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Calderdale Strategic Transport Model Update

Local Model Validation Report

Confidential October 2016

CALDERDALE STRATEGIC TRANSPORT MODEL UPDATE

LOCAL MODEL VALIDATION REPORT

Calderdale Metropolitan Borough Council

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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

1.1 BACKGROUND

1.1.1 WSP | Parsons Brinckerhoff has been commissioned by Calderdale Metropolitan Borough Council (CMBC) under the West Yorkshire plus Transport Fund (WY+TF) to update and extend the existing Calderdale Strategic Transport Model (CSTM) to represent the 2014 travel patterns and highway network conditions, to enable assessment of proposed developments and infrastructure schemes and more specifically test identified schemes as part of the WY+TF.

1.1.2 A strategic highway model of the Calderdale Borough covering Halifax town and the adjacent centres was developed by Mouchel in 2008 and further expanded in 2009. The CSTM represented travel patterns that occurred across the key road network within the Calderdale borough, during a typical 2009 weekday. The model was developed to assess development options associated with Calderdale's Local Development Framework (LDF) and also to enable testing of a series of highway improvements options.

1.1.3 The CSTM was updated in 2014. The base year was updated to 2014 by an extensive data collection exercise incorporating traffic counts and road side interviews. The extent of the model network was unchanged providing coverage of the Calderdale borough. The CSTM represented travel patterns that occurred across the key road network during a non-biased month. This update was developed to test development options associated with Calderdale's Local Plan and also to enable testing of a series of highway improvement options on the strategic network in Calderdale.

1.1.4 A second update to the CSTM was undertaken in 2016. The purpose of the update was to extend and improve the network and zoning outside of Calderdale, specifically in Kirklees and Bradford. This would enable the model to be a more suitable tool for use in assessment of highway improvements schemes with improved route choices from outside Calderdale, and for analysing cross boundary impacts of Local Plan developments, with particular attention on the boundary with Kirklees.

1.1.5 The base year of the CSTM was unaltered at 2014 (see 2.3 for details). Additional data was obtained to enable the coverage of the model to be extended. The model update process has been carried out in accordance, where appropriate for model purpose, with the Department for Transport web based Transport Analysis Guidance (WebTAG) on http://www.dft.gov.uk/webtag. This provides detailed guidance on the appraisal of transport projects and wider advice on scoping and carrying out transport studies. The guidance and a report of model performance against criteria contained within it, is essential for confidence in evidence base produced for large scale projects requiring government approval.

1.2 REPORT PURPOSE

1.2.1 This report is a Local Model Validation Report (LMVR) for the second update to the CSTM – the extension and improvement of network and zoning in Kirklees and Bradford. This report details the development of the model, the data required to develop the model and the calibration and validation of the traffic model against WebTAG criteria to accurately represent the 2014 observed traffic levels and routeing behaviour.

1.3 REPORT STRUCTURE

1.3.1 The structure of this report is as follows:

- Section 2: Model Overview;
- Section 3: Calibration & Validation Data;
- Section 4: Network Development;
- Section 5: Matrix Development;
- Section 6: Calibration & Validation Result;
- Section 7: Standards Achieved; and
- Section 8: Summary.

2 MODEL OVERVIEW

2.1 INTRODUCTION

2.1.1 This section of the report details the specification of the CSTM regarding the parameters used and modelled area covered.

2.2 MODELLING SOFTWARE USED

2.2.1 SATURN (Simulation and Assignment of Traffic in the Urban Road Network) Version 11.3.12U was used for the updating of the CSTM. SATURN is a recognised industry-standard transport modelling tool providing:

- A modelling and assessment platform supported by CMBC, West Yorkshire Combined Authority (WYCA) and Highways England (HE);
- WebTAG compliance in terms of structure and model convergence, and output statistics essential for scheme appraisal and the determination of robustness in decision-making and scheme design; and
- A comprehensive and efficient data input and analysis capability.

2.3 BASE YEAR

2.3.1 The base year of the CSTM remained unaltered at 2014. This decision was based upon the vast majority of the observed data (traffic counts and roadside interviews) being collected in 2014, and that the current network in 2016 has a key link closed to traffic (Elland Bridge) following storm damage. Any data used from outside 2014 was factored to 2014 by use of long term counts analysis.

2.4 TIME PERIODS

2.4.1 The model has been developed for the time periods below. The interpeak hour is an average hour between the times of 10:00 and 16:00.

- Average weekday AM Peak Hour: 08:00 – 09:00;
- Average weekday Interpeak Hour: 10:00 – 16:00; and
- Average weekday PM Peak Hour: 17:00 – 18:00.

2.4.2 These time periods had been adopted for all previous versions of the model. As a sense check ten permanent count sites on the Calderdale network were examined to confirm the peak hours did match the time periods specified above.

2.4.3 The percentage of total daily flow was calculated for each hour for each permanent count site for all weekdays in June 2014. A map of the count site location is shown in Figure 2.1and the results are plotted in Figure 2.2 below.

Figure 2.1 – Location of Calderdale permanent count sites

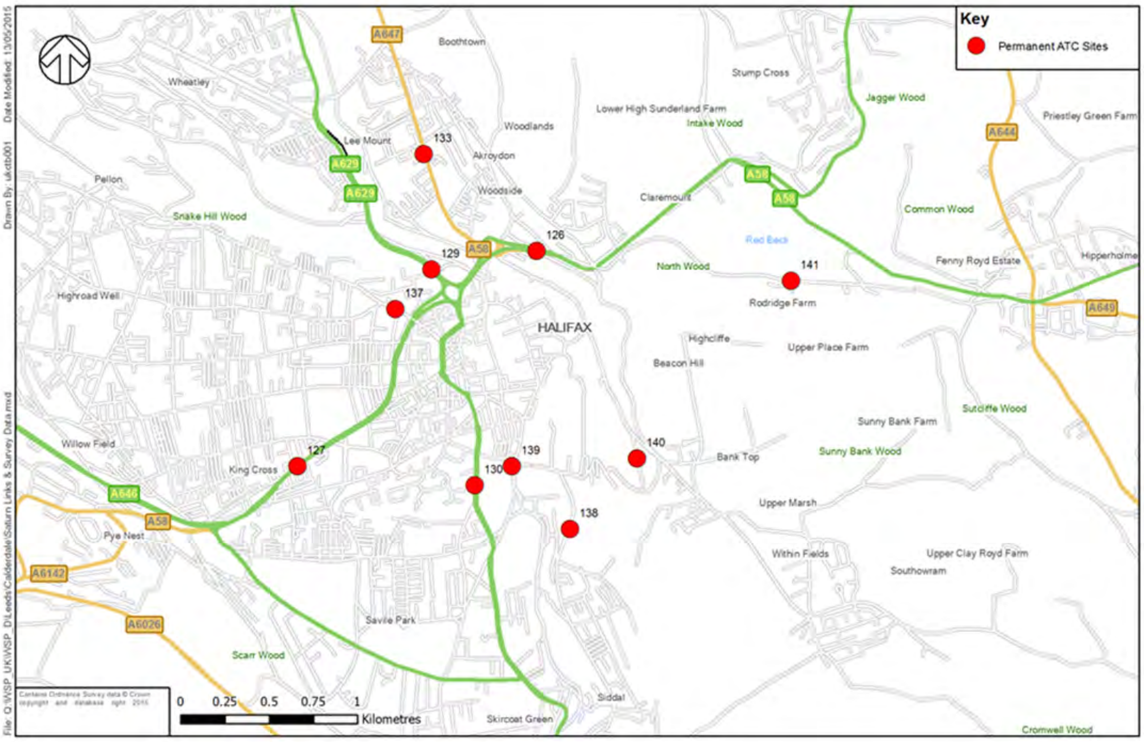
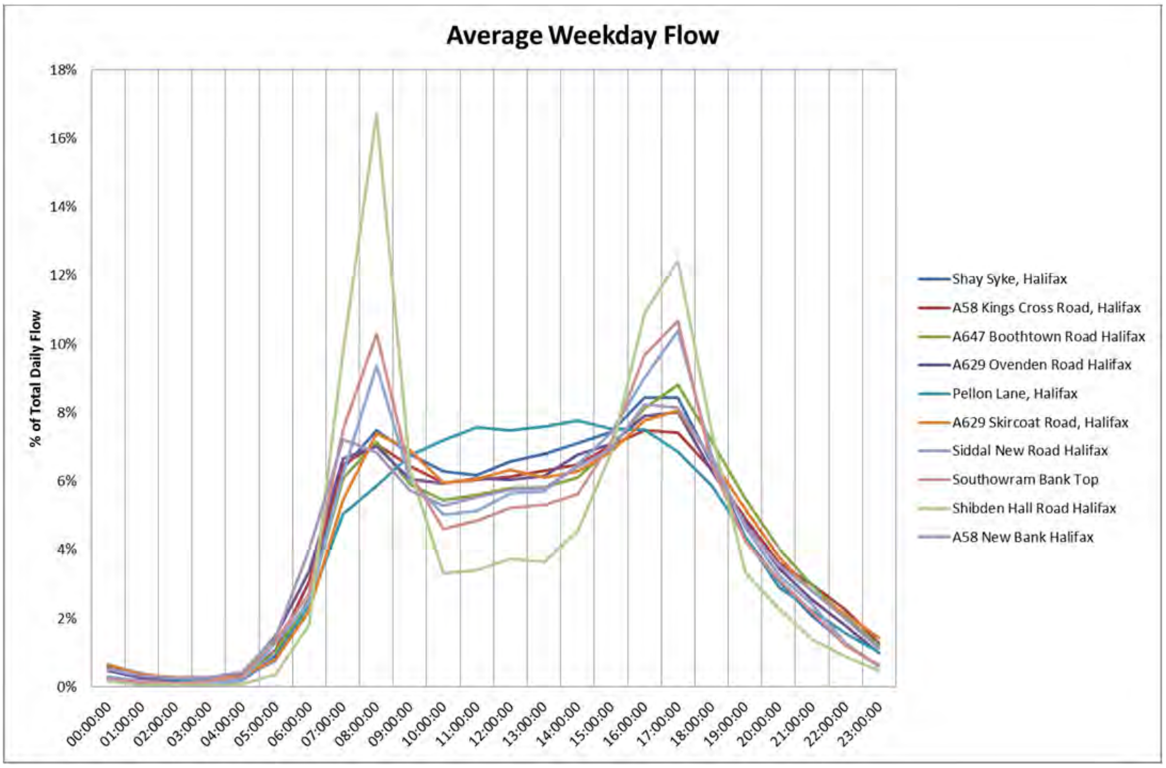


Figure 2.2 – Weekday flow variation at Calderdale permanent count sites



2.4.4 Analysis of this data shows that the modelled time periods as specified above are correct. The only outlier is the site on Pellon Lane which has a higher percentage of daily flow in the inter peak than the morning and evening peak periods. This is due to its location being in proximity to several retail parks which attract inter peak trips.

2.5 USER CLASSES

2.5.1 SATURN permits a multiple user class assignment in which combinations of vehicle type and journey purpose may be assigned onto the highway network. This CSTM update comprises of six user classes:

- User Class 1: Cars on employers' business;
- User Class 2: Cars commuting;
- User Class 3: Cars 'other' trips;
- User Class 4: Light Goods Vehicles (LGV) all purposes;
- User Class 5: Other Goods Vehicles – 2 and 3 axle rigid (OGV1) all purposes; and
- User Class 6: Other Goods Vehicles – 3 axle articulated and 4+ axle (OGV2) all purposes.

2.5.2 As in the previous 2014 update, Public Service Vehicles (PSVs) i.e. buses have not been included in the model as a distinct user class and have been modelled on the network as fixed flows throughout model. This fixed flow is on a specified route within the model input files and has a peak hour frequency relevant to the hour modelled. This allows a realistic approach to routeing and the capture of congestion and consequently the journey times around the model.

2.6 PASSENGER CAR UNITS

2.6.1 Passenger Car Units (PCUs) are factors that allow a consistent approach to assess all user classes within the model. These standard factors have been taken from TAG Unit M3.1 Highway Assignment Modelling Appendix D – Section D7 conversion to Passenger Car Units (Jan 2014):

- Car: 1.0
- LGV: 1.0
- HGV on motorway and all-purpose dual carriageway: 2.5
- HGV on all other types of road: 2.0

2.6.2 In an assignment model it is not possible to allocate different PCU factors to a particular user class according to the link type. Guidance is not given on this aspect in WebTAG, so a default PCU factor of 2.0 has been applied to all HGV's, since the majority of links within the model are not motorway or all-purpose dual carriageway.

2.7 GENERALISED COST PARAMETERS

2.7.1 In the CSTM routeing of trips between origins and destinations have been depicted by weighting applied to time and distance. The weightings are based on central government research into the values of time and the perceived costs of the travel of road users.

2.7.2 Generalised costs were calculated using value of time, GDP growth rates, purpose splits and vehicle operating costs recommended by the DfT for use in economic appraisals of transport projects in England, as presented in the WebTAG Databook December 2015 release with October 2015 consultation values of time values. The October 2015 consultation values of time were viewed as being more in line with what will be released in the Autumn 2016 data book update due in November 2016, and the best available information at the time of modelling. . Use of the consultation figures will minimise the impact of the Autumn 2016 update on the difference in highway assignment user class routing between base and forecast years.

2.7.3 The values used in the Base model are shown in Table 2.1 and Table 2.2. Table 2.1 outlines the Pence Per Minute (PPM) values by peak period and user class, and Table 2.2 shows this in terms of Pence Per Kilometre (PPK). All PPM values have been calculated using perceived values of time.

Table 2.1 – Generalised Cost Parameters, Pence Per Minute (PPM)

PEAK	CAR EMPLOYER'S BUSINESS	CAR COMMUTING	CAR OTHER	LGV	OGV1	OGV2
AM	29.71	19.92	13.73	20.92	21.19	21.19
IP	30.44	20.25	14.62	20.92	21.19	21.19
PM	30.13	19.99	14.38	20.92	21.19	21.19

Table 2.2 – Generalised Cost Parameters, Pence Per Kilometre (PPK)

PEAK	CAR EMPLOYER'S BUSINESS	CAR COMMUTING	CAR OTHER	LGV	OGV1	OGV2
AM	13.55	6.91	6.91	13.86	30.57	61.67
IP	13.55	6.91	6.91	13.86	30.57	61.67
PM	13.55	6.91	6.91	13.86	30.57	61.67

2.8 TRANSPORT MODEL AREA

2.8.1 The fully modelled area covers the Calderdale borough and the northern and eastern parts of Kirklees that border Calderdale. Within this area all key highway links and junctions are modelled, with appropriate minor road network detailed around the urbanised areas of the districts.

2.8.2 Outside the fully modelled area there is a buffer / external network to allow appropriate routeing of trips into the fully modelled area. This network includes links into eastern Lancashire, north east Kirklees and Wakefield and Bradford / Leeds. Give the location (and the topography) a more extensive external network was not deemed necessary bearing in mind the proposed uses of the model outlined in Section 1.2.

2.8.3 The coverage of the model includes the M62 Junction 22 through to Junction 29, the M1 Junction 40 to Junction 42, the A629 between Illingworth and Huddersfield via Halifax town centre, the A641 from Bradford through Brighouse to Huddersfield, the A640 west of Huddersfield, the A646 to Hebden Bridge and Todmorden, A6036 to Shelf and the A644 Queensbury to Cooper Bridge via Brighouse.

2.8.4 The model includes urbanised areas such as Halifax, Elland, Sowerby Bridge and Brighouse in considerable detail, with local roads included within the assignment as well as major strategic roads.

