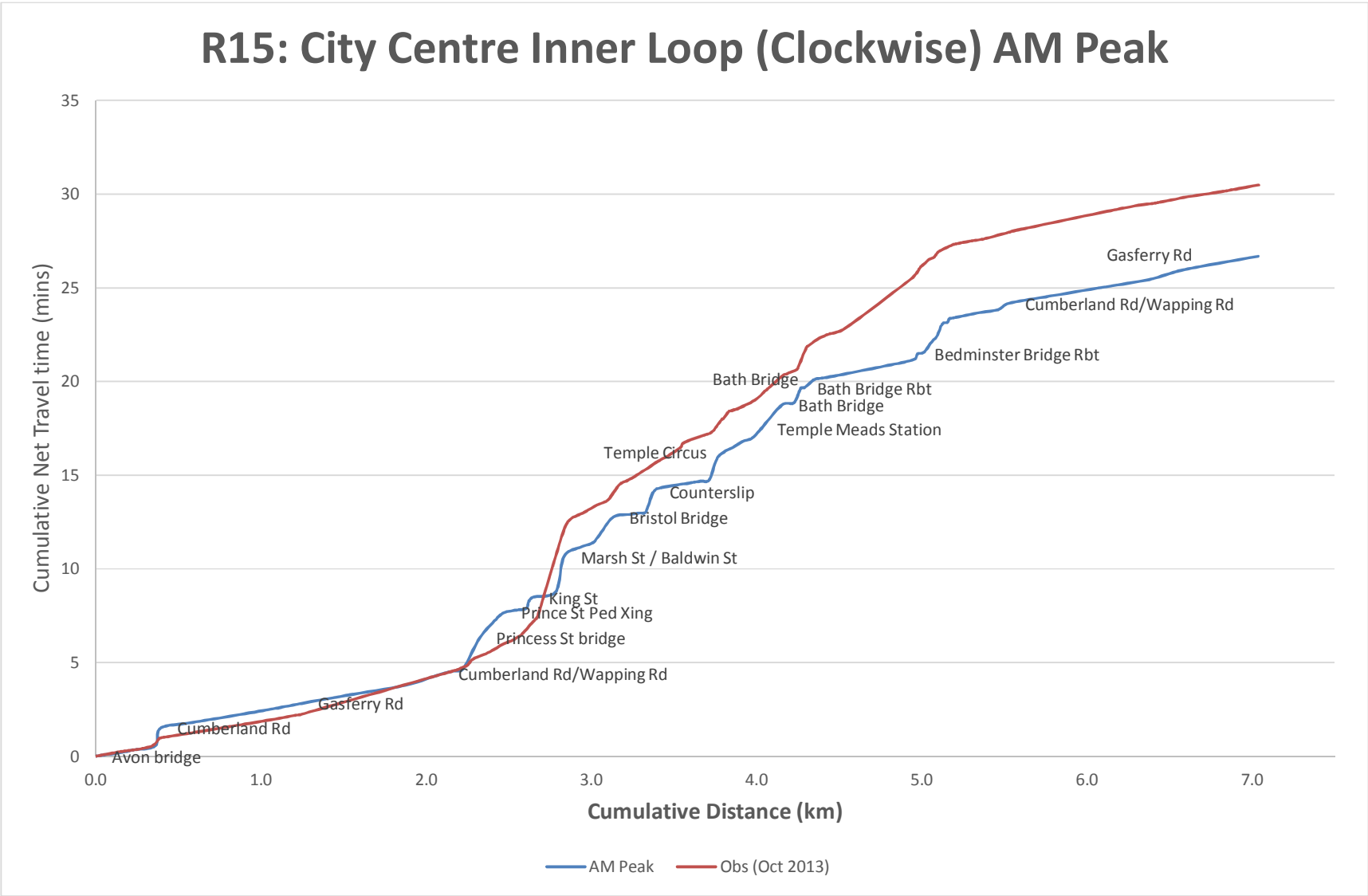
R12&13: A4174 Westbound (A4 to Filton Rbt) AM Peak



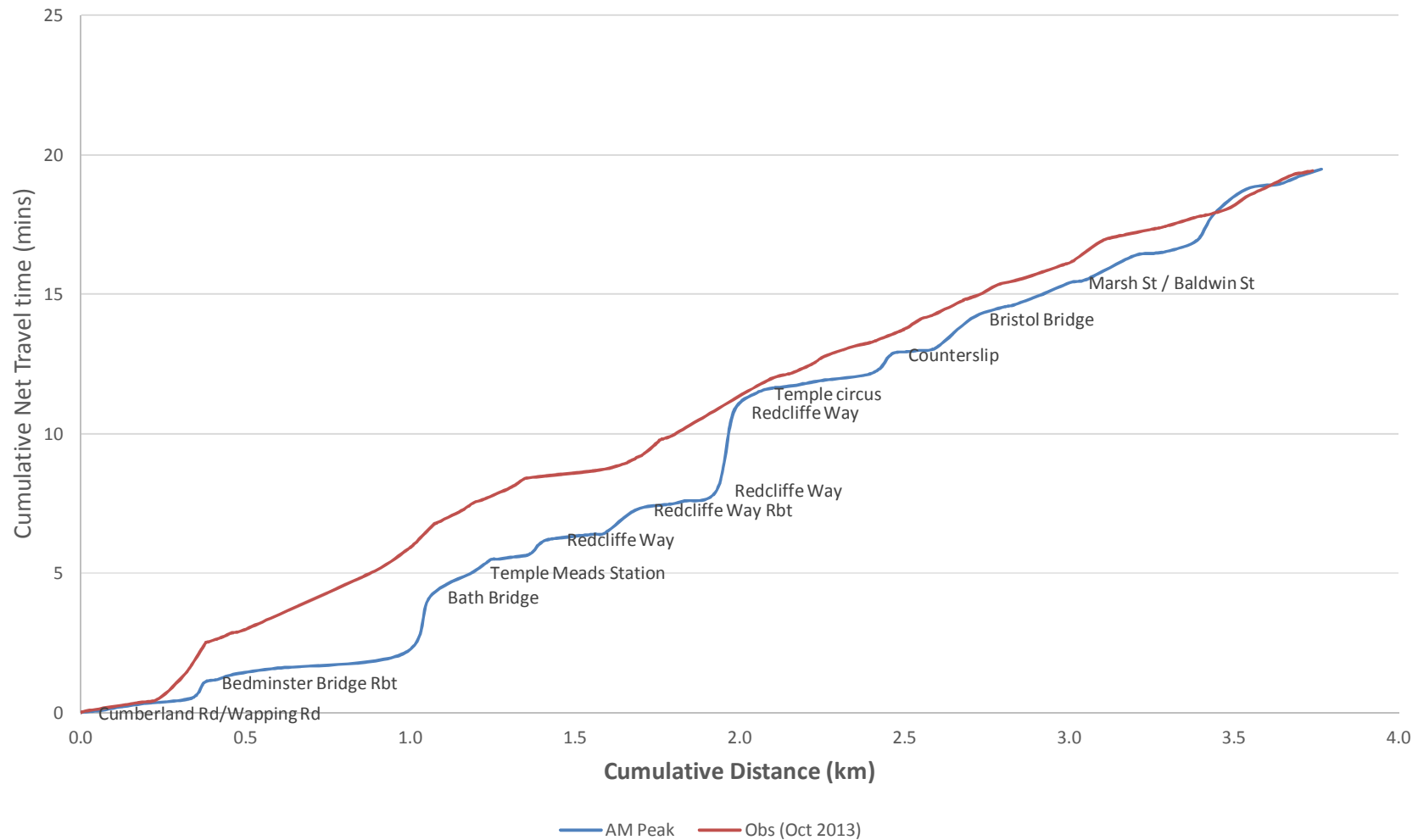


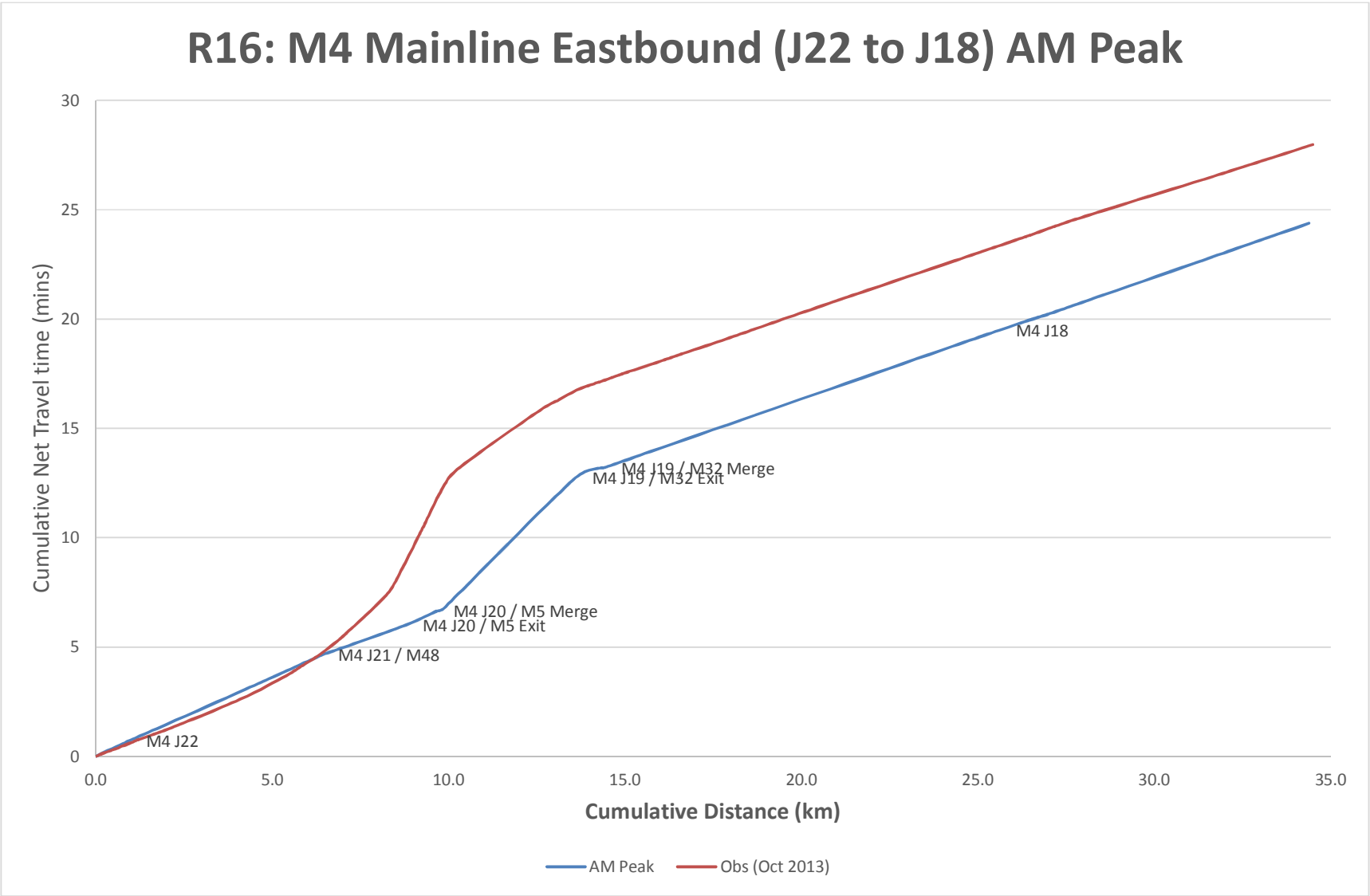
R14: City Centre Outer Loop (Anti-Clockwise) AM Peak



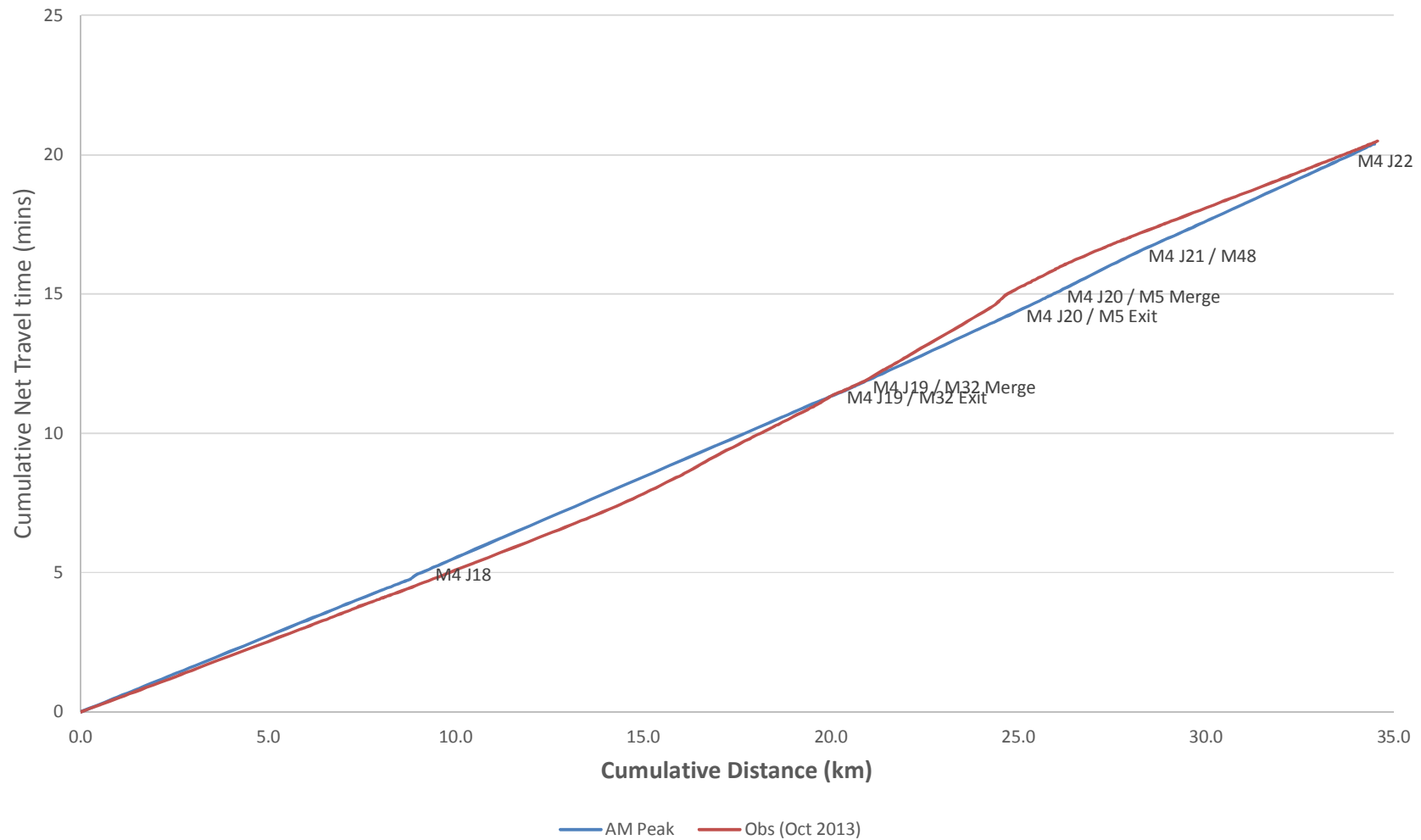


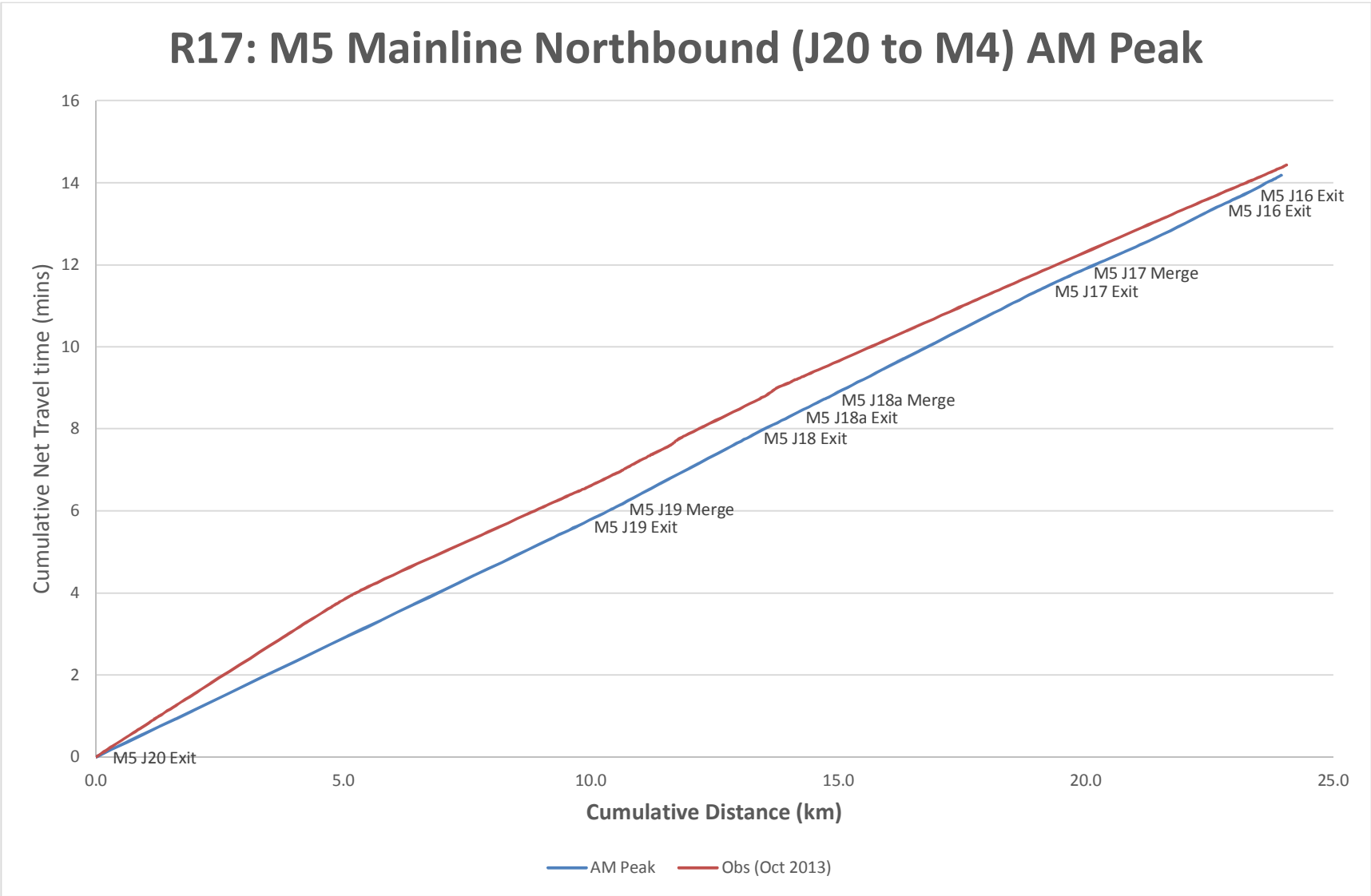
R15: City Centre Inner Loop (Anti-Clockwise) AM Peak



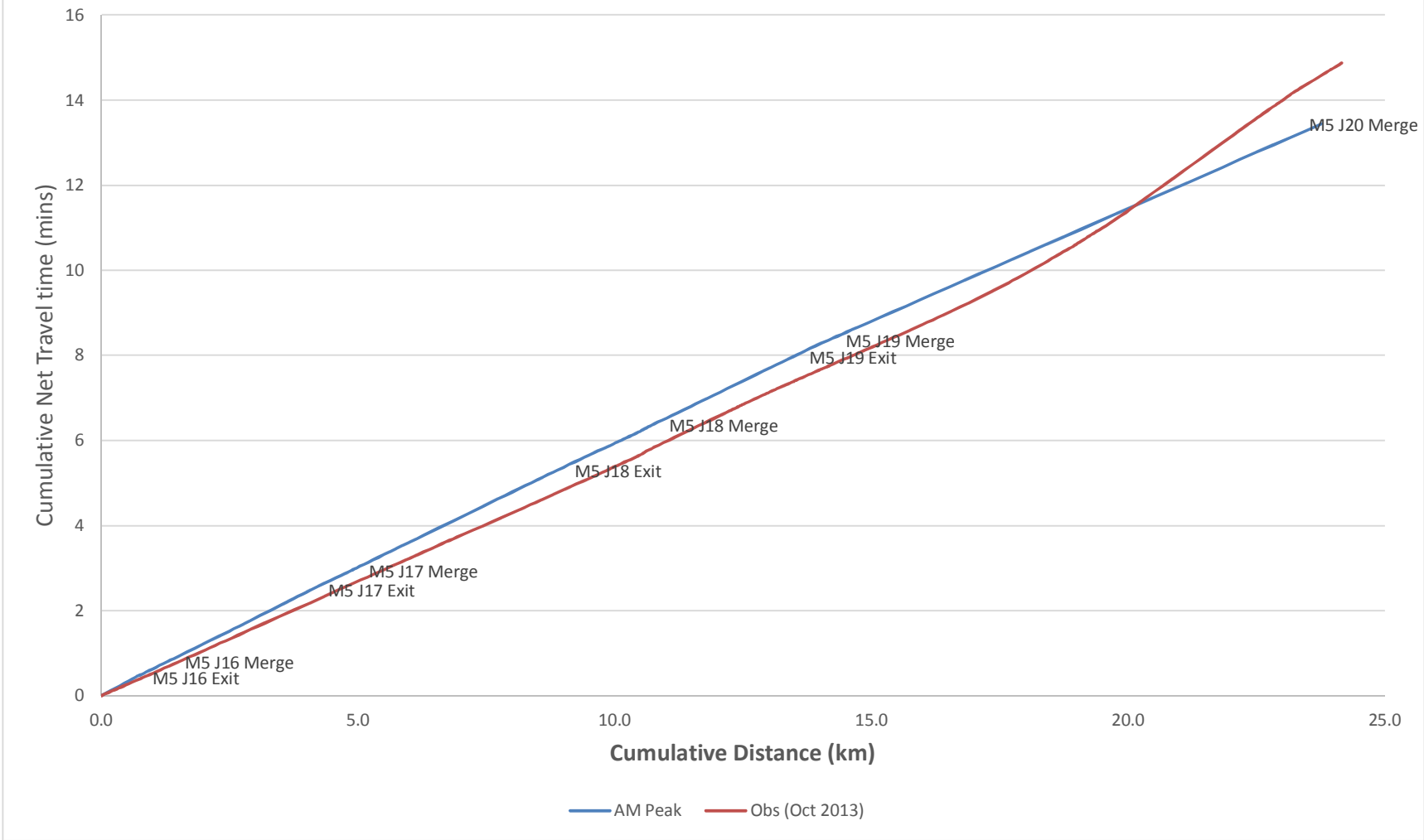


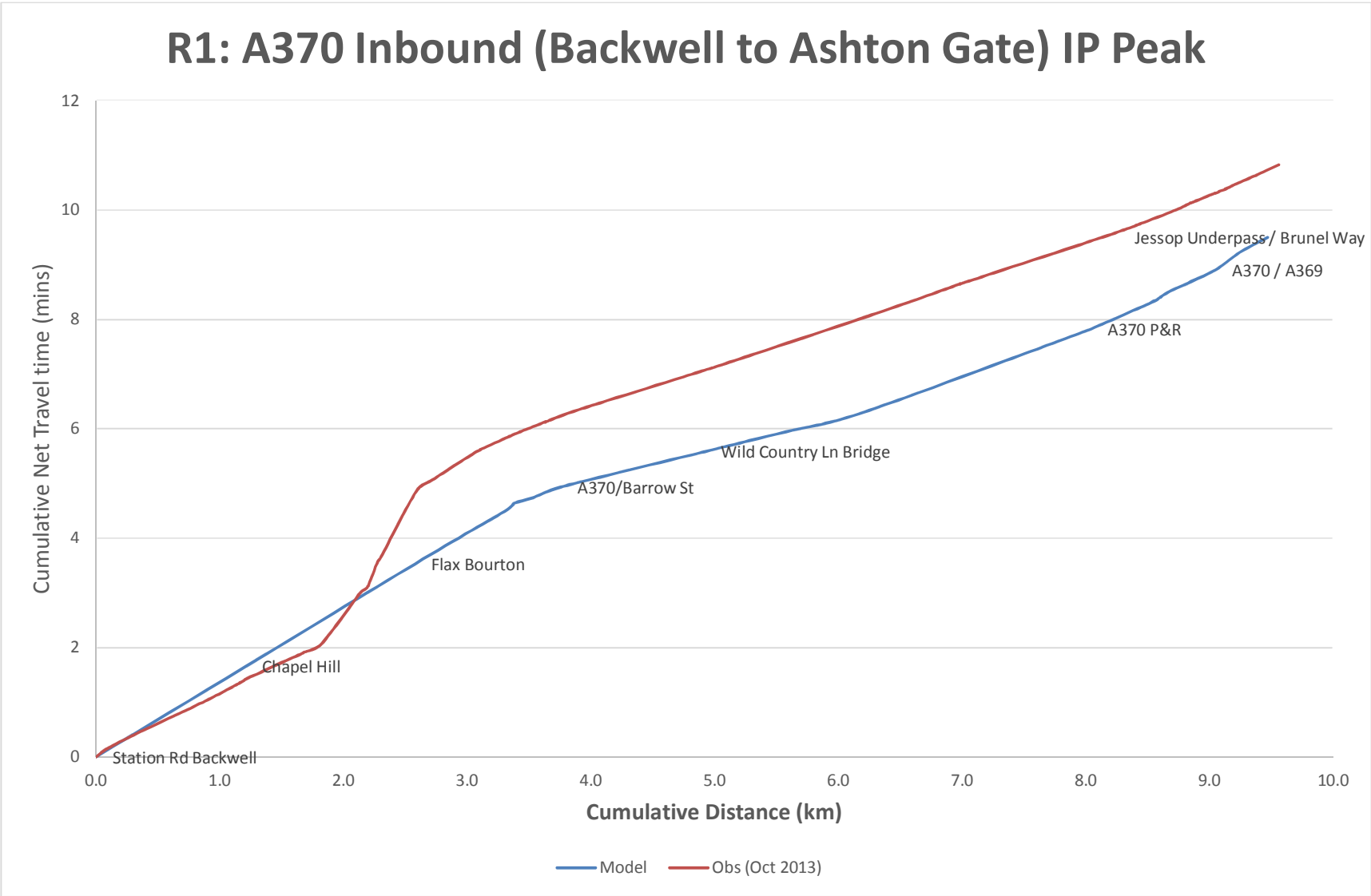
R16: M4 Mainline Westbound (J18 to J22) AM Peak



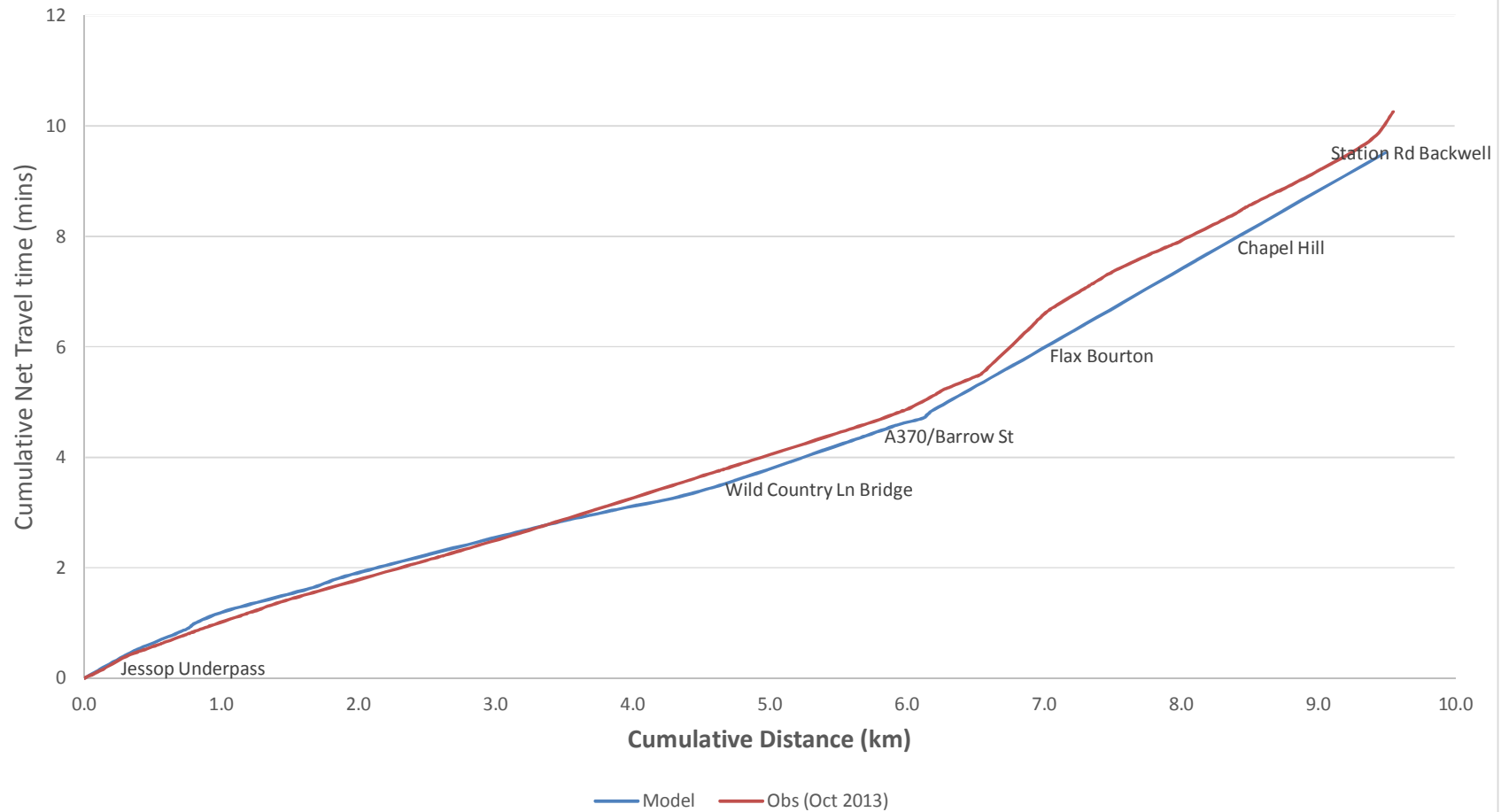


R17: M5 Mainline Southbound (M4 to J20) AM Peak

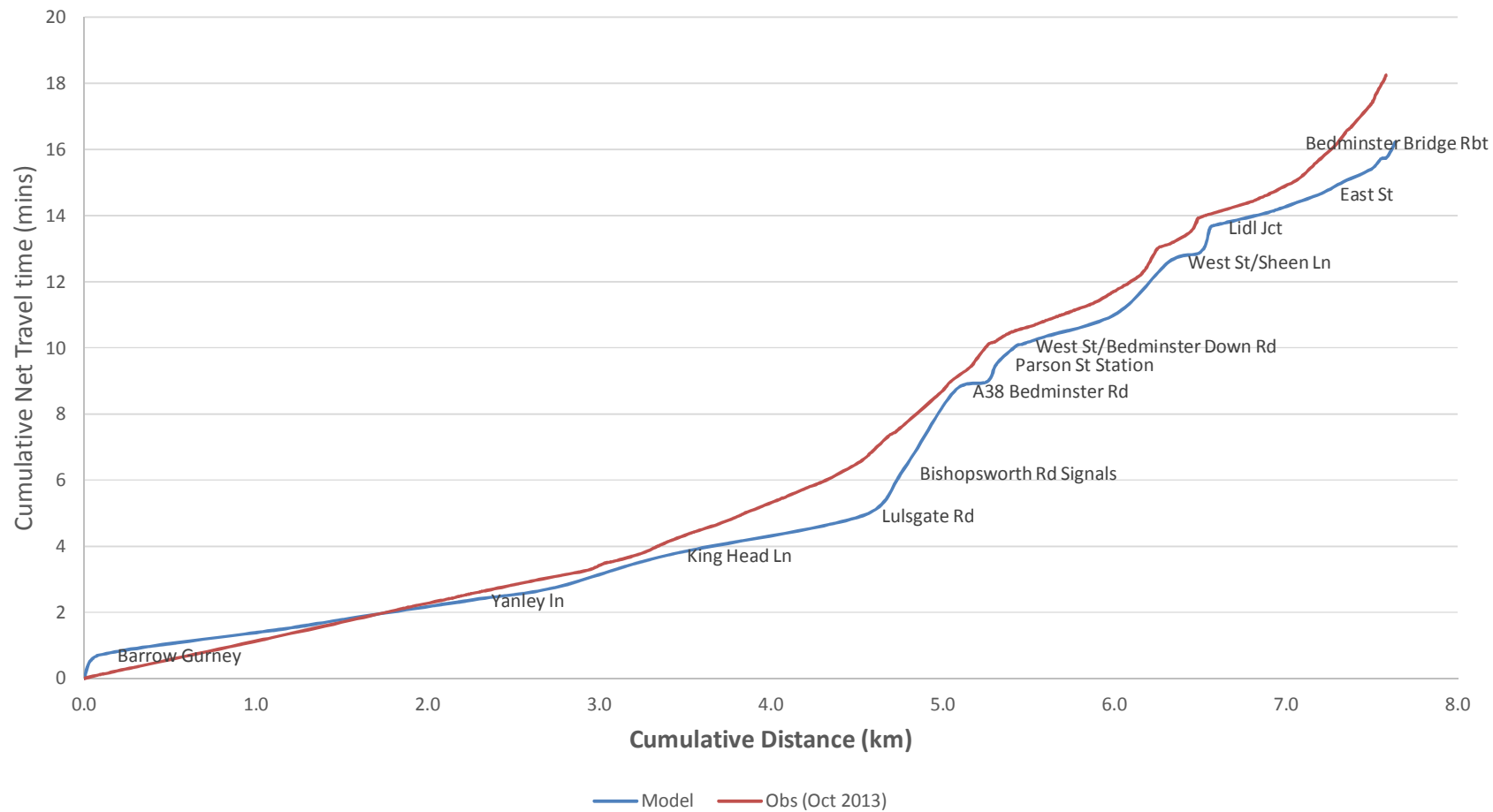




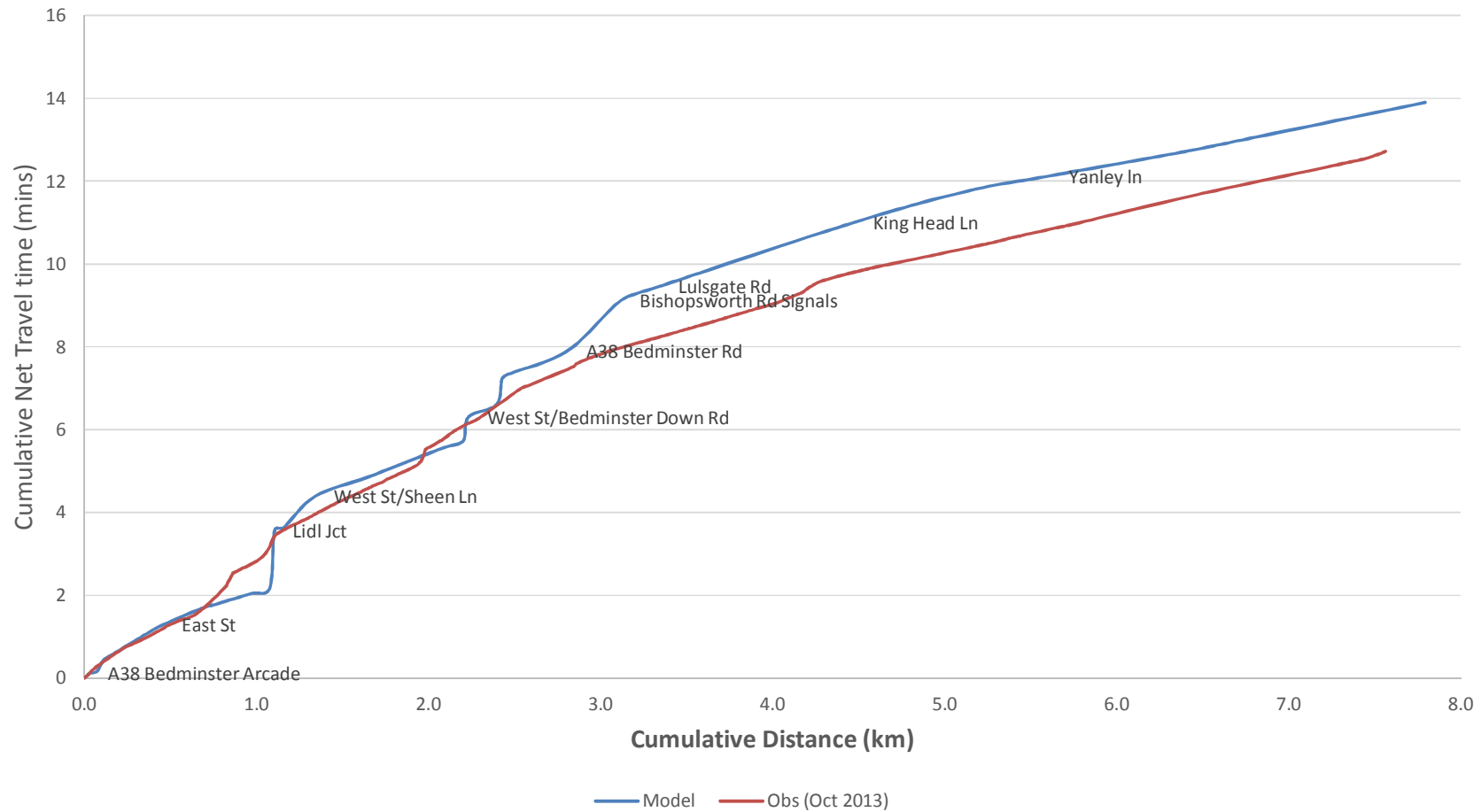
R1: A370 Outbound (Jessop Underpass to Backwell) IP Peak