2.8.5 The transport model area and links included with the model are shown in Figure 2.3 below.

Figure 2.3 - CSTM network

2.9 ZONING SYSTEM

2.9.1 The zone system of the CSTM has been designed such that it is sufficiently detailed to credibly represent loading points from different land uses onto the transport network. The smallest zones are within the urban areas of the fully modelled area becoming increasingly coarse further away from the study area. The zoning system made use of the following administrative boundaries:

- 2011 Census Output Areas (COA);
- 2011 Census Wards;
- 2011 Census Employment Zones;
- Districts;
- Counties;
- National Trip End Model (NTEM) Zones (which are based on COA); and
- West Yorkshire Urban Dynamic Model (UDM) Zones (which are based on COA).

2.9.2 Within Calderdale the zoning remained relatively unaltered from the previous model structure which had been based on census boundaries. Additional zones were added based upon the likely location of large local plan residential and employment sites.

2.9.3 Zoning was completely reconstructed in Kirklees, Wakefield, Leeds and Bradford. The basis of the zoning was COAs and UDM zones. UDM zones were used as any Gross Value Added assessment undertaken forms an important part the economic section within a Business case that the CSTM would be used to support, e.g. A629 Phases 1 and 2. It is therefore important that the CSTM zoning is readily aligned to the UDM model zone structure for this purpose.

2.9.4 The zones to the north and west of Calderdale remained unaltered, as did the large external western zone. To the east the external zone was further subdivided into north east, east and south east to allow loading of trips on M1 north and south of junction with M62, and on M62 east of junction with M1.

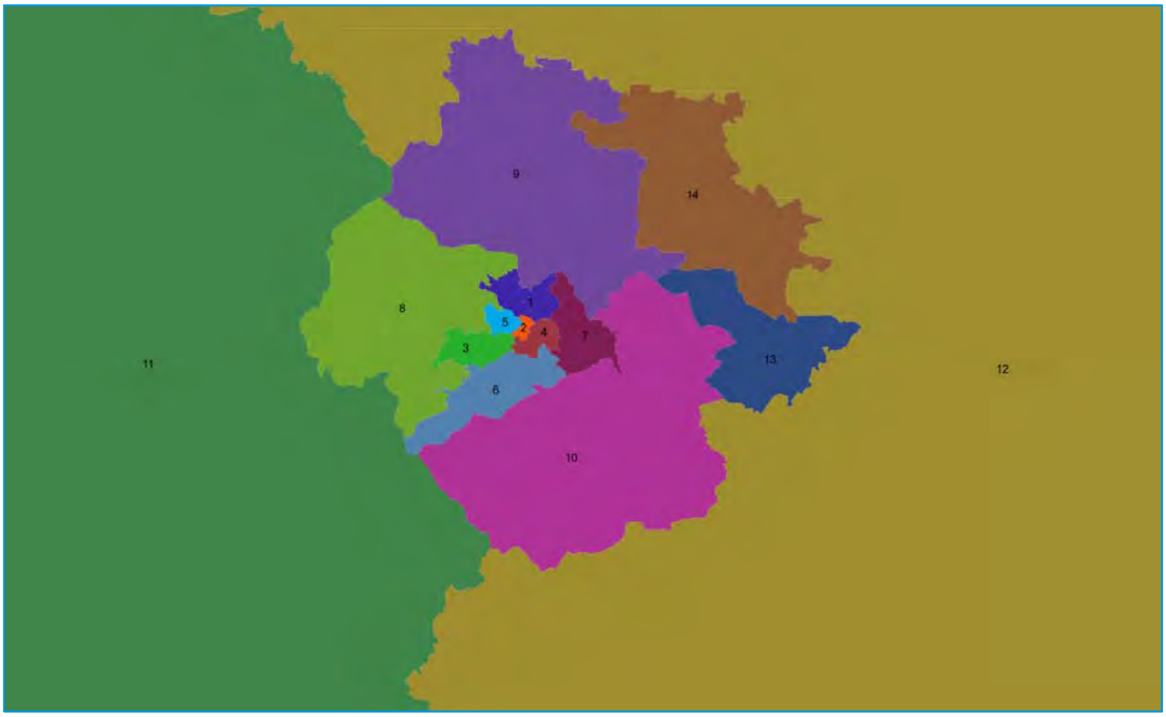
2.9.5 In total there are 335 zones in the CSTM. This has increased from 278 in the previous version of the model and thus reflects the greater granularity and detail outside of Calderdale. Plans of the CSTM zones can be found in Appendix H.

2.9.6 The zones were aggregated into a sector system in order to ease analysis and reporting. A total of 14 sectors were created. These are shown in Table 2.3 below and Figure 2.4.

Table 2.3 – Sector description

NUMBER	AREA
1	Northern Halifax
2	Halifax Town Centre
3	Sowerby Bridge
4	South Eastern Halifax
5	West Halifax
6	Elland
7	Brighouse
8	Hebden Bridge & Todmorden
9	Bradford
10	Kirklees
11	West of England, Wales and Scotland
12	East of England
13	Wakefield
14	Leeds

Figure 2.4 - Sector map



2.9.7 The full extent of the sectors along with zone plots can be found in Appendix H.

3 CALIBRATION AND VALIDATION DATA

3.1 INTRODUCTION

3.1.1 This section of the report outlines the survey data used to calibrate and validate the model. The surveyed data used was as follows:

- Roadside Interview Data for Matrix Building;
- Traffic Count Data for Matrix Estimation / Calibration;
- Traffic Count Data for Validation; and
- Journey Time Data for Validation.

3.1.2 The majority of the traffic count data and roadside interview data was collected in 2013 and 2014 and this data was used in the previous CSTM update. In order to extend the network into Kirklees additional traffic and roadside interview data was provided by Kirklees Council that had been used in the recent construction of the Kirklees Transport Model. This data was collected in 2015.

3.1.3 In addition to the Kirklees data, traffic counts were commissioned in Calderdale. This was to address any areas lacking in data from the previous model update and to assist in the production of a town centre micro-simulation model. This set of data was collected in March 2016.

3.1.4 All traffic count data used in calibration and validation was factored to June 2014 which was the month in which the roadside interview surveys were conducted in Calderdale. The factors were calculated from permanent traffic count sites located on the Calderdale highway network. A map of the permanent count sites in shown in Figure 2.1 above.

3.1.5 Journey time data was obtained from the Traffic Master database. Average journey times for June 2014 were obtained for all routes.

3.1.6 The types of data used for the calibration and validation of the model are listed below. Full details of the data sources and dates of collection are given in Appendix B.

- 23 Road Side Interviews (RSI) – 19 in Calderdale, four in Kirklees;
- 156 Automatic Traffic Counts (ATCs) across Calderdale, Kirklees and Bradford;
- 52 Classified Turning Counts (CTCs) in Calderdale;
- Nine Highways England TRADS counts sites on M62 mainline and slip roads; and
- Three Automatic Number Plate Recognition (ANPR) sites in Elland.

3.1.7 The data used from the ATCs was the total vehicle flow as any vehicle splits provided by ATCs can be prone to inaccuracy. In order to convert the total vehicle flow from the ATCs to the three vehicle types used in the model (car, LGV and HGV) a vehicle split was applied taken from the MCC data collected in April and October 2014.

3.1.8 The vehicle splits are shown in Table 3.2 and Table 3.3.

Table 3.1 – AM Vehicle % split

	AM % SPLIT			
	Car	LGV	OGV1	OGV2
Mway and A Roads	82.0%	11.6%	2.9%	1.4%
B Roads and other	85.0%	9.2%	2.7%	0.8%

Table 3.2 – IP Vehicle % Split

	IP % SPLIT			
	Car	LGV	OGV1	OGV2
Mway and A Roads	78.8%	13.8%	3.2%	1.5%
B Roads and other	80.8%	10.9%	3.3%	1.1%

Table 3.3 – PM Vehicle % Split

	PM % SPLIT			
	Car	LGV	OGV1	OGV2
Mway and A Roads	89.0%	7.6%	0.8%	0.4%
B Roads and other	88.7%	6.8%	1.0%	0.3%

3.1.9 Application of these split factors was not required in Kirklees as each Kirklees ATC had an Manual Classified Count (MCC) undertaken at the same location at one day during the collection period.

3.2 ROADSIDE INTERVIEW DATA

3.2.1 The locations, survey dates and direction of survey are given in Table 3.4 below.

Table 3.4 – RSI site locations

SITE ID	DESCRIPTION	DATE	INTERVIEW DIRECTION
1	A58 Rochdale Road	17/06/2014	Eastbound
2	A646 Burnley road	10/06/2014	Eastbound
3	Moor End Road	10/06/2014	North-Westbound
4	Shroggs Road	10/06/2014	Southbound
5	Ovenden Road	18/06/2014	Southbound
6	Haley Hill	18/06/2014	South-Eastbound
7	Stainland Road	18/06/2014	Northbound
8	A629 Elland Wood Bottom	11/06/2014	Southbound
9	New Road	11/06/2014	Southbound
10	New Hey Road	24/06/2014	North-Eastbound
11	Clough Lane	24/06/2014	Eastbound

SITE ID	DESCRIPTION	DATE	INTERVIEW DIRECTION
12	A641 Huddersfield Road	17/06/2014	Southbound
13	A644 Wakefield Road	17/06/2014	Eastbound
14	Walton Lane	17/06/2014	Northbound
15	Birkby Lane	19/06/2014	Eastbound
16	A58 Whitehall Road	19/06/2014	Eastbound
17	Bradford Road	12/06/2014	Northbound
18	Wade House Road	12/06/2014	North-Eastbound
19	A644 Brighouse & Denholme Gate Road	12/06/2014	Southbound
20	A629 East of junction with Blacker Road North	21/04/2015	South-Eastbound
23	A640 East of roundabout junction with Blacker Road	21/04/2015	South-Eastbound
24	A641 South of Cobcroft Road junction	22/04/2015	Southbound
25	A62 North East Huddersfield, east of Bradley Mills Road	22/04/2015	South-Westbound

3.2.2 Only four of nine available RSI sites in Kirklees were used in the matrix building process, hence the gap in Site ID from 20 to 23. The unused Kirklees RSI sites were on the southern approaches to Huddersfield as well as one site on a minor northern approach to Huddersfield which was not included in the CSTM network.

3.2.3 The locations are plotted in Figure 3.1 below.

Figure 3.1 – RSI Site Locations

3.2.4 Information on the following was obtained for each respondent:

- Vehicle type;
- Number of occupants;
- Origin postcode for trip;
- Reason for being at origin;
- Destination postcode for trip; and
- Reason for going to destination.

3.2.5 RSIs were conducted between 07:00 and 19:00 on the respective survey date. MCCs were also carried out over the same time period, on the same day as the relevant RSI in both directions, in order to gain a full understanding of the vehicle types at each location.

3.2.6 For each RSI site an ATC (at least two weeks' worth of data) was under taken at the same location. The relevant ATC was used to expand the MCC counts at the RSI sites in order to provide a more robust long-term average traffic count unaffected by disruptions to traffic flow and routeing associated with the RSIs themselves.

3.2.7 Table 3.5 below shows the number of logical face-to-face interviews in the interview direction and the proportion of the total traffic (as recorded by the on the day MCC) these represent. Logic checks were carried out, with data excluded if any key field related to the RSI record was incomplete.

Table 3.5 – RSI surveys and sample size

SITE ID	DESCRIPTION	INTERVIEW DIRECTION	LOGICAL SURVEYS	TRAFFIC FLOW	SAMPLE PERCENTAGE
1	A58 Rochdale Road	EB	690	3876	18%
2	A646 Burnley road	EB	1,024	7173	14%
3	Moor End Road	NWB	743	1558	48%
4	Shroggs Road	SB	686	3235	21%
5	Ovenden Road	SB	789	8349	9%
6	Haley Hill	SEB	1,004	6381	16%
7	Stainland Road	NB	858	7630	11%
8	A629 Elland Wood Bottom	SB	1,135	14402	8%
9	New Road	SB	517	1234	42%
10	New Hey Road	NEB	593	4438	13%
11	Clough Lane	EB	817	7160	11%
12	A641 Huddersfield Road	SB	909	7766	12%
13	A644 Wakefield Road	EB	891	6828	13%
14	Walton Lane	NB	1,267	3472	36%
15	Birkby Lane	EB	824	2864	29%
16	A58 Whitehall Road	EB	765	7892	10%
17	Bradford Road	NB	810	5480	15%
18	Wade House Road	NEB	748	7265	10%
19	A644 Brighouse & Denholme Gate Road	SB	1,005	4273	24%
20	A629 East of junction with Blacker Road North	SEB	708	7655	9%
23	A640 East of roundabout junction with Blacker Road	SEB	592	9020	7%
24	A641 South of Cobcroft Road junction	SB	611	9030	7%
25	A62 North East Huddersfield, east of Bradley Mills Road	SWB	637	9518	7%

3.2.8 Typical sample rates for RSIs generally line in the range of 10-20%. The samples achieved here are mostly within that range though the busier routes into Huddersfield and on the A629 in Calderdale fall outside of that range.

3.2.9 Appendix G contains origin and destination postcode plots for each RSI site. In certain instances, there are records which appear to be the wrong side of the RSI based on whether they are an origin or destination and the interview direction. Examination of these individual records does not show these interviews to be illogical definitively - they could be part of a linked trip or a logical journey for the specific respondent involved. It was decided to not exclude such records to ensure the data used was not biased by presumptions of travel patterns through the RSI sites.

3.3 TRAFFIC COUNTS FOR MATRIX ESTIMATION

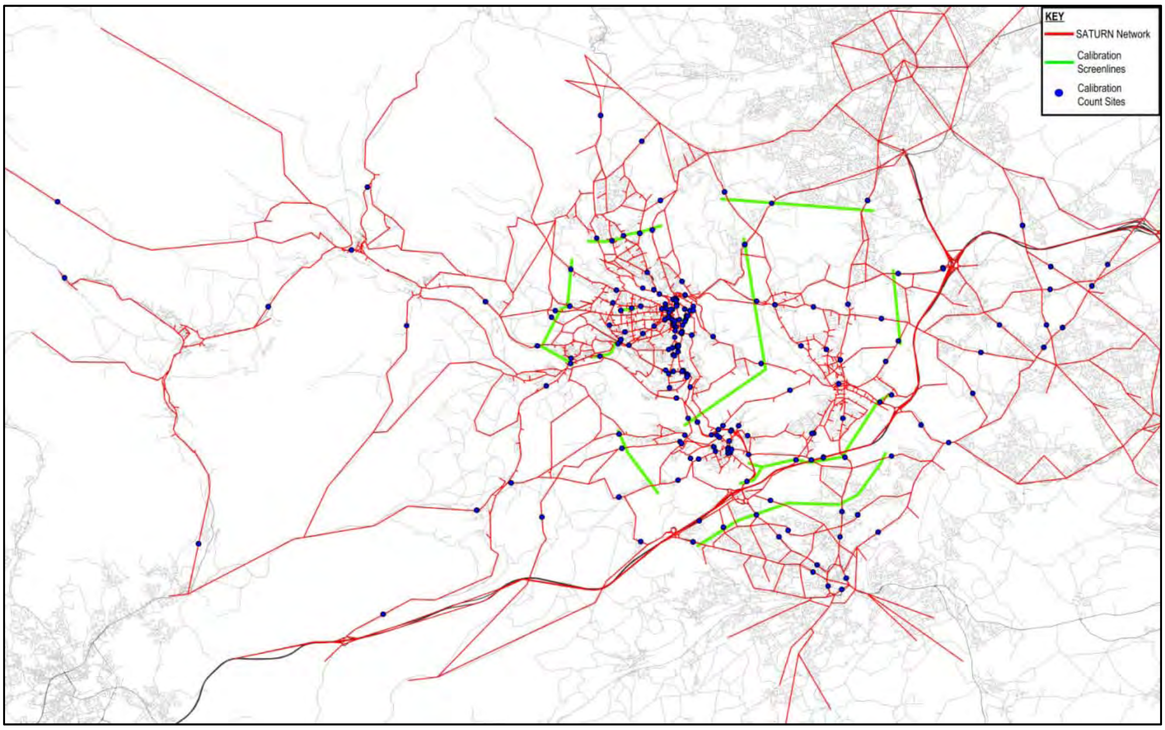
3.3.1 In order to improve the fit between the model flow and observed flow, it was necessary to use certain counts to factor the matrices. This process is known as Matrix Estimation. To facilitate this, several traffic counts were identified for this purpose within the study area.

3.3.2 Traffic counts were identified based upon prior matrix performance and importance of link flow within the context of the model. As stated above all counts were factored to June 2014.

3.3.3 In addition to the individual link counts, 11 screenlines were identified across which flow would be factored to the total observed flow of the screenline. Screenlines were located along geographical features such as rivers, railway lines and M62, and typically corresponded to the boundaries of sectors detailed in 2.9.

3.3.4 The counts and screenlines used for matrix estimation are shown in Figure 3.2 below.

Figure 3.2 – Calibration count sites and screenlines



3.3.5 A full list of calibration traffic counts can be found in Appendix B.

3.4 TRAFFIC COUNTS FOR VALIDATION

3.4.1 Counts were also obtained for independent validation of the traffic model, and as with calibration counts, flows were factored to June 2014. A number of validation counts were one-day manual classified counts. This was in part due to the Elland Bridge closure which prevented a more comprehensive data update in Calderdale due to the altered traffic routeing.

3.4.2 As with the calibration, screenlines were identified to give an indication of the performance across a range of key links. A total of five validation screenlines were identified.

3.4.3 The location of validation count sites are shown in Figure 3.3 below.

Figure 3.3 – Validation count sites and screenlines

3.4.4 A full list of validation traffic counts can be found in Appendix B.

3.5 JOURNEY TIME DATA

3.5.1 Journey time data was obtained from TrafficMaster data. TrafficMaster is an online tool which calculates average journey time based on real-life traffic delays and movements. Trafficmaster uses in vehicle tracking systems, GPS based equipment such as Satellite Navigation and Bluetooth to measure where the vehicle is on the road. The journey time route observations were taken for average weekdays in June 2014 and were provided for 16 bi-directional routes. These routes provided sufficient coverage of the Calderdale network with cross boundary routes into Kirklees being an addition from the previous model update.

3.5.2 The journey time data was provided for average node to node journey times for all peak periods.

These routes are shown in Figure 3.4 and described in

3.5.3 Table 3.6 covering major strategic movements and key route paths in the modelled area.

Figure 3.4 – Journey Time Routes

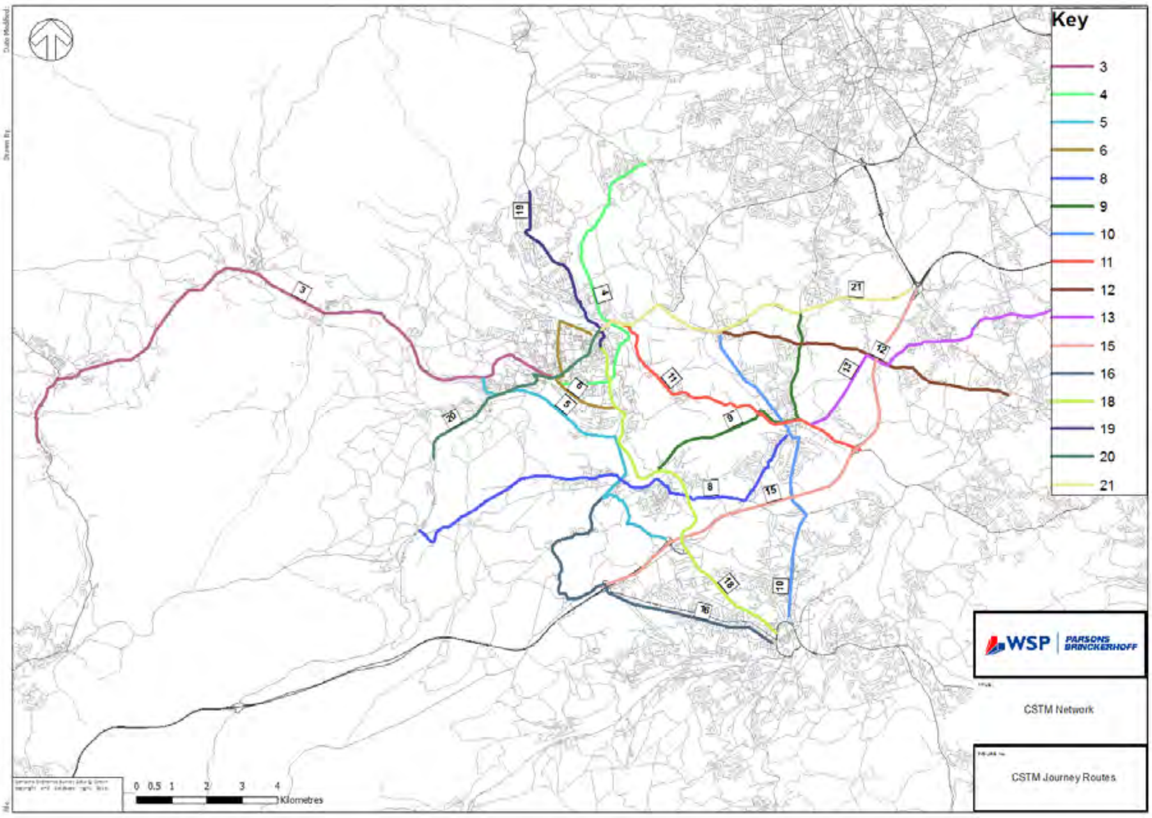


Table 3.6 – Journey Time Route Description

NAME	DESCRIPTION
Route 3 EB	A646/A6033 from A58 Rochdale Road junction to Walsden.
Route 3 WB	A6033/A646 from Walsden to A58 Rochdale Road Junction
Route 4 NB	Free School Lane to Halifax Road/Windy Bank Lane junction via Shaw Hill, Charlestown Road, Boothtown Road, Halifax Road.
Route 4 SB	Halifax Road/Windy Bank Lane junction to Free School Lane via Halifax road, Boothtown Road, Charlestown Road, Shaw Hill.
Route 5 NB	Tuel Lane/A646 junction to M62 junction 24 via Tuel Lane, Wakefield Road, Stainland Road, Blackley Road.
Route 5 SB	M62 junction 24 to Tuel Lane/A646 junction via Blackley Road, Stainland Road, Wakefield Road, Tuel Lane.
Route 6 NB	Halifax Town Centre to Calder Royal Hospital via Pellon Lane west, Queens road, A646 Dryclough Lane.
Route 6 SB	Calder Royal Hospital to Halifax Town Centre via A646 Dryclough Lane, Queens Road, Pellon Lane East.
Route 8 WB	Ripponden to Brighouse via B6113 Rochdale Road, Elland Town centre, B6114 Dewsbury Road, A643 Crowtrees Lane.
Route 8 EB	Brighouse to Ripponden via A642 Crowtrees Lane, B6113 Dewsbury Road, Elland Town Centre, B6113 Rochdale Road.
Route 9 SB	A641/A58 junction to A629/A6025 junction via A641 southbound, Brighouse Town centre, A6025 West.
Route 9 NB	A629/A6025 junction to A58/A641 via A6025 junction via A6015 East, Brighouse town Centre, A641 northbound
Route 10 SB	Hipperholme to Huddersfield via A644, A641.
Route 10 NB	Huddersfield to Hipperholme via A641, A644.
Route 11 EB	Halifax Town Centre to M62 junction 25 via Southowram, Brighouse.
Route 11 WB	M62 junction 25 to Halifax Town Centre via Brighouse, Southowram.
Route 12 EB	Hipperholme to Liversedge via A649.

NAME	DESCRIPTION
Route 12 WB	Liversedge to Hipperholme via A649.
Route 13 EB	Brighouse to Birstall via A643.
Route 13 WB	Birstall to Brighouse via A643.
Route 15 WB	M62 junction 23 to M62 junction 26.
Route 15 EB	M62 junction 26 to M62 junction 23.
Route 16 SB	Stainland to Huddersfield via Holywell Green, Outlane, A640.
Route 16 NB	Huddersfield top Stainland via A640, Outlane, Holywell Green.
Route 18 NB	Huddersfield to Halifax Town Centre via A629
Route 18 SB	Halifax Town Centre to Huddersfield via A629.
Route 19 NB	Halifax Town Centre to Illingworth via A629
Route 19 SB	Illingworth to Halifax Town Centre via A629.
Route 20 EB	Triangle to Halifax Town Centre (New Bank Gyratory) via A58, Sowerby Bridge.
Route 20 WB	Halifax Town Centre (New Bank Gyratory) to Triangle via Sowerby Bridge, A58.
Route 21 EB	Halifax Town Centre (New Bank Gyratory) to M62 junction 26 via A58.
Route 21 WB	M62 junction 26 to Halifax Town Centre (New Bank Gyratory) via A58.

4 NETWORK DEVELOPMENT

4.1 INTRODUCTION

4.1.1 The network development covers all key highway links and junctions covering both the Calderdale district and the northern half of the Kirklees district. All key movements have been completed in the simulation area of the network however a large buffer network has been established for route choice.

4.2 NETWORK BUILDING

4.2.1 The previous update of the model covered the Calderdale district with only zone connectors heading into Kirklees. The previous version of the model was updated from 2009 to 2014 and validated to 2014 flows. The previous version of the model has a small amount of network covering the flows that would be accessing Kirklees via a few select cross boundary elements of the network.

4.2.2 A 'node' is a part of the model where there is a significant amount of change, for example a speed limit or junction, that needs to have detail in order to change the effect on the connected link. A node is categorised as simulation if it has detailed information that can be edited that has a direct effect on the network, and is categorised as buffer network if there is less information associated. The 'buffer network' is purely provided for route choice across the model.

4.2.3 The link and junction coding has been built in the same way as the previous SATURN update, with standardised saturation flows for turning movements and standard speed/flow curves. The speed flow curves have come from the original Mouchel update of the model, and have continued into the latest update. The speed flow curve relationship can be found in Appendix A with descriptions of the links. Speed limits have been taken into account with the road speed limit in the simulation network and an average speed across the buffer links taken from TrafficMaster.

4.2.4 Google aerial mapping has been used to loosely determine the location of the main roads within Kirklees and how they connect to the Calderdale district. This was then updated with an internal GIS system to determine lengths of links within SATURN and number of lanes on links. The same program has been used to calculate flare distances for effective lengths.

4.2.5 The A62 has been the focus point for splitting the model between simulation and buffer. This splits out the simulation in to Huddersfield and the buffer into Liversedge and Dewsbury, Wakefield, Leeds and Bradford. The A62 has been decided upon to be the split between simulation and buffer as the largest movement of traffic across the border of Calderdale and Kirklees is seen to use the A640, A629 and A641. The simulation network/buffer network split across the model is shown in Figure 4.1 below.

Figure 4.1 – Simulation/Buffer Network Split

4.2.6 It should be noted that the junctions of the A62 with A6107 Bradley Road, A644 Cooper Bridge and A644 Huddersfield Road have been included within simulation. This is to ensure complete coverage of the Calderdale highway network in simulation. The rest of the A62 is in buffer.

4.2.7 Development of the network consisted of the following checks:

- Link Length;
- Speed/Flow relationship;
- Link type and Saturation flows;
- Link capacity;
- Single/dual lanes;
- One/two way operation;
- Number of effective lanes;
- Length and position of effective flares/right turn refuges;
- Public transport routeing; and
- Junction updates.

5 MATRIX DEVELOPMENT

5.1 MATRIX BUILDING INTRODUCTION

5.1.1 This section outlines the methodology used to build the AM peak, Inter peak and PM peak matrices.

5.1.2 The matrix building methodology can be considered in three stages:

- RSI Matrix - processing of RSI survey data to create a matrix;
- Infill Matrix – using the base matrix from the previous update to fill in gaps in RSI Matrix coverage; and
- Synthetic Matrix – for trips between newly disaggregated zones in Kirklees.

5.2 RSI MATRIX

5.2.1 RSI data includes information on:

- The time at which the vehicle passed through the RSI site
- Vehicle type;
- Vehicle occupancy;
- Purpose of a journey; and
- Origin and destination address of a trip.

5.2.2 The RSI data obtained was the primary source of data used to build the demand matrices and capture trips local to the study area. For each site and interview direction, vehicles surveyed were split into four vehicle types detailed below. Motorcycles were not included as they were not a designated user class within the model and do not generally contribute to congestion:

- Car / Taxi;
- LGV ;
- OGV1; and
- OGV2.

5.2.3 The RSI origin-destination data was cleaned and assigned to their appropriate zone. The interview records have been divided by time period, purpose and vehicle type.

5.2.4 For the non-interview direction in the AM peak period (07:00-10:00), the car, taxi and LGV RSI records in the PM peak (16:00-19:00) were selected. This makes the assumption that the PM peak (16:00-19:00) interview direction records made the other leg of their journey between the respective origin and destination zones in the non-interview direction in the AM peak (07:00-10:00) and therefore the data was transposed. The transposed records were then scaled to match the non-interview AM peak count controlled by journey purpose and vehicle type. The equivalent process was applied in the PM peak (16:00-19:00), using transposed AM peak movements and scaled accordingly. In the interpeak (10:00-16:00), the transpose of the interpeak interview movements was used.

5.2.5 Trips within each peak period are generally considered to remain representative of trip behaviour within that period. For example, trips in the AM peak period (07:00-10:00) are mostly commuting trips, and the origin-destination patterns across the whole period are reflected in the patterns of the peak hour itself (08:00-09:00). To increase the sample rate car and LGV user interview data for 3 hours (07:00-10:00; 16:00-19:00) for the AM peak and PM peak and 6 hours (10:00-16:00) for the inter peak was taken into account and factored to the count of the peak of one hour period being modelled. This makes best use of the RSI data and reduces the reliance on the existing matrix. Trips are not mixed between time periods for the Car and LGV user classes.

5.2.6 Because the number of observations was small, OGV1 and OGV2 trips were not split into peak periods, instead the entire RSI survey period (07:00-19:00) for these user classes were included in the respective peak matrix which was being built irrespective of the time the interview was recorded for this journey. This was done to limit the number of instances where no heavy vehicles were present in the creation of expansion factors.

5.2.7 Hourly expansion factors were then derived in order to expand the RSI matrix from representing a sample of the traffic to the total traffic flow. This was done by dividing the ATC volume by the total number of interviews for the relevant vehicle type. These expansion factors were then used against each individual RSI record to create a matrix which matched the ATC totals. The expansion factors for each site are given in Table 5.1.