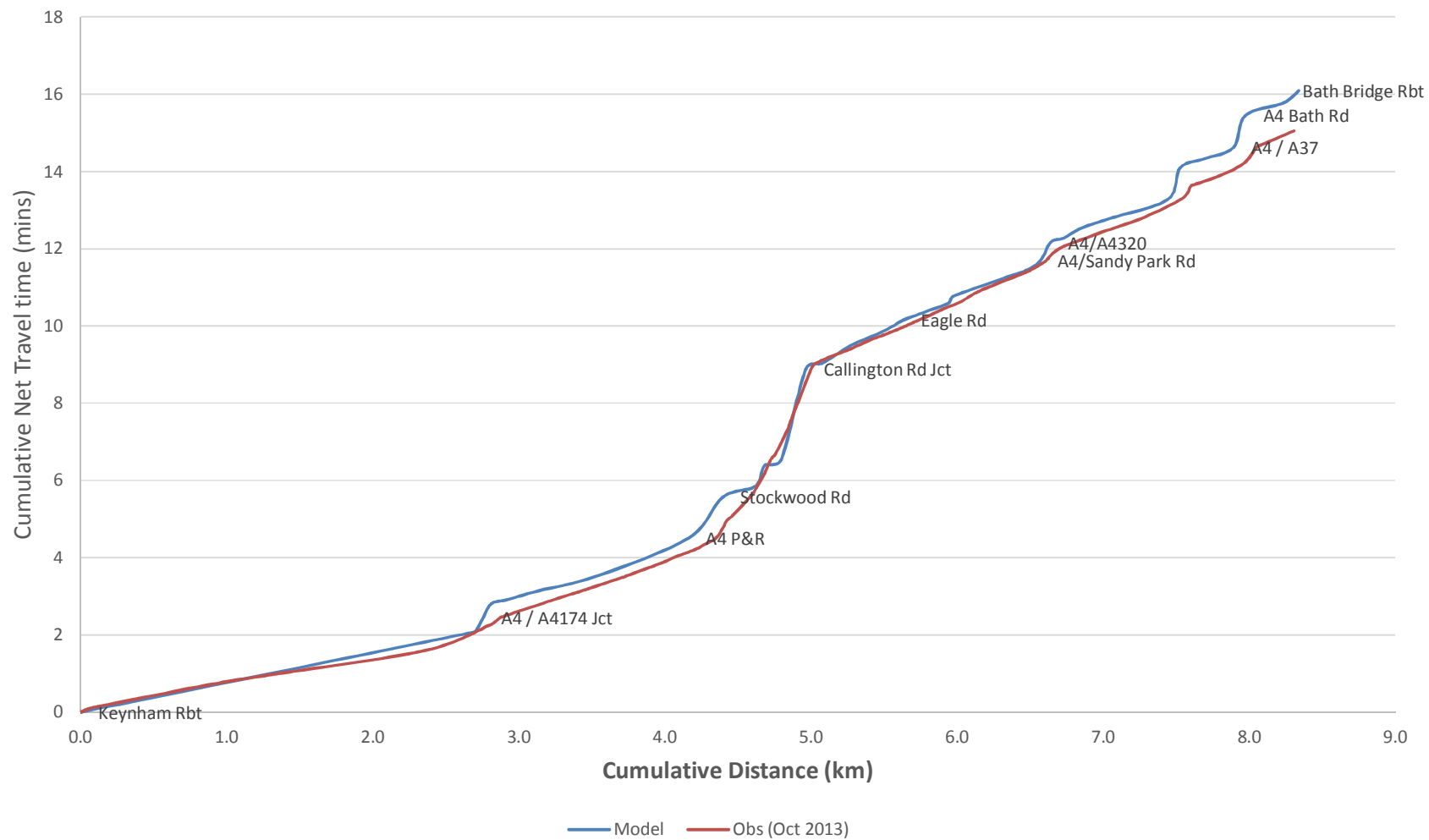
R2: A38 Inbound (Barrow Gurney to Bedminster Bridge) IP Peak



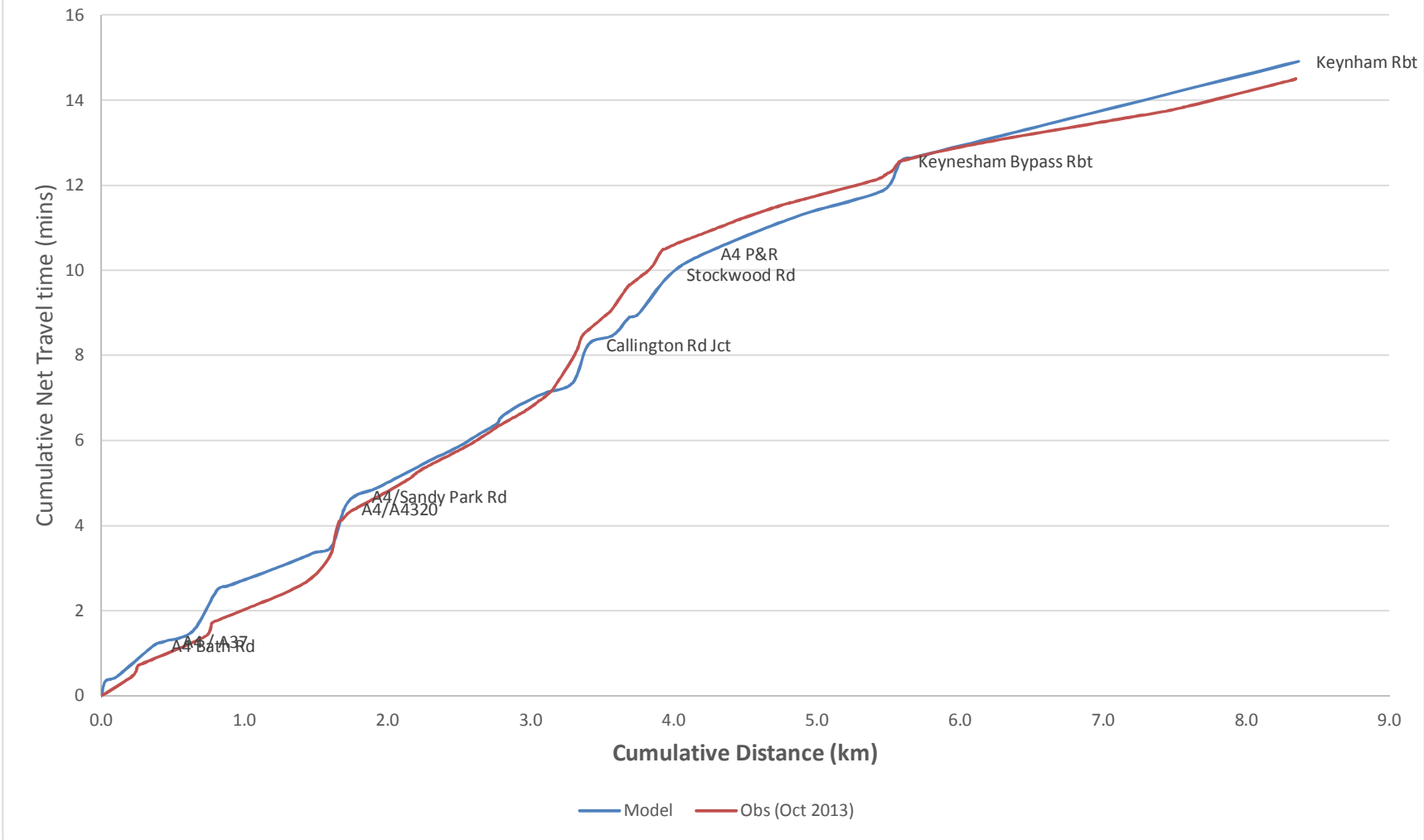
R2: A38 Outbound (Bedminster Bridge to Barrow Gurney) IP Peak



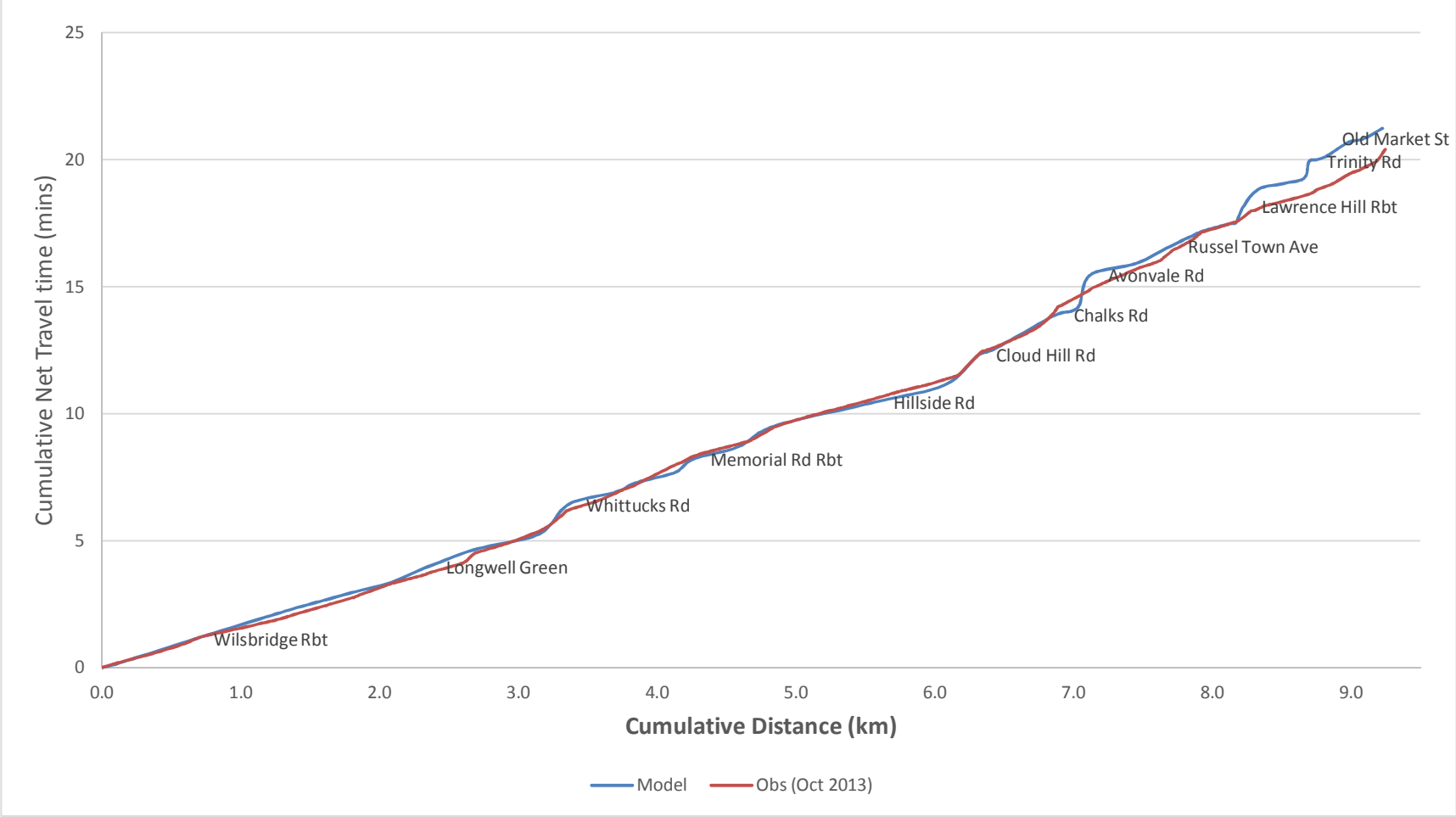
R3: A4 Inbound (Keynesham to Bath Bridge) IP Peak



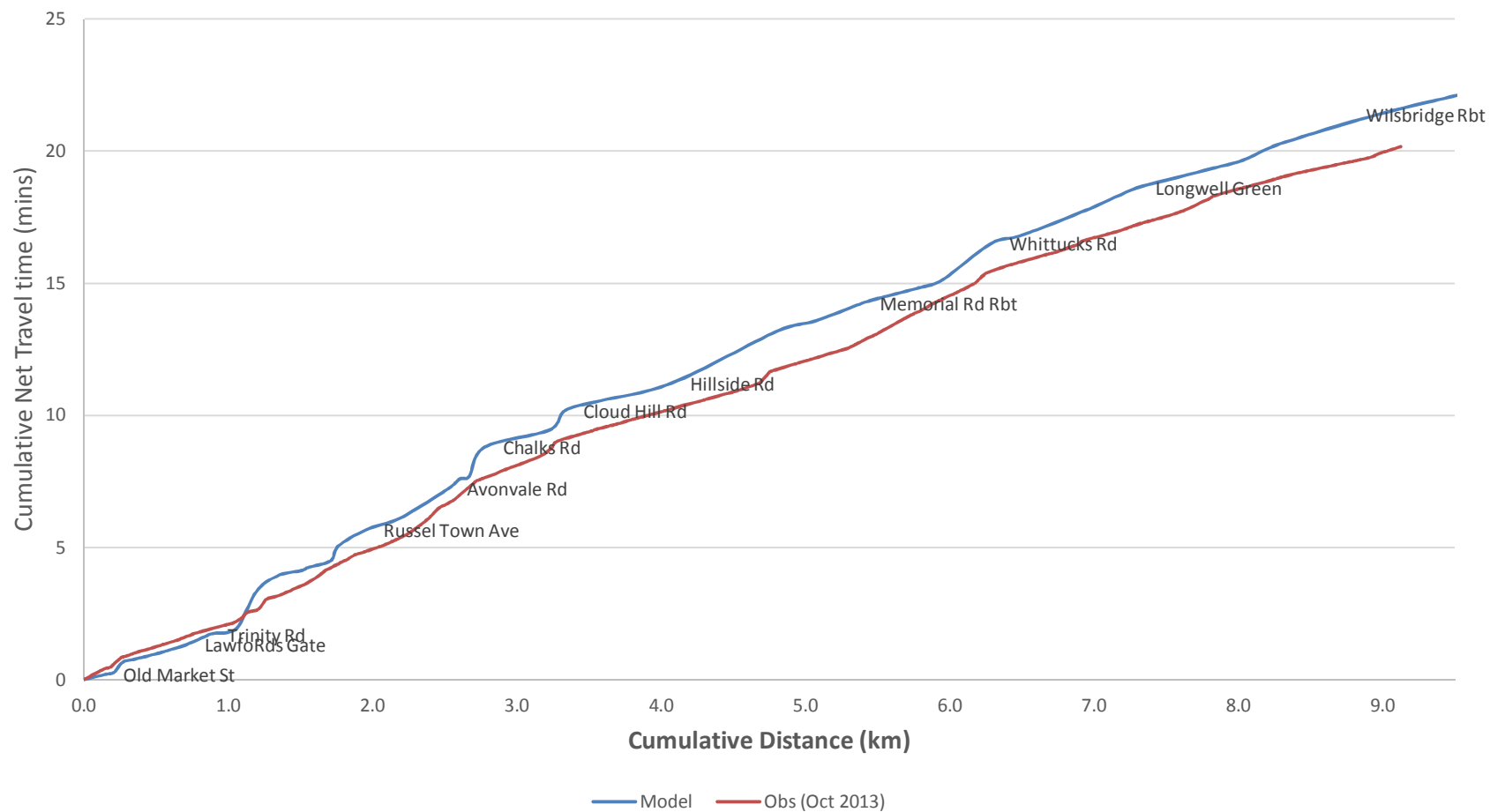
R3: A4 Outbound (Bath Bridge to Keynesham) IP Peak



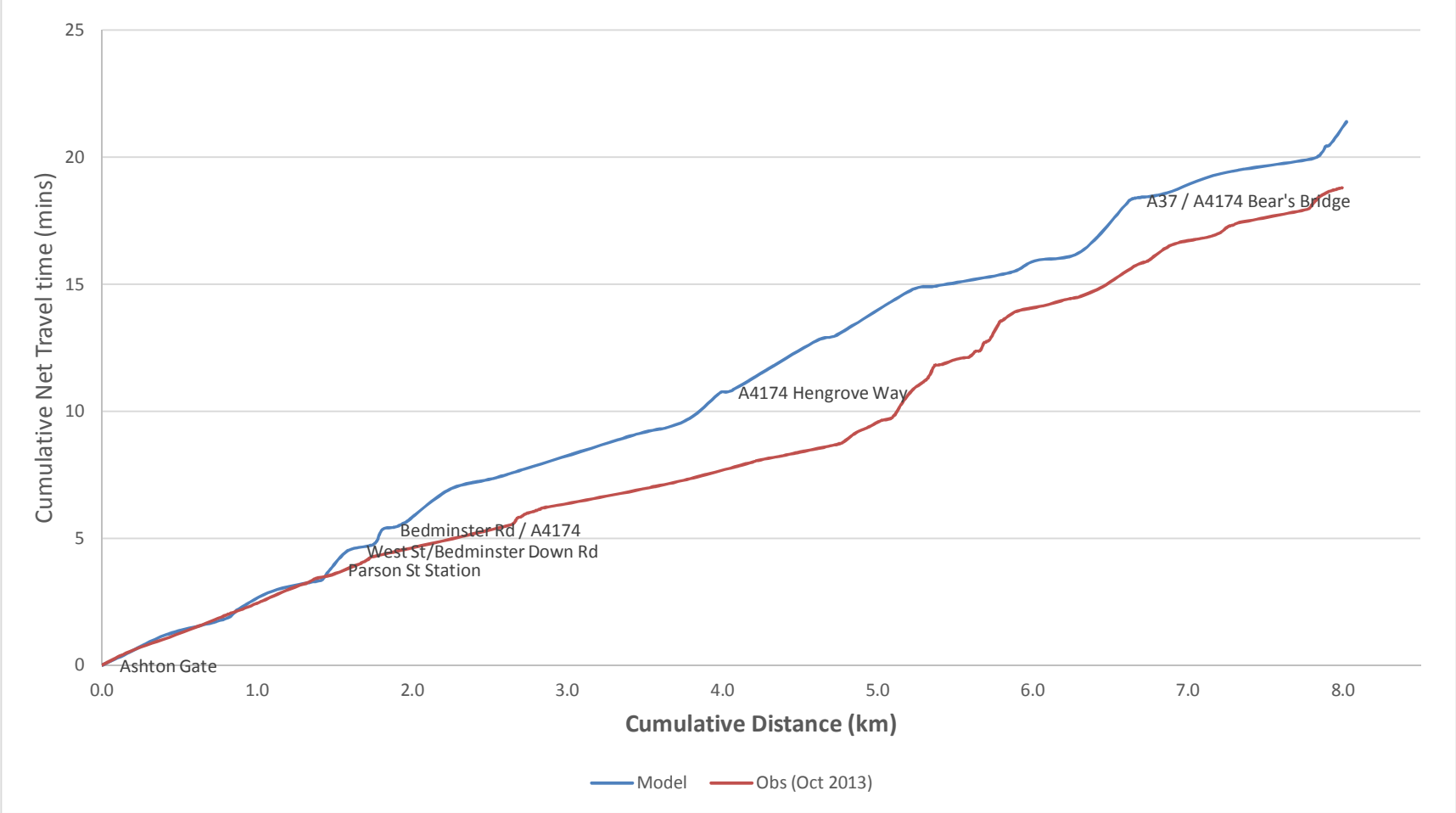
R4: A431 Inbound (Willsbridge to Old Market St) IP Peak



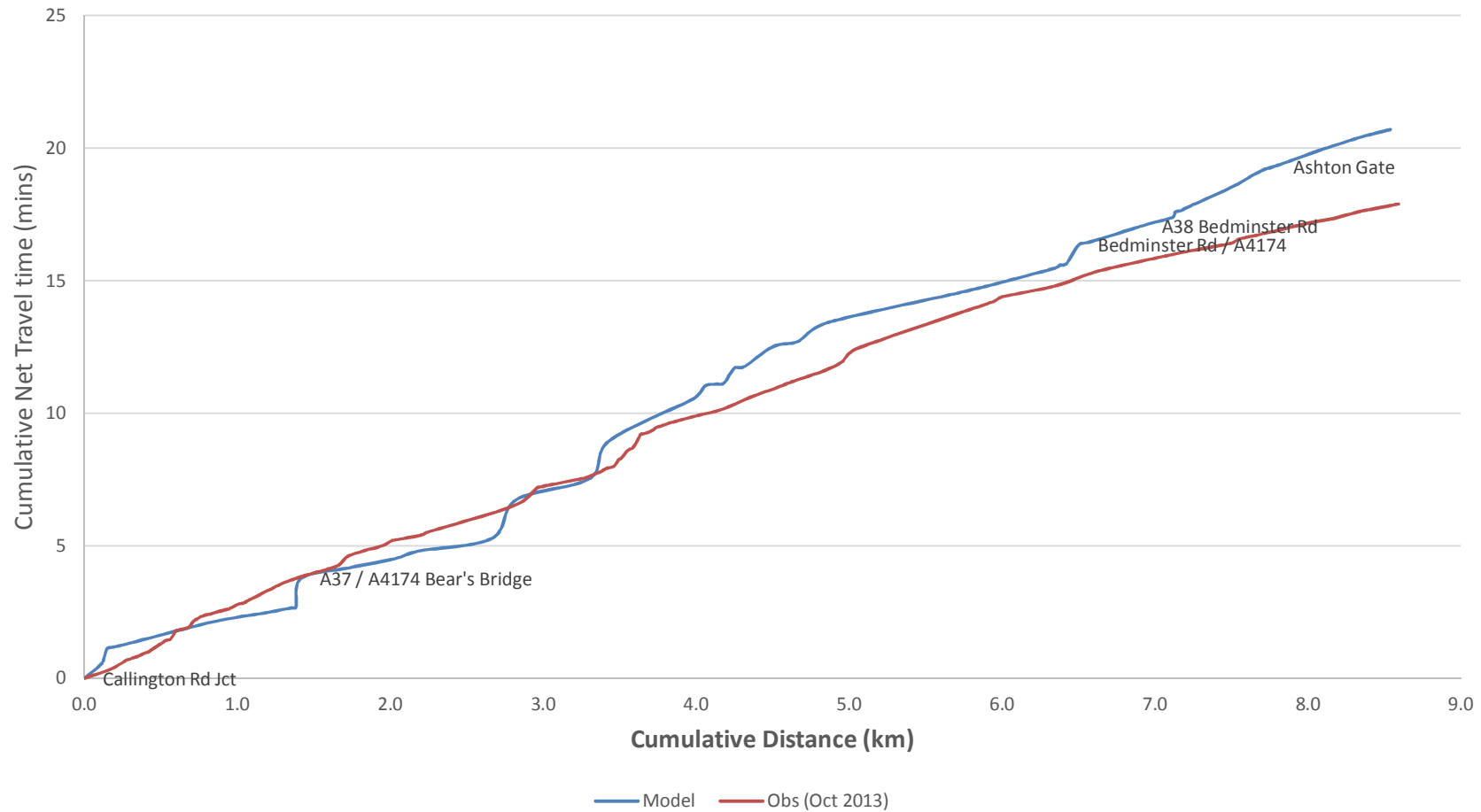
R4: A431 Outbound (Old Market St Jct to Willsbridge) IP Peak



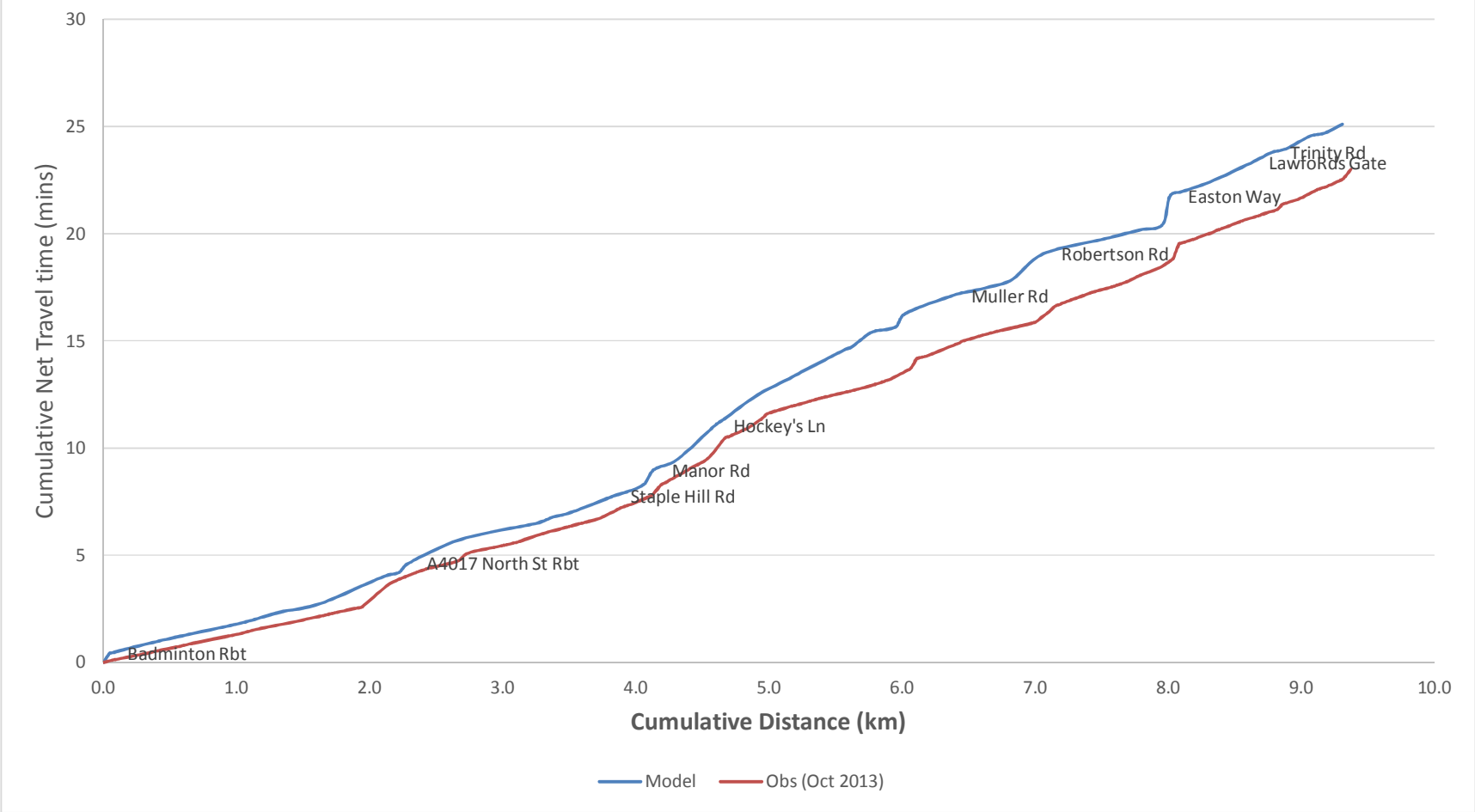
R5: A38 Eastbound (Ashton Gate to Brislington {via Hengrove}) IP Peak



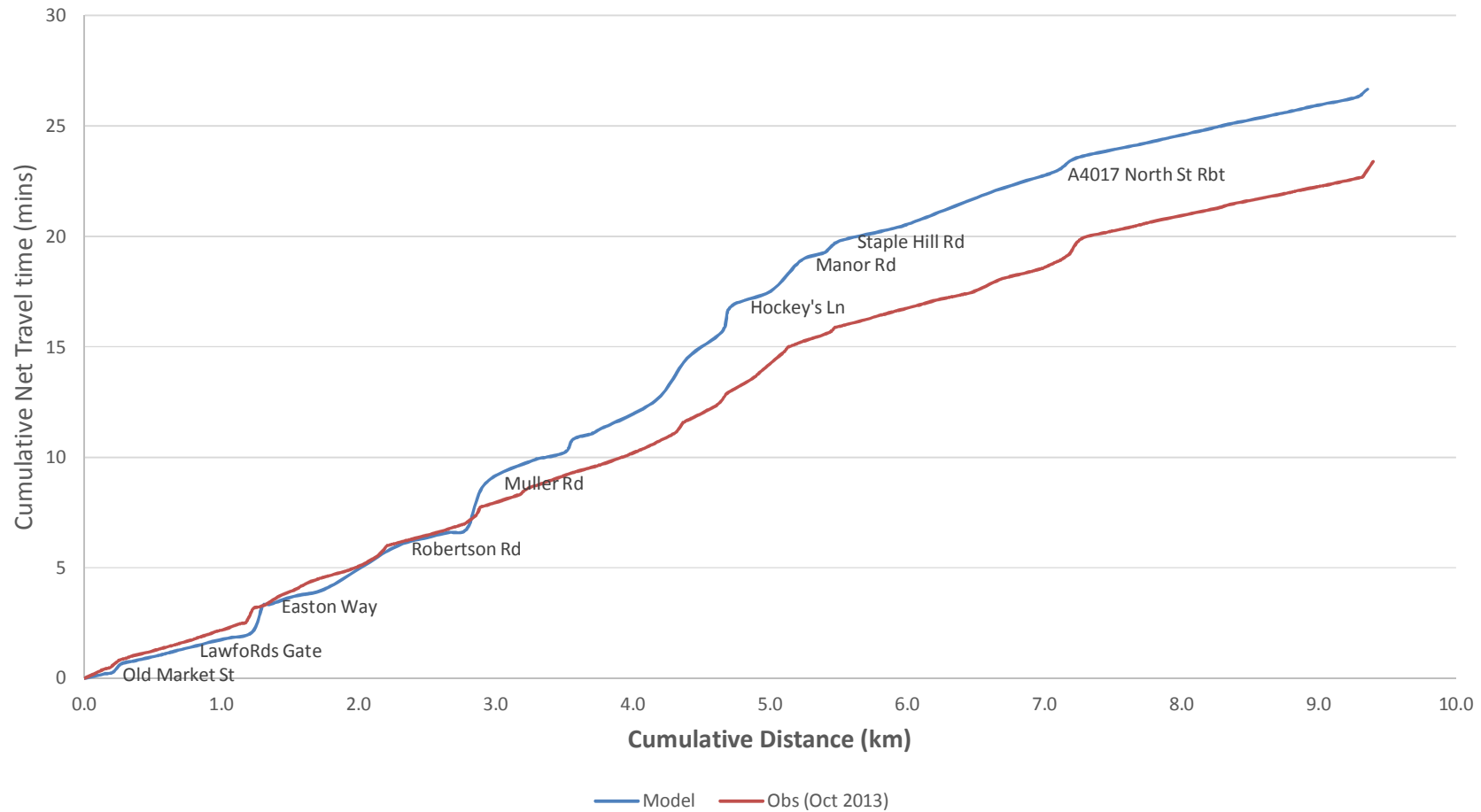
R5: A38 Westbound (Brislington to Ashton Gate {via Hengrove}) IP Peak