Table 5.1 – RSI expansion factors by interview direction and vehicle type

RSI SITE	PEAK PERIOD	INTERVIEW DIRECTION				NON-INTERVIEW DIRECTION			
		CAR	LGV	OGV1	OGV2	CAR	LGV	OGV1	OGV2
RSI 1	AM	1.99	2.59	0.26	5.18	1.92	4.06	0.36	3.05
	IP	0.80	1.45	0.42	7.43	0.90	1.55	0.45	6.53
	PM	1.85	1.85	0.26	1.05	3.21	4.31	0.05	3.02
RSI 2	AM	1.85	1.77	3.57	1.53	2.68	6.56	12.70	9.94
	IP	1.11	1.35	6.71	5.28	1.20	1.41	6.55	5.79
	PM	2.85	3.25	1.70	2.55	2.14	1.56	0.54	1.63
RSI 3	AM	0.90	0.85	0.13	0.00	1.15	1.15	0.72	2.87
	IP	0.38	0.48	0.41	0.59	0.37	0.48	0.19	0.55
	PM	1.06	0.82	0.13	0.53	0.90	0.49	0.12	0.47
RSI 4	AM	2.06	2.83	0.34	0.00	1.29	6.53	0.35	0.00
	IP	0.67	0.83	0.42	-	0.91	1.15	0.38	-
	PM	1.44	2.27	0.00	0.00	2.59	3.51	0.00	0.00
RSI 5	AM	4.66	5.60	1.72	-	2.68	9.86	1.98	-
	IP	1.58	2.18	1.85	-	1.66	2.28	1.62	-
	PM	3.83	5.02	0.48	-	5.14	4.89	0.54	-
RSI 6	AM	3.04	3.63	-	-	1.49	4.33	-	-
	IP	1.05	1.39	-	-	0.94	1.46	-	-
	PM	2.63	4.83	-	0.00	2.85	2.93	-	0.00
RSI 7	AM	3.50	3.61	1.09	9.03	1.96	5.97	1.11	7.46
	IP	1.17	1.70	0.87	7.29	1.12	1.55	1.00	7.07
	PM	3.33	6.48	0.23	1.88	2.81	2.31	0.08	0.91
RSI 8	AM	4.47	8.03	5.26	-	3.49	8.55	5.40	-
	IP	1.88	2.50	6.85	-	1.77	2.46	5.65	-
	PM	4.72	8.35	1.49	-	3.43	6.36	2.24	-
RSI 9	AM	0.79	0.60	0.00	0.00	0.69	0.91	0.00	0.00
	IP	0.41	0.72	0.56	0.00	0.44	0.65	0.62	0.00
	PM	0.88	0.85	0.00	0.00	1.30	0.88	0.00	0.00
RSI 10	AM	3.07	5.39	0.56	0.48	3.41	4.09	0.46	0.46
	IP	1.22	1.94	0.48	0.39	1.33	2.07	0.49	0.05
	PM	3.25	3.71	0.20	0.00	3.06	5.77	0.07	0.00

RSI SITE	PEAK PERIOD	INTERVIEW DIRECTION				NON-INTERVIEW DIRECTION			
		CAR	LGV	OGV1	OGV2	CAR	LGV	OGV1	OGV2
RSI 11	AM	4.09	2.77	4.91	-	3.32	2.79	9.00	-
	IP	1.18	1.42	7.35	-	1.20	1.52	7.00	-
	PM	3.35	2.44	1.66	-	4.08	2.96	1.00	0.00
RSI 12	AM	4.13	2.95	0.86	-	4.29	5.46	0.90	-
	IP	1.12	1.40	0.98	-	1.11	1.45	0.73	-
	PM	4.40	4.91	0.14	-	4.07	1.74	0.22	-
RSI 13	AM	2.53	3.37	1.71	1.31	1.45	3.24	0.89	0.65
	IP	1.13	1.55	1.17	1.34	0.97	1.20	0.84	0.89
	PM	2.75	3.39	0.38	0.46	2.29	1.36	0.29	0.49
RSI 14	AM	1.13	0.93	0.37	1.10	0.88	2.27	0.38	0.99
	IP	0.36	0.46	0.25	1.50	0.32	0.38	0.22	1.00
	PM	1.20	2.57	0.11	0.68	1.32	0.88	0.10	0.00
RSI 15	AM	1.43	2.55	2.38	0.89	1.22	2.65	0.30	0.00
	IP	0.39	0.48	1.33	0.32	0.39	0.62	1.11	0.30
	PM	1.43	1.68	0.87	0.00	1.76	2.69	0.23	0.00
RSI 16	AM	2.96	3.17	1.24	-	2.62	4.84	1.29	-
	IP	1.39	2.07	1.52	-	1.39	2.29	1.46	-
	PM	2.88	2.67	0.57	-	3.71	3.54	0.79	-
RSI 17	AM	3.22	4.06	1.14	6.53	2.57	6.32	0.96	2.23
	IP	1.15	1.32	0.86	4.71	1.11	1.45	0.83	4.64
	PM	3.00	5.58	0.37	0.52	3.23	3.17	0.37	1.03
RSI 18	AM	4.26	3.76	5.95	14.69	3.28	8.84	7.86	8.84
	IP	1.48	3.19	6.24	8.23	1.50	2.85	7.96	12.40
	PM	4.02	5.17	2.25	6.74	4.52	3.40	3.02	3.40
RSI 19	AM	1.90	2.73	6.26	-	1.56	3.27	11.31	-
	IP	0.78	0.94	9.23	-	0.79	1.00	9.19	-
	PM	2.27	1.99	5.98	-	2.68	3.25	4.07	-
RSI 20	AM	3.10	8.84	4.74	7.17	2.27	-	1.98	4.89
	IP	1.38	8.80	3.44	6.25	1.37	7.19	2.93	5.09
	PM	3.11	-	0.61	0.00	3.27	5.74	1.00	1.31
RSI 23	AM	5.53	-	5.92	5.47	3.58	-	6.40	5.97
	IP	1.87	9.90	5.67	6.59	1.80	9.86	5.82	6.79
	PM	4.07	-	1.25	2.49	4.60	-	1.58	3.15
RSI 24	AM	4.84	83.33	2.91	-	5.00	87.33	4.21	-
	IP	2.08	19.87	2.19	-	2.21	19.20	3.43	-
	PM	4.25	42.55	0.20	-	5.01	42.35	0.23	0.00
RSI 25	AM	3.09	22.88	9.03	-	5.28	40.46	5.23	-
	IP	2.07	32.66	6.45	-	2.02	31.68	6.25	-
	PM	6.05	20.00	0.50	-	3.56	9.55	1.11	-

5.2.8 Matrix totals for each RSI site matched to their respective ATC direction are provided in Table 5.2.

Table 5.2 – Individual RSI matrix totals (vehicles)

RSI SITE	PEAK PERIOD	INTERVIEW DIRECTION					NON-INTERVIEW DIRECTION				
		CAR	LGV	OGV1	OGV2	TOTAL	CAR	LGV	OGV1	OGV2	TOTAL
RSI 1	AM	332	28	5	5	371	306	53	7	3	369
	IP	231	43	8	7	291	261	46	9	7	323
	PM	294	24	5	1	324	536	47	1	3	588
RSI 2	AM	498	62	11	2	572	613	177	38	10	838

RSI SITE	PEAK PERIOD	INTERVIEW DIRECTION					NON-INTERVIEW DIRECTION				
		CAR	LGV	OGV1	OGV2	TOTAL	CAR	LGV	OGV1	OGV2	TOTAL
	IP	438	87	20	5	551	476	91	20	6	593
	PM	652	88	5	3	747	577	54	2	2	634
RSI 3	AM	130	25	1	0	156	230	21	6	6	262
	IP	115	21	3	1	140	111	21	2	1	134
	PM	211	15	1	1	228	131	14	1	1	147
RSI 4	AM	420	28	3	0	451	196	33	3	0	232
	IP	187	22	4	0	214	254	31	3	1	289
	PM	218	11	0	0	230	528	35	0	0	563
RSI 5	AM	852	101	22	25	1000	476	99	26	11	612
	IP	540	98	24	16	677	566	103	21	14	704
	PM	682	50	6	7	745	941	88	7	4	1040
RSI 6	AM	759	84	7	2	853	350	56	7	7	421
	IP	458	65	11	5	539	408	69	9	4	490
	PM	618	63	1	0	682	712	67	4	0	783
RSI 7	AM	808	72	13	9	902	403	60	13	7	483
	IP	400	63	10	7	481	383	58	12	7	460
	PM	685	65	3	2	755	648	46	1	1	696
RSI 8	AM	1275	128	32	21	1456	969	111	32	28	1140
	IP	882	170	41	22	1115	830	167	34	23	1054
	PM	1311	109	9	13	1441	977	102	13	13	1105
RSI 9	AM	119	12	0	0	131	97	10	0	0	107
	IP	72	14	1	0	87	77	12	1	0	91
	PM	123	9	0	0	132	195	18	0	0	213
RSI 10	AM	568	48	8	3	628	419	41	6	3	470
	IP	277	37	7	3	323	300	39	7	0	346
	PM	400	37	3	0	440	566	52	1	0	619
RSI 11	AM	782	78	5	3	867	684	53	9	4	750
	IP	395	51	7	6	459	402	55	7	4	468
	PM	690	46	2	1	739	780	83	1	0	864
RSI 12	AM	826	97	12	8	943	832	76	13	9	930
	IP	454	70	14	7	545	447	73	10	5	535
	PM	853	69	2	2	925	815	57	3	1	876
RSI 13	AM	405	138	41	34	618	353	75	21	17	466
	IP	350	101	28	35	513	299	78	20	23	420
	PM	670	78	9	12	769	367	56	7	13	443
RSI 14	AM	307	41	7	1	356	275	39	7	1	321
	IP	194	31	4	1	231	174	26	4	1	204
	PM	375	44	2	1	421	359	39	2	0	400
RSI 15	AM	254	38	7	1	300	256	45	1	0	301
	IP	135	26	4	0	165	133	34	3	0	171
	PM	299	29	3	0	331	312	40	1	0	353
RSI 16	AM	595	83	17	15	710	426	92	18	17	553
	IP	412	93	21	22	549	413	103	20	23	560
	PM	470	51	8	7	535	746	92	11	8	857
RSI 17	AM	672	61	16	13	762	477	76	13	4	571
	IP	375	61	12	9	457	362	67	12	9	450
	PM	558	67	5	1	631	674	48	5	2	729
RSI 18	AM	834	71	18	15	938	547	88	24	9	668
	IP	477	92	19	8	596	484	83	24	12	603
	PM	672	52	7	7	737	886	65	9	3	963

RSI SITE	PEAK PERIOD	INTERVIEW DIRECTION					NON-INTERVIEW DIRECTION				
		CAR	LGV	OGV1	OGV2	TOTAL	CAR	LGV	OGV1	OGV2	TOTAL
RSI 19	AM	427	68	13	14	521	390	88	23	10	511
	IP	317	68	18	18	421	321	72	18	19	430
	PM	565	54	12	10	641	603	81	8	3	696
RSI 20	AM	539	62	33	14	648	400	51	14	10	475
	IP	459	79	24	12	575	456	65	21	10	551
	PM	547	40	4	0	591	569	40	7	3	618
RSI 23	AM	791	75	12	5	883	509	73	13	6	600
	IP	556	59	11	7	633	536	59	12	7	613
	PM	579	48	2	2	632	657	41	3	3	704
RSI 24	AM	833	83	12	3	931	801	87	17	2	907
	IP	560	79	9	3	651	595	77	14	4	689
	PM	681	43	1	1	725	861	42	1	0	905
RSI 25	AM	568	114	36	11	730	675	121	21	14	832
	IP	640	131	26	18	815	623	127	25	20	795
	PM	774	60	2	8	844	654	48	4	7	714

5.2.9 Some expansion factors are less than 1. This occurs primarily in the interpeak, where trips across the whole 6 hour interpeak period are factored to match the count for the single average interpeak hour. Small expansion factors in the AM and PM peaks occur as a result of factoring 3 hour peak period observations to a single peak hour count taken as an average from multiple ATC observations. This average may well be lower than the MCC undertaken on the particular survey day.

5.2.10 Each individual directional RSI matrix was assigned in isolation to the modelled network in order to check the routeing, and origin-destination patterns appeared logical. These checks also assisted in refining the coding of the SATURN network.

5.2.11 The RSI matrices were combined and the multiple observations of a trip at more than one RSI site were removed by applying the double counting technique at matrix level. All the trips from Zone A to B at different sites were summed up and then divided by the number of sites they appear in.

5.2.12 The final RSI matrix totals (in pcu) for each peak are shown in Table 5.3.

Table 5.3 - RSI matrix totals (pcu)

USER CLASS ID	USER CLASS DEFINITION	AM PEAK (08:00-09:00)	AVE INTER PEAK (10:00-16:00)	PM PEAK (17:00-18:00)
UC1	Car Employers Business	2,763	2,989	1,737
UC2	Car Commuting	12,977	3,193	10,104
UC3	Car Other	4,984	8,671	11,515
UC4	LGV	2,896	2,966	2,174
UC5	OGV1	1,257	1,194	249
UC6	OGV2	356	360	119
Total		**25,234**	**19,373**	**25,997**

5.3 INFILL MATRIX

5.3.1 To account for vehicle trips that are otherwise unobserved by any of the surveys, matrices assigned in the previous CSTM were used to represent the best estimate of unknown movements. This is particularly important for car-based trips, where a large number of trips will occur over short distances on local roads, so would not be captured by the RSI surveys. Other vehicle types will be more strategic in nature, so should be captured by the RSI.

5.3.2 The matrices from the previous model were disaggregated to account for the increase in the number of zones from 278 to 335. The majority of the disaggregation took place within Kirklees, but there was also disaggregation in Calderdale and Bradford. The zone population was used as the basis for disaggregation, with RSI data used where appropriate.

5.3.3 Disaggregation of the previous model matrices did not account for all trips between newly disaggregated zones. As the majority of disaggregation took place on the edge of simulation and in buffer areas of the model a simplified approach was used to create these trips. Trip ends for all zones in the model were estimated from NTEM (v6.2) trip ends by trip purpose for car drivers.

5.3.4 The NTEM trip ends were disaggregated to the model zone structure using a combination of 2011 census population and workplace zone data. For each zone the population and number of workers was calculated. Where a model zone was smaller than a census output area (population) or work place zone (workers) a factor based upon model zone area was applied.

5.3.5 Factors were applied to the NTEM trip end dependent upon trip type and time of day, e.g. all home based AM origins were factored by population in the model zone, whereas home based work destinations in the AM were factored by number of workers in the model zone. An upper limit of 1,500 trips was applied to reflect the impacts of the zone granularity and the lack of inter zonal trips produced by the gravity model. Goods vehicle trips were based upon non home based employer's business trip ends. A factor was calculated from expanded RSI data which was applied to the non home based employer's trip end for each model zone.

5.3.6 The final synthetic trip ends were used within a gravity model matrix builder to produce a full synthetic matrix (335 * 335 zones). Each user class matrix was calibrated to the previous base matrix trip distribution by use of a Tanner function. The R2 value exceeded 0.75 in all cases which indicated that the distribution fit was sufficient for purpose.

5.3.7 The synthetic matrix built by the gravity modeller was combined with the disaggregated base matrices. The only part of the synthetic matrix used was the trips between disaggregated zones (with the exception of the external zone disaggregation). A trip threshold limit of 0.1 was applied, i.e. if base disaggregated trip is less than 0.1, replace with synthetic trip. The final matrix was a disaggregated base with synthetic infill between newly disaggregated zones. This was then applied with the RSI matrices as described below.

5.4 PRIOR MATRIX

5.4.1 The final AM peak, PM peak and interpeak infill matrices were assigned to the corresponding SATURN networks. The trips that passed through the 23 RSI sites were identified by means of select link analysis and then replaced with the observed RSI Matrices for each time period thus producing the initial prior matrix.

5.4.2 The final prior trip matrix was calibrated by undertaking select link analysis at calibration sites and applying scaling factors to adjust the flows, before reinserting the adjusted matrix into the full trip matrix. This provides a targeted adjustment of the matrix that does not distort the observed origin-destination patterns by introducing an excessive volume of short trips - a typical concern when matrix estimation is used, and the reason for the strict controls on its effect set out in WebTAG.

5.4.3 The additional scaling was deemed necessary given the large area of the model where disaggregation had taken place and the simplified approach to creating synthetic trips. The creation of synthetic trips placed emphasis on the distribution between the disaggregated zones rather than the actual trip levels. Thus some control to observed data was needed.

5.4.4 Matrix totals for each stage are shown in Table 5.4.

Table 5.4 – Matrix Totals (pcus)

MATRIX	AM PEAK (08:00-09:00)	INTER PEAK (10:00-16:00)	PM PEAK (17:00-18:00)
RSI	25,234	19,373	25,997
Base Disaggregated	74,556	74,706	78,027
Select Link Analysis	23,890	21,496	26,756
Initial Prior	75,900	72,583	77,269
Final Prior	**74,126**	**70,932**	**76,010**

5.4.5 In creating the matrices, the best use has been made of the available data. Information from the latest RSI surveys accounts for 26-34% of trips. The remainder of trips unobserved by the RSIs has been taken from the existing model matrices with some synthetically created trips, as they are the next best source of information for these trips.

5.5 MATRIX ESTIMATION

5.5.1 The matrix estimation function within SATURN (SATME2) was used in order to refine the prior trip matrices to improve the fit between observed and modelled traffic flows. When using matrix estimation there is the potential to cause large changes in trip distributions and trip lengths so the process was closely monitored and a full range of performance indicators were produced as described below.

5.5.2 Matrix estimation used a total of 382 link counts spread across the modelled area. Within these counts were 10 bi directional screenlines across which the total modelled flow was constrained to the total observed flow. The performance of these screenlines is a good indicator that total trip movements in the matrix are generally representative of existing movements in the modelled area.

5.5.3 An additional screenline was reported in calibration which used the individual link observed flows as targets. This screenline included key links such as Stainland Road, A629 approach to Calder Hebble junction and A58 west of Hipperholme and thus given the future scheme testing requirements of the model, the individual modelled link flows were required to fit a closely as possible to observed flows.

5.5.4 Matrix estimation resulted in the following changes to the matrix totals as shown in Table 5.5.

Table 5.5 –Trip matrix estimation totals (pcus)

	AM			INTER PEAK			PM		
LEVEL	**PRIOR**	**POST**	**% DIFF**	**PRIOR**	**POST**	**% DIFF**	**PRIOR**	**POST**	**% DIFF**
UC1	8009	8236	3%	9789	10048	3%	6533	6913	6%
UC2	36617	38133	4%	15284	15655	2%	29203	30132	3%
UC3	17249	18411	7%	32687	34094	4%	32825	34853	6%
UC4	6477	6531	1%	6850	7059	3%	4862	4930	1%
UC5	4119	4541	10%	4508	5002	11%	1812	1965	8%
UC6	1654	1694	2%	1813	1929	6%	773	815	5%
TOTAL	**74126**	**77547**	**5%**	**70932**	**73788**	**4%**	**76010**	**79607**	**5%**

5.5.5 Matrix estimation is intended to be used to refine estimated matrices and the WebTAG matrix estimation criteria were monitored to ensure that significant changes did not occur. The results of matrix estimation are given in Table 5.6 below.

Table 5.6 –Trip matrix estimation performance

			AM		INTER PEAK		PM	
MEASUREMENT		**REQUIREMENT**	**VALUE**	**PASS**	**VALUE**	**PASS**	**VALUE**	**PASS**
Cells	Slope	Within 0.98 and 1.02	1.025	No	1.034	No	0.998	Yes
	Intercept	Near 0	0.014	Yes	0.004	Yes	0.033	Yes
	R-Sq	> 0.95	0.9441	No	0.9539	Yes	0.9547	Yes
Rows	Slope	Within 0.99 and 1.01	1.04	No	1.017	No	1.005	Yes
	Intercept	Near 0	1.449	No	4.835	No	9.672	No
	R-Sq	> 0.98	0.9855	Yes	0.9867	Yes	0.9775	No
Columns	Slope	Within 0.99 and 1.01	1.023	No	1.029	No	1.012	No
	Intercept	Near 0	5.095	No	2.37	No	8.123	No
	R-Sq	> 0.98	0.9823	Yes	0.9784	No	0.9787	No
Mean Trip Length	Prior	Within 5%	12.072	Yes	10.629	Yes	11.676	Yes
	Post		11.838		10.439		11.369	
	Diff		1.9%		1.8%		2.6%	

MEASUREMENT		REQUIREMENT	AM VALUE	AM PASS	INTER PEAK VALUE	INTER PEAK PASS	PM VALUE	PM PASS
Standard Deviation	Prior	Within 5%	14.220	Yes	12.879	Yes	13.688	Yes
	Post		13.677		12.452		13.097	
	Diff		3.8%		3.3%		4.3%	

5.5.6 The effect of matrix estimation on the cell and trip end values does not fall within the guidelines prescribed by WebTAG. However upon examination the values of R-Sq and slope mostly fall just outside the requirements rather than being a long way off. Only trip end intercepts (judged to have failed if less than -1 or greater than +1) could be considered to be a long way from meeting the criteria.

5.5.7 The performance can be attributed to the construction of the prior matrices. Three sources of data were merged (RSI, existing base matrices and synthetic trips) to produce the final prior matrices. As stated above the synthetic trip production was more targeted towards creating a distribution between the new zones rather than accurately modelling trip levels. Thus when matrix estimation was applied larger than expected changes occurred. The matrix build methodology was judged to be the most proportionate approach given the timescales and location of synthetic trips on the edge of the simulation area.

5.5.8 Additionally while the zoning has been disaggregated within Kirklees and Bradford, outside of these areas it remains large, with one external zone covering west of England and Scotland and, three zones covering the east of England. Traditionally there would be more external zones with larger cell values (especially intra zonal) which can tend to improve the matrix integrity performance. The actual value added to model performance by improving external to external demand was not considered beneficial to the model for its purpose of Local Plan assessment.

5.5.9 Average trip lengths showed small changes due to matrix estimation with all mean and standard deviation differences within 5%.

5.5.10 Changes in sector to sector movements were also monitored in line with WebTAG guidance. WebTAG sets a target of differences within 5% for sector to sector movements. The results are given in Table 5.7.

Table 5.7 – Sector to sector matrix performance

MEASUREMENT	AM	INTER PEAK	PM
Differences within 5%	20%	19%	18%
Absolute differences within 100 trips	90%	91%	84%
GEH < 5	89%	92%	85%

5.5.11 The model has been divided into 14 sectors resulting in 196 sector to sector movements. These have been constructed with the intention of analysing movements of future economic analysis of highway improvements. This has resulted in sector to sector movements with relatively low level of trips, and thus matrix estimation results in a high percentage change.

5.5.12 For this reason the number of sector to sector movements that change by less than 100 trips and the GEH are also included for comparison. The number of movements meeting these criteria is much higher than that meeting the 5% difference requirement.

5.5.13 Given the expansion of the model into an area with a mixture of observed and synthetic trips it is considered that the comparison of the prior and post matrix estimation matrices is acceptable.

5.5.14 Sector to sector matrices and trip length distribution plots are included in Appendix F.

5.5.15 The construction of the prior matrices involved merging together RSI, existing infill and synthetic trip matrices. The existing infill did not cover the expansion area of the model so a basic gravity model synthetic matrix was produced. The method used recognised the location of the synthetic trip as on the edge of the model area and as such it was deemed more expedient to rely on matrix estimation to provide the fit to observed data.

5.5.16 In order to enhance the model, additional count data was used in Halifax town centre and in Elland which had not been available for previous updates to the model. (The previous model had no counts in Halifax town centre). Thus the infill matrix may not have provided a good fit to this observed data and the changes brought about by matrix estimation to meet these new observed counts has resulted in the cell and trips end comparisons not meeting WebTAG criteria.

5.5.17 The matrix estimation effects show that trip lengths and standard deviations are not being changed greatly and the while some of the cell and trip end requirements are not met, the values returned are not too far outside of the WebTAG targets. As such it is deemed that the matrix estimation performance is acceptable.

6 CALIBRATION AND VALIDATION RESULT

6.1 INTRODUCTION

6.1.1 The process of model calibration is designed to ensure that the network parameters that control the model's calculations are sufficient enough to represent accurate delay and route choice and replicate traffic patterns in the network. The calibration relies heavily on the location of traffic loading on to the network and the delay at key areas being characteristic to the network.

6.1.2 The validation of the model requires that the modelled flows on the network match traffic flows not used in other stages of the model build, and that modelled journey times match observed journey times for selected routes across the model.

6.1.3 A number of calibration and validation checks have been used to reach the criteria set out in TAG. These are;

- Model convergence;
- Routeing Validation; Screenline calibration and validation;
- Link flow calibration and validation; and
- Journey time validation.

6.2 MODEL CONVERGENCE

6.2.1 Model assignment of trips to the highway network was undertaken based on a 'Wardrop User Equilibrium', which seeks to minimise travel costs on all routes for traffic flows in the network. The Equilibrium is based on the following;

6.2.2 "Traffic arranges itself on congested networks such that the cost of travel on all routes used between each origin-destination pair is equal to the minimum cost of travel and unused routes have equal or greater costs."

6.2.3 The Wardrop User Equilibrium that is implemented in SATURN follows the Franke-Wolfe Algorithm, which provides an iterative process to the Equilibrium calculations. This process is based on 'All or Nothing' iterations, which are combined to minimise and 'Objective Function'. The travel costs on each route are then calculated and compared to the last iteration. The process then terminates and a model is categorised as converged if there is a succession of iteration costs not changing by a significant amount. This process therefore sets-up a multi-routeing between any origin-destination pair.

6.2.4 Calibrating a model requires the close monitoring of model convergence until a satisfactory level is achieved. The convergence is needed to ensure that traffic flows remain stable between successive iterations providing a robust platform for further modelling and confidence for the user.

6.2.5 In accordance with criteria set out in WebTAG Unit M3.1 (Jan 2014), the parameters of %Flow, %GAP and Delta (δ) have been monitored to determine the level of convergence. %Flow measures the proportion of links in the network with flows changing by less than 1% from the previous iteration. Δ is the difference between costs on chosen routes and costs on minimum cost paths. %GAP is a generalisation of the δ function to include the interaction effects within the simulation.

6.2.6 The convergence criteria used for this model is set out below in Table 6.1

Table 6.1 – Convergence Criteria

MEASURE OF CONVERGENCE	ACCEPTABLE VALUE
'DELTA' AND '%GAP'	LESS THAN 0.1% OR AT LEAST STABLE WITH CONVERGENCE FULLY DOCUMENTED AND ALL OTHER CRITERIA MET
PERCENTAGE OF LINKS WITH FLOW CHANGE <1%	FOUR CONSECUTIVE ITERATIONS GREATER THAN 98%
PERCENTAGE OF LINKS WITH COST CHANGE <1%	FOUR CONSECUTIVE ITERATIONS GREATER THAN 98%
PERCENTAGE CHANGE IN TOTAL USER COSTS	FOUR CONSECUTIVE ITERATIONS LESS THAN 0.1%

6.2.7 WebTAG M3.1 suggests that delta (δ) and %GAP values of less than 0.1% is the most fundamental indicator of model convergence and should be achieved as a minimum. Table 6.2, Table 6.3 and Table 6.4 indicate satisfactory convergence has been achieved in all peak periods regarding these parameters. Percentage Flow has also met criteria of four successive iterations of greater than 98% with a percentage change of less than 1%. (The SATURN parameter RSTOP was set to 98.5, thus providing better conversion than required). These tables show that the base model for all peaks has achieved all necessary criteria required to be converged.

Table 6.2 – AM peak convergence results

ITERATION	DELTA (Δ)	%FLOW	%GAP
24	0.0068	98.3	0.028
25	0.0112	98.3	0.011
26	0.0106	98.9	0.019
27	0.009	98.9	0.0096
28	0.0058	98.9	0.027
29	0.0087	98.7	0.0071

Table 6.3 – Inter peak convergence results

ITERATION	DELTA (Δ)	%FLOW	%GAP
17	0.0023	96.5	0.005
18	0.0023	97.6	0.0023
19	0.0028	98.8	0.0027
20	0.0017	98.9	0.002
21	0.0021	99.3	0.0029
22	0.001	98.9	0.0022

Table 6.4 – PM peak convergence results

ITERATION	DELTA (Δ)	%FLOW	%GAP
36	0.0153	98.2	0.025
37	0.0142	98.2	0.015
38	0.009	99.1	0.035
39	0.0121	98.7	0.02
40	0.0079	98.8	0.012
41	0.0107	98.8	0.029

6.3 ROUTEING VALIDATION

6.3.1 The calibration of a model crucially relies on traffic entering and exiting the detailed modelling area at the correct points and travelling along the correct routes. The TREE function within SATURN programme P1X plots all routes within the network between two zones. By using the TREE function for many zone pairs throughout the study area, routes used by traffic have been examined to ensure that they are reasonable and resemble expected routes throughout the network by vehicles in the base traffic flow situation.

6.3.2 Plotted TREEs display the percentage of traffic using each route, thus highlighting the most common path taken. To check that the assigned routes were feasible, TREEs were generated for representative origin-destination pairs. Origin-destination zones had to be selected with enough distance to allow route choice but not unreasonable movements. TREE plots can be found In Appendix G.

6.3.3 In accordance with WebTAG M3.1, the number of origin destination pairs have been selected based on the following formula:

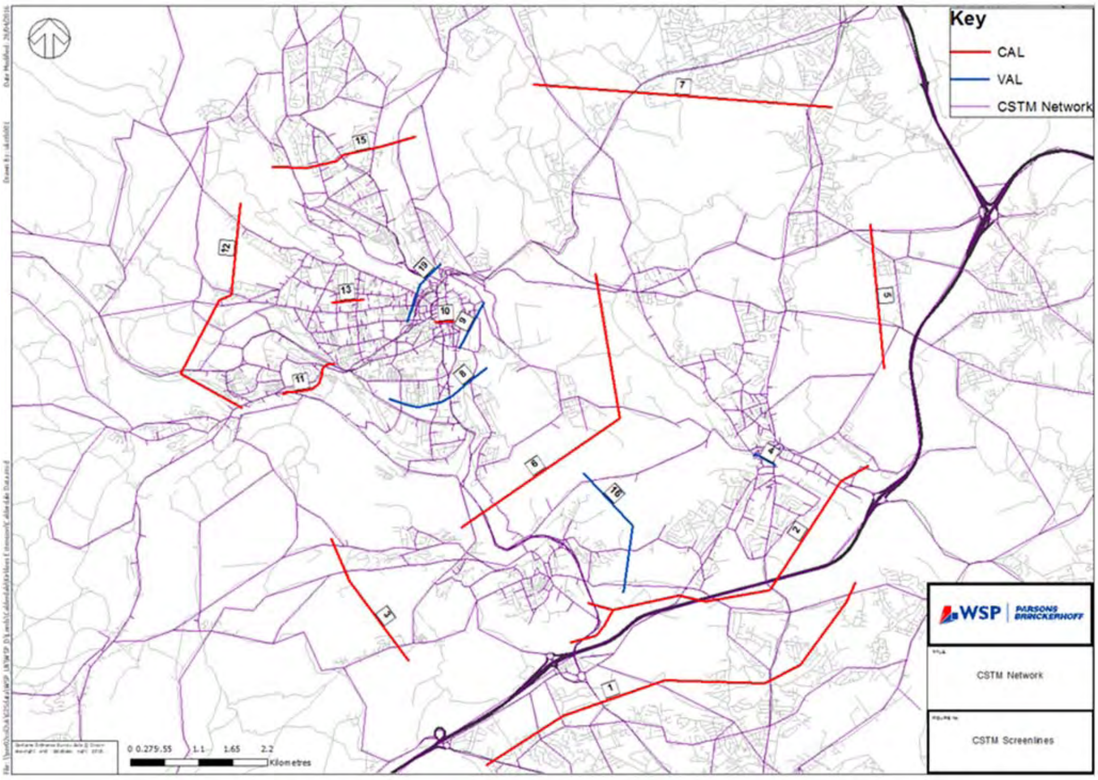
"Number of OD pairs = (number of zones)$^{0.25}$ x the number of user classes"

6.3.4 The above formula has therefore given a total number of 26 O-D pairs ($335^{0.25}$ x 6).

6.4 SCREENLINE PERFORMANCE

6.4.1 A total of 16 bi-directional screenlines were constructed, combining ATCs from across the simulation area. As discussed in Chapter 3, 11 screenlines were used in calibration with the remaining five used for validation. A map of the calibration and validation screenlines is shown in Figure 6.1.