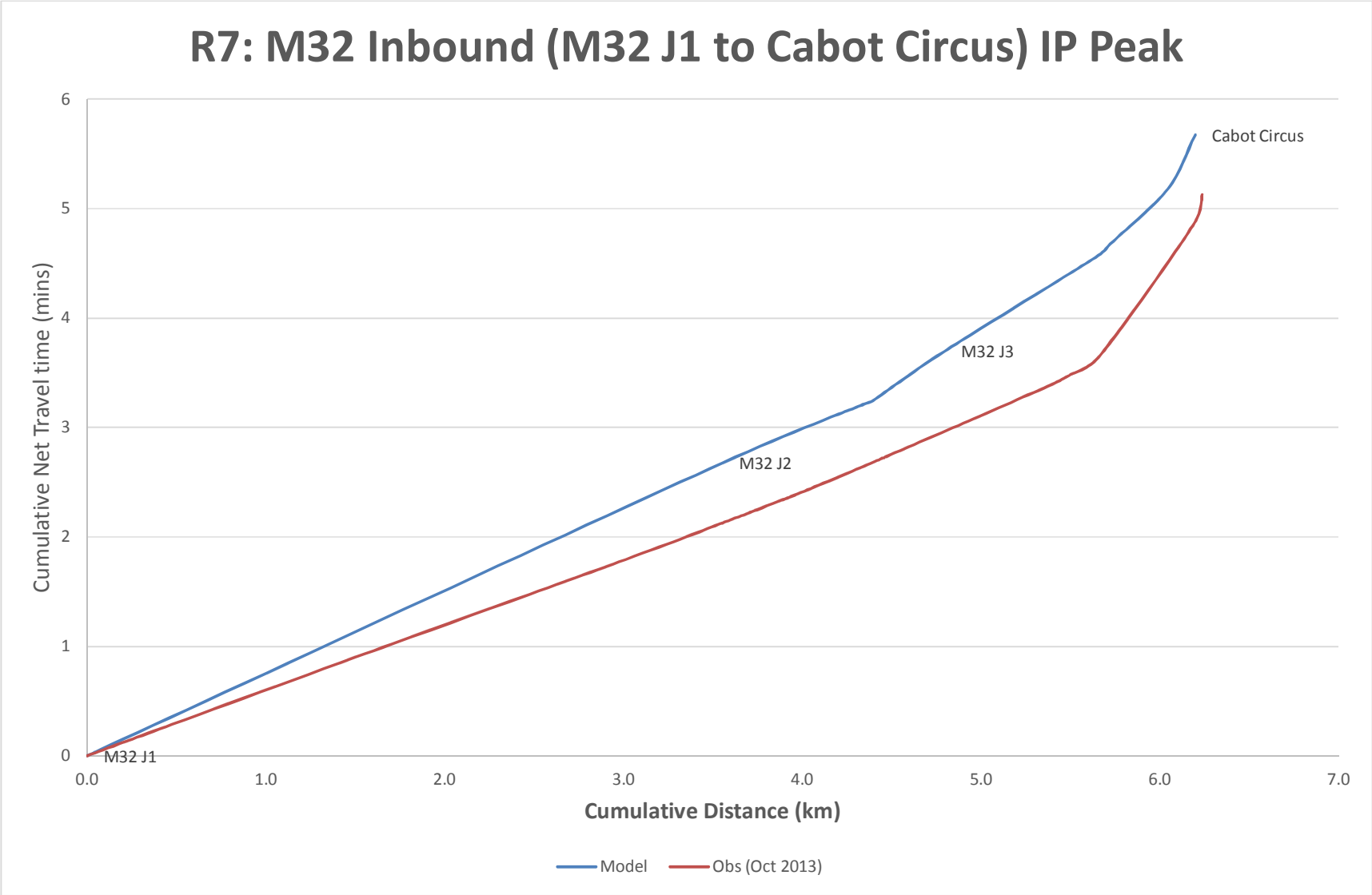


R6: A432 Inbound (A4174 Badminton Rbt to Old Market St) IP Peak

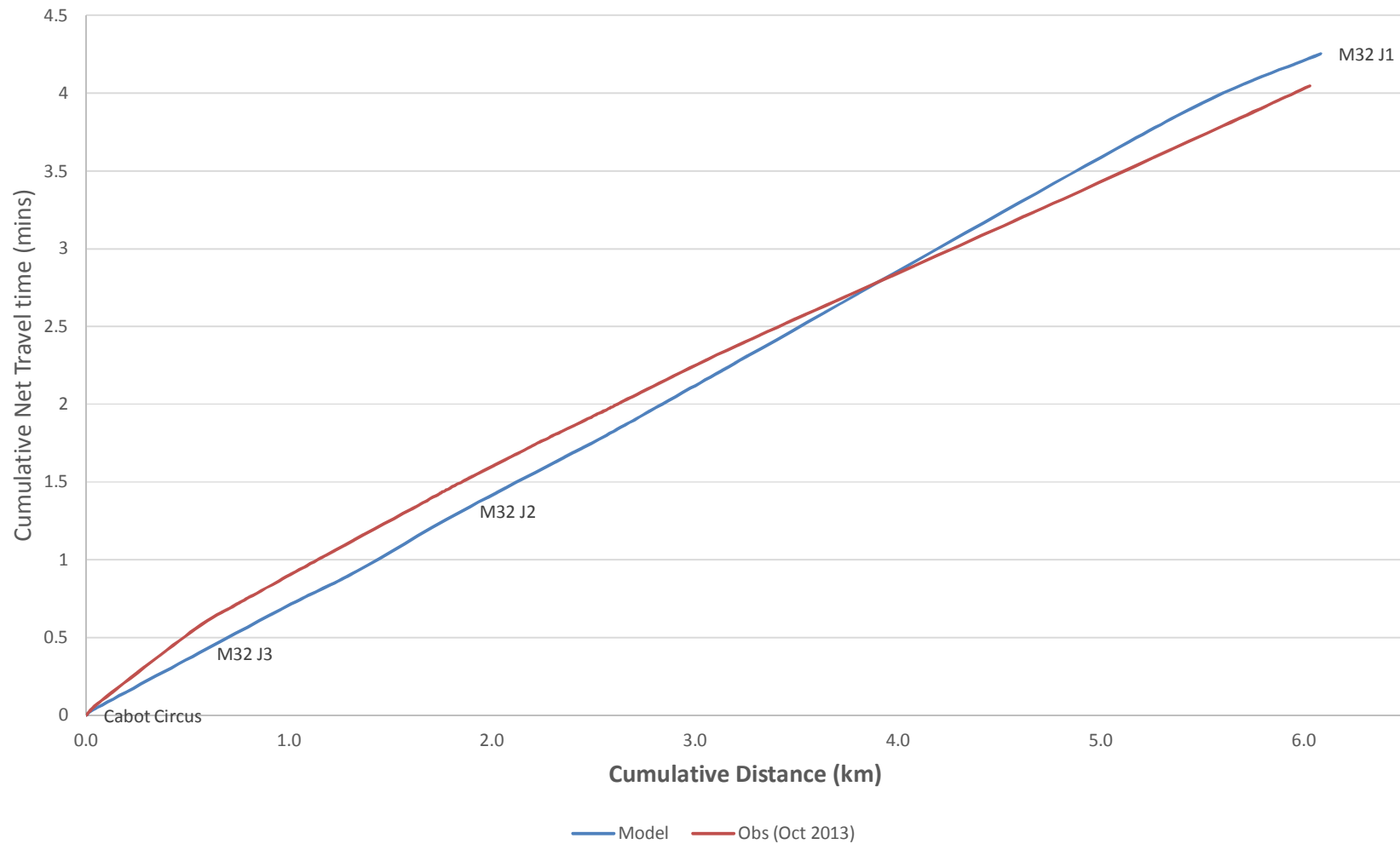


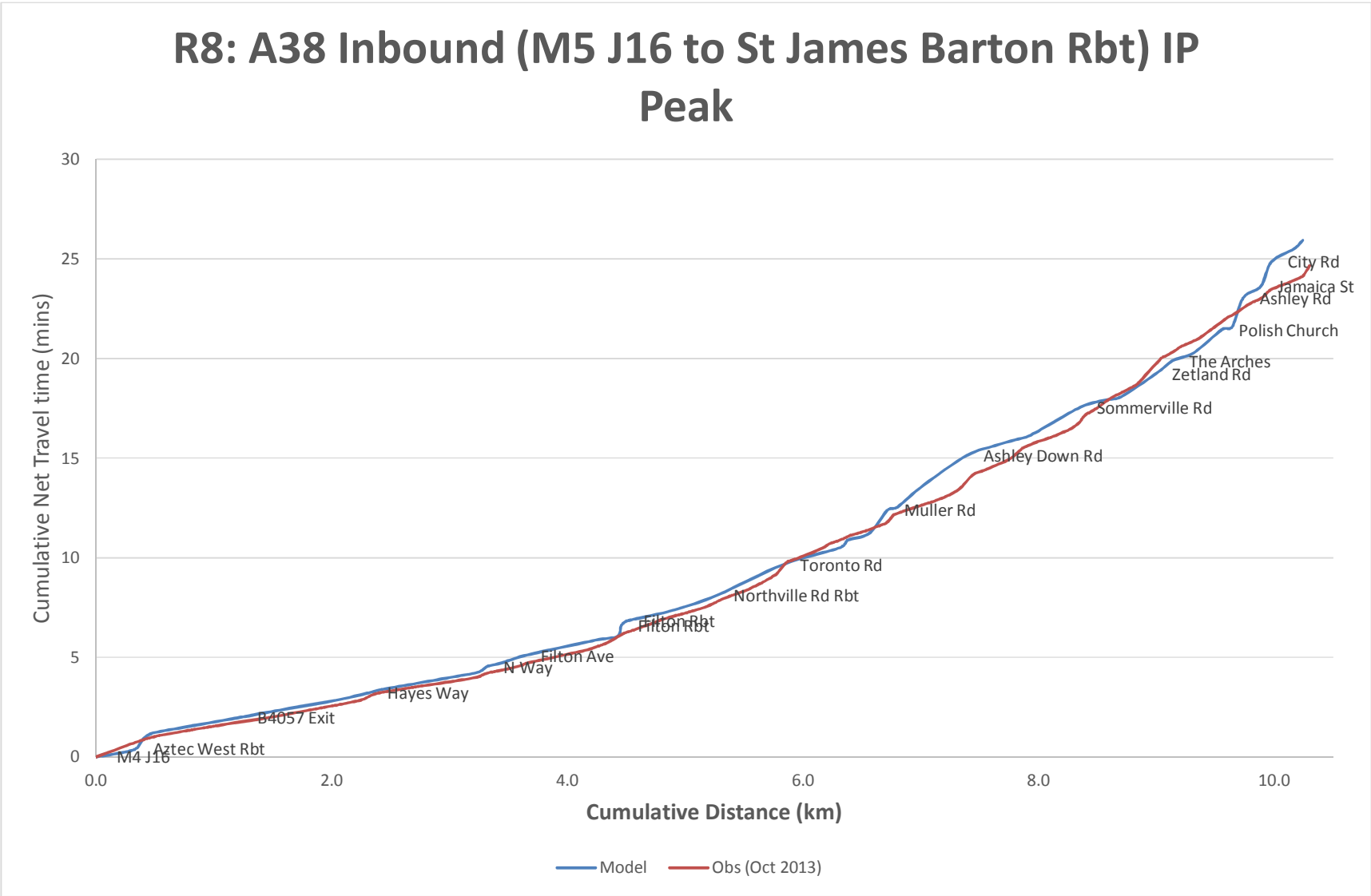
R6: A432 Outbound (West St to A4174 Badminton Rbt) IP Peak



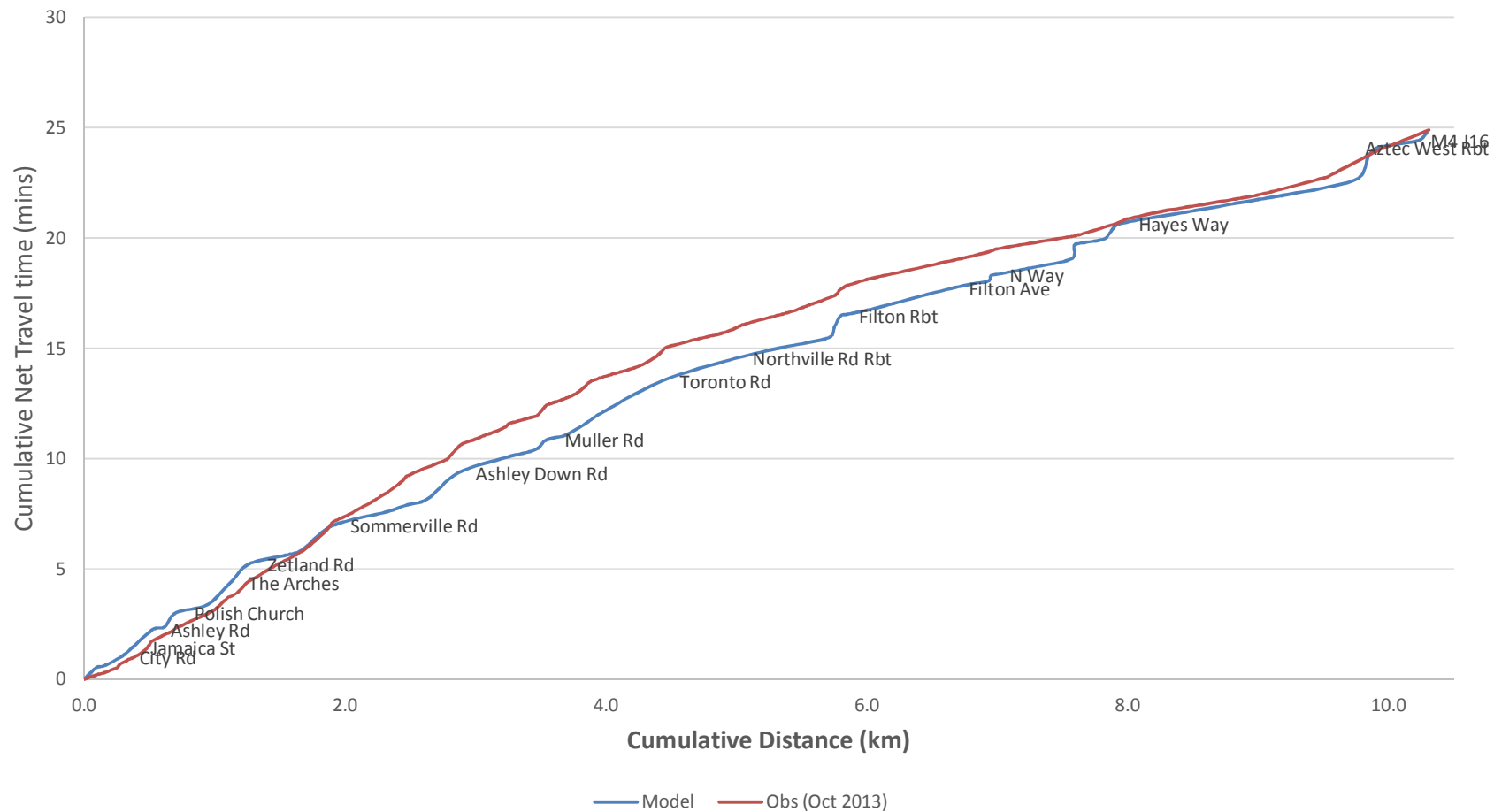


R7: M32 Outbound (Cabot Circus to M32 J1) IP Peak

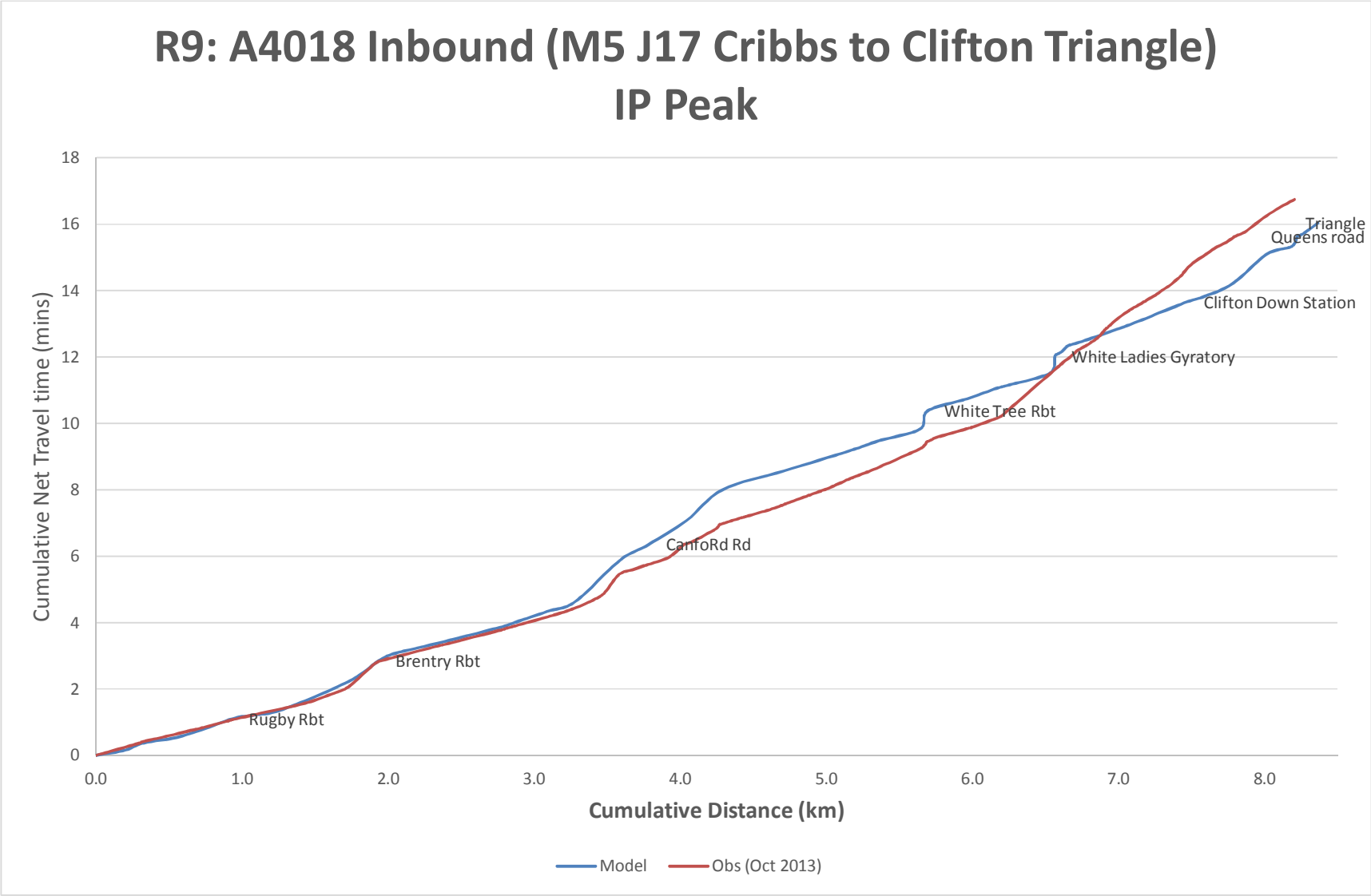




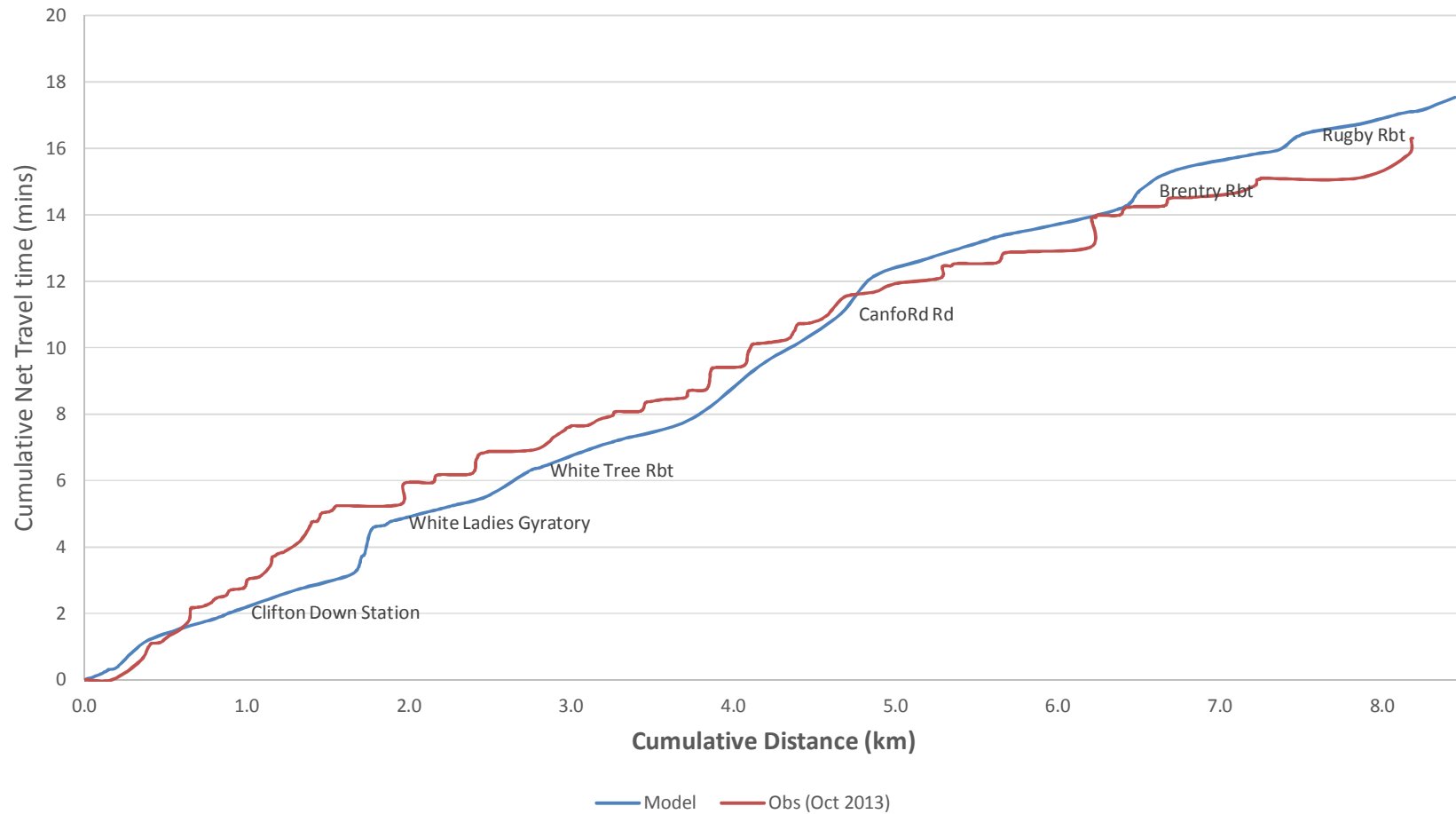
R8: A38 Outbound (St James Barton Rbt to M5 J16) IP Peak



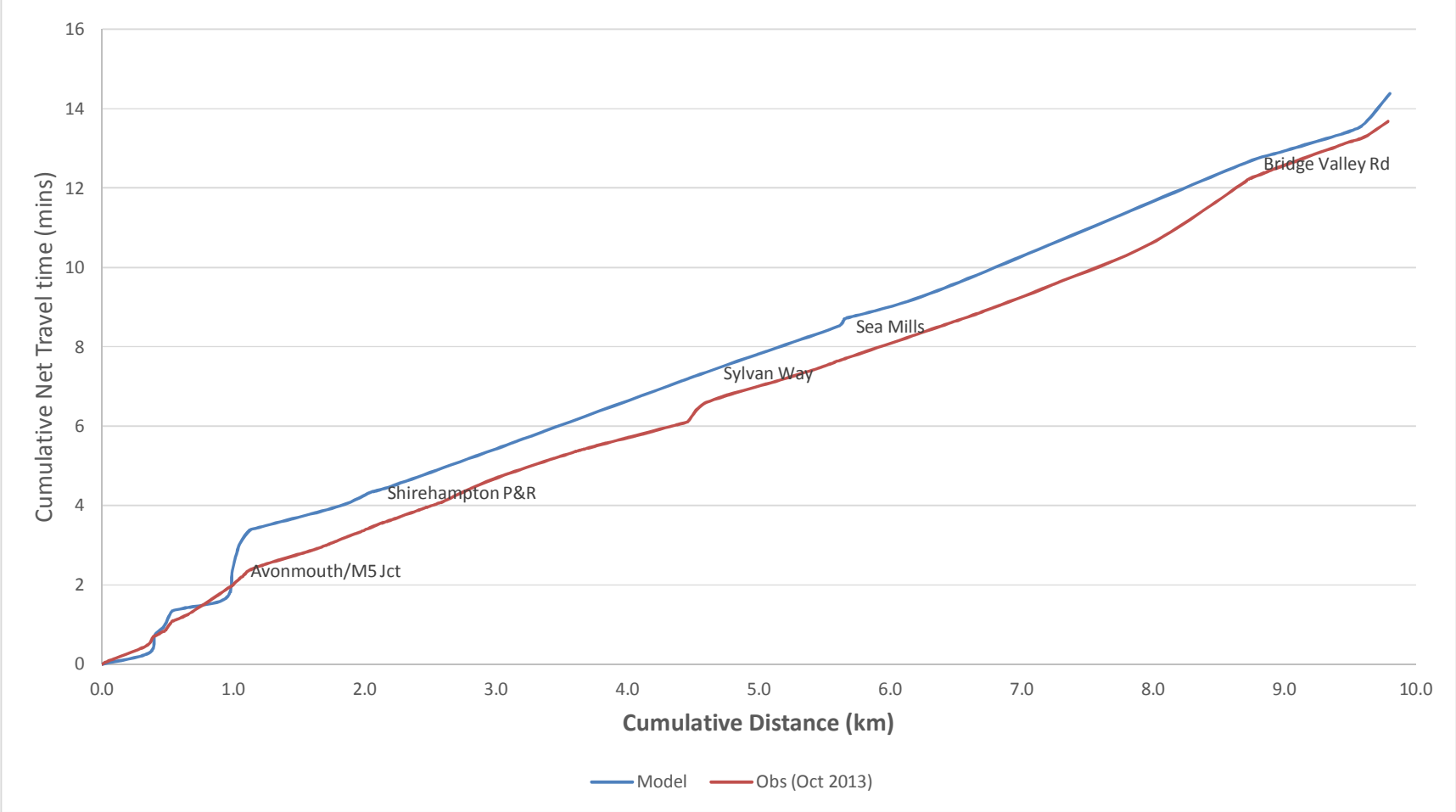
R9: A4018 Inbound (M5 J17 Cribbs to Clifton Triangle) IP Peak



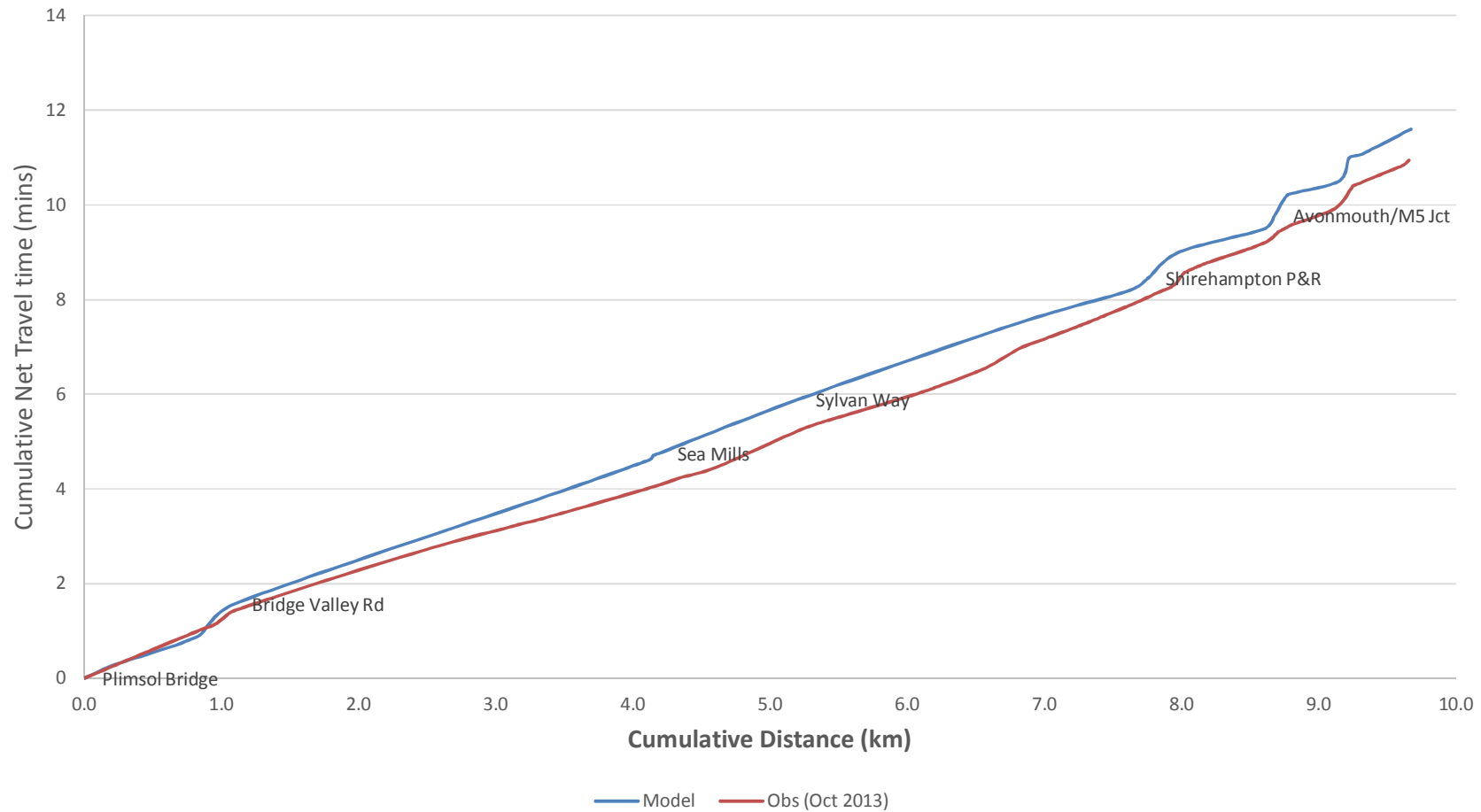
R9: A4018 Outbound (College Green to M5 J17 Cribbs) IP Peak



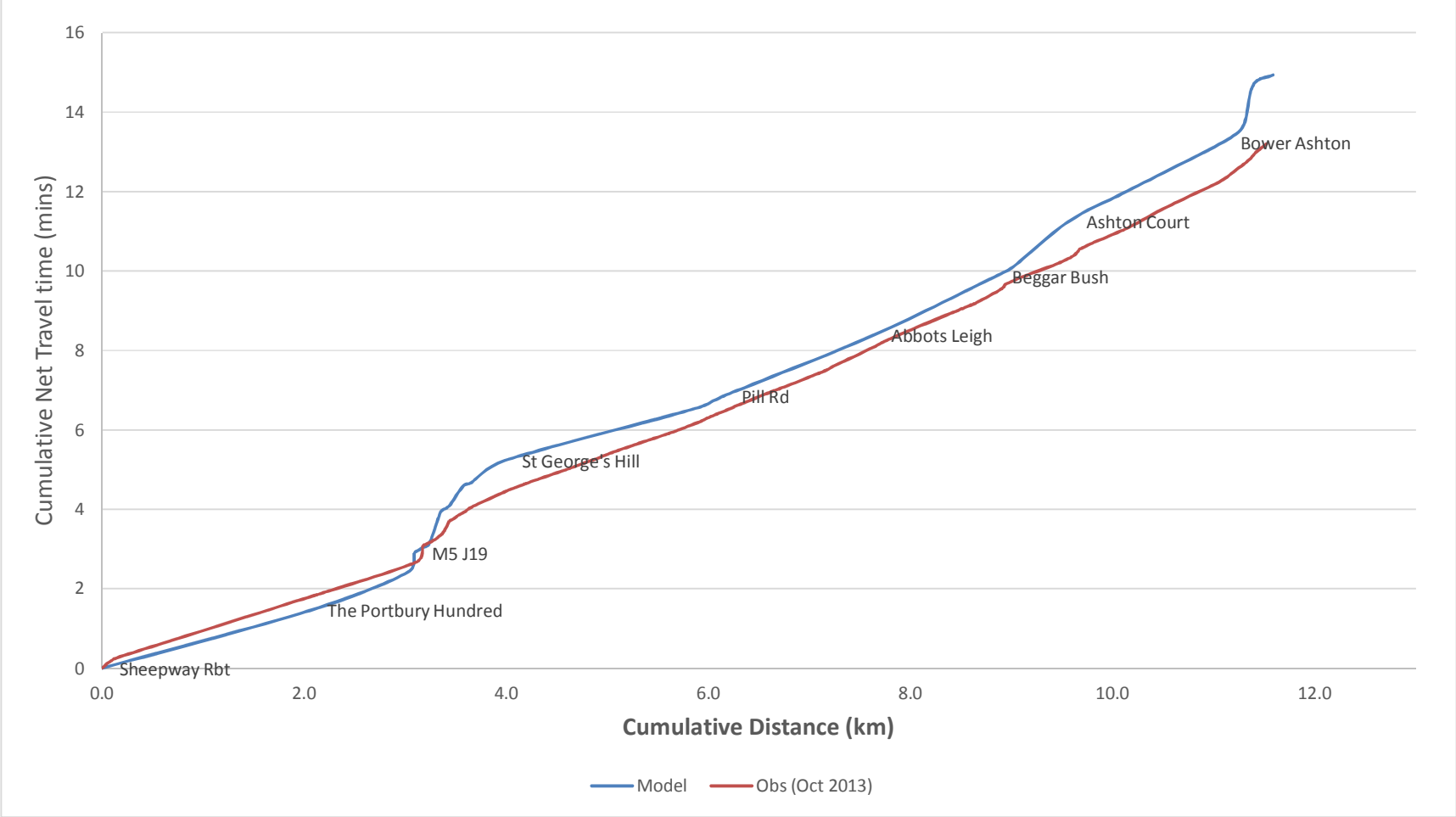
R10: A4 Portway Inbound (Avonmouth to Hotwells) IP Peak