Figure 6.1 – Screenline locations



6.4.2 WebTAG unit M3.1 table 1 stipulates that modelled flow on screenline should be within 5% of the observed flow. The screenlines were initially prepared according to WebTAG guidance for potential use in matrix estimation, which recommend a small number of counts (as opposed to the recommendation of five links or more in WebTAG unit M3.1 paragraph3.2.6). The count coverage is generally such that it is not possible to create larger screenlines (greater than five links) that are meaningful.

6.4.3 The tables below provide a comparison of model flows compared to observed flows across the 32 screenlines. Given the variation on the levels of flow across these screenlines (observed values ranging from 4,000 to 300 vehicles per hour) the GEH of each screenline has also been included in the tables.

6.4.4 Table 6.5 and Table 6.6 contain the screenline results for the AM peak model.

Table 6.5 – AM peak calibration screenline results

SCREENLINE		AM PEAK			
ID	Name	Observed	Modelled	%Diff	GEH
1	SCL 1 NB	3531	3529	0%	**0.033**
2	SCL 1 SB	4119	4045	-2%	**1.156**
3	SCL 2 NB	3925	3790	-3%	**2.174**
4	SCL 2 SB	3624	3559	-2%	**1.089**
5	SCL 3 EB	644	735	**14%**	**3.470**
6	SCL 3 WB	434	475	**9%**	**1.925**
9	SCL 5 EB	1366	1415	4%	**1.311**

SCREENLINE		AM PEAK			
10	SCL 5 WB	1176	1273	8%	2.783
11	SCL 6 EB/SB	3377	3165	-6%	3.707
12	SCL 6 WB/NB	3458	3259	-6%	3.422
13	SCL 7 NB	2486	2464	-1%	0.436
14	SCL 7 SB	1959	1943	-1%	0.370
19	SCL 10 NB	2053	2042	-1%	0.246
20	SCL 10 SB	1130	1132	0%	0.046
23	SCL 11 EB	1448	1377	-5%	1.885
24	SCL 11 WB	1623	1644	1%	0.525
25	SCL 12 EB	1845	1878	2%	0.761
26	SCL 12 WB	1881	1860	-1%	0.497
27	SCL 13 NB	410	406	-1%	0.203
28	SCL 13 SB	456	459	1%	0.115
29	SCL 15 NB	1369	1342	-2%	0.745
30	SCL 15 SB	2191	2156	-2%	0.742

Table 6.6 – AM peak validation screenline results

SCREENLINE		AM PEAK			
ID	Name	Observed	Modelled	%Diff	GEH
7	SCL 4 NB	1673	1552	-7%	2.997
8	SCL 4 SB	1308	1482	13%	4.657
15	SCL 8 NB	1865	1718	-8%	3.476
16	SCL 8 SB	1306	1259	-4%	1.309
17	SCL 9 EB	418	377	-10%	2.039
18	SCL 9 WB	803	799	0%	0.123
31	SCL 16 EB	1315	1374	4%	1.612
32	SCL 16 WB	1256	1184	-6%	2.054
37	SCL 19 NB	2263	2366	5%	2.155
38	SCL 19 SB	3185	3198	0%	0.238

6.4.5 Table 6.5 demonstrates that in the AM peak 77% (17 / 22) of calibration screenlines meet the flow requirement and all screenlines have a GEH less than four. Screenline 3 is relatively low flow and produces a low GEH. Screenline 5 fails in the WB direction, but produces a GEH of under 3. Screenline 6 is just outside the flow requirement in both directions. This is the one calibration screenline which has been calibrated to individual link flows in order to produce accurate link flows on Stainland Road, A629 and A58, as a consequence the overall flow just falls outside requirement.

6.4.6 Table 6.6 demonstrates that in the AM peak 50% (5 / 10) of validation screenlines meet the flow requirement and 90% of screenlines (9/ 10) have a GEH less than four. The screenlines failing on flow requirement are all fairly close to meeting the standard or in the case of Screenline 9 eastbound have a low GEH. The one screenline producing a GEH over four is Screenline 4 southbound through Brighouse which reports a GEH of 4.7 with observed flows of 1308 and modelled flows of 1482.

6.4.7 Table 6.7 and Table 6.8 contain the screenline results for the inter peak model.

Table 6.7 – Inter peak calibration screenline results

SCREENLINE		INTER PEAK			
ID	Name	Observed	Modelled	%Diff	GEH
1	SCL 1 NB	2985	2960	-1%	0.466
2	SCL 1 SB	3042	3011	-1%	0.573
3	SCL 2 NB	2621	2620	0%	0.034
4	SCL 2 SB	2602	2614	0%	0.226
5	SCL 3 EB	320	318	-1%	0.108
6	SCL 3 WB	283	293	4%	0.592
9	SCL 5 EB	945	924	-2%	0.674
10	SCL 5 WB	936	930	-1%	0.201
11	SCL 6 EB/SB	2749	2506	-9%	4.724
12	SCL 6 WB/NB	2639	2452	-7%	3.703
13	SCL 7 NB	1621	1615	0%	0.158
14	SCL 7 SB	1689	1707	1%	0.436
19	SCL 10 NB	1253	1259	0%	0.158
20	SCL 10 SB	1171	1182	1%	0.335
23	SCL 11 EB	1564	1529	-2%	0.905
24	SCL 11 WB	1533	1537	0%	0.113
25	SCL 12 EB	1459	1458	0%	0.030
26	SCL 12 WB	1547	1550	0%	0.086
27	SCL 13 NB	484	471	-3%	0.600
28	SCL 13 SB	463	457	-1%	0.292
29	SCL 15 NB	1298	1301	0%	0.060
30	SCL 15 SB	1302	1300	0%	0.051

Table 6.8 – Inter peak validation screenline results

SCREENLINE		PM PEAK			
ID	Name	Observed	Modelled	%Diff	GEH
7	SCL 4 NB	1126	1170	4%	1.303
8	SCL 4 SB	1140	1124	-1%	0.450
15	SCL 8 NB	1167	1024	-12%	4.321
16	SCL 8 SB	1120	1127	1%	0.209
17	SCL 9 EB	322	371	15%	2.628
18	SCL 9 WB	316	366	16%	2.689
31	SCL 16 EB	811	816	1%	0.188
32	SCL 16 WB	802	878	9%	2.601
37	SCL 19 NB	2408	2351	-2%	1.181
38	SCL 19 SB	2462	2503	2%	0.806

6.4.8 Table 6.7 demonstrates that in the inter peak 91% (20 / 22) of calibration screenlines meet the flow requirement and 95% (21 / 22) screenlines have a GEH less than four. As in AM peak model Screenline 6 does not meet requirement on flow and in the eastbound / southbound direction has a GEH greater than 4. On closer examination of the individual counts it can be seen that the poor performance in both directions is wholly attributable to low flow on the A58 into Hipperholme. Unlike the AM and PM peak models the inter peak does not have a traffic count in that location and as a result flow is low through this area of known delay.

6.4.9 Table 6.8 demonstrates that in the interpeak peak 60% (6 / 10) of validation screenlines meet the flow requirement and 90% (9 / 10) screenlines have a GEH less than four. Screenline 9 and 16 are relatively low and as such can be considered to be performing adequately given the GEH values and absolute flow differences. Screenline 8 northbound do not meet flow requirement but the absolute difference is still within 150 vehicles given the lower flows in the inter peak.

6.4.10 Table 6.9 and Table 6.10 contain the screenline results for the PM peak model.

Table 6.9 – PM peak calibration screenline results

SCREENLINE		**PM PEAK**			
ID	Name	Observed	Modelled	%Diff	GEH
1	SCL 1 NB	3768	3837	2%	**1.104**
2	SCL 1 SB	4305	4244	-1%	**0.930**
3	SCL 2 NB	3533	3525	0%	**0.134**
4	SCL 2 SB	3968	3931	-1%	**0.594**
5	SCL 3 EB	451	436	-3%	**0.717**
6	SCL 3 WB	540	572	**6%**	**1.385**
9	SCL 5 EB	1287	1329	3%	**1.166**
10	SCL 5 WB	1609	1600	-1%	**0.235**
11	SCL 6 EB/SB	3628	3490	-4%	**2.304**
12	SCL 6 WB/NB	3493	3398	-3%	**1.615**
13	SCL 7 NB	2154	2136	-1%	**0.399**
14	SCL 7 SB	2698	2747	2%	**0.925**
19	SCL 10 NB	1280	1318	3%	**1.070**
20	SCL 10 SB	1750	1733	-1%	**0.400**
23	SCL 11 EB	1756	1764	0%	**0.179**
24	SCL 11 WB	1580	1544	-2%	**0.920**
25	SCL 12 EB	1722	1733	1%	**0.276**
26	SCL 12 WB	1999	1970	-1%	**0.663**
27	SCL 13 NB	550	541	-2%	**0.424**
28	SCL 13 SB	511	512	0%	**0.036**
29	SCL 15 NB	2089	2099	0%	**0.209**
30	SCL 15 SB	1620	1627	0%	**0.159**

Table 6.10 – PM peak validation screenline results

SCREENLINE		**PM PEAK**			
ID	Name	Observed	Modelled	%Diff	GEH
7	SCL 4 NB	1392	1376	-1%	**0.433**

8	SCL 4 SB	1740	1643	-6%	2.365
15	SCL 8 NB	1443	1512	5%	1.809
16	SCL 8 SB	1603	1614	1%	0.275
17	SCL 9 EB	869	731	-16%	4.872
18	SCL 9 WB	568	622	9%	2.194
31	SCL 16 EB	1482	1397	-6%	2.242
32	SCL 16 WB	1234	1118	-9%	3.376
37	SCL 19 NB	3362	3385	1%	0.388
38	SCL 19 SB	2789	2758	-1%	0.589

6.4.11 Table 6.9 demonstrates that in the PM peak 95% (21 / 22) of calibration screenlines meet the flow requirement and all screenlines have a GEH less than four. In the PM peak model it is Screenline 3 that does not meet requirement on flow in the westbound direction. However this is a low flow screenline and the actual flow difference is only 32 vehicles and as such should not be a cause for concern.

6.4.12 Table 6.10 demonstrates that in the PM peak 50% (5 / 10) of validation screenlines meet the flow requirement and 90% (9 / 10) of screenlines have a GEH less than four. Screenlines 4 and 16 are performing adequately given the GEH values and the maximum difference in flow is only 116 vehicles (SCL 16 WB). The one screenline producing a GEH over four is Screenline 9 eastbound to the south east of Halifax which reports a GEH of 4.9 with observed flows of 869 and modelled flows of 731.

6.4.13 Overall the screenline analysis shows that the model provides a good level of fit to observed movements. As expected calibration performance is good across all time periods. The validation screenlines do not perform as well against the flow requirement but this can be attributed the low flow nature of some of the screenlines and as such the GEH performance is shown to be good with only three values greater than four across all time periods.

6.4.14 Appendix D outlines the performance of each count included within each respective screenline.

6.5 LINK FLOW CALIBRATION AND VALIDATION

6.5.1 The assignment of the matrix to the network should reproduce the overall level and general distribution of observed traffic, which is assessed by comparing assignment results with selected observed link flows within the study area. The assessment is conducted in accordance with guidance provided by WebTAG.

6.5.2 A modified Chi^2 statistic known as the Geoffrey Edwards Havers (GEH) statistic was used to determine best fit. The statistic uses the formula shown below to calculate a value for the difference between observed (O) and modelled (M) flows:

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

6.5.3 The calibration was undertaken for a comprehensive set of traffic count sites for each time period. The calibration counts have been further compared as a whole and as a series of screenlines. To further assess current traffic movements WebTAG recommends counts from ATCs are used in preference to counts from MCC. Where duplicate counts occur on links, ATCs have been taken in preference to MCC, as a more reliable data source. Arm totals from MCC and CTC have been used to further inform calibration and validation where no other data is available.

6.5.4 The criteria used for measuring the acceptance of the model performance are defined in WebTAG and are also shown in Table 6.5 below.

6.5.5 The GEH statistic takes account of the fact that when traffic flows are low the percentage difference between observed and modelled flows may be high but the significance of this difference is small. A GEH value greater than 10 indicates that closer attention is required as the match between observed and modelled flows is poor, while a GEH of less than 5 indicates a very good fit.

6.5.6 It is an important measure of model performance that the model reproduces the observed volumes of traffic. The WebTAG criteria for comparing the performance of the model traffic counts are reproduced in Table 6.11. Modelled flows are expected to be within a certain tolerance of the observed values and this best fit is measured using the GEH statistic. Both the flow comparison and GEH criteria are assessed in this report.

Table 6.11 – WebTAG criteria

CRITERIA AND MEASURE: ASSIGNED MODEL HOURLY FLOWS COMPARED WITH OBSERVED FLOWS		ACCEPTABILITY GUIDELINE
Flow criteria		
Observed flows < 700 vph	Modelled flows within ±100 vph	> 85% of links
Observed flow 700 – 2,700 vph	Modelled flows within ±15%	>85% of links
Observed flows > 2,700 vph	Modelled flow within ±400 vph	>85% of links
Total Screenline flows (normally >5 links) to be within ±5%		All (or nearly all) screenlines
GEH Criteria		
GEH statistic for individual links < 5		>85% of links
GEH statistic of screenline totals		All (or nearly all) screenlines

6.5.7 Appendix C details modelled flow compared with the observed flow for each individual count used during the calibration and validation process. Counts were excluded if they overlapped with or if the data collected conflicted with adjacent counts. Counts were also excluded if they were located at a minor junction/link not included in the model simulation network.

6.5.8 The summary of the link flow calibration and validation results for the AM peak model for all vehicles is shown below in Table 6.12**Error! Reference source not found.** and a summary of the distribution of GEH values is provided in **Error! Reference source not found.**Table 6.13.

Table 6.12 – AM Peak Summary – All Vehicles

CRITERIA AND MEASURE		ACCEPTABILITY GUIDELINE	CALIBRATION			VALIDATION		
Flow criteria								
Observed	Modelled	Requirement	Total	Model	%	Total	Model	%
< 700 vph	±100 vph	> 85% of links	300	269	90%	90	74	82%
700 – 2,700 vph	±15%	> 85% of links	80	62	78%	20	14	70%
> 2,700 vph	±400 vph	> 85% of links	2	2	100%	4	4	100%
GEH criteria								
GEH Statistic for individual links < 5	> 85% of links		382	326	85%	114	88	77%

6.5.9 For all vehicles calibration counts the AM peak model has 87% of links meeting criteria on flow (combined 333 / 382) and 85% on GEH (326/ 382). However on links between 700 and 2,700 vph only 78% of links meet calibration criteria.

6.5.10 For all vehicles validation counts the AM peak model has 81% of links meeting criteria on flow (combined 92 / 114) and 77% on GEH (88 / 114).

6.5.11 Although WebTAG guidance is not met on validation links there are not too many links with high GEH values. **Error! Reference source not found.** shows that when calibration and validation links are combined, 83% of links (414 / 496) have a GEH less than 5. For links with GEH less than 6 this rises to 89% (443 / 496) and 97% (479 / 496) achieve a GEH under 10. This indicates that the model is a good representation of observed counts and therefore existing traffic conditions.

Table 6.13 – % AM links meeting GEH – All Vehicles

GEH RANGE	CALIBRATION	VALIDATION	COMBINED
GEH < 2	62%	0%	48%
GEH < 4	79%	70%	77%
GEH < 6	91%	85%	89%
GEH < 8	95%	90%	94%
GEH < 10	97%	96%	97%
GEH < 5	**85%**	**77%**	**83%**

6.5.12 The summary of the link flow calibration and validation results for the AM peak model for cars only is shown below in Table 6.14 and a summary of the distribution of GEH values is provided in Table 6.15.

Table 6.14 – AM Peak Summary – Cars

CRITERIA AND MEASURE		ACCEPTABILITY GUIDELINE	CALIBRATION			VALIDATION		
Flow criteria			Total	Model	%	Total	Model	%
Observed	Modelled	Requirement						
< 700 vph	±100 vph	> 85% of links	333	304	91%	99	82	83%
700 – 2,700 vph	±15%	> 85% of links	48	40	83%	15	12	80%
> 2,700 vph	±400 vph	> 85% of links	1	1	100%	0	0	0%
GEH criteria								
GEH Statistic for individual links < 5	> 85% of links		382	334	87%	114	89	78%

6.5.13 For car calibration counts the AM peak model has 90% of links meeting criteria on flow (combined 345 / 382) and 87% on GEH (334 / 382).

6.5.14 For car validation counts the AM peak model has 82% of links meeting criteria on flow (combined 94 / 114) and 78% on GEH (89 / 114).

Table 6.15 – % AM links meeting GEH – Cars

GEH RANGE	CALIBRATION	VALIDATION	COMBINED
GEH < 2	66%	37%	59%

GEH < 4	82%	63%	78%
GEH < 6	91%	84%	90%
GEH < 8	96%	92%	95%
GEH < 10	97%	95%	97%
GEH < 5	87%	78%	85%

6.5.15 The summary of the link flow calibration and validation results for the inter peak model for all vehicles is shown in Table 6.16 and a summary of the GEH values for calibration and validation links are provided in Table 6.17.

Table 6.16 – IP Summary – All Vehicles

CRITERIA AND MEASURE		ACCEPTABILITY GUIDELINE	CALIBRATION			VALIDATION		
Flow criteria			Total	Model	%	Total	Model	%
Observed	Modelled	Requirement						
< 700 vph	±100 vph	> 85% of links	336	317	94%	101	88	87%
700 – 2,700 vph	±15%	> 85% of links	42	38	90%	9	8	89%
> 2,700 vph	±400 vph	> 85% of links	2	2	100%	4	3	75%
GEH criteria								
GEH Statistic for individual links < 5	> 85% of links		380	342	90%	114	87	76%

6.5.16 For all vehicle calibration counts the inter peak model has 94% of links meeting criteria on flow (combined 357 / 380) and 90% on GEH (342 / 380). The links meet the flow criteria for all flow categories.

6.5.17 There are two less calibration counts in the inter peak than the AM peak and PM peak models due to the use of a morning and evening only manual count on the A58 at Hipperholme.

6.5.18 For all vehicle validation counts the inter peak model has 87% of links meeting criteria on flow (combined 99 / 114) and 76% on GEH (87 / 114). The difference between flow criteria results and GEH is due to the number of low flow links in the inter peak model meaning that the flow criteria for observed flows less than 700 is easier to meet.

6.5.19 Although WebTAG guidance is not met on validation links (for GEH) there are not too many links with high GEH values. **Error! Reference source not found.** shows that when calibration and validation links are combined, 87% of links (429 /494) have a GEH less than 5. For links with GEH less than 6 this rises to 91% (452 / 494) and 98% (483 / 494) achieve a GEH under 10. This indicates that the model is a good representation of observed counts and therefore existing traffic conditions.

Table 6.17 – % IP links meeting GEH – All Vehicles

GEH RANGE	CALIBRATION	VALIDATION	COMBINED
GEH < 2	76%	0%	59%
GEH < 4	87%	68%	83%
GEH < 6	93%	87%	91%
GEH < 8	97%	93%	96%
GEH < 10	98%	96%	98%

GEH < 5	**90%**	**76%**	**87%**

6.5.20 The summary of the link flow calibration and validation results for the inter peak model for cars is shown in Table 6.18 and a summary of the GEH values for calibration and validation links are provided in Table 6.19.

Table 6.18 – IP Summary – Cars

CRITERIA AND MEASURE		ACCEPTABILITY GUIDELINE	CALIBRATION			VALIDATION		
Flow criteria			Total	Model	%	Total	Model	%
Observed	Modelled	Requirement						
< 700 vph	±100 vph	> 85% of links	360	348	97%	108	94	87%
700 – 2,700 vph	±15%	> 85% of links	20	19	95%	6	6	100%
> 2,700 vph	±400 vph	> 85% of links	0	0	0%	0	0	0%
GEH criteria								
GEH Statistic for individual links < 5	> 85% of links		380	347	91%	114	92	81%

6.5.21 For car calibration counts the inter peak model has 97% of links meeting criteria on flow (combined 367 / 380) and 91% on GEH (347 / 380).

6.5.22 For car validation counts the inter peak model has 88% of links meeting criteria on flow (combined 100 / 114) and 81% on GEH (92 / 114).

Table 6.19 – % IP links meeting GEH – Cars

GEH RANGE	CALIBRATION	VALIDATION	COMBINED
GEH < 2	79%	44%	71%
GEH < 4	89%	73%	85%
GEH < 6	93%	85%	91%
GEH < 8	97%	92%	96%
GEH < 10	98%	96%	98%
GEH < 5	**91%**	**81%**	**89%**

6.5.23 The summary of the link flow calibration and validation results for the PM peak model for all vehicles is shown in Table 6.20 and a summary of the GEH values for calibration and validation links is provided in Table 6.21.

Table 6.20 – PM Summary – All Vehicles

CRITERIA AND MEASURE		ACCEPTABILITY GUIDELINE	CALIBRATION			VALIDATION		
Flow criteria			Total	Model	%	Total	Model	%
Observed	Modelled	Requirement						
< 700 vph	±100 vph	> 85% of links	292	259	89%	85	70	82%
700 – 2,700 vph	±15%	> 85% of links	88	73	83%	25	15	60%
> 2,700 vph	±400 vph	> 85% of links	2	2	100%	4	3	75%
GEH criteria								

GEH Statistic for individual links < 5	> 85% of links		382	330	86%	114	80	70%

6.5.24 For all vehicles calibration counts the PM peak model has 87% of links meeting criteria on flow (combined 334 / 382) and 86% on GEH (330 / 382). However on links between 700 and 2,700 vph only 83% of links meet calibration criteria.

6.5.25 For all vehicles validation counts the PM peak model has 75% of links meeting criteria on flow (combined 88 / 114) and 70% on GEH (80 / 114).

6.5.26 Although WebTAG guidance is not met on validation links there are not too many links with high GEH values. **Error! Reference source not found.** shows that when calibration and validation links are combined, 83% of links (410 / 496) have a GEH less than 5. For links with GEH less than 6 this rises to 86% (427 / 494) and 96% (474 / 494) achieve a GEH under 10. This indicates that the model is a good representation of observed counts and therefore existing traffic conditions.

Table 6.21 – % PM links meeting GEH – All Vehicles

GEH RANGE	CALIBRATION	VALIDATION	COMBINED
GEH < 2	61%	0%	47%
GEH < 4	80%	62%	76%
GEH < 6	89%	76%	86%
GEH < 8	94%	89%	93%
GEH < 10	96%	94%	96%
GEH < 5	**86%**	**70%**	**83%**

6.5.27 The summary of the link flow calibration and validation results for the PM peak model for cars is shown in Table 6.22 and a summary of the GEH values for calibration and validation links is provided in Table 6.23.

Table 6.22 – PM Summary – Cars

CRITERIA AND MEASURE		ACCEPTABILITY GUIDELINE	CALIBRATION			VALIDATION		
Flow criteria			Total	Model	%	Total	Model	%
Observed	Modelled	Requirement						
< 700 vph	±100 vph	> 85% of links	322	287	89%	95	72	76%
700 – 2,700 vph	±15%	> 85% of links	58	49	84%	18	13	72%
> 2,700 vph	±400 vph	> 85% of links	2	2	100%	1	1	100%
GEH criteria								
GEH Statistic for individual links < 5	> 85% of links		382	333	87%	114	80	70%

6.5.28 For car calibration counts the PM peak model has 88% of links meeting criteria on flow (combined 338 / 382) and 87% on GEH (333 / 382).

6.5.29 For validation counts the PM peak model has 75% of links meeting criteria on flow (combined 86 / 114) and 70% on GEH (80 / 114). This increases to 88% for combined GEH <6 and 92% for validation GEH <8.

Table 6.23 – % PM links meeting GEH – Cars

GEH RANGE	CALIBRATION	VALIDATION	COMBINED
GEH < 2	64%	33%	57%
GEH < 4	82%	62%	78%
GEH < 6	91%	78%	88%
GEH < 8	94%	88%	92%
GEH < 10	97%	93%	96%
GEH < 5	**87%**	**70%**	**83%**

6.5.30 The performance at validation counts is generally lower than that for calibration counts. This is because by definition, counts at calibration sites have been specifically targeted with matrix and network adjustments to ensure that they correspond to observed flows. Validation counts are an independent check on model performance that have not been specifically targeted. It is therefore to be expected that more calibration sites will pass the criteria than validation sites.

6.5.31 Overall the model performs well on link calibration meeting WebTAG criteria in all time periods for both all vehicles and cars only. The link validation falls just outside WebTAG criteria, but there are not very many links with large differences in flow. When calibration and validation results are combined the results show that there is a good overall fit between modelled and observed traffic flows across the model.

6.6 JOURNEY TIME VALIDATION

6.6.1 To assist the validation of the highway models, journey time data was collected from Traffic Master for 32 routes across the district. The journey routes are described in Chapter 3.5. The observed journey times have then been compared to modelled journey times and graphs have been used to visualise where delay is experienced along the routes. These graphs and individual journey route maps can be found in Appendix E.

6.6.2 WebTAG Unit M3.1 paragraph 3.2.10 requires that total modelled journey times should be within 15% or one minute, whichever is greater, of the observed average time.

6.6.3 The performance of the AM peak model is shown in Table 6.24.

Table 6.24 – AM peak hour journey time route comparison

NAME	OBSERVED (S)	MODELLED (S)	DIFFERENCE (S)	%	PASS?
Route 3 EB	2099	1804	295	14%	Yes
Route 3 WB	1844	1703	141	8%	Yes
Route 4 NB	879	818	61	7%	Yes
Route 4 SB	866	861	5	1%	Yes
Route 5 NB	1428	1361	66	5%	Yes
Route 5 SB	1110	1087	23	2%	Yes
Route 6 NB	760	853	-93	-12%	Yes
Route 6 SB	775	816	-41	-5%	Yes
Route 8 WB	1634	1375	259	16%	No
Route 8 EB	1372	1164	208	15%	No
Route 9 SB	785	855	-70	-9%	Yes
Route 9 NB	822	748	74	9%	Yes
Route 10 SB	1111	1094	18	2%	Yes
Route 10 NB	1053	955	98	9%	Yes
Route 11 EB	855	878	-23	-3%	Yes
Route 11 WB	1057	1087	-30	-3%	Yes
Route 12 EB	827	926	-99	-12%	Yes

NAME	OBSERVED (S)	MODELLED (S)	DIFFERENCE (S)	%	PASS?
Route 12 WB	1234	871	363	29%	No
Route 13 EB	889	898	-9	-1%	Yes
Route 13 WB	877	891	-14	-2%	Yes
Route 15 WB	481	474	7	1%	Yes
Route 15 EB	585	514	71	12%	Yes
Route 16 SB	918	813	105	11%	Yes
Route 16 NB	907	838	69	8%	Yes
Route 18 NB	1575	575	42	7%	Yes
Route 18 SB	1204	661	68	9%	Yes
Route 19 NB	617	985	101	9%	Yes
Route 19 SB	729	964	-116	-14%	Yes
Route 20 EB	1085	979	141	13%	Yes
Route 20 WB	848	1107	185	14%	Yes
Route 21 EB	1120	1804	295	14%	Yes
Route 21 WB	1292	1703	141	8%	Yes

6.6.4 Only three routes do not meet criteria; Route 8 westbound and eastbound and Route 12 westbound. The remaining routes meet criteria giving a 94% pass rate in the AM peak period.

6.6.5 Route 8 runs from Brighouse to Ripponden via Rastrick, Elland and Greetland. This route does not meet criteria in both the westbound and eastbound directions due to the delay caused on the approach to the signals in West Vale at the Stainland Road/Rochdale Road cross roads. Route 8 is marginally outside WebTAG criteria but the time vs distance profile is a good fit between observed and modelled times apart from the West Vale signals.

6.6.6 Route 12 westbound terminates at the junction of Wakefield Road and Leeds Road in Hipperholme. It is on the final approach to this junction where the modelled journey time deviates from the observed. Hipperholme is an area of significant delay and congestion which becomes difficult to replicate in a strategic model without affecting the balance between flow and delay which will cause inappropriate routing in the model. The time vs distance profile for this route shows a good fit between observed and modelled times until reaching Hipperholme.

6.6.7 The performance of the inter peak model is shown in Table 6.25.

Table 6.25 – Inter peak hour journey time route comparison

NAME	OBSERVED (S)	MODELLED (S)	DIFFERENCE (S)	%	PASS?
Route 3 EB	1981	1724	257	13%	Yes
Route 3 WB	1859	1679	179	10%	Yes
Route 4 NB	857	809	48	6%	Yes
Route 4 SB	826	784	42	5%	Yes
Route 5 NB	1022	978	44	4%	Yes
Route 5 SB	996	955	41	4%	Yes
Route 6 NB	855	855	0	0%	Yes
Route 6 SB	780	814	-34	-4%	Yes
Route 8 WB	1212	1087	125	10%	Yes
Route 8 EB	1122	1023	99	9%	Yes
Route 9 SB	670	680	-10	-1%	Yes
Route 9 NB	711	693	18	3%	Yes
Route 10 SB	751	805	-54	-7%	Yes
Route 10 NB	800	824	-24	-3%	Yes
Route 11 EB	839	767	72	9%	Yes
Route 11 WB	845	856	-11	-1%	Yes
Route 12 EB	694	706	-12	-2%	Yes
Route 12 WB	844	741	103	12%	Yes
Route 13 EB	808	786	21	3%	Yes
Route 13 WB	802	820	-19	-2%	Yes

NAME	OBSERVED (S)	MODELLED (S)	DIFFERENCE (S)	%	PASS?
Route 15 WB	480	471	9	2%	Yes
Route 15 EB	460	469	-9	-2%	Yes
Route 16 SB	823	741	82	10%	Yes
Route 16 NB	892	726	166	19%	No
Route 18 NB	1091	584	24	4%	Yes
Route 18 SB	934	636	20	3%	Yes
Route 19 NB	608	870	-42	-5%	Yes
Route 19 SB	655	918	-123	-15%	No
Route 20 EB	828	760	93	11%	Yes
Route 20 WB	795	815	76	9%	Yes
Route 21 EB	852	1724	257	13%	Yes
Route 21 WB	891	1679	179	10%	Yes

6.6.8 Only two routes do not meet criteria; Route 16 northbound and Route 20 westbound. The remaining routes meet criteria giving a 94% pass rate in the inter peak period.

6.6.9 Route 16 Northbound runs from Huddersfield to Elland via the A640, passing through junction 23 of the M62 and Sowood. The modelled time is quicker than the observed. This is due to lack of delay leaving Huddersfield where the network is on the edge of simulation with only major links modelled and on the rural roads between Sowood and Stainland. Outside of those areas the time vs distance profile is fairly consistent with the observed data.