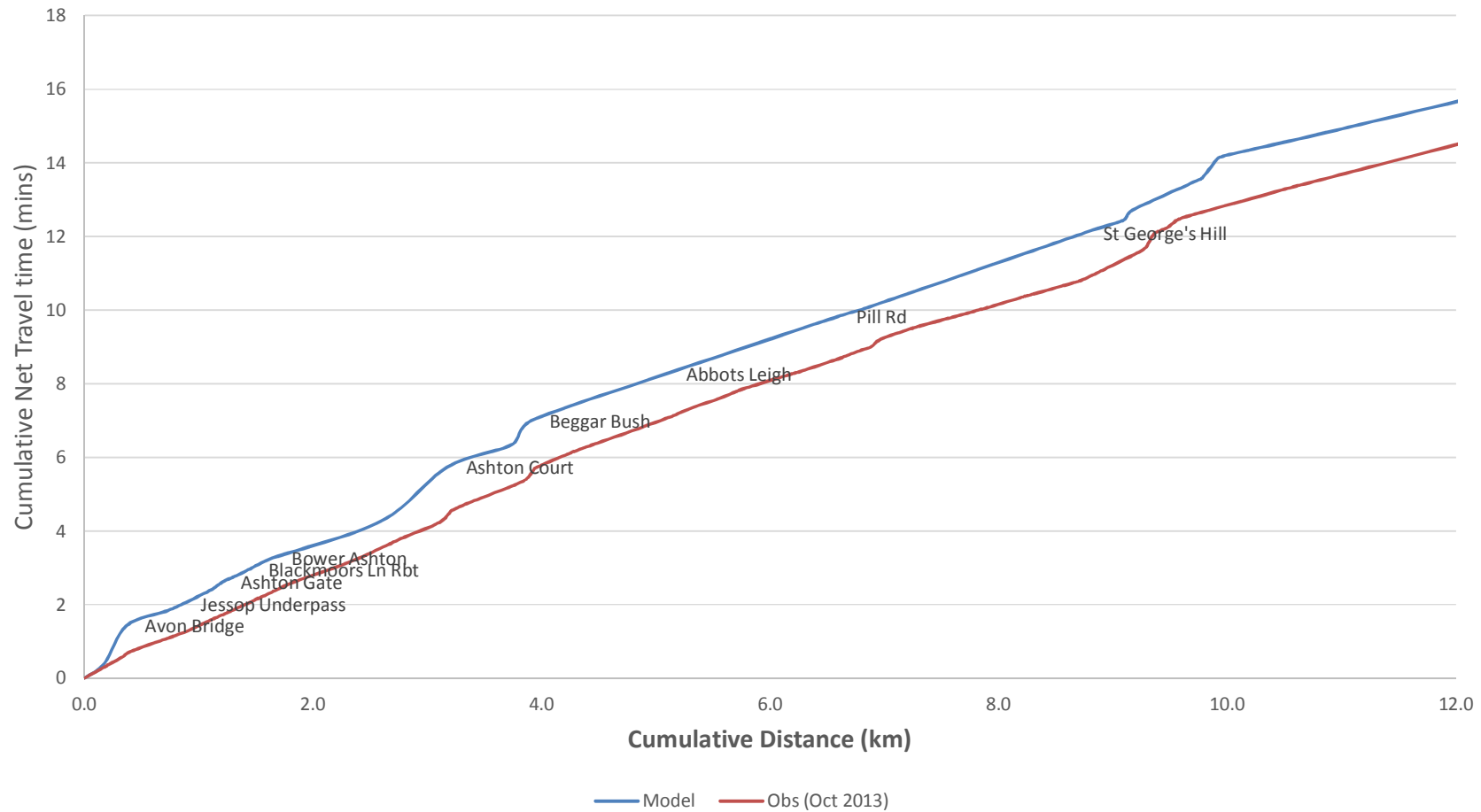
R10: A4 Portway Outbound (Hotwells to Avonmouth) IP Peak

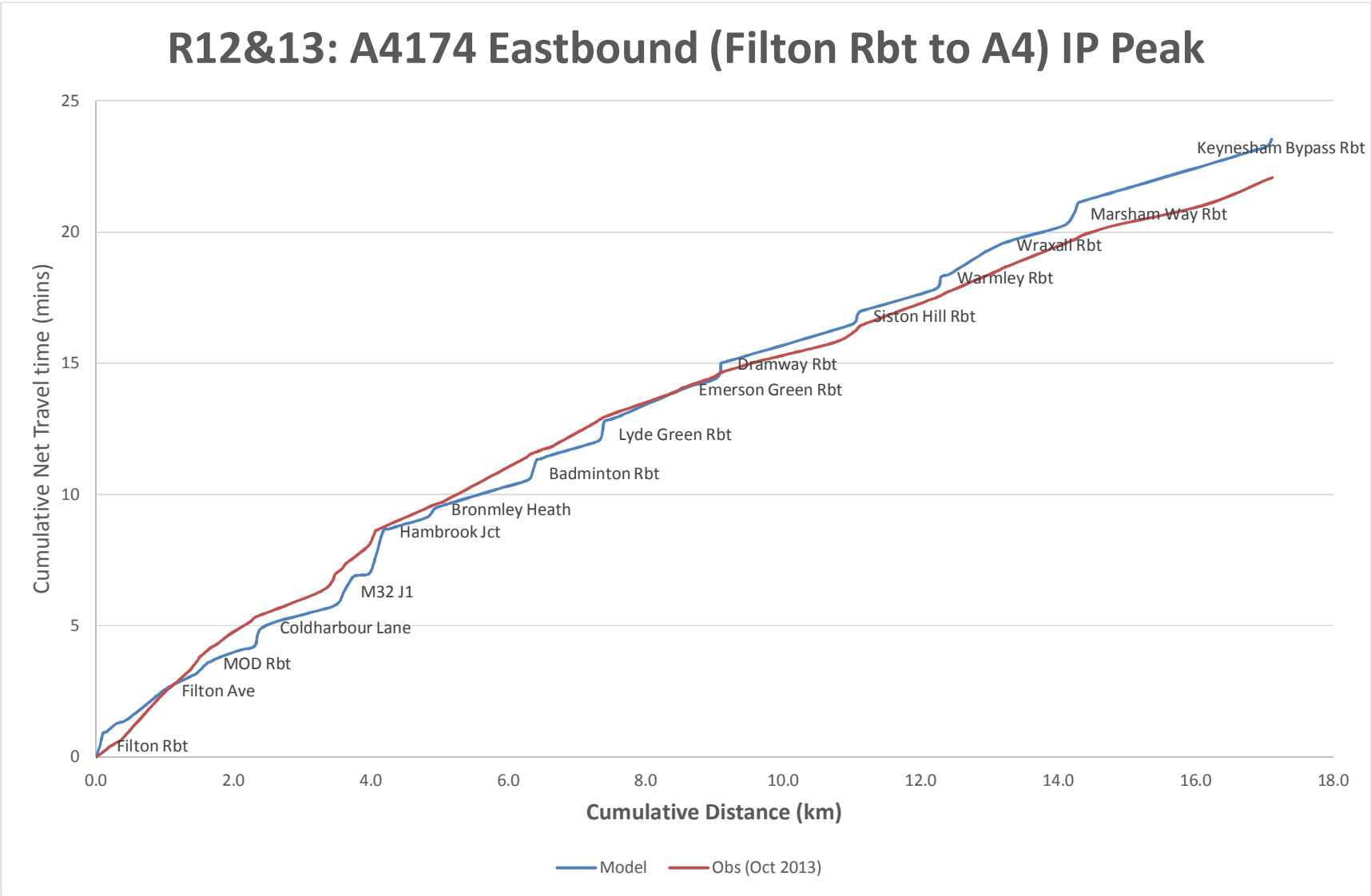


R11: A369 Inbound (Portishead to A4 Bristol Gate) IP Peak

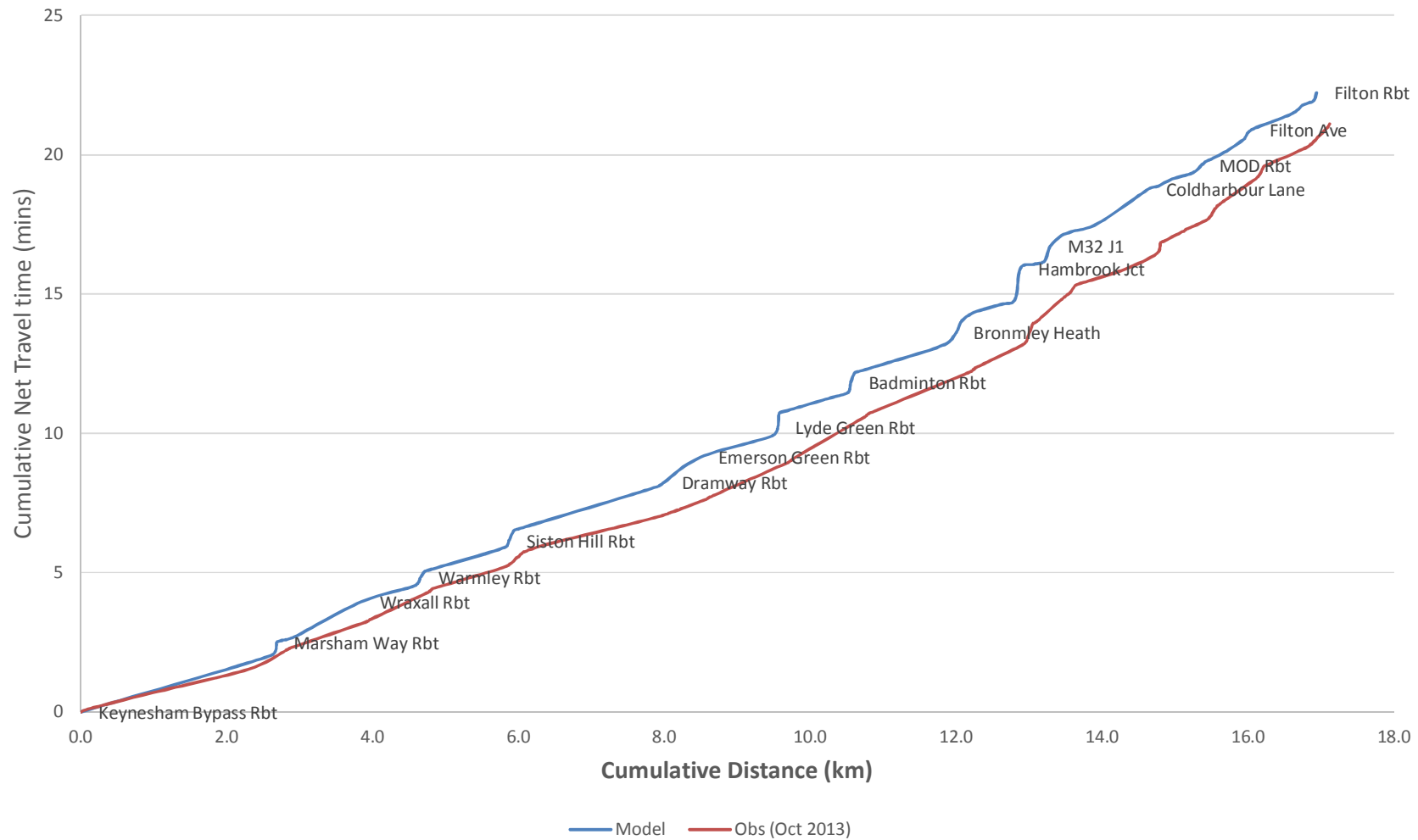


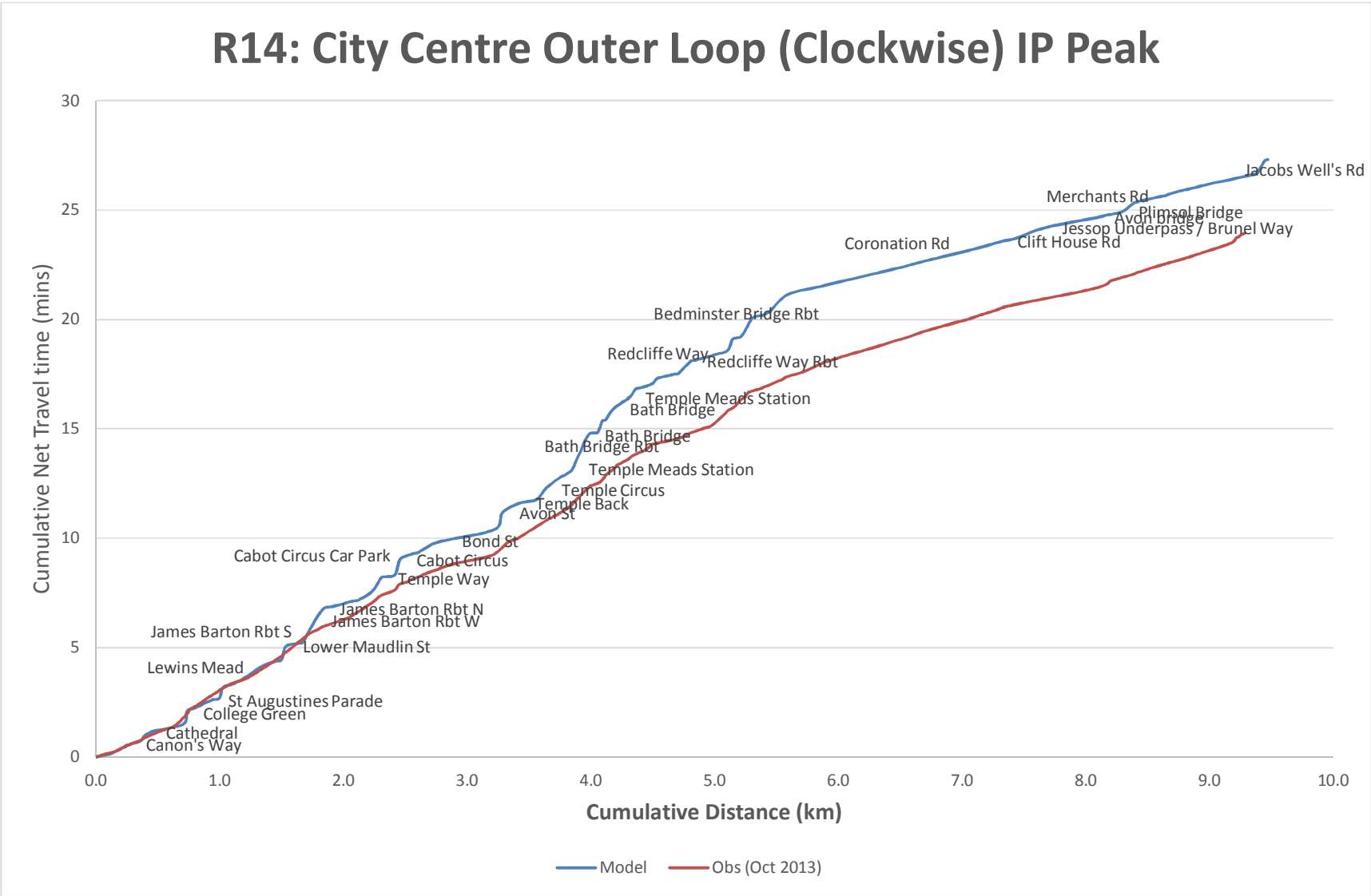
R11: A369 Outbound (A4 Bristol Gate to Portishead) IP Peak



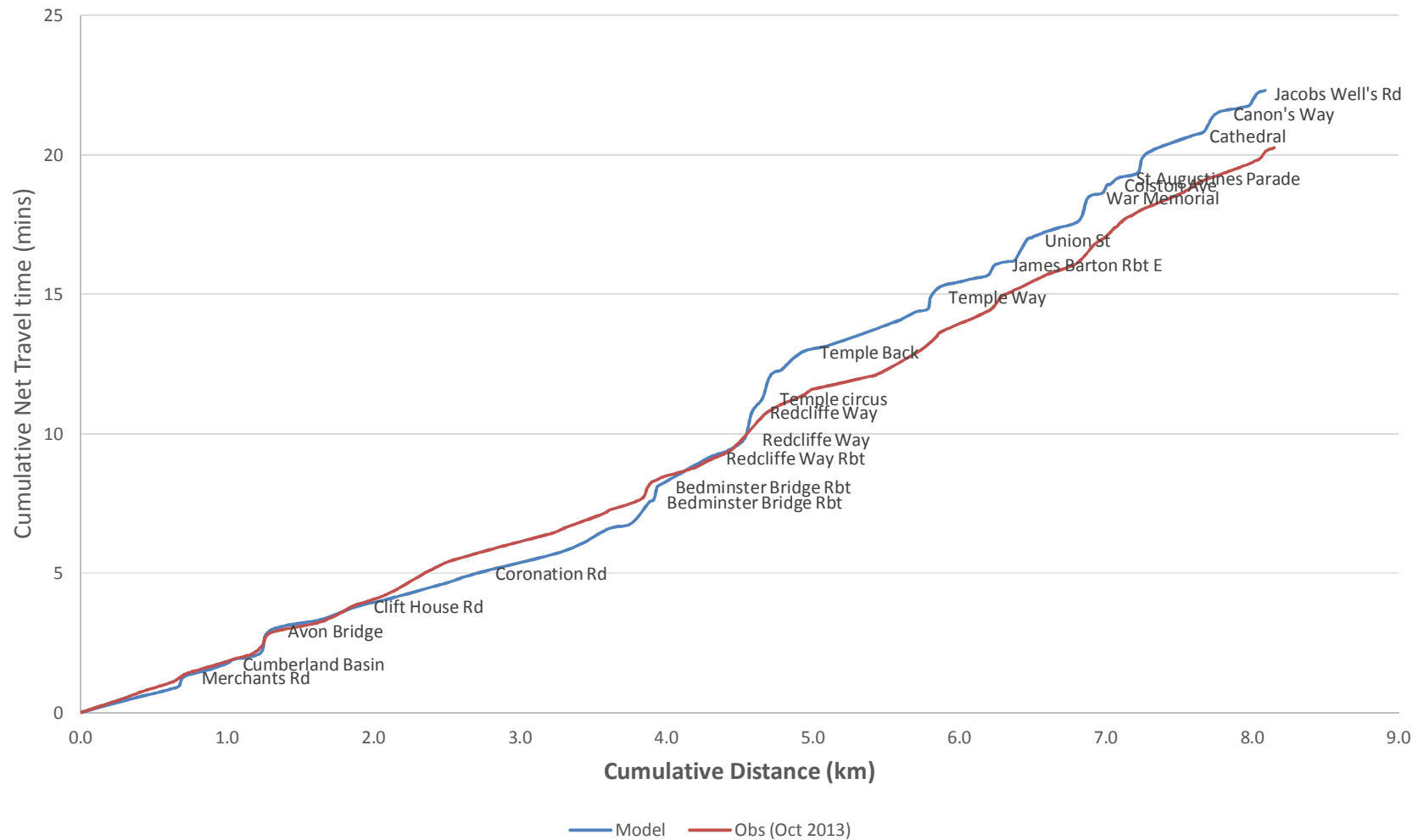


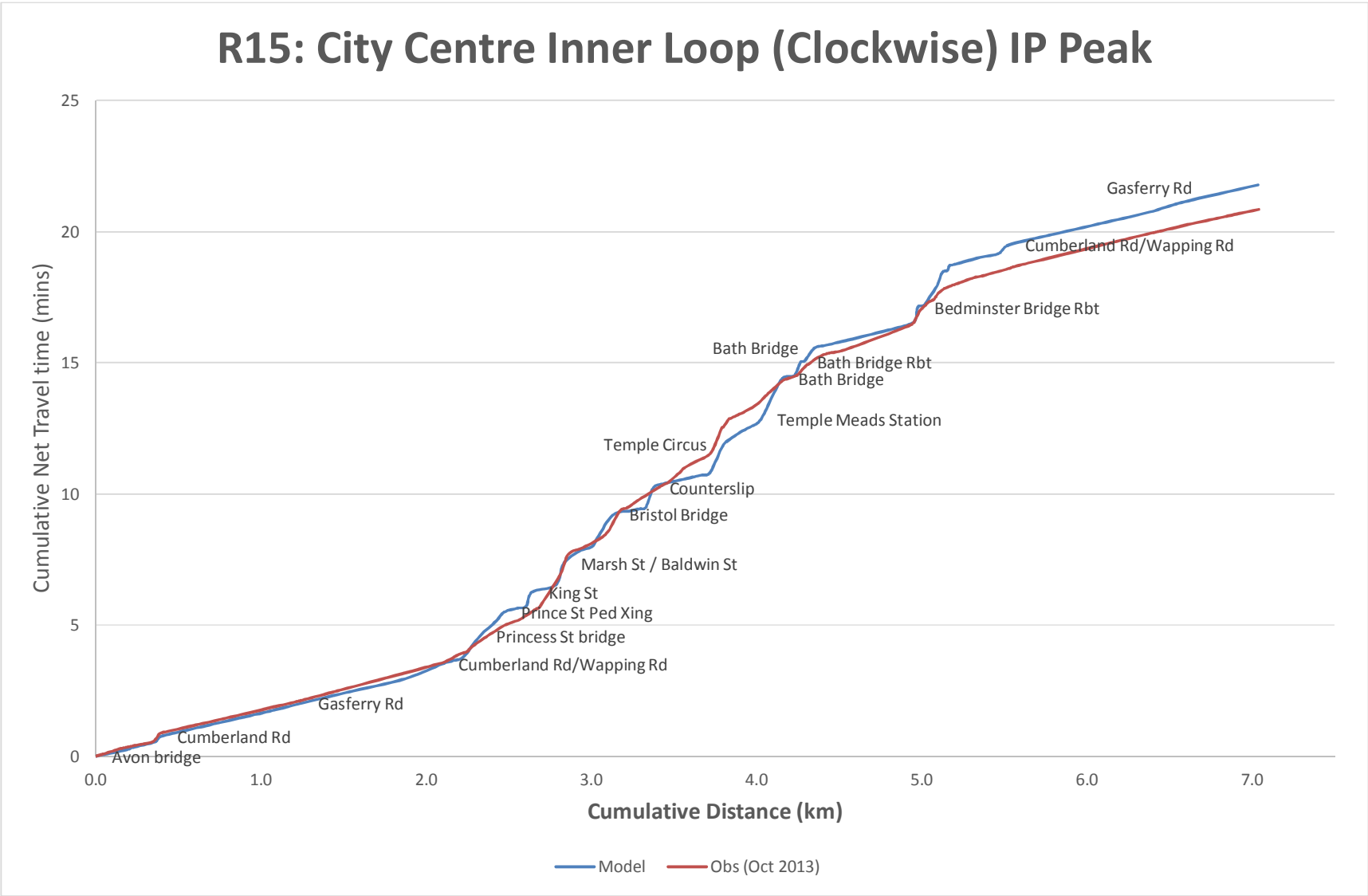
R12&13: A4174 Westbound (A4 to Filton Rbt) IP Peak



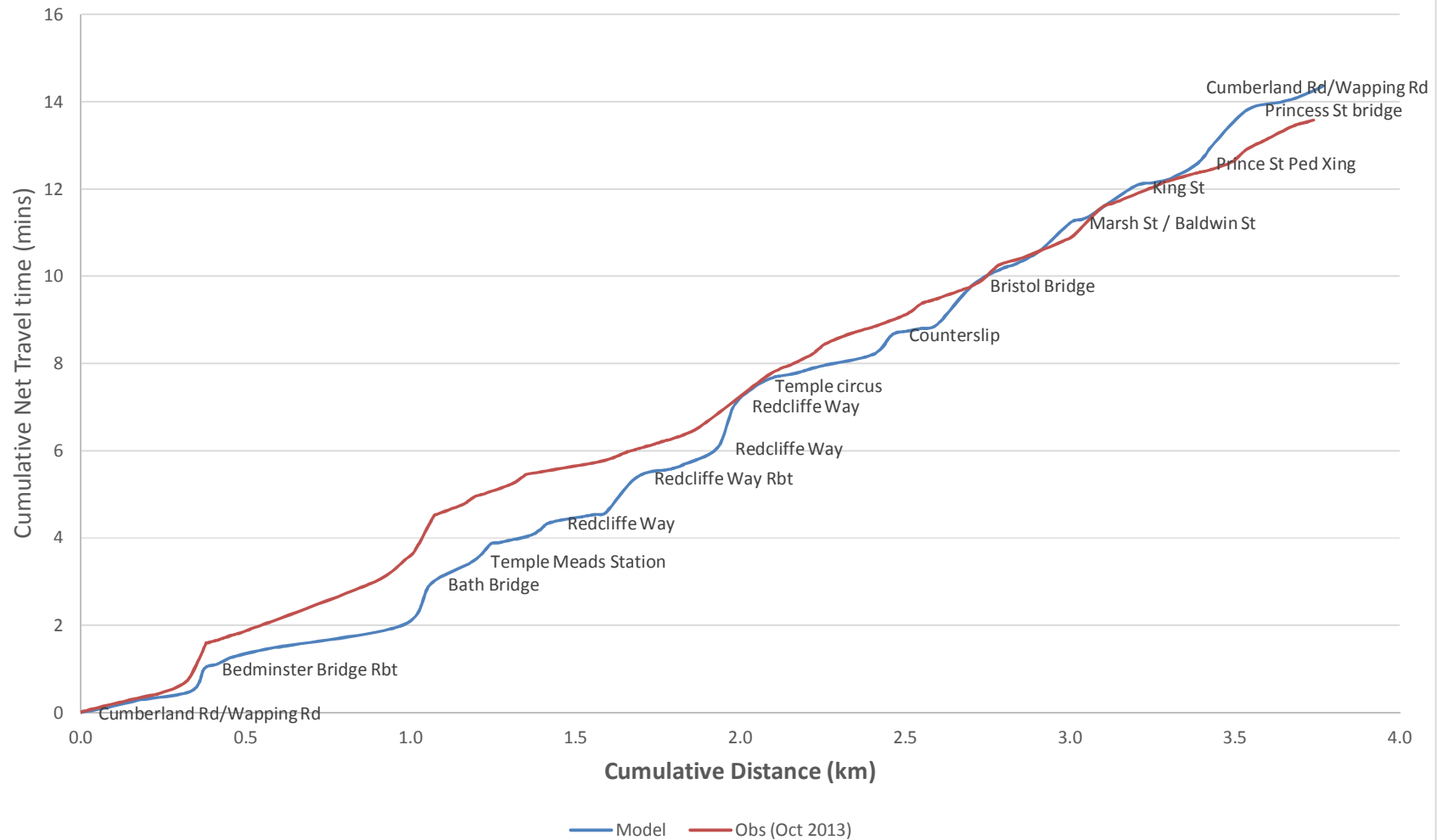


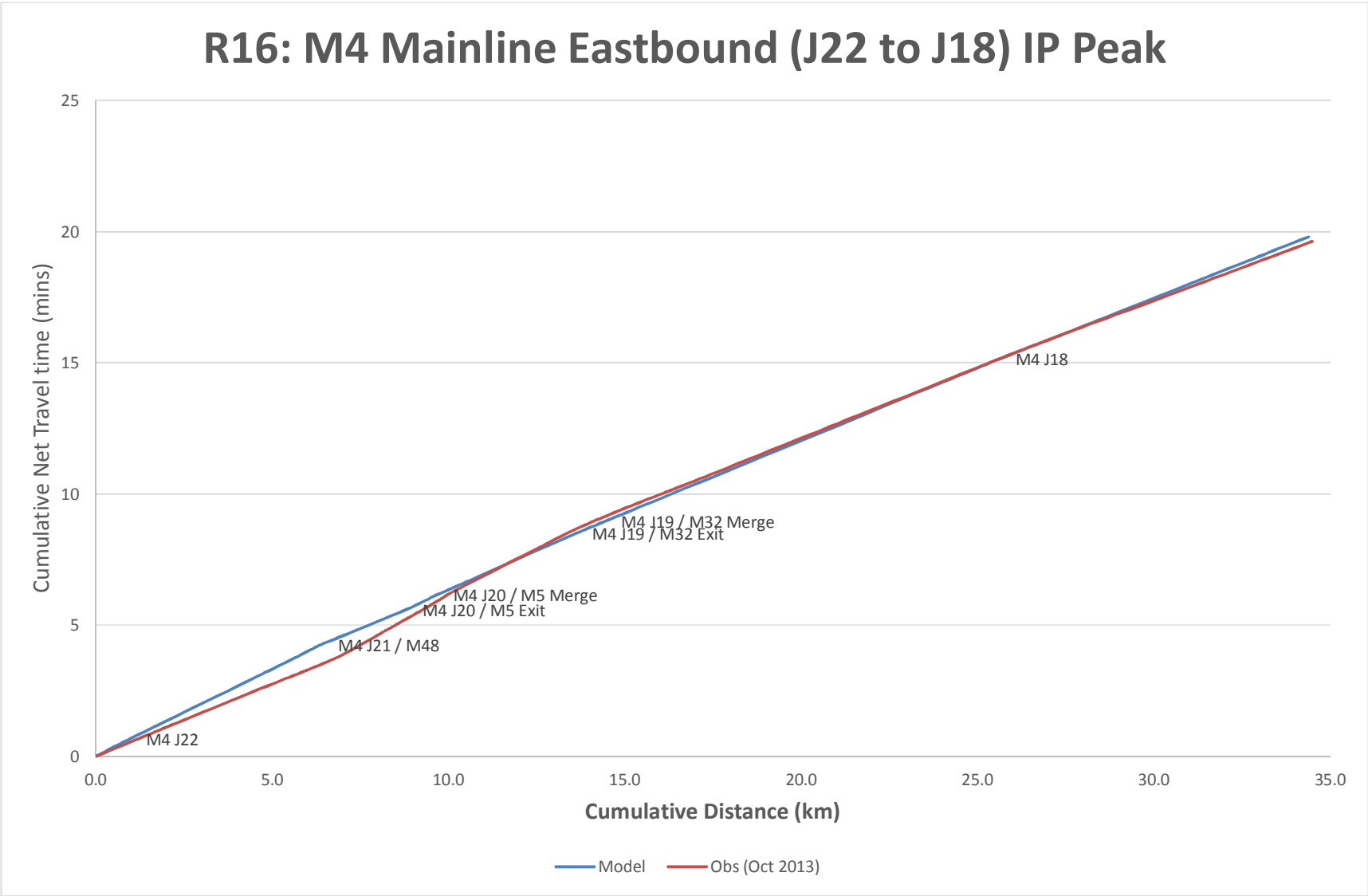
R14: City Centre Outer Loop (Anti-Clockwise) IP Peak



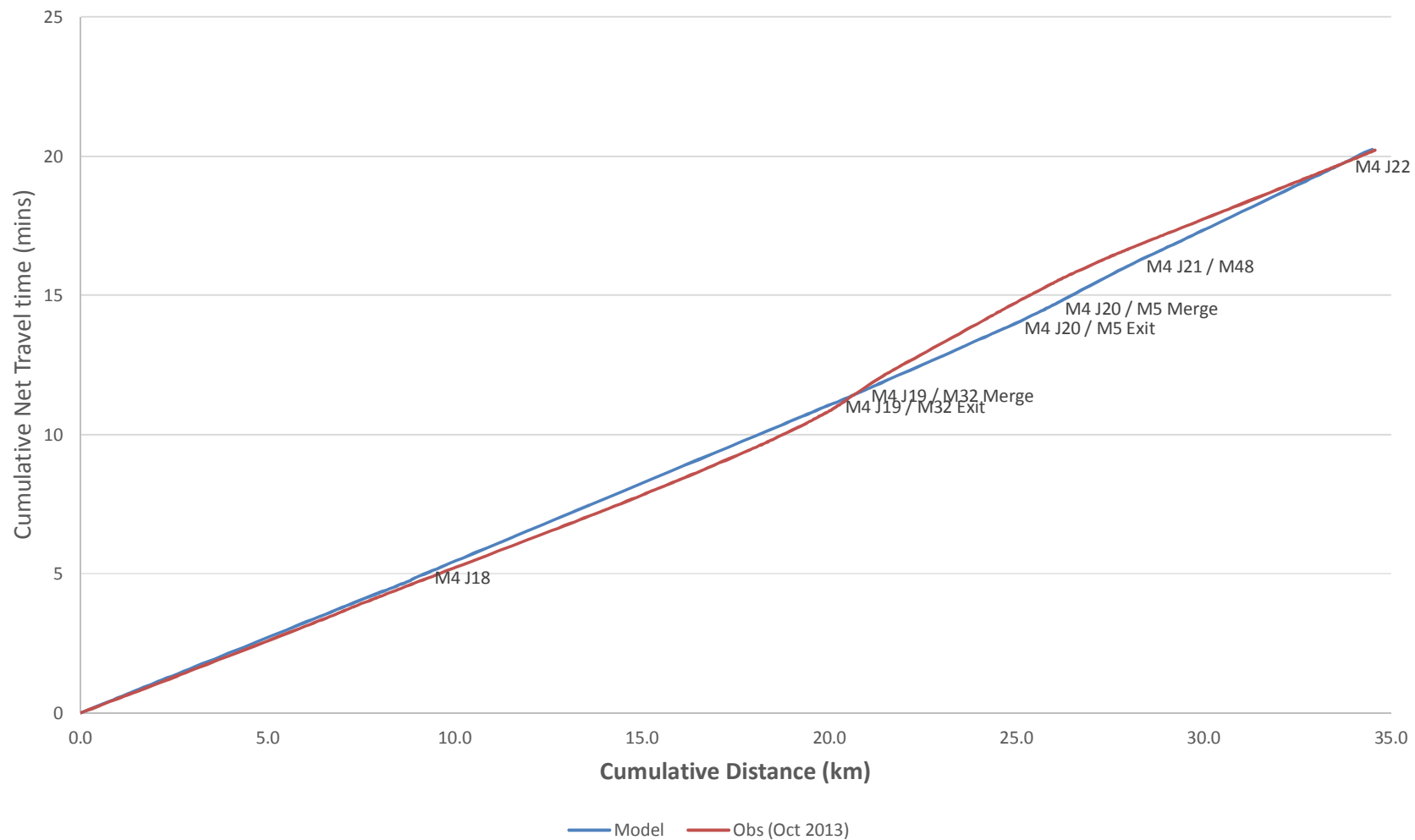


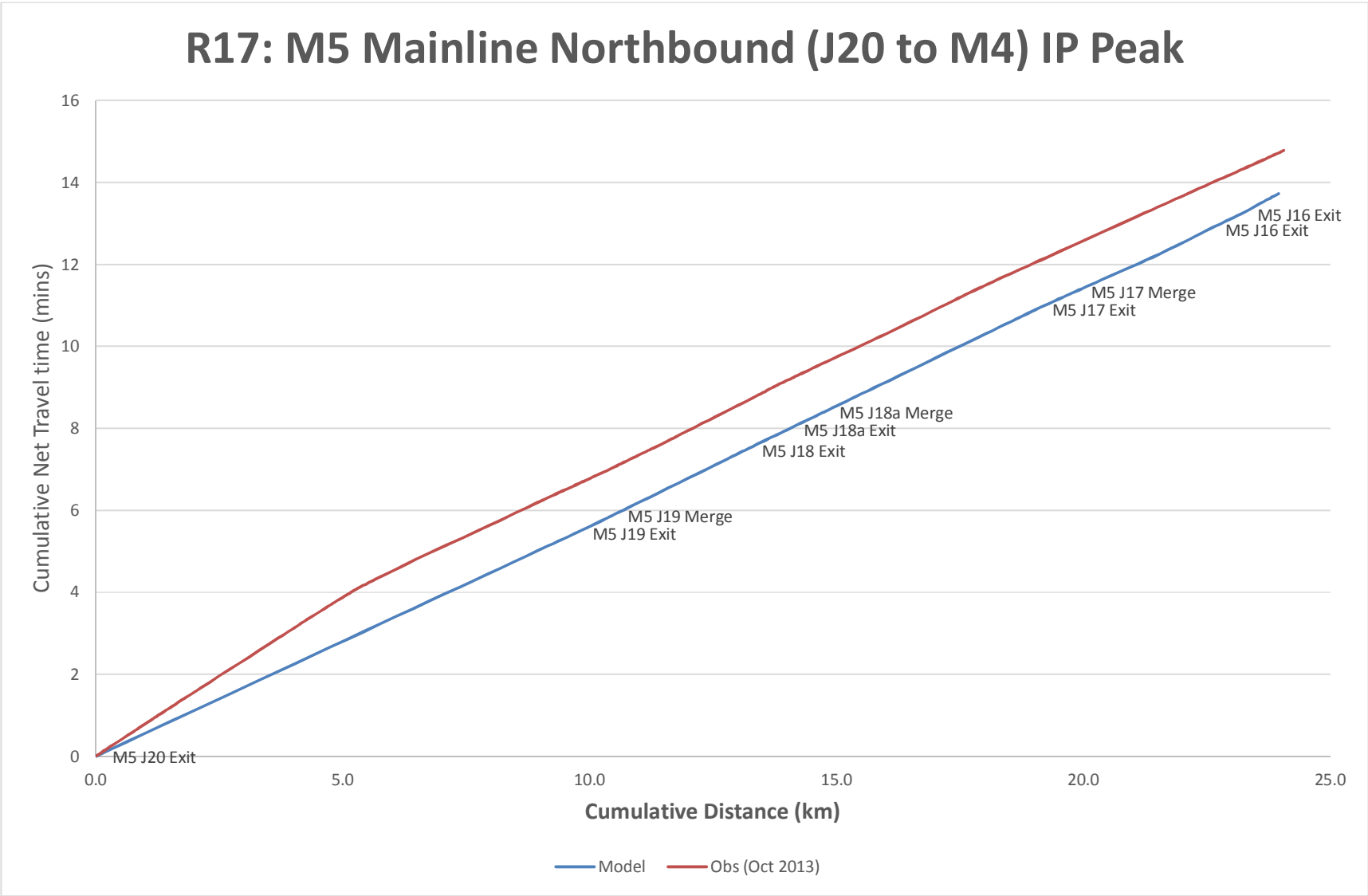
R15: City Centre Inner Loop (Anti-Clockwise) IP Peak



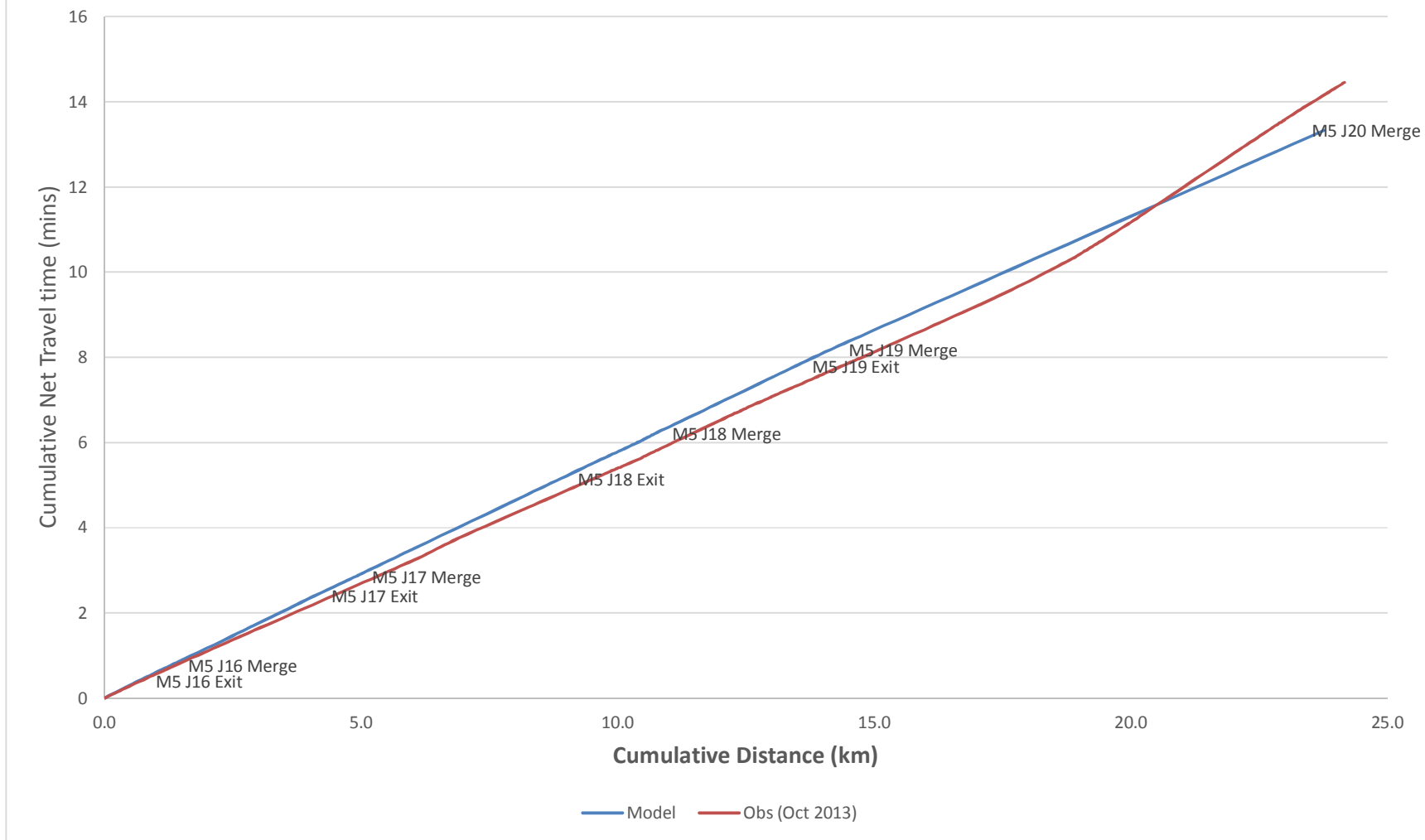


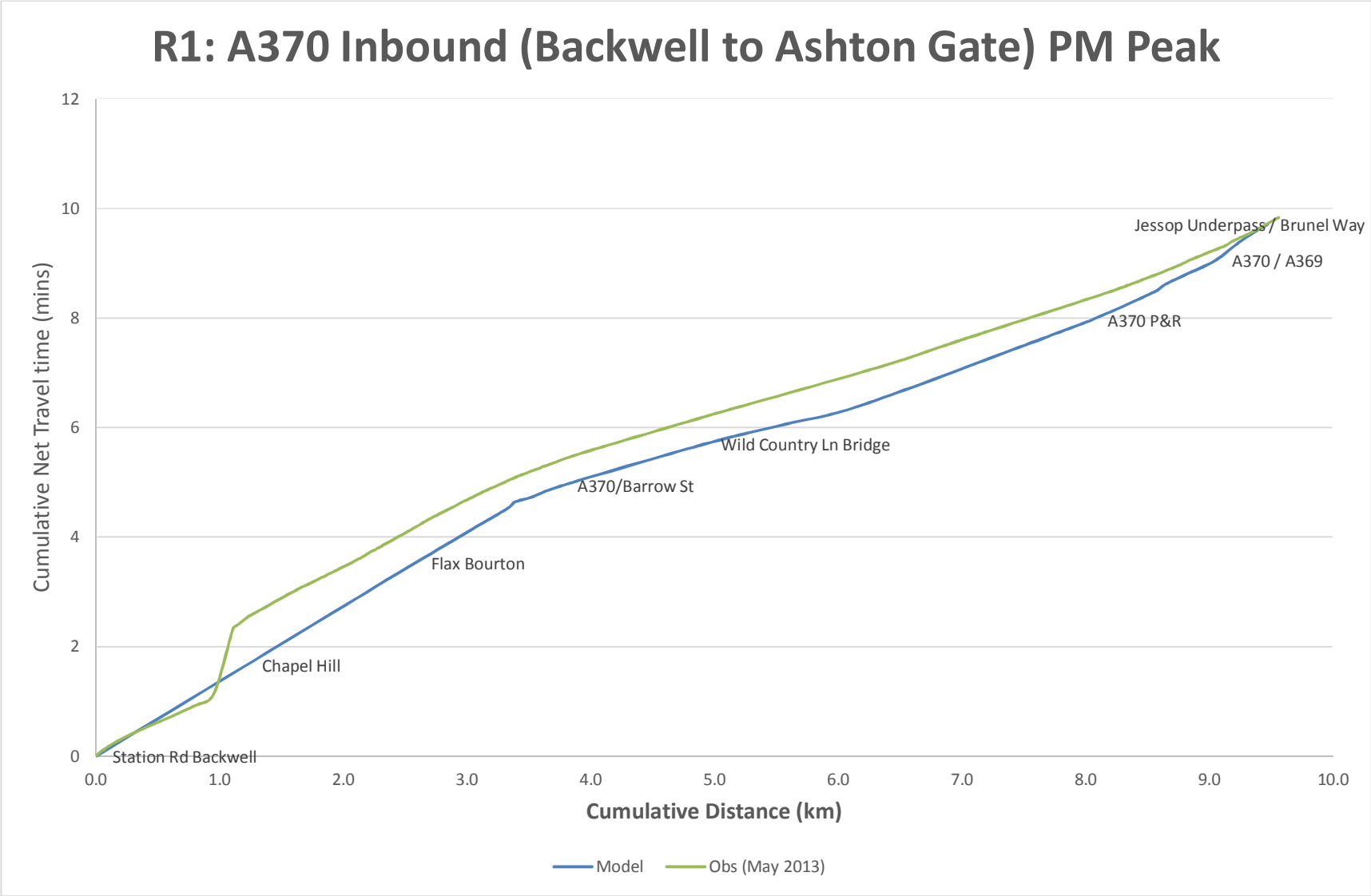
R16: M4 Mainline Westbound (J18 to J22) IP Peak



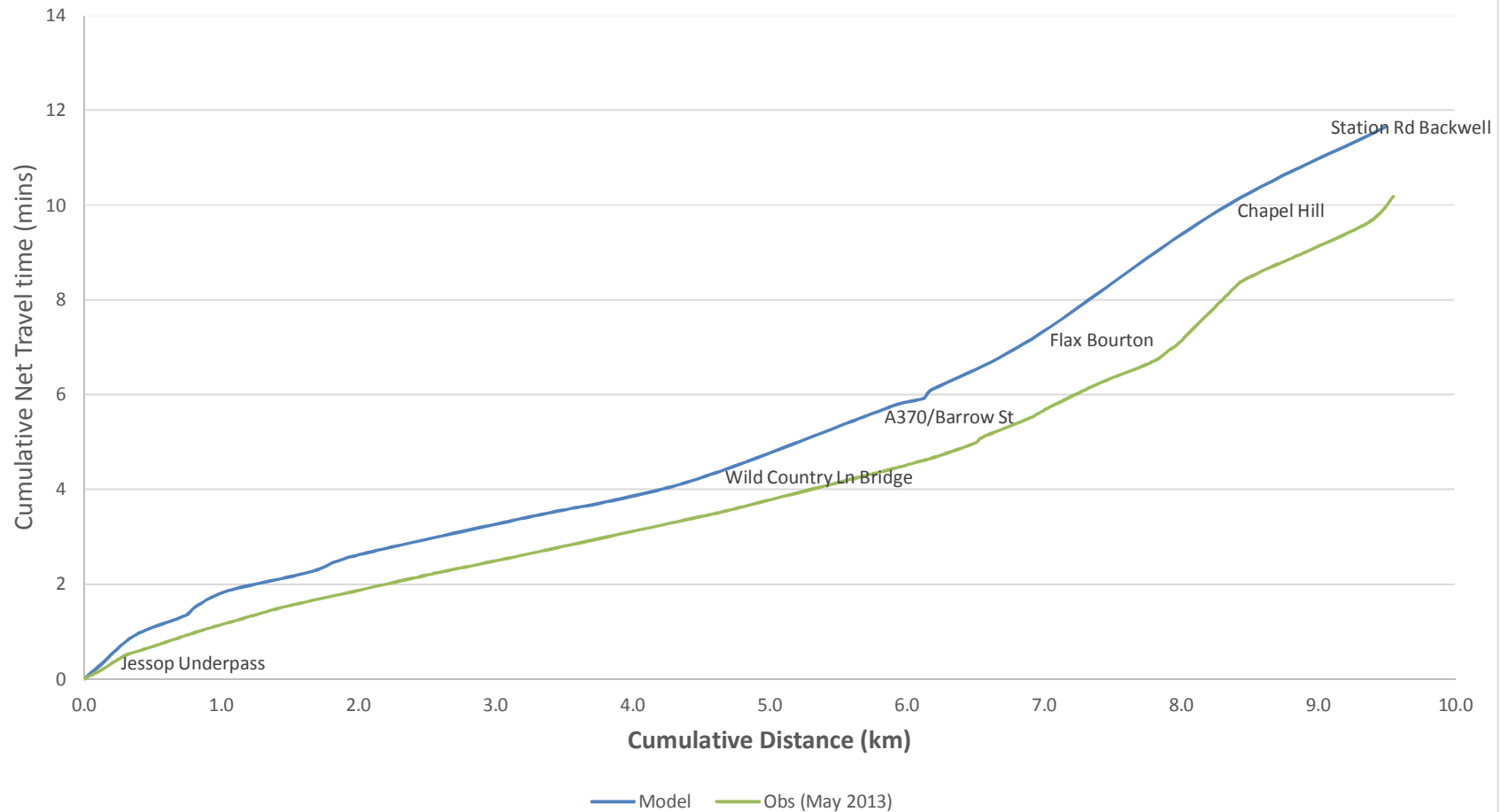


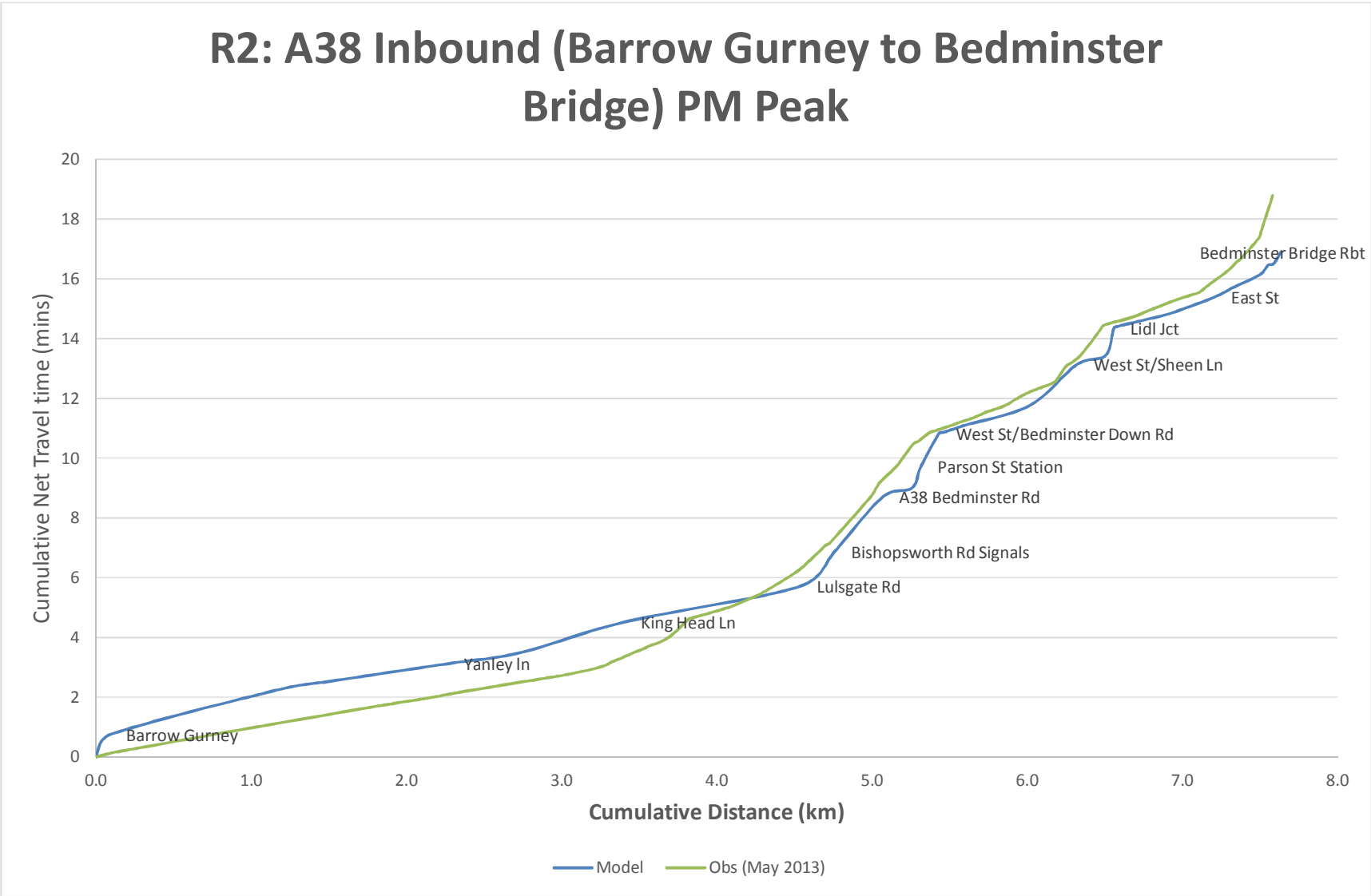
R17: M5 Mainline Southbound (M4 to J20) IP Peak



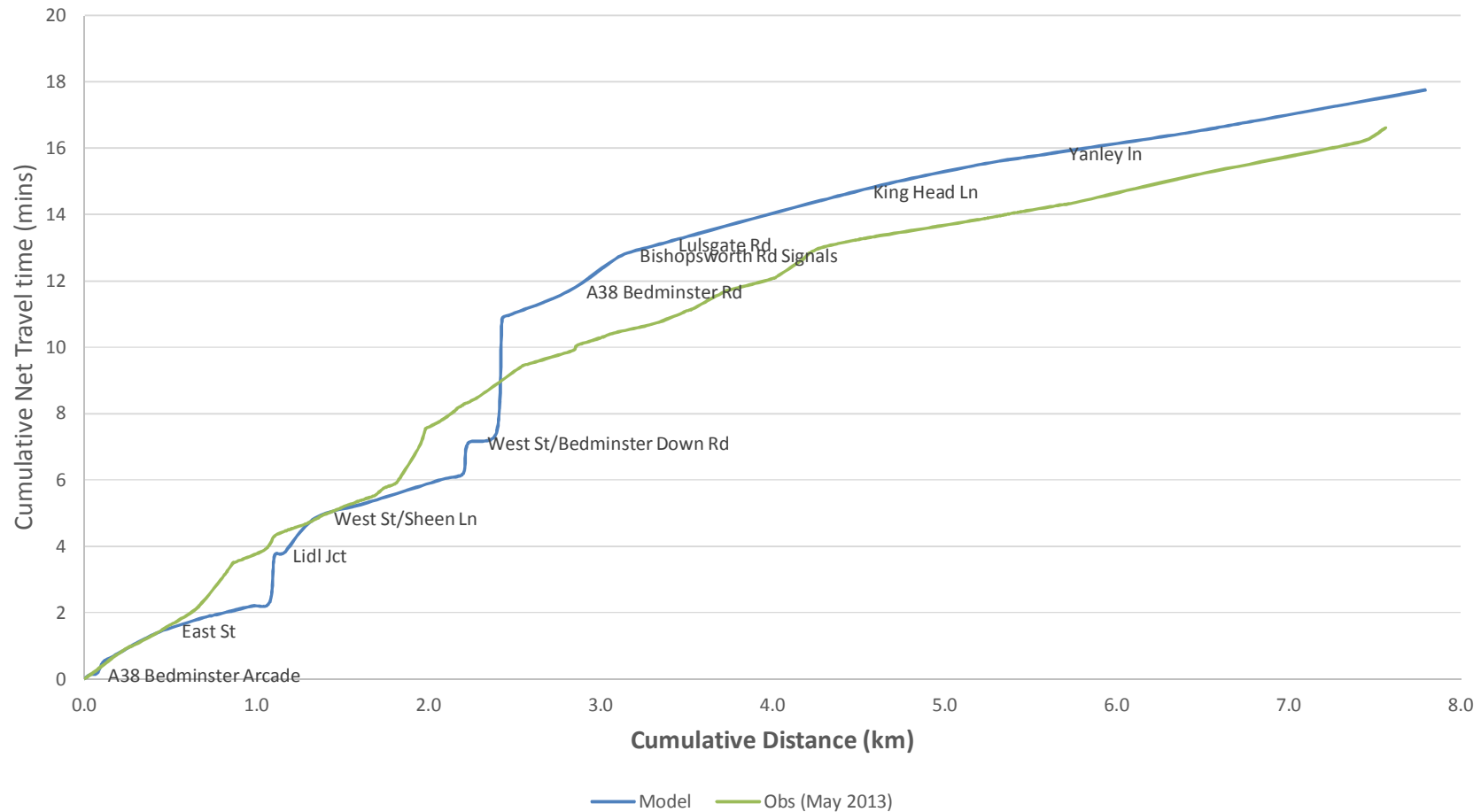


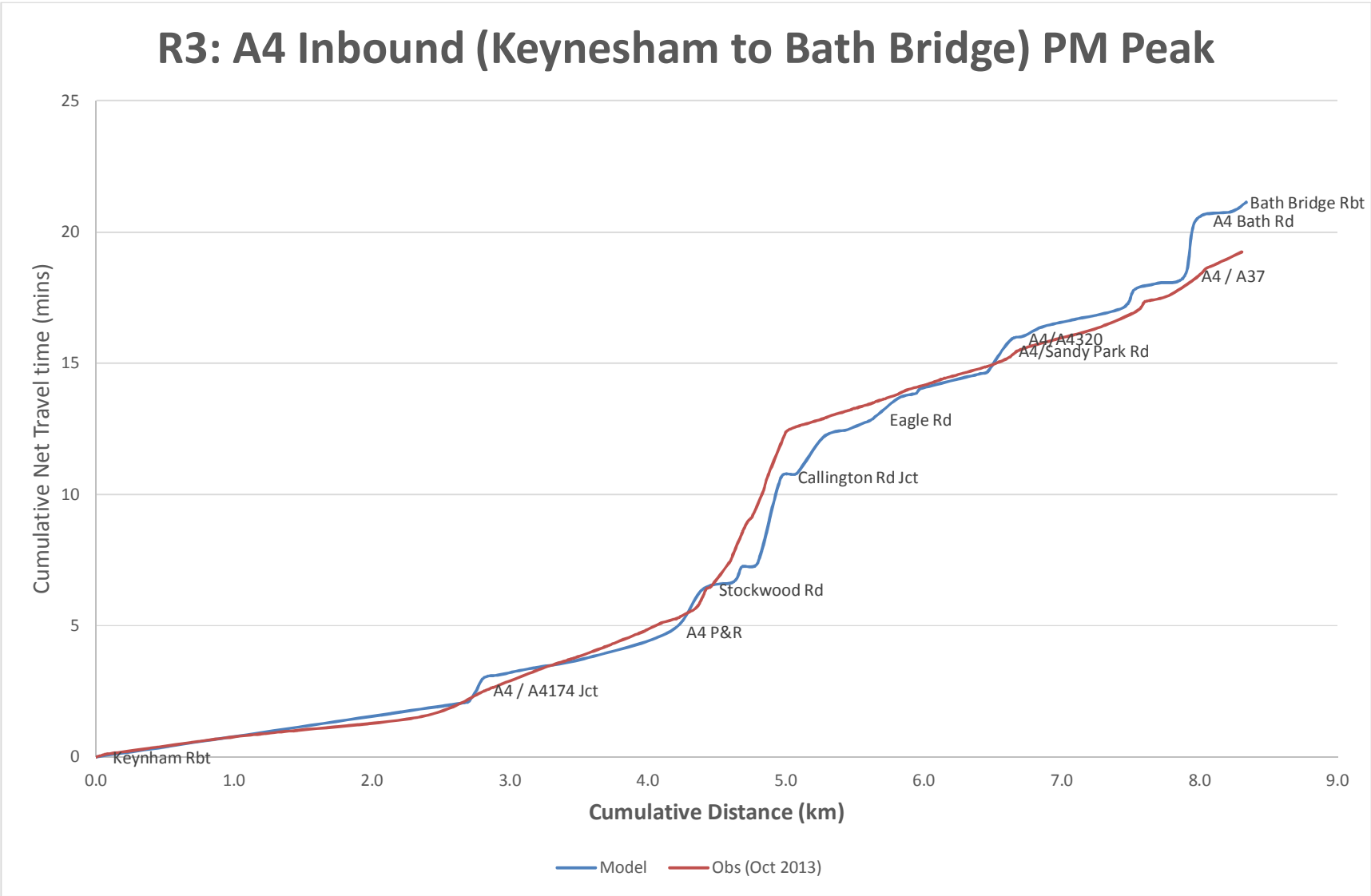
R1: A370 Outbound (Jessop Underpass to Backwell) PM Peak



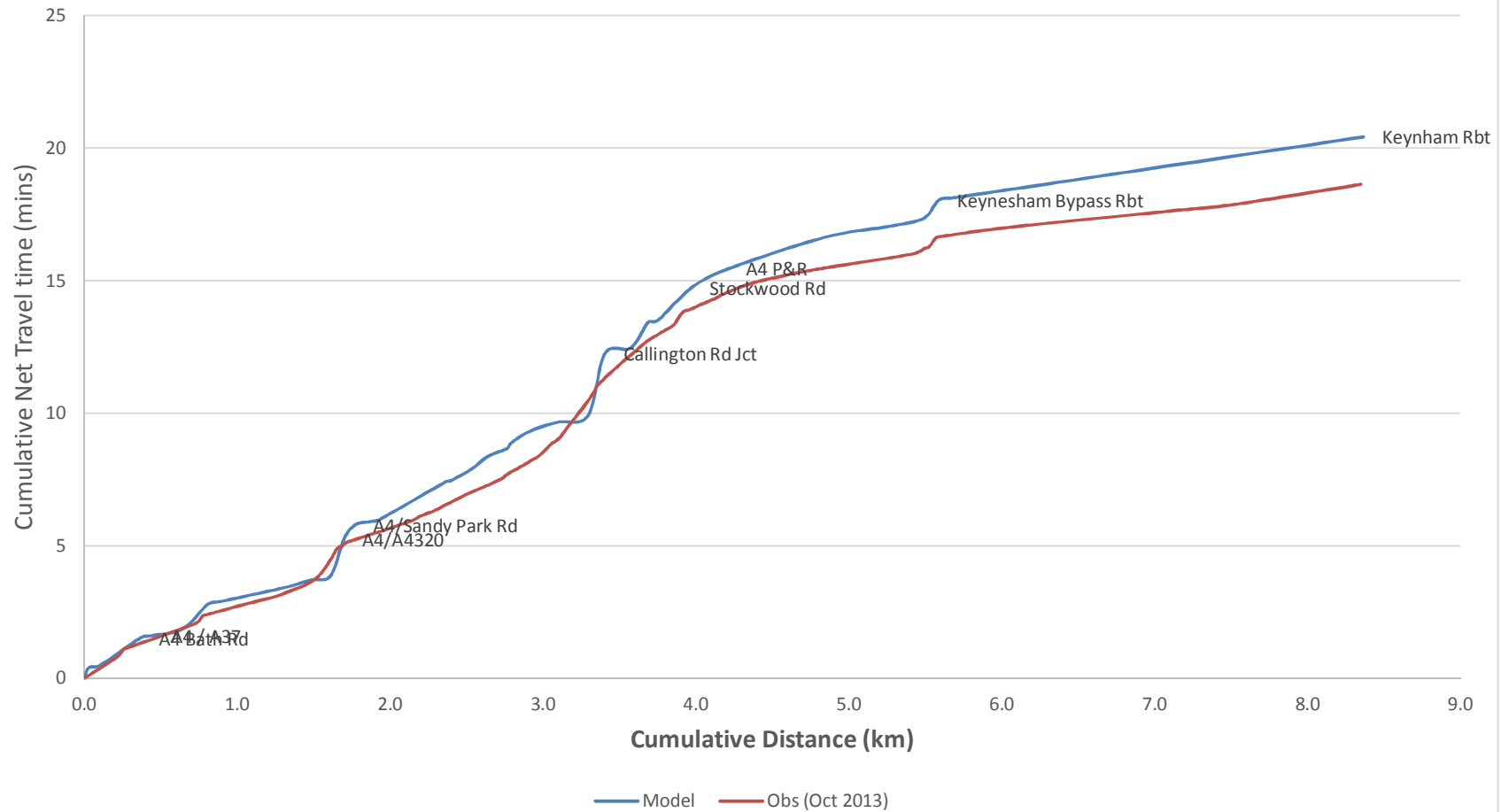


R2: A38 Outbound (Bedminster Bridge to Barrow Gurney) PM Peak

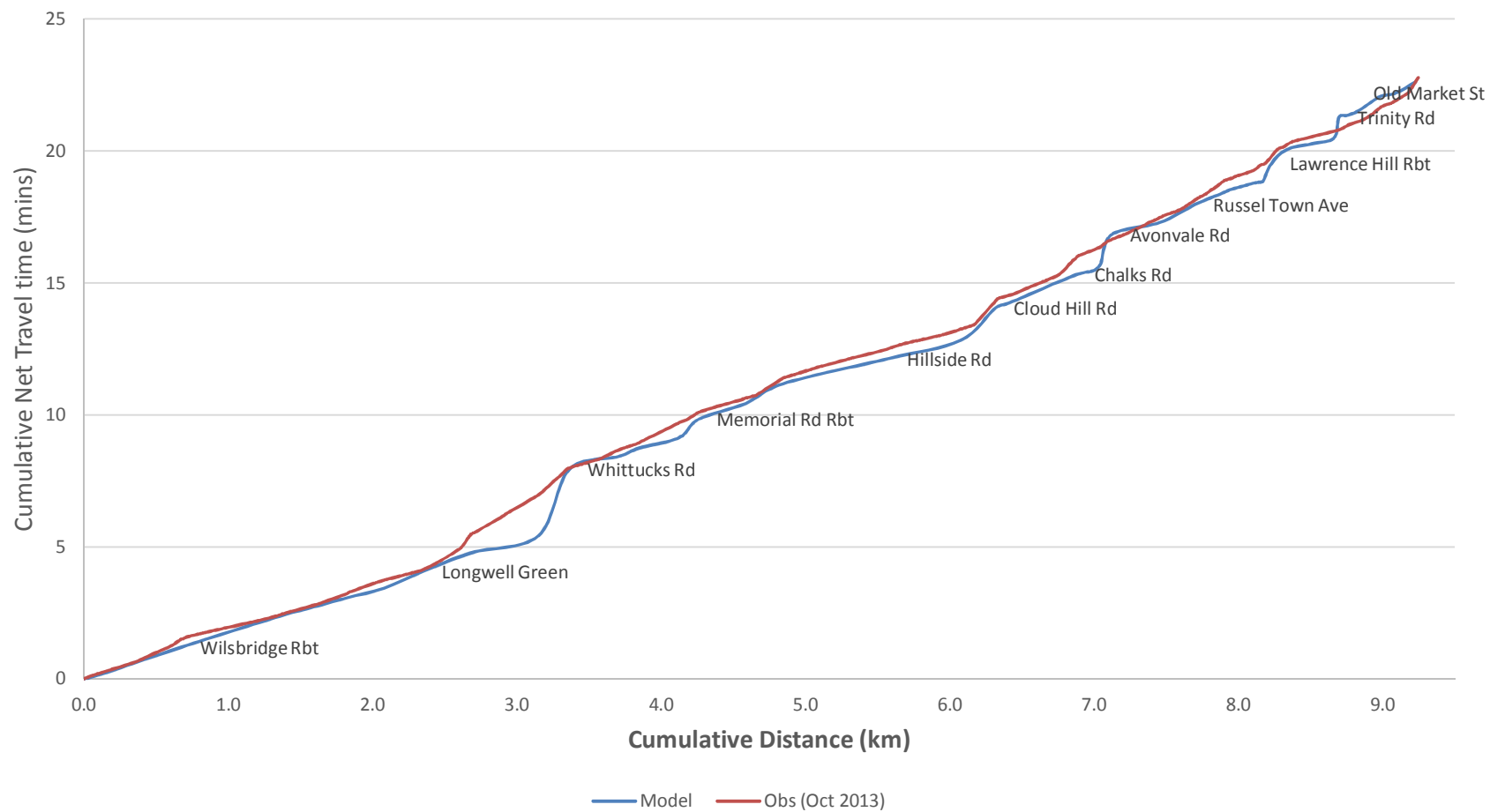




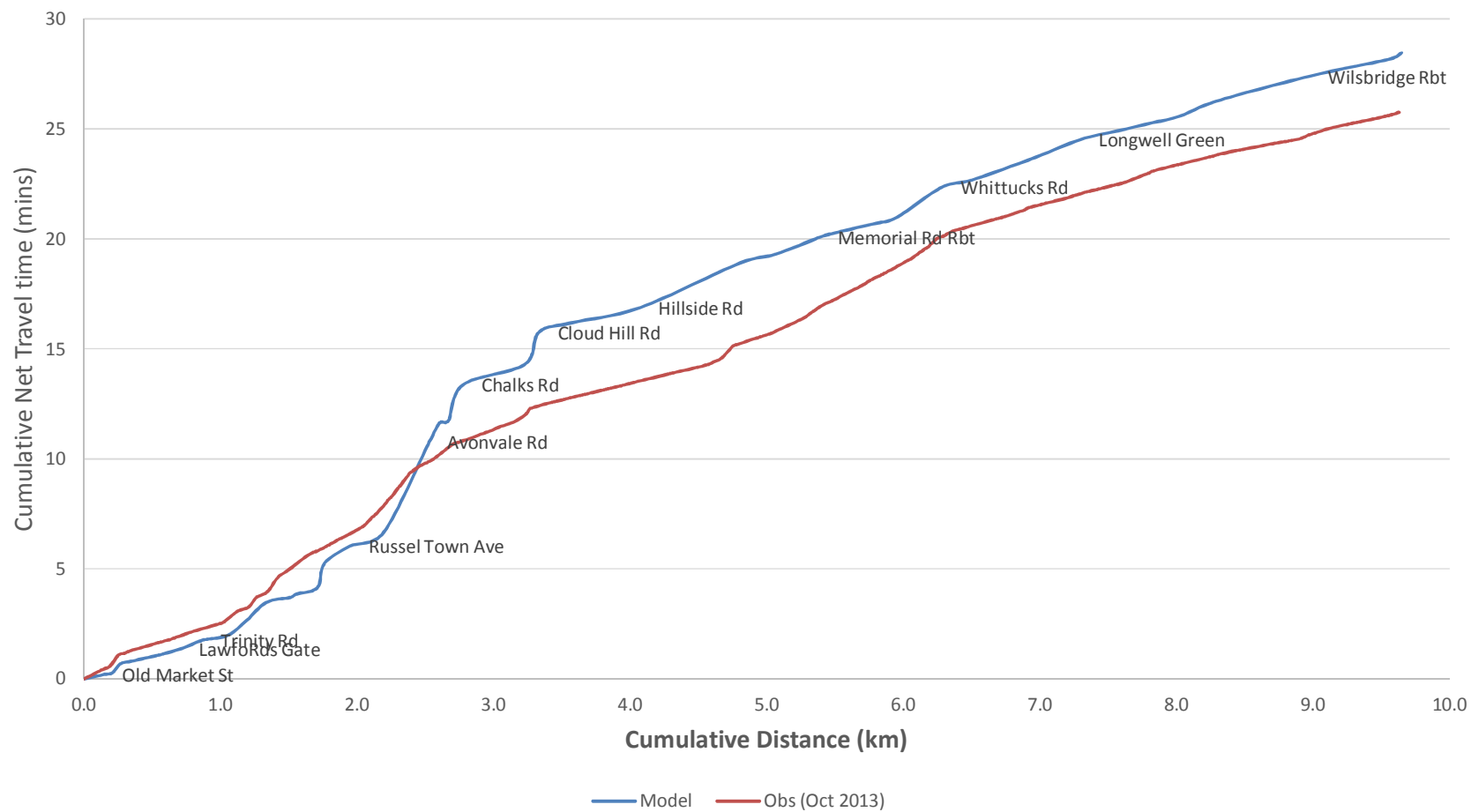
R3: A4 Outbound (Bath Bridge to Keynesham) PM Peak



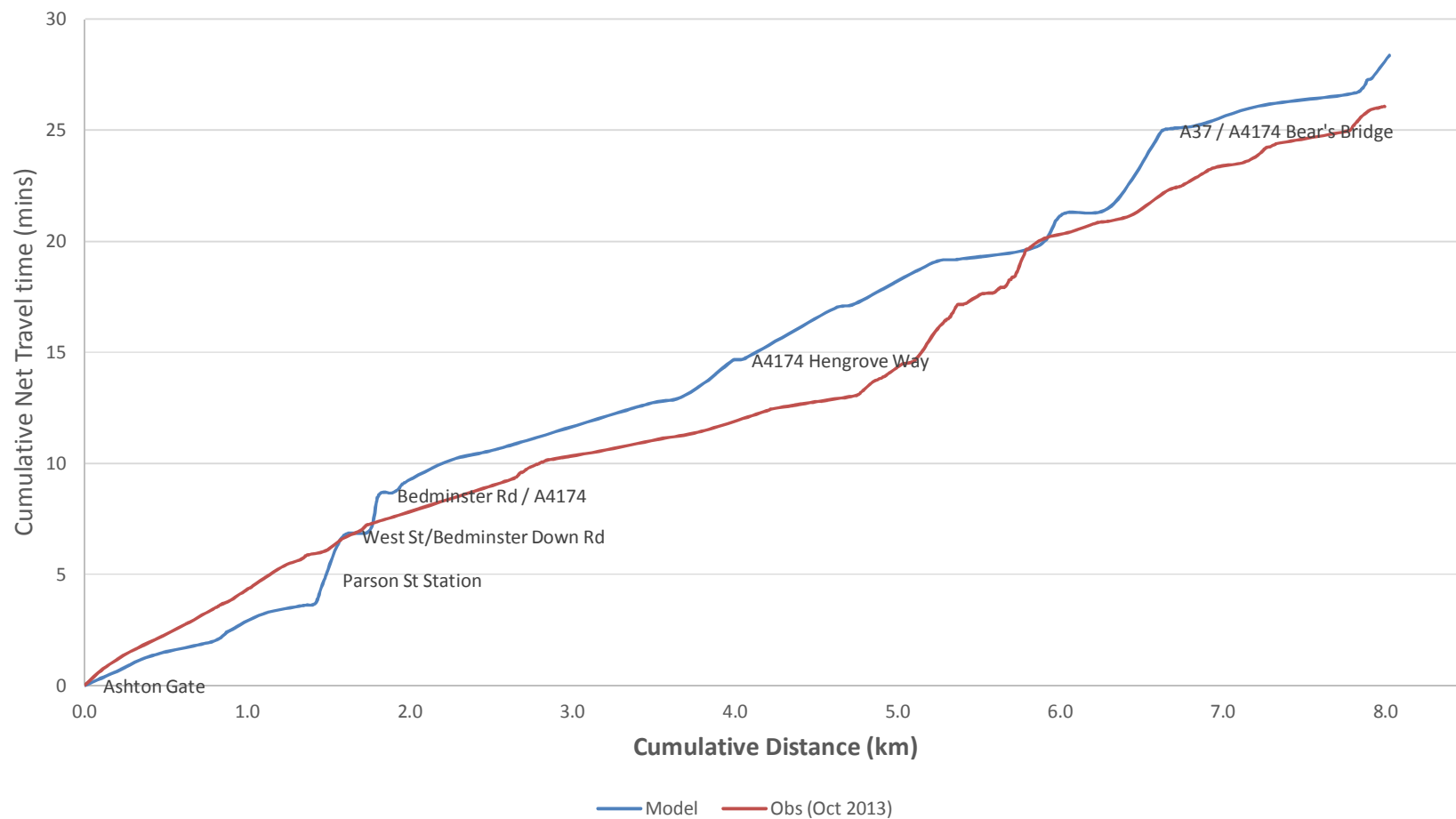
R4: A431 Inbound (Willsbridge to Old Market St) PM Peak



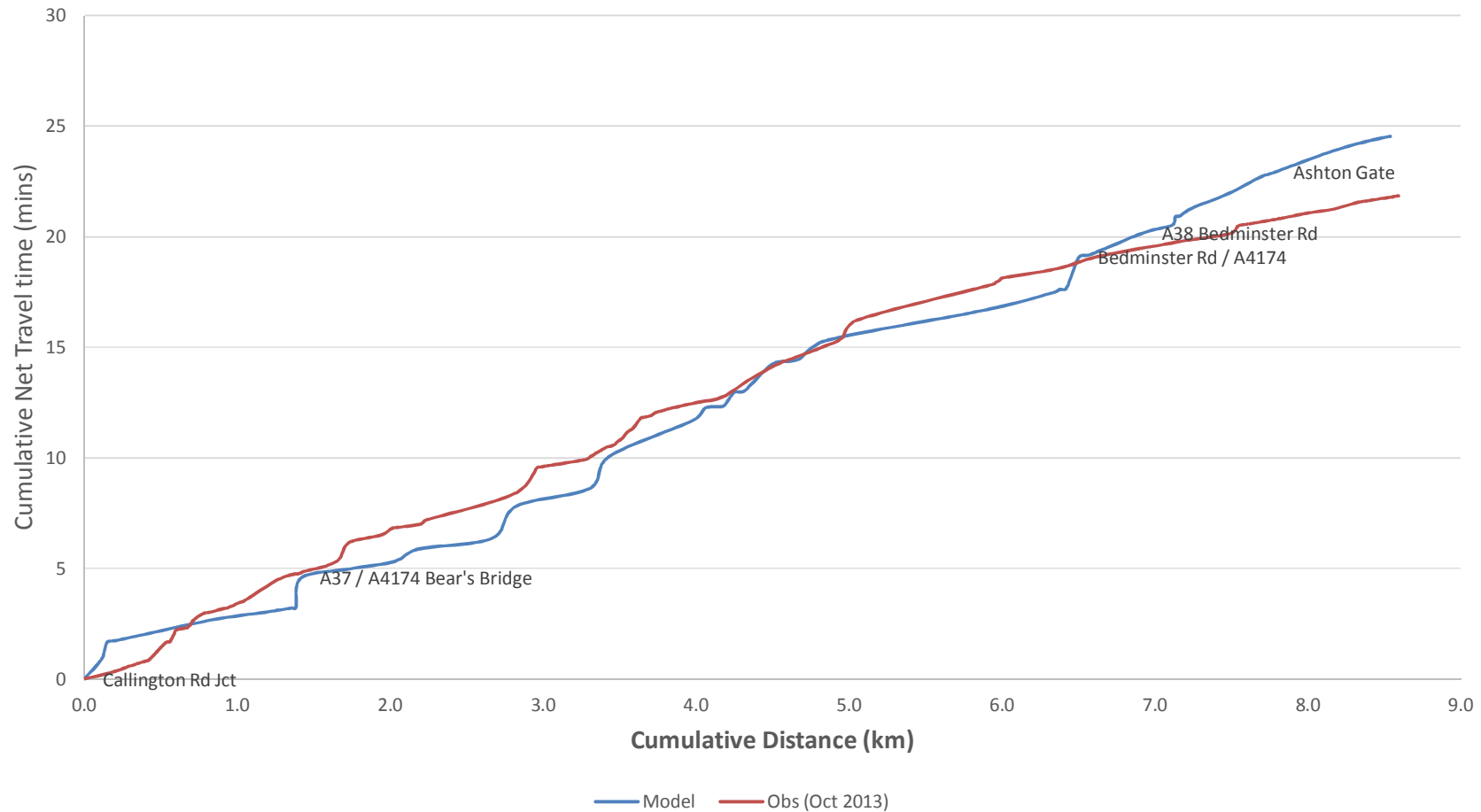
R4: A431 Outbound (Old Market St Jct to Willsbridge) PM Peak

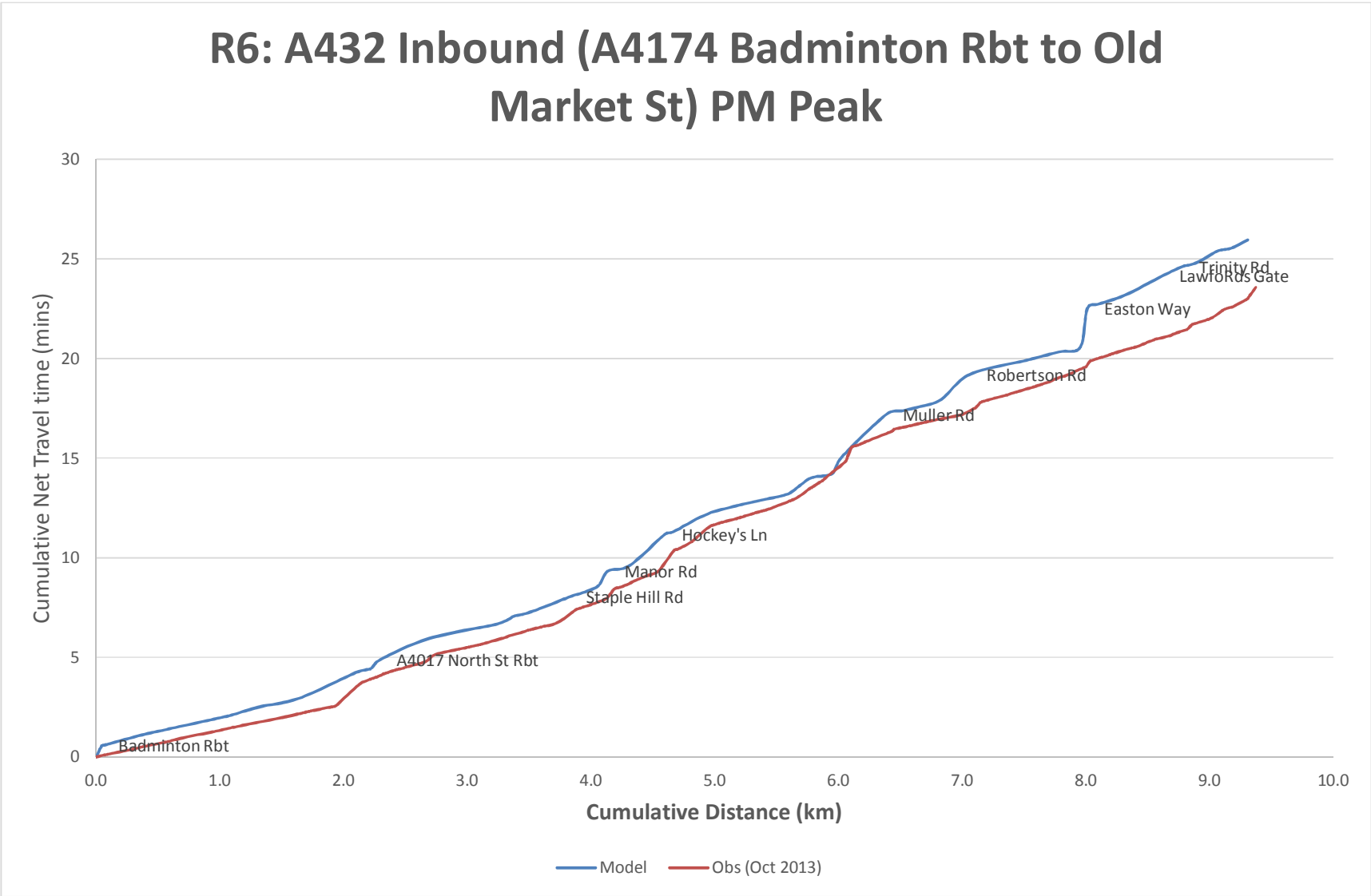


R5: A38 Eastbound (Ashton Gate to Brislington {via Hengrove}) PM Peak

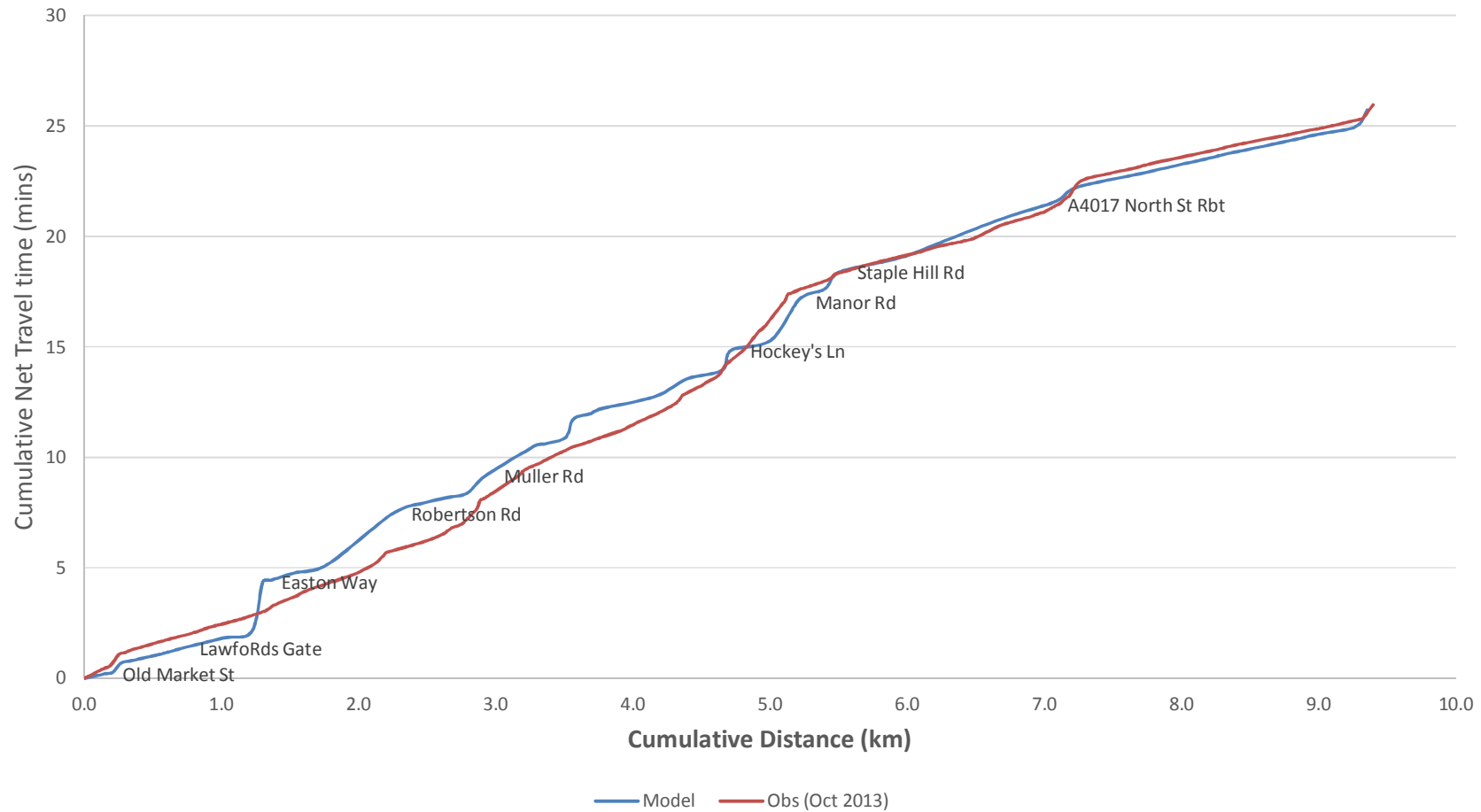


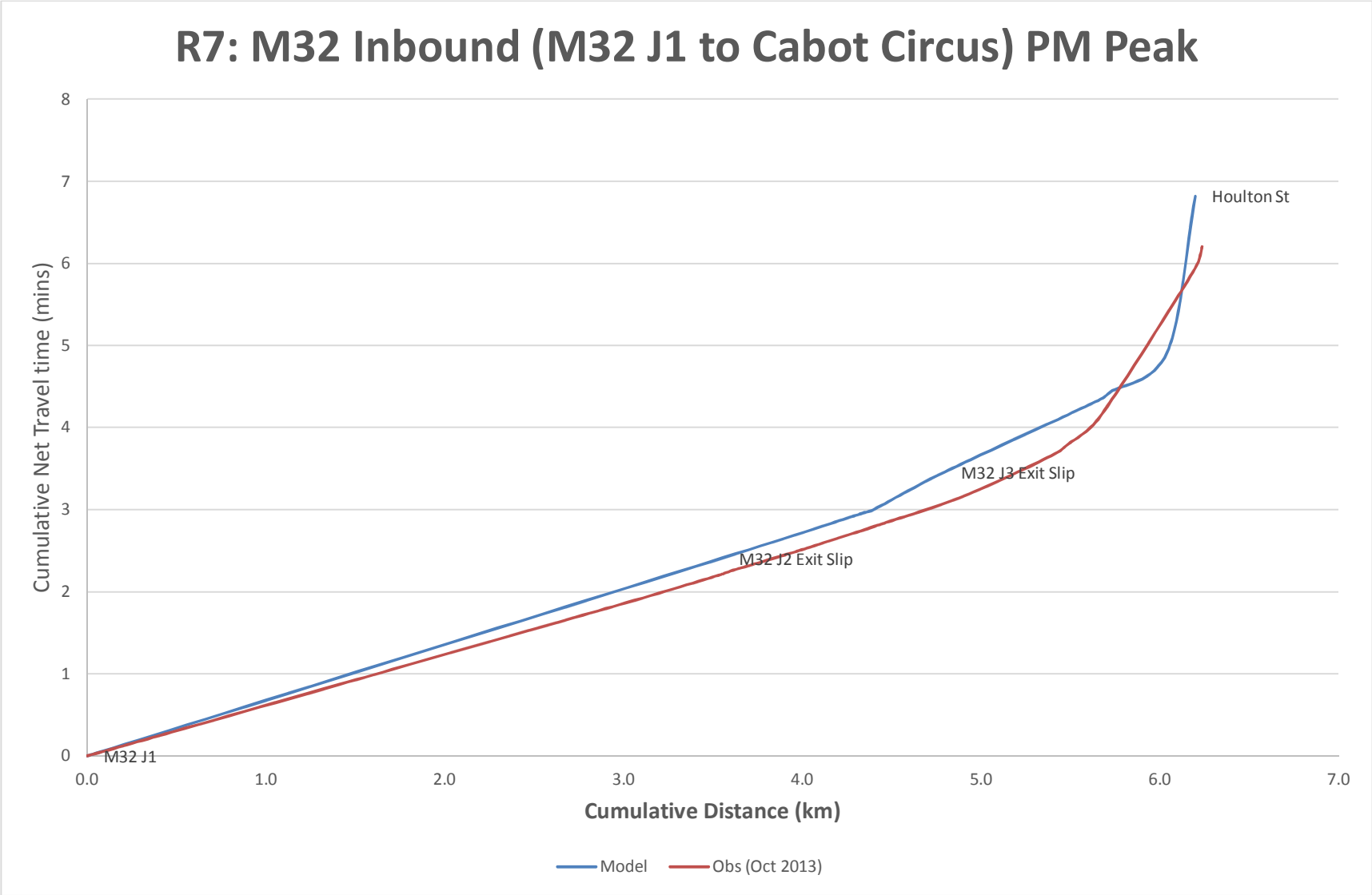
R5: A38 Westbound (Brislington to Ashton Gate {via Hengrove}) PM Peak



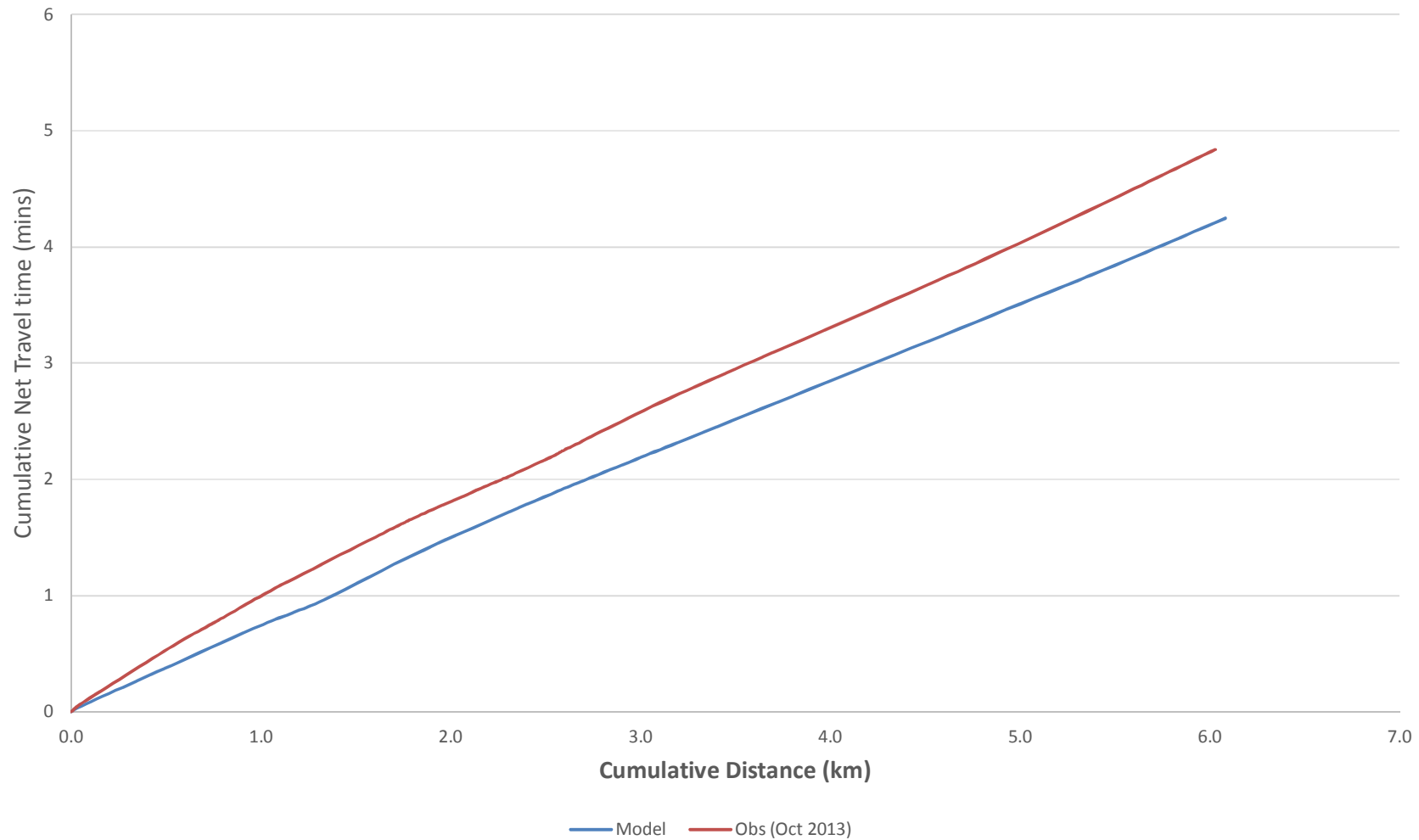


R6: A432 Outbound (West St to A4174 Badminton Rbt) PM Peak

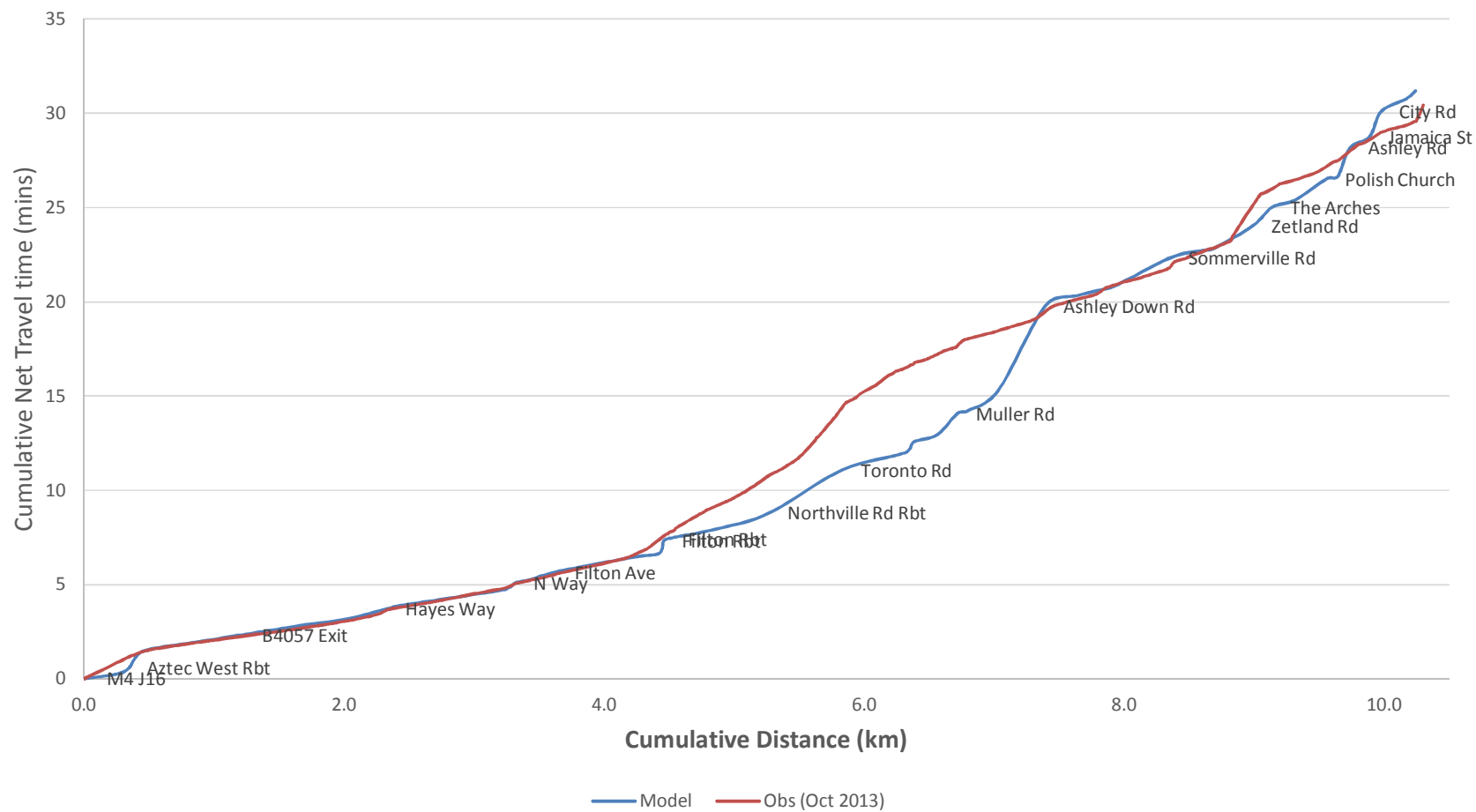




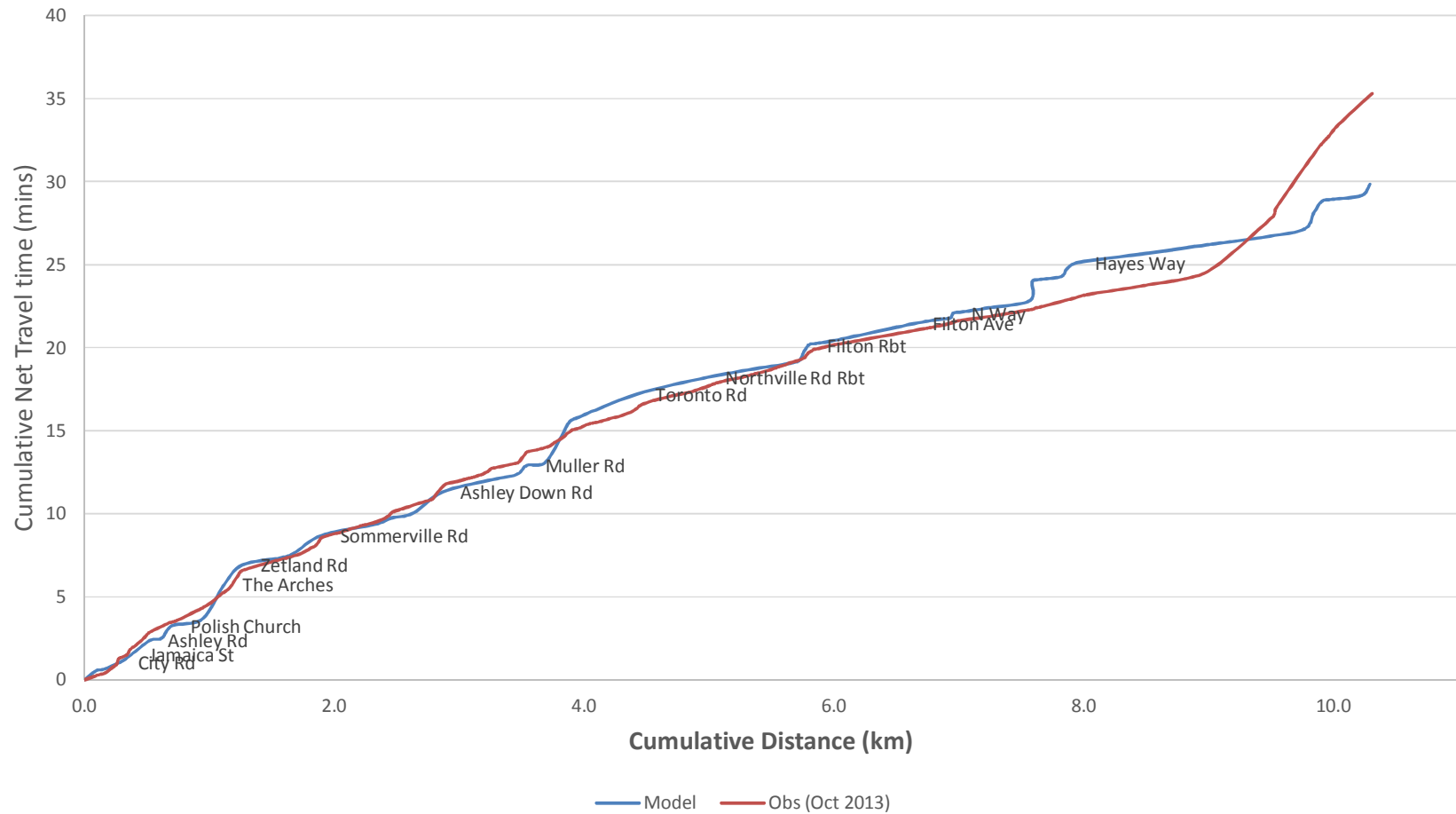
R7: M32 Outbound (Cabot Circus to M32 J1) PM Peak



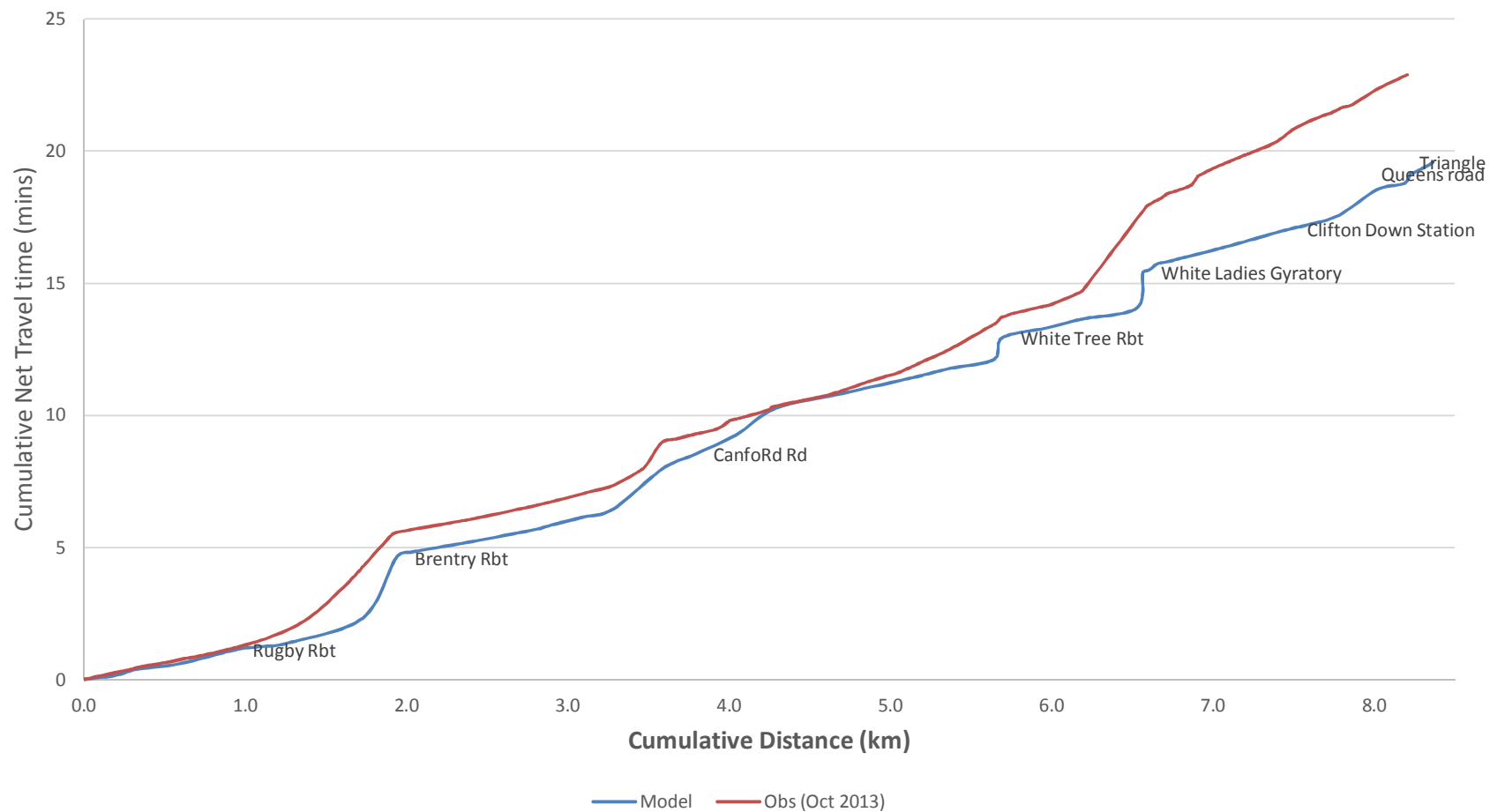
R8: A38 Inbound (M5 J16 to St James Barton Rbt) PM Peak



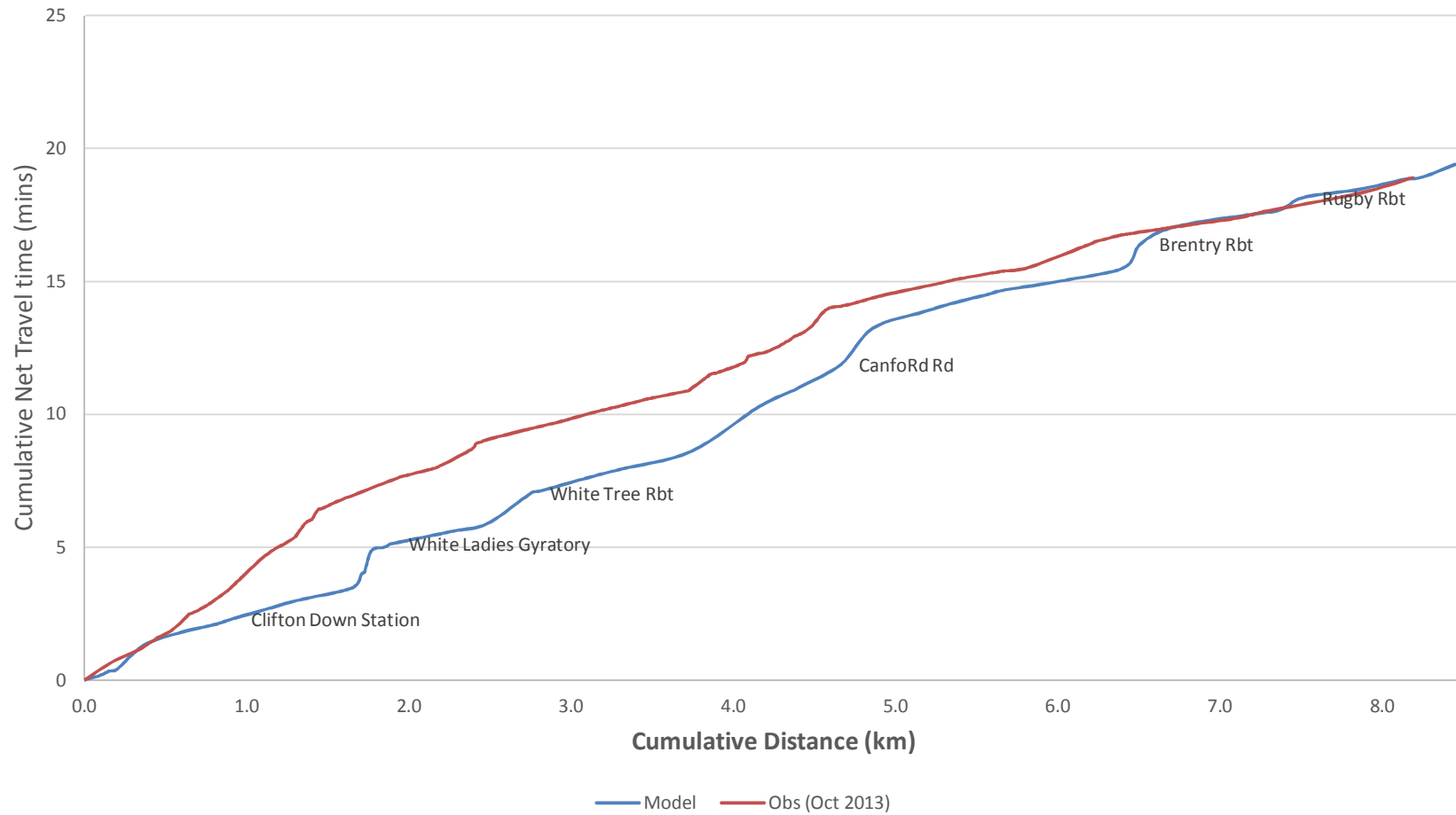
R8: A38 Outbound (St James Barton Rbt to M5 J16) PM Peak



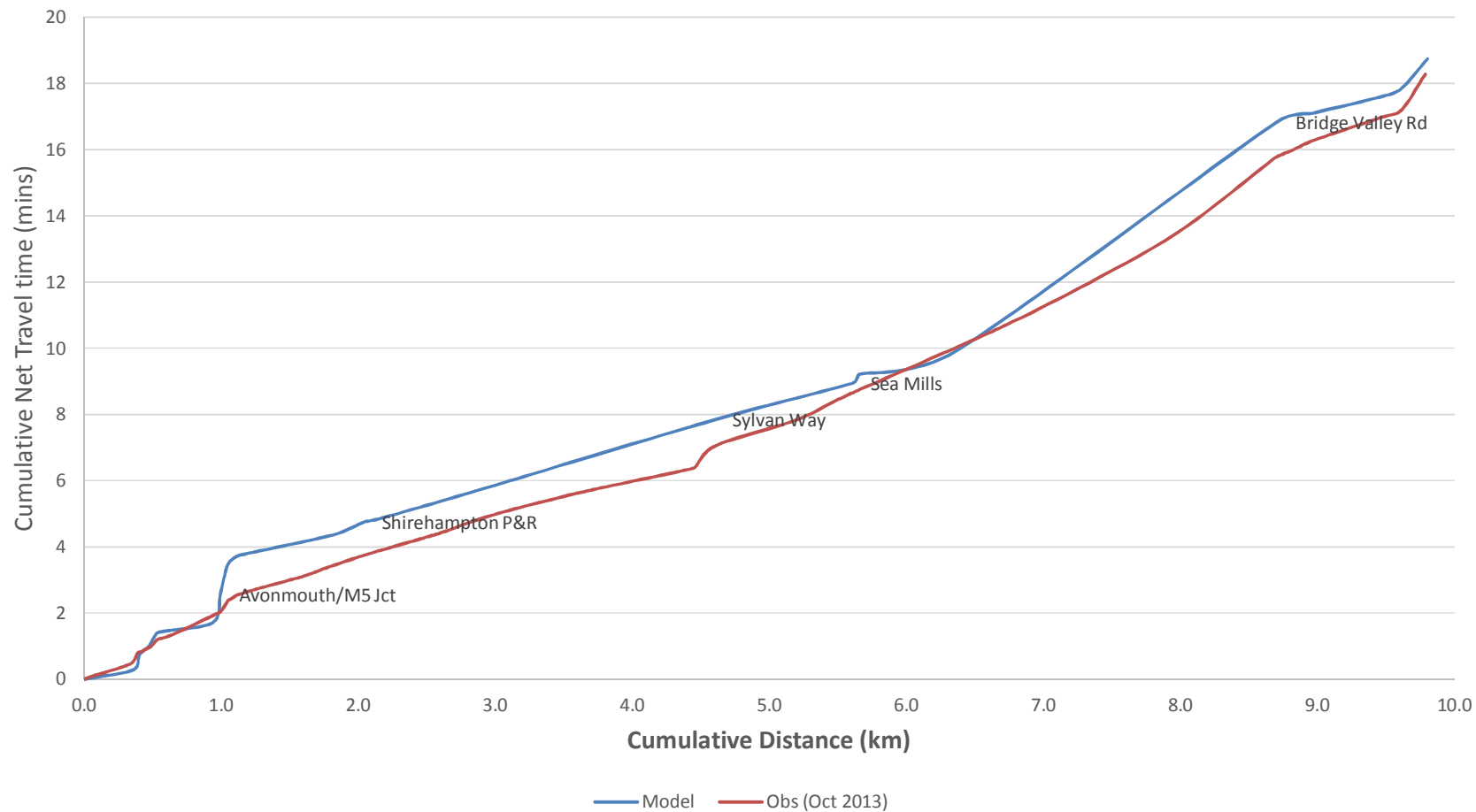
R9: A4018 Inbound (M5 J17 Cribbs to Clifton Triangle) PM Peak



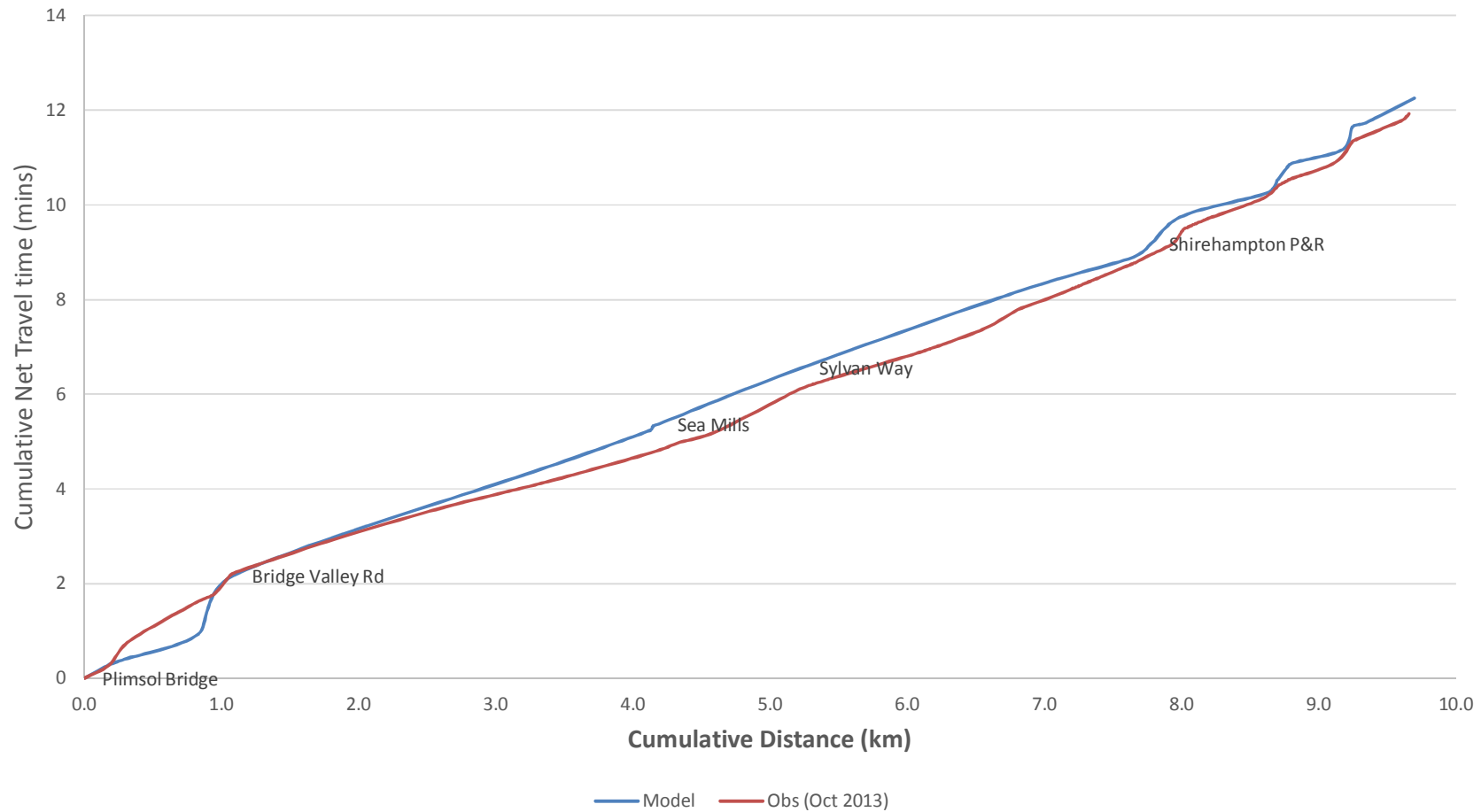
R9: A4018 Outbound (College Green to M5 J17 Cribbs) PM Peak



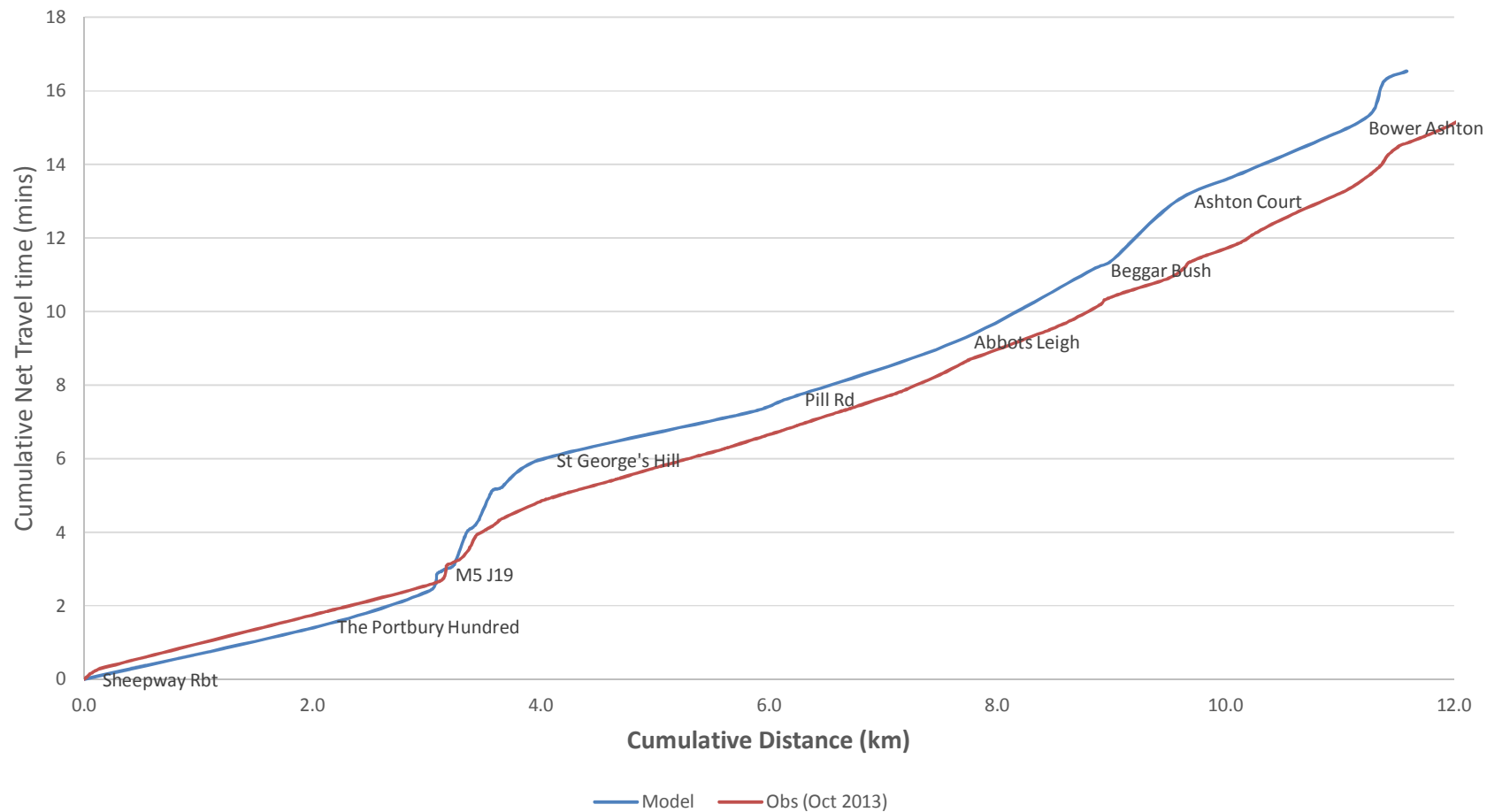
R10: A4 Portway Inbound (Avonmouth to Hotwells) PM Peak



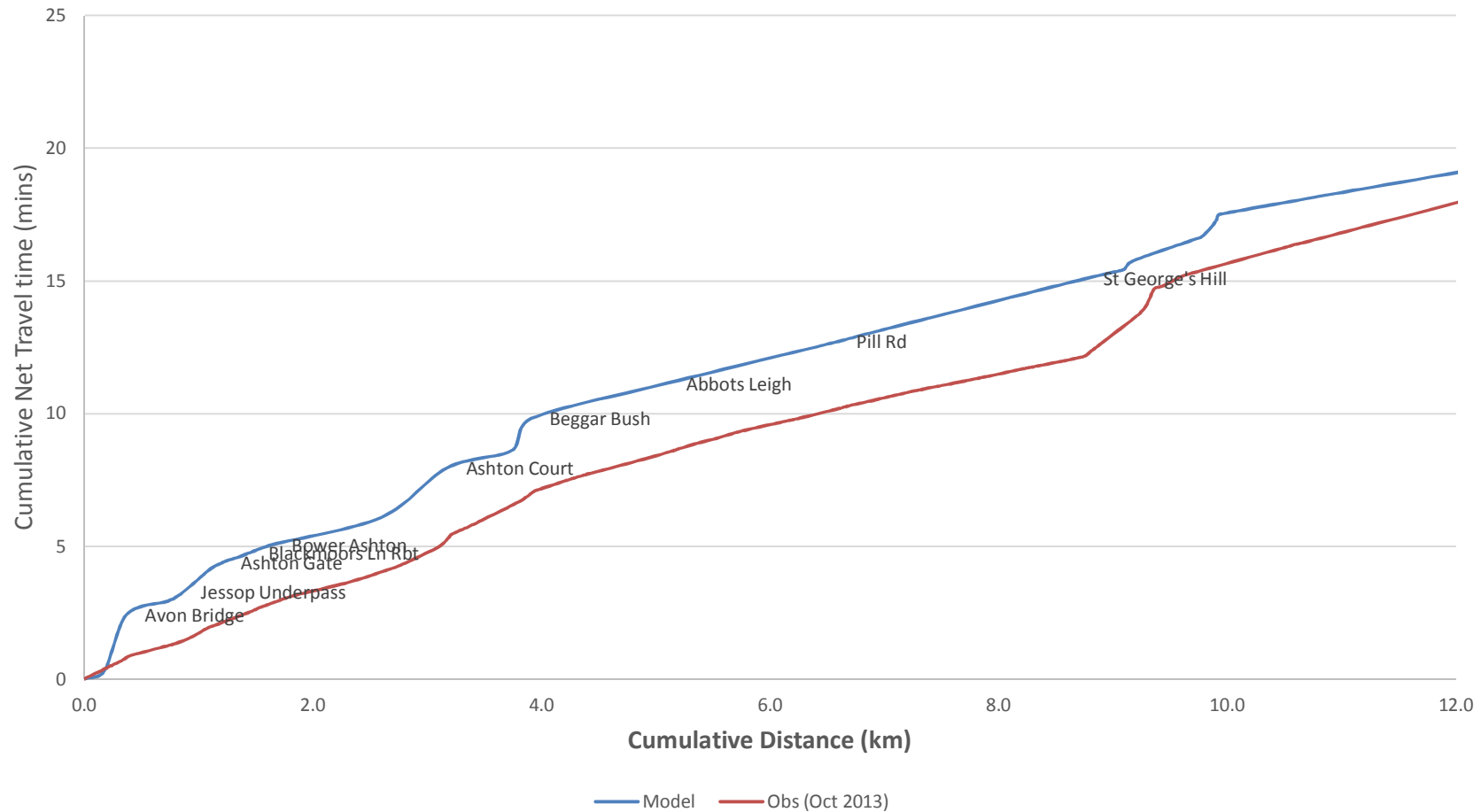
R10: A4 Portway Outbound (Hotwells to Avonmouth) PM Peak

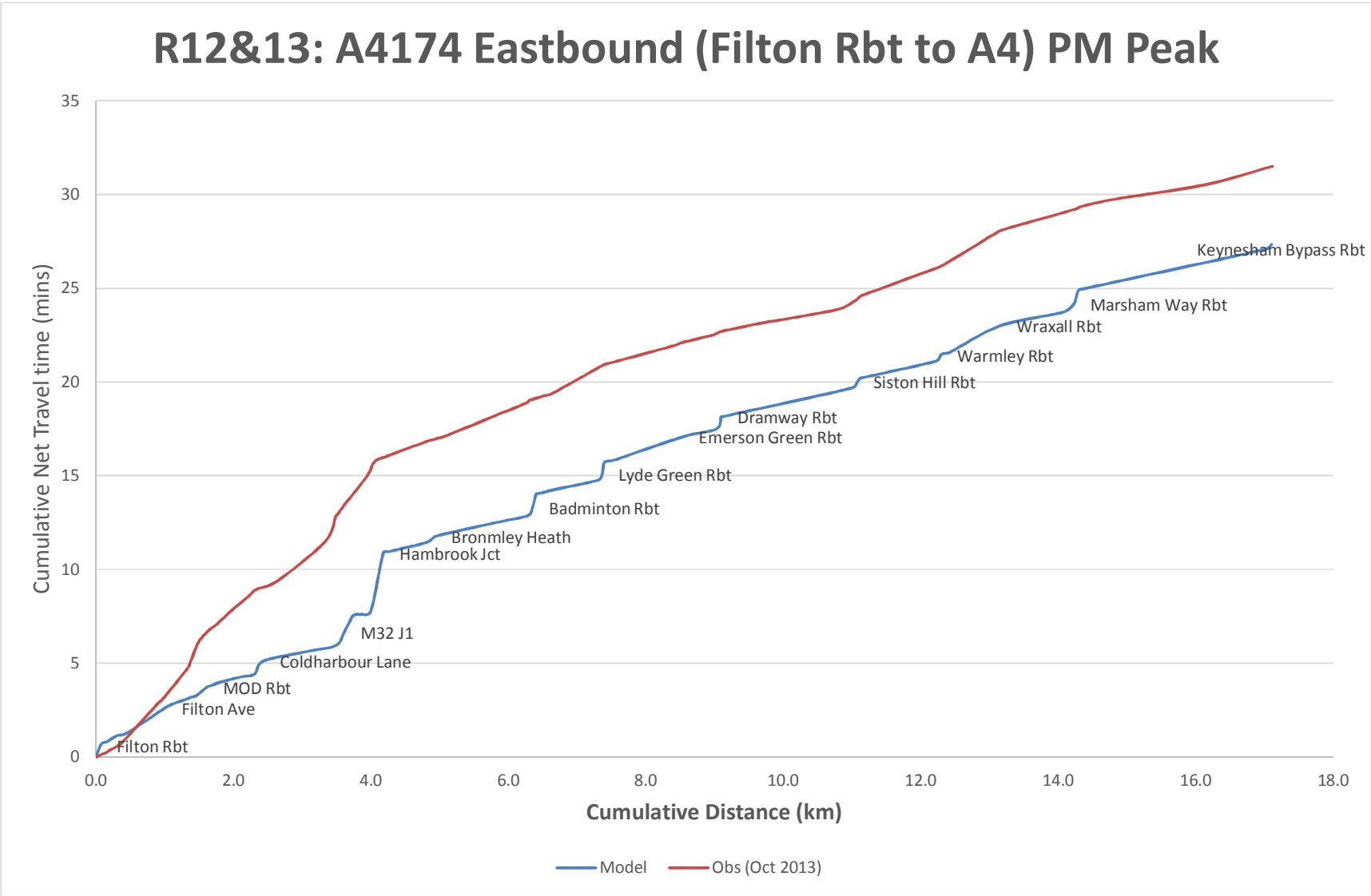


R11: A369 Inbound (Portishead to A4 Bristol Gate) PM Peak

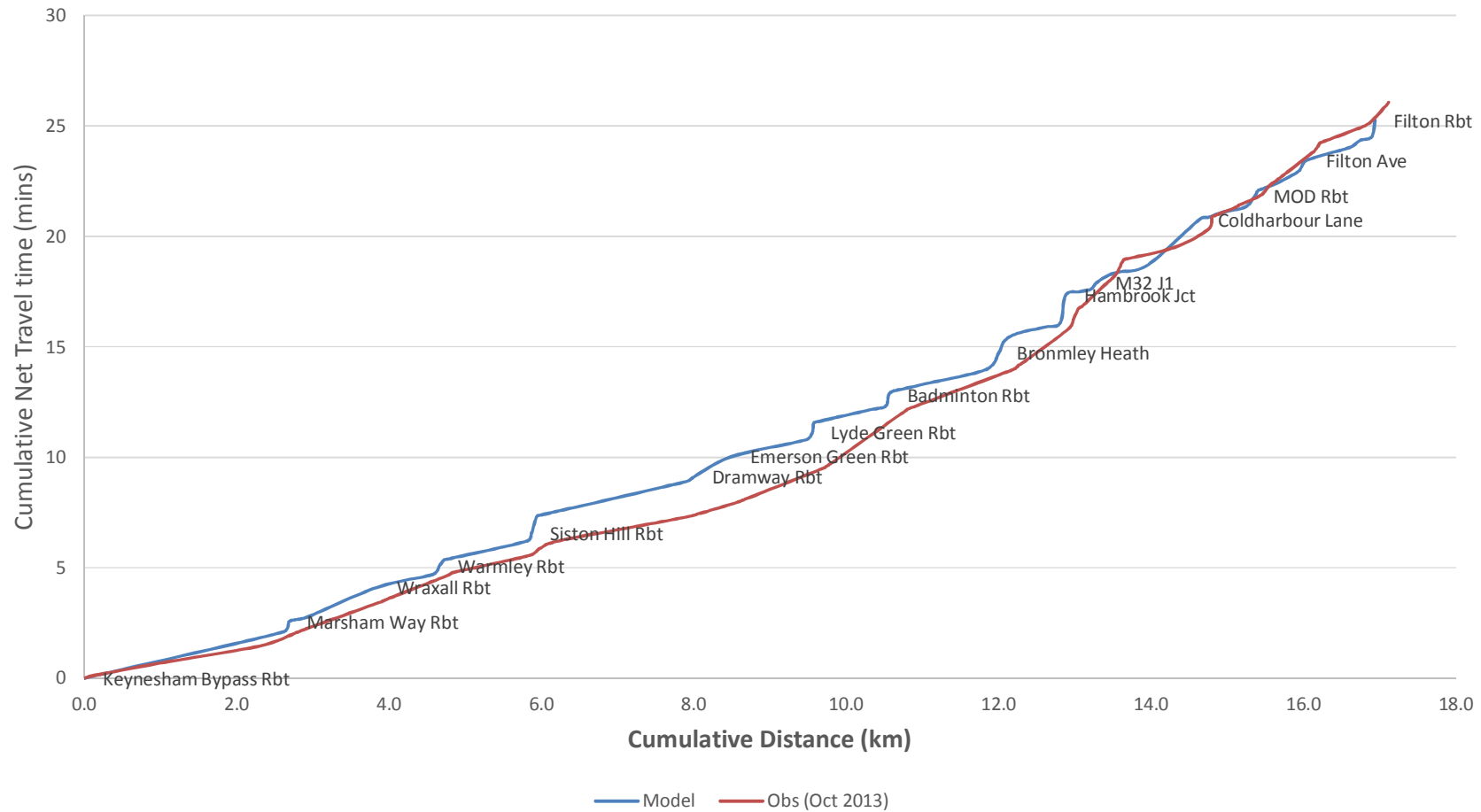


R11: A369 Outbound (A4 Bristol Gate to Portishead) PM Peak

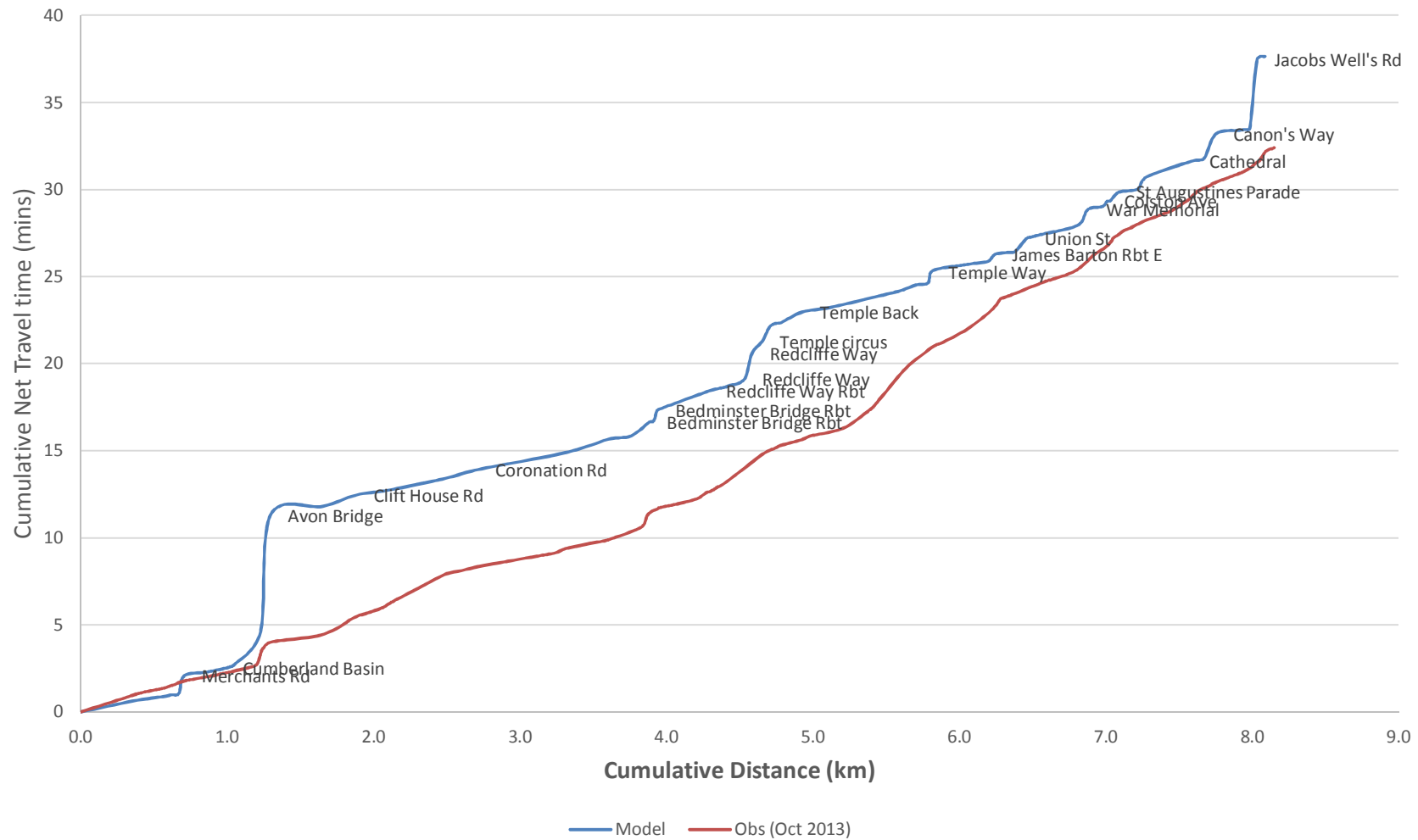


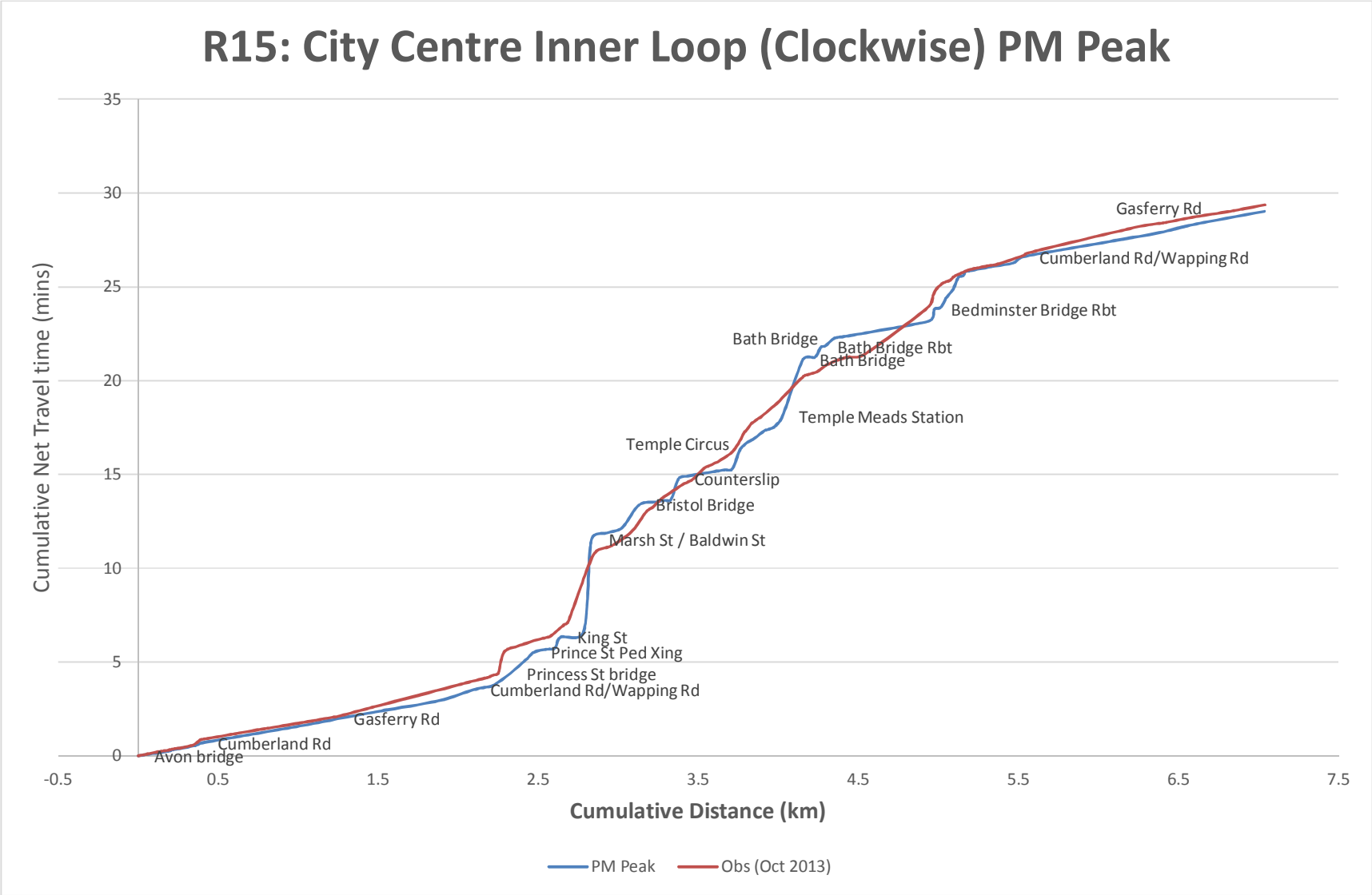


R12&13: A4174 Westbound (A4 to Filton Rbt) PM Peak

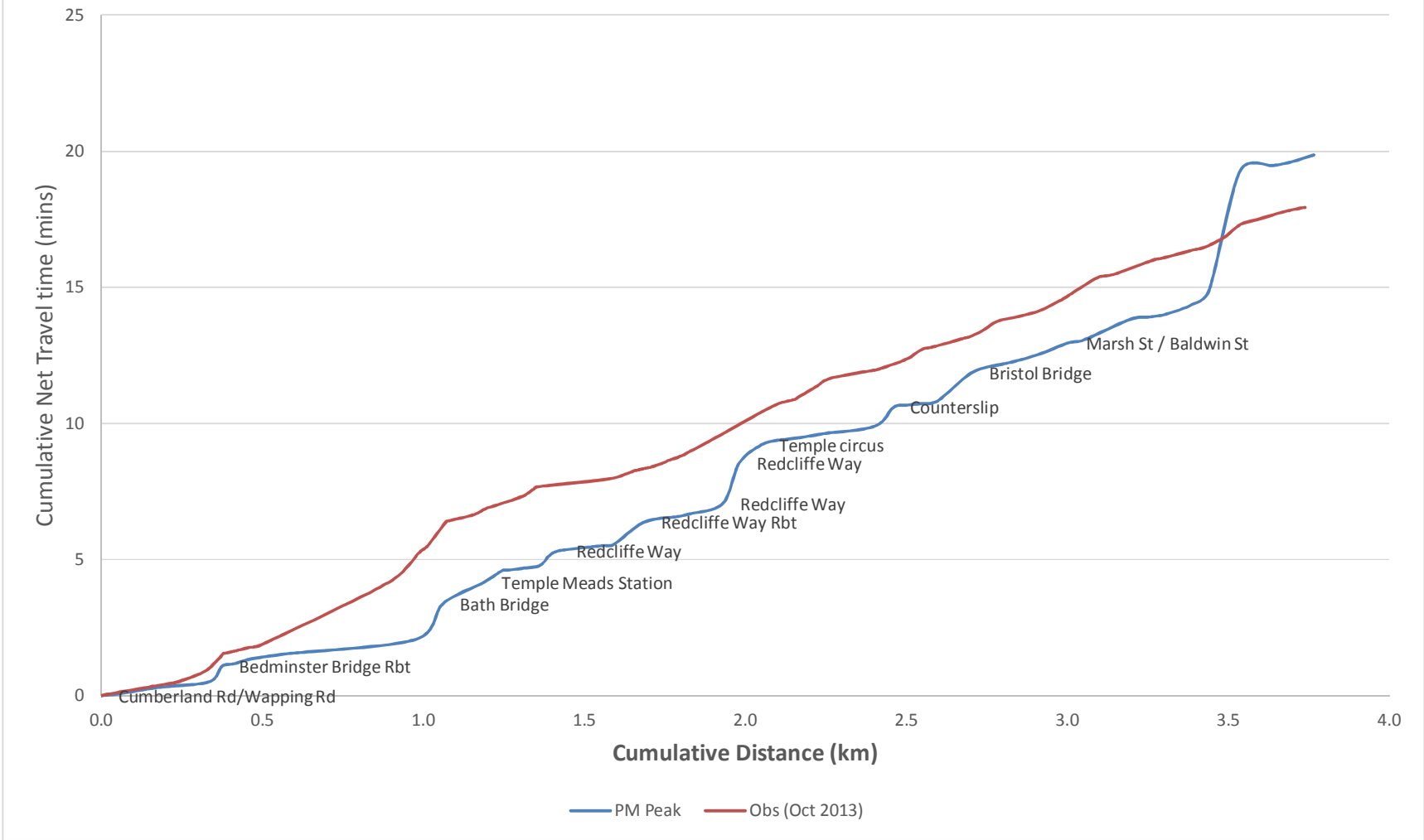


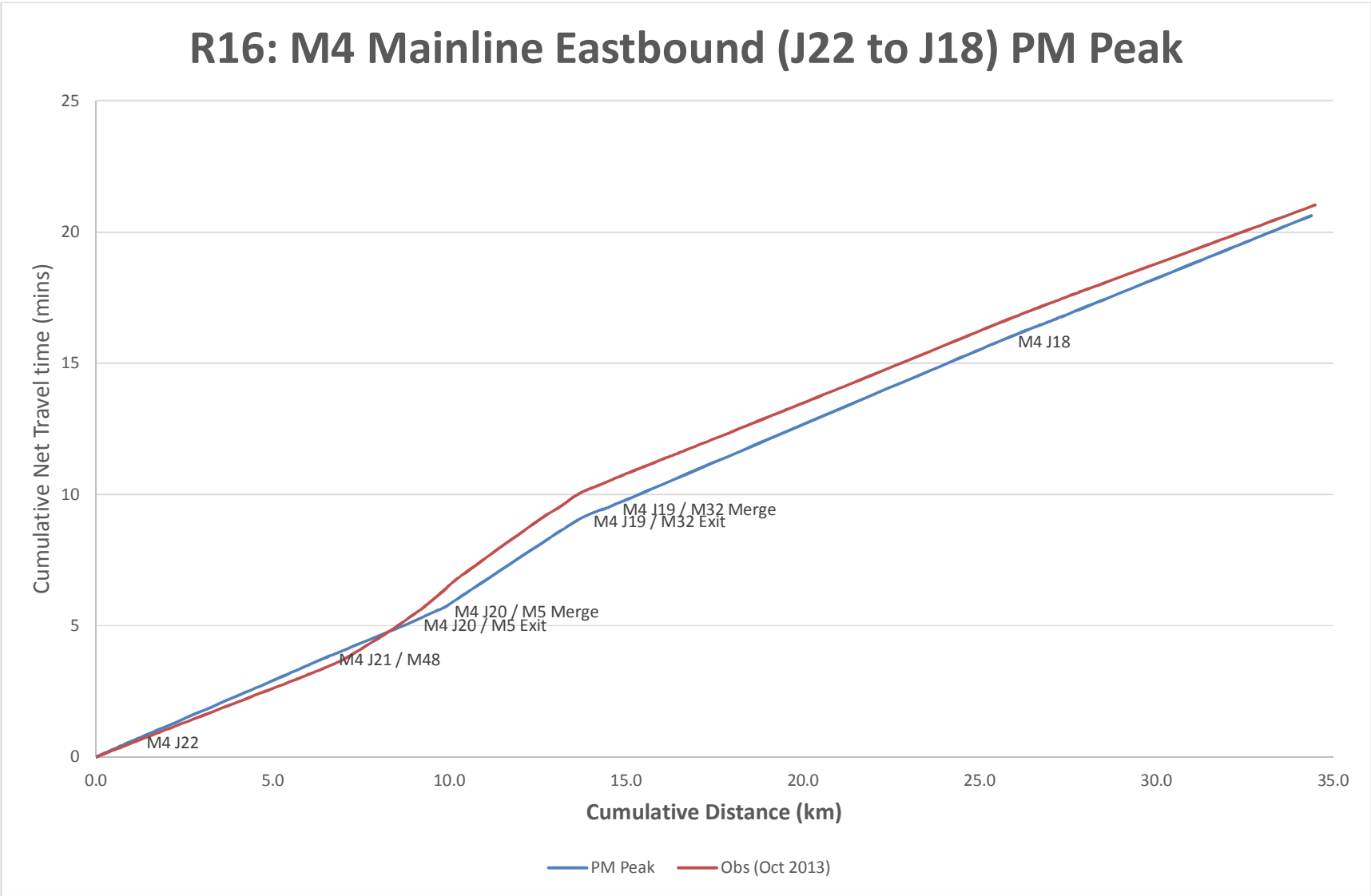
R14: City Centre Outer Loop (Anti-Clockwise) PM Peak



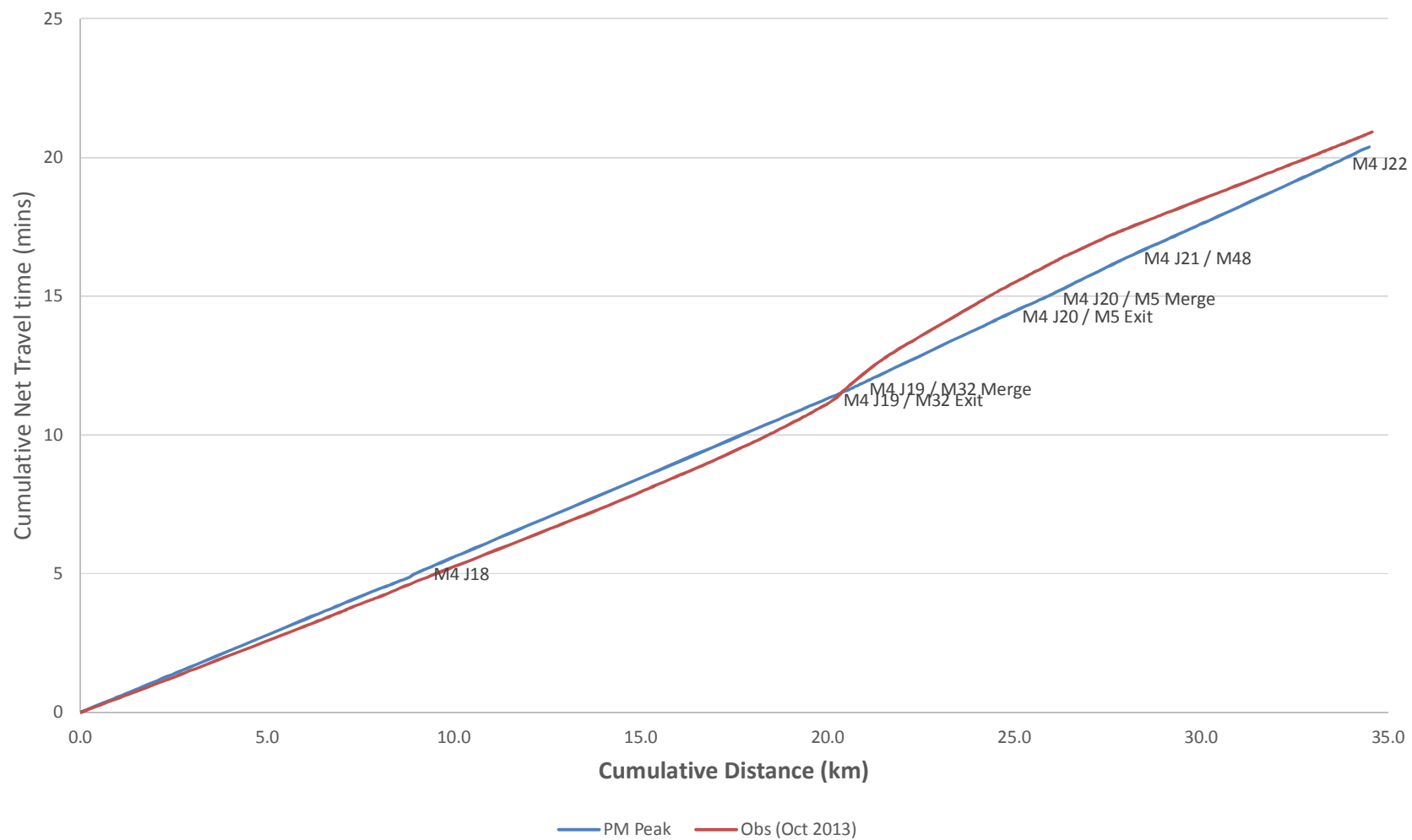


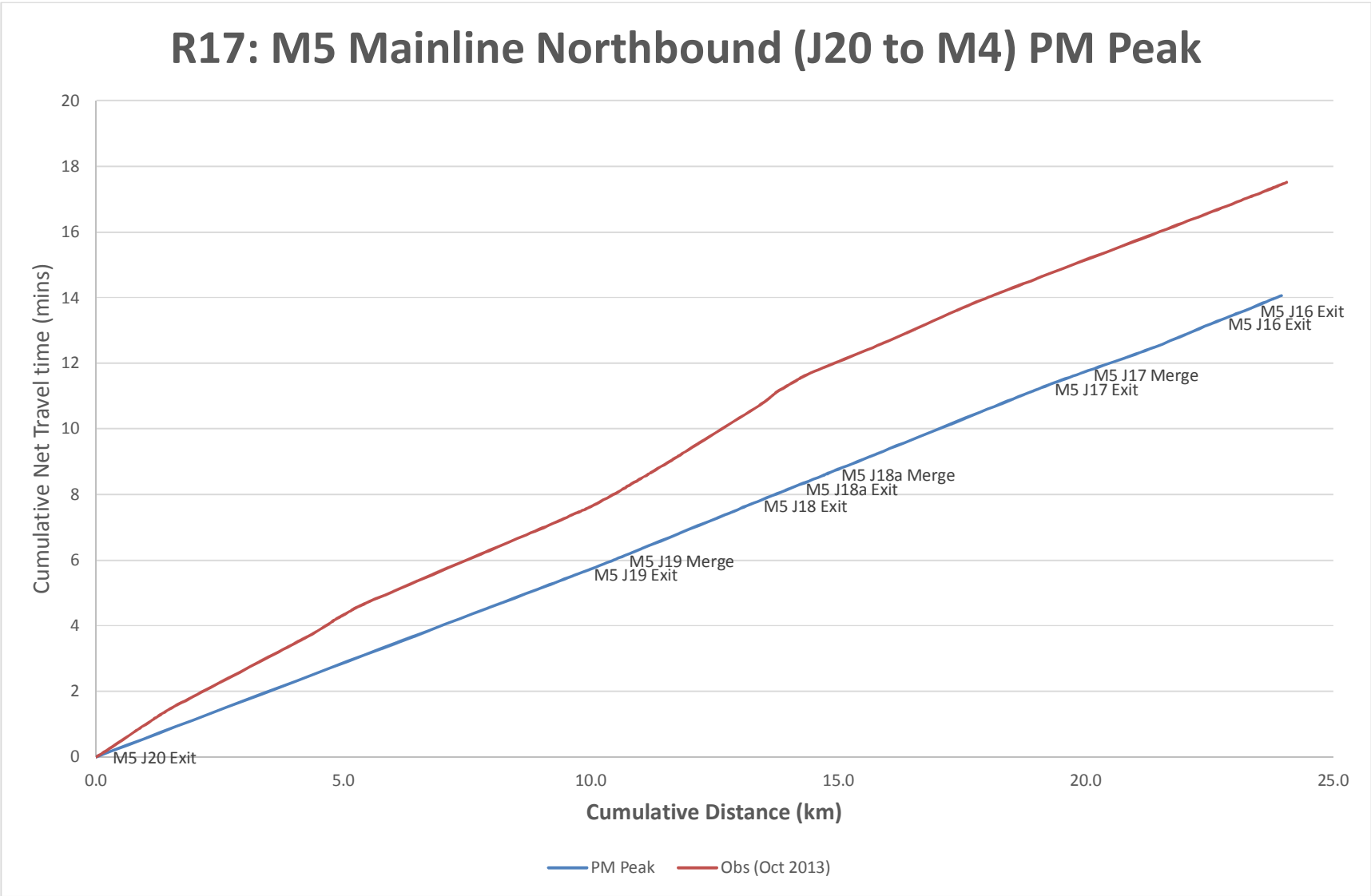
R15: City Centre Inner Loop (Anti-Clockwise) PM Peak



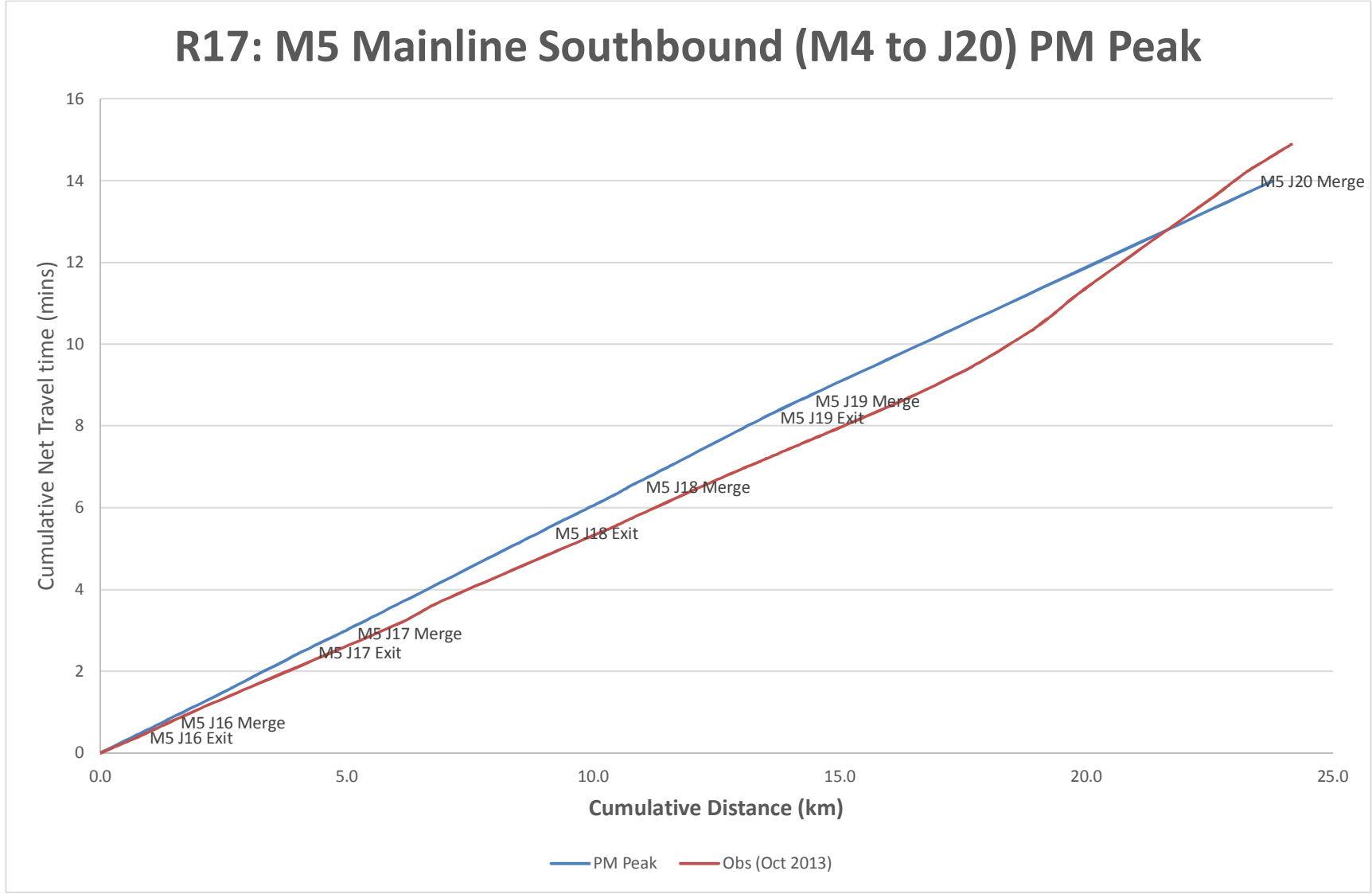


R16: M4 Mainline Westbound (J18 to J22) PM Peak



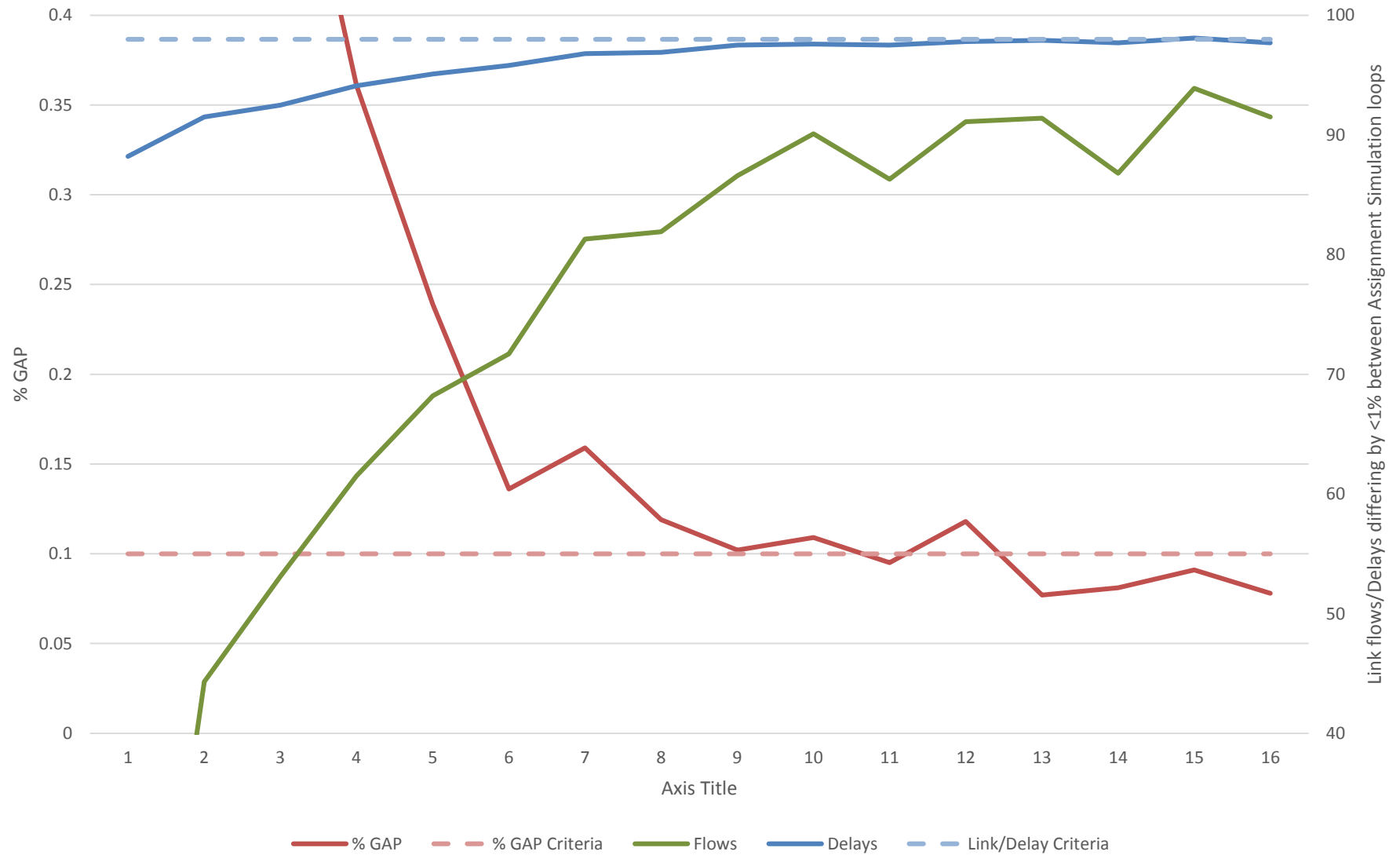


R17: M5 Mainline Southbound (M4 to J20) PM Peak



Appendix G: Model Convergence Graphs

Figure G1 - AM Peak: % GAP and Link Flows



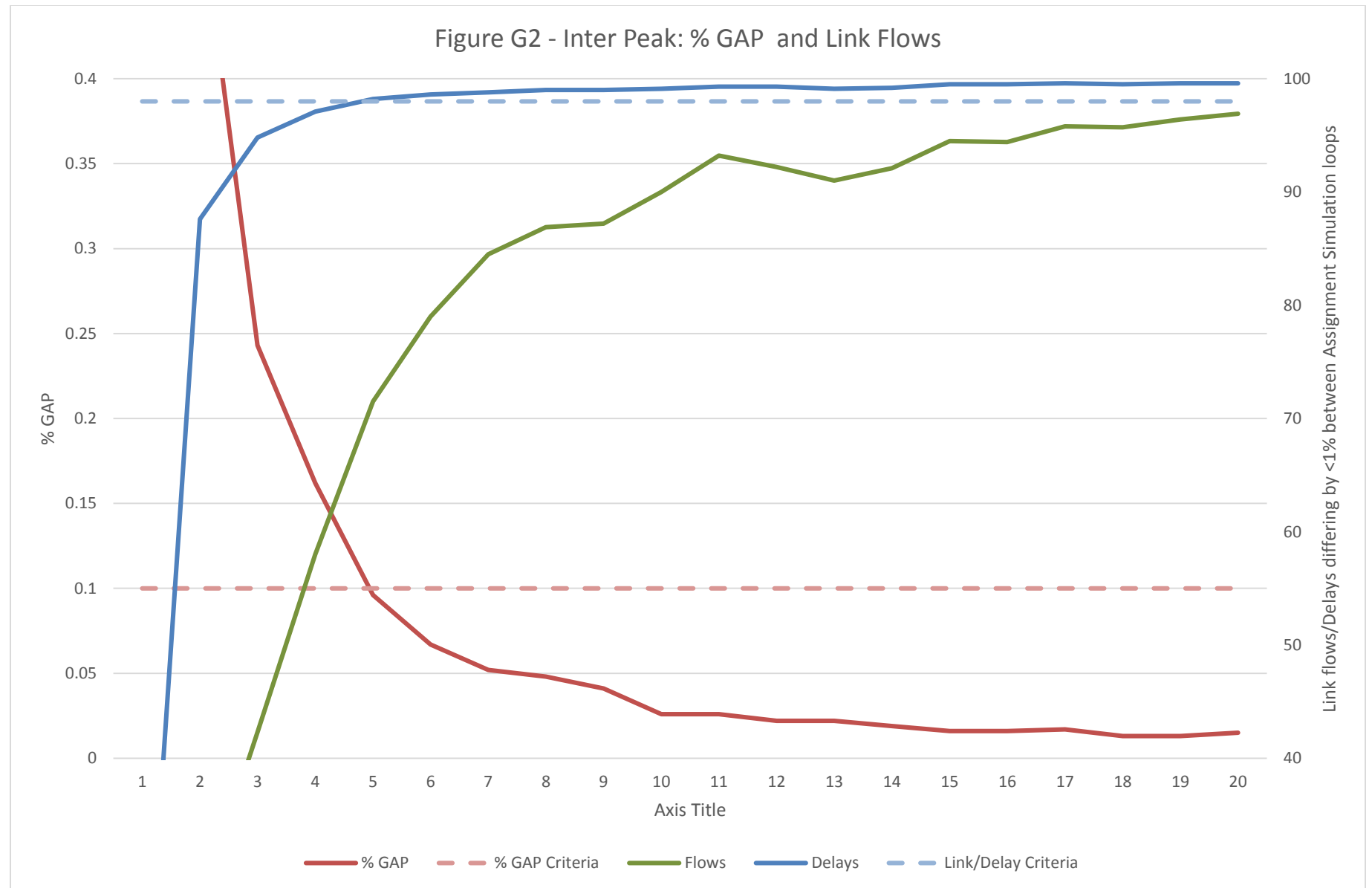


Figure G3 - PM Peak: % GAP and Link Flows