6.6.10 Route 20 Westbound runs from Halifax to Sowerby Bridge and terminates just after Triangle. The modelled journey time is slightly too slow, the delay is experienced on the final journey route section after passing through Sowerby Bridge. The modelled flow is a good fit to the observed on this final section so it was not deemed to be worthwhile to try and quicken the route up which could be to the detriment of the flow.

6.6.11 The performance of the PM peak model is shown in Table 6.26.

Table 6.26 – PM peak hour journey time route comparison

NAME	OBSERVED (S)	MODELLED (S)	DIFFERENCE (S)	%	PASS?
Route 3 EB	1859	1825	34	2%	Yes
Route 3 WB	2053	1787	267	13%	Yes
Route 4 NB	998	1027	-30	-3%	Yes
Route 4 SB	999	859	140	14%	Yes
Route 5 NB	1317	1305	12	1%	Yes
Route 5 SB	1092	1181	-88	-8%	Yes
Route 6 NB	815	908	-93	-11%	Yes
Route 6 SB	775	817	-42	-5%	Yes
Route 8 WB	1316	1428	-112	-9%	Yes
Route 8 EB	1200	1262	-62	-5%	Yes
Route 9 SB	782	813	-32	-4%	Yes
Route 9 NB	884	761	123	14%	Yes
Route 10 SB	995	990	5	0%	Yes
Route 10 NB	1039	1068	-29	-3%	Yes
Route 11 EB	1036	875	161	16%	No
Route 11 WB	1325	1129	196	15%	Yes
Route 12 EB	700	784	-83	-12%	Yes
Route 12 WB	1065	1038	27	3%	Yes
Route 13 EB	914	860	54	6%	Yes
Route 13 WB	881	849	32	4%	Yes
Route 15 WB	578	497	81	14%	Yes
Route 15 EB	488	475	13	3%	Yes
Route 16 SB	827	853	-27	-3%	Yes
Route 16 NB	975	865	111	11%	Yes

NAME	OBSERVED (S)	MODELLED (S)	DIFFERENCE (S)	%	PASS?
Route 18 NB	1382	655	14	2%	Yes
Route 18 SB	1418	630	20	3%	Yes
Route 19 NB	669	968	92	9%	Yes
Route 19 SB	650	1074	-129	-14%	Yes
Route 20 EB	1060	955	603	39%	No
Route 20 WB	944	1274	48	4%	Yes
Route 21 EB	1558	1825	34	2%	Yes
Route 21 WB	1322	1787	267	13%	Yes

6.6.12 Only two routes do not meet criteria; Route 11 eastbound and Route 21 eastbound. The remaining routes meet criteria giving a 94% pass rate in the inter peak period.

6.6.13 Route 11 runs eastbound from Halifax Town Centre to M62 junction 25 via Southowram and Brighouse. The modelled time is quicker than the observed, with the difference occuring in the section on Brookfoot Lane and A6025 Elland Road on the approach to the junction with A643 and Ludensheid Link. The observed time for this section is 85 second slower in the PM than the AM. Observed traffic counts are available on Church Lane and Elland Road west of the section in question. The modelled flow fits well to observed at these count locations, however there is no count on Elland Road on approach to the A643 /Ludensheid Link junction. The quicker modelled time would suggest that there is less flow in the model at this junction than occurs in reality.

6.6.14 Route 21 eastbound runs on the A58 from Halifax to M62 Junction 26 at Chain Bar. The large difference between modelled and observed times occurs at the end of the route on the approach to Chain Bar roundabout. This roundabout is on the edge of the simulation area and as such the levels of flow and routeing in this area cannot be expected to be as accurate as in other parts of the simulation area. As a result the queuing and delay experience on the approach to this roundabout is not replicated in the model. The observed profile on this approach is markedly different in the PM peak than other time periods indicating a congestion problem. Further examination of the preceding month (May 2014) and following year (June 2015) showed a reduction in delay on the last section of between 200 and 240 seconds. This would suggest that the observed data for June 2014 was not under normal network conditions.

6.7 CALIBRATION AND VALIDATION CONCLUSIONS

6.7.1 The model calibration and validation process was undertaken successfully and shows the model provides a satisfactory representation of the existing traffic conditions within the study area across all three peaks.

6.7.2 In all peaks at least 30 out of 32 (94%) of screenlines (calibration and validation combined) have a GEH value under 4, and no screenline has a GEH value greater than 5. Meeting WebTAG criteria on screenline flow is more difficult due to the low number of sites in some of the screenlines and the relatively low total observed flows across the screenlines. The GEH comparison is included to show that the fit across screenlines while not WebTAG compliant is still relatively close.

6.7.3 The link flow calibration and validation process for all time periods are at sufficient standard to provide confidence the model is replicating existing traffic conditions. In all peaks link calibration meets WebTAG requirements. Link validation does not meet WebTAG requirements, but there are not too many large fails (i.e. high values of GEH) and when combined with the calibration links the fit to observed flow across the model is good – GEH less than five 83% in AM, 87% in inter peak and 83% in PM.

6.7.4 Journey time routes are validated to an acceptable level in all peaks with at least 91% of journey times meeting WebTAG criteria in all peaks.

6.7.5 Validation across journey time routes and screenlines provide further confirmation that the base year model represents observed traffic conditions in Calderdale.

7 STANDARDS ACHIEVED

7.1 MODEL PERFORMANCE

7.1.1 The table below summarises how the model has actually performed against the standards given in WebTAG.

Table 7.1 – Summary of standards achieved

MODEL ASPECT	CRITERION	ACCEPTABILITY GUIDELINE	ACTUAL MODEL PERFORMANCE
Matrix Estimation	Matrix zonal cell values	Slope within 0.98and 1.02 Intercept near zero R-Sq in excess of 0.95	Slope only satisifies criteria in PM time period. Satisfies intercept criteria for all time periods Satisfies R-Sq criteria for all time periods except AM.
	Matrix zone trip ends	Slope within 0.99 and 1.01 Intercept near zero R-Sq in excess of 0.98	Only satisfies R-Sq criteria in AM and IP for row trip ends. Other slope and R-Sq values are just outside criteria
	Trip length distributions	Means within 5% Standard deviations within 5%	The criteria met for combined user classes in all time periods.
	Sector to sector level matrices	Differences within 5%	Fails criteria in all time periods. The sector trip ends are relatively small and performs well on GEH (85-92%)
Assignment Convergence	Delta and %GAP	Less than 0.01%	Satisfied for all time periods
Link Calibration (Individual & Screenlines)	Individual flows within 100 veh/hr of counts for flows less than 700 veh/hr	> 85% of cases	AM: 87% for total vehicles, 90% for car IP: 94% for total vehicles, 97% for car PM: 87% for total vehicles, 88% for car
	Individual flows within 15% of counts for flows from 700 veh/hr to 2,700 veh/hr	> 85% of cases	
	Individual flows within 400 veh/hr of counts for flows more than 2,700 veh/hr	> 85% of cases	
	GEH < 5 for individual flows	> 85% of cases	AM: 85% for total vehicles, 87% for car IP: 90% for total vehicles, 91% for car PM: 86% for total vehicles, 87% for car
	Differences between modelled flows and counts should be less than 5% of the counts	All or nearly all screenlines	AM: 77% for total vehicles, 77% for car IP: 91% for total vehicles, 100% for car PM: 95% for total vehicles, 95% for car

MODEL ASPECT	CRITERION	ACCEPTABILITY GUIDELINE	ACTUAL MODEL PERFORMANCE
Link Validation (Individual & Screenlines)	Individual flows within 100 veh/hr of counts for flows less than 700 veh/hr	> 85% of cases	AM: 81% for total vehicles, 82% for car IP: 87% for total vehicles, 88% for car PM: 77% for total vehicles, 75% for car
	Individual flows within 15% of counts for flows from 700 veh/hr to 2,700 veh/hr	> 85% of cases	
	Individual flows within 400 veh/hr of counts for flows more than 2,700 veh/hr	> 85% of cases	
	GEH < 5 for individual flows	> 85% of cases	AM: 77% for total vehicles, 78% for car IP: 76% for total vehicles, 81% for car PM: 70% for total vehicles, 70% for car
	Differences between modelled flows and counts should be less than 5% of the counts	All or nearly all screenlines	AM: 50% for total vehicles, 50% for car IP: 60% for total vehicles, 50% for car PM: 50% for total vehicles, 50% for car
Journey Times	Modelled times along routes should be within 15% of surveyed time, or 1 minute if higher	> 85% of all routes	Criteria met for all time periods: AM - 91% of routes within 15% IP - 94% of routes within 15% PM - 94% of routes within 15%

7.1.2 The radar plots below graphically present the performance of the model against the thresholds of the key acceptability criteria, these figures clearly show the model performs to an acceptable level and robustly represents the local traffic conditions.

Figure 7.1 – AM peak summary

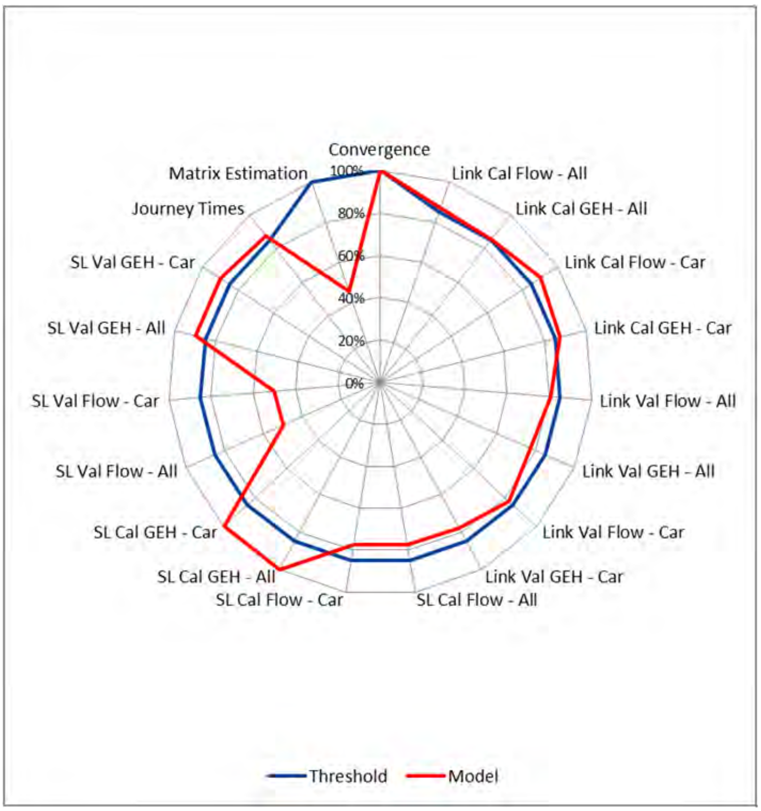


Figure 7.2 – Inter peak summary

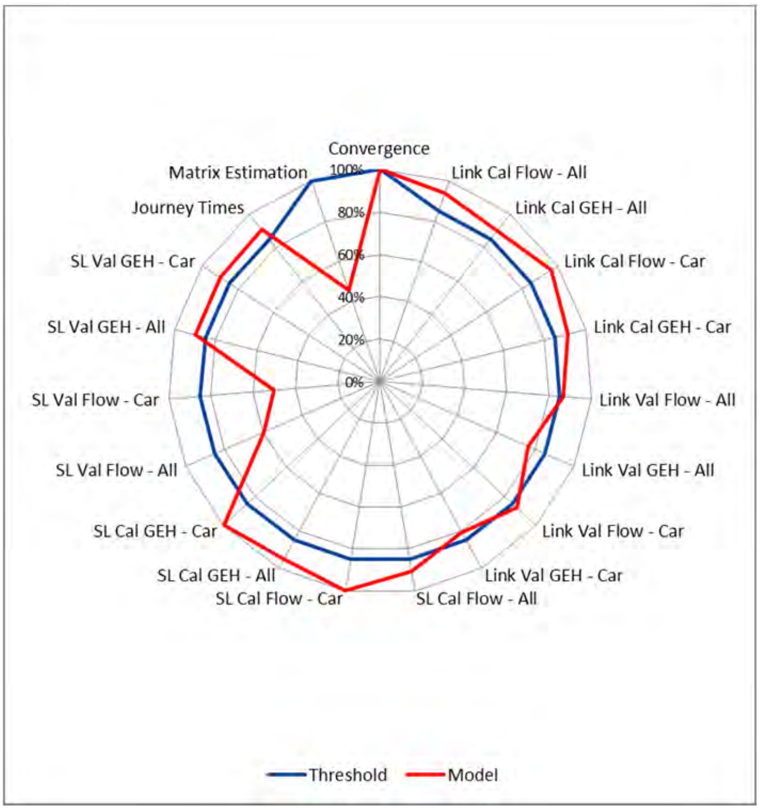
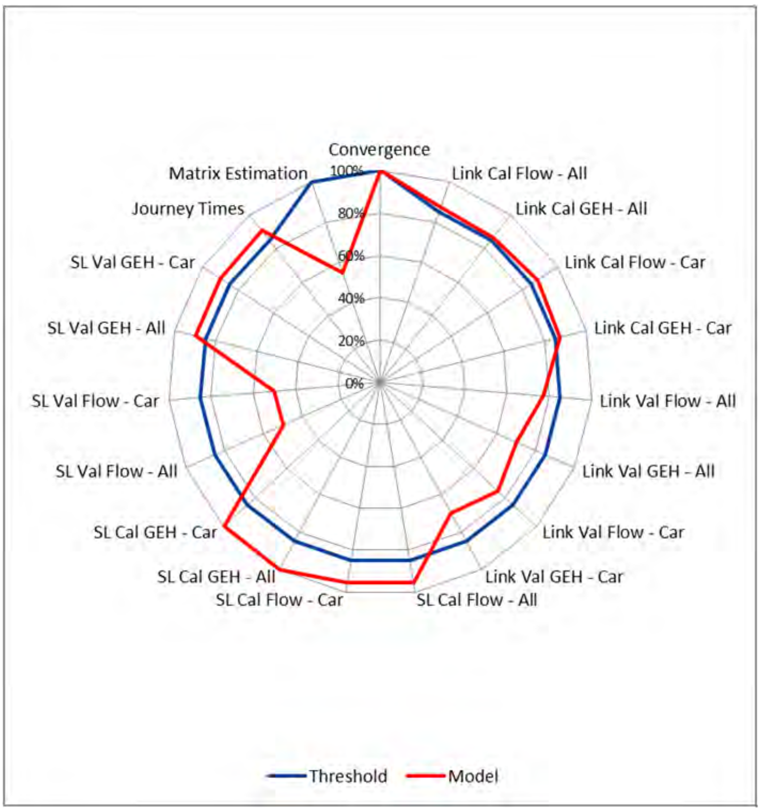


Figure 7.3 – PM peak summary



8 SUMMARY

8.1 SUMMARY

8.1.1 WSP | Parsons Brinckerhoff have been commissioned under the Metro Framework by Calderdale Metropolitan Borough Council (CMBC) to update and extend the existing Calderdale Strategic Transport Model (CSTM) to represent the current 2014 travel patterns and highway network conditions for the AM, Inter and PM peak periods. This Local Model Validation Report (LMVR) outlined the processes and procedures used to produce a fully validated 2014 highway transport model.

8.1.2 Bearing in mind that the model will also be used for assessment of proposed developments and infrastructure schemes as part of the WY+TF, engagement has been carried out with WYCA throughout the model build process. Interim model performance results have been shared and discuss with WYCA at several key intervals in the model build process.

8.1.3 The model development has involved a comprehensive and extensive data collection and summary exercise, including commissioning of data to extend the modelled area and bring together a base platform to validate against. Demand data was used from 23 RSI sites across Calderdale and Kirklees with the remaining unobserved trips being a combination of existing base matrices and new synthetic trips on the edge of the modelled area.

8.1.4 The model has been extended to include the area of Kirklees adjacent to Calderdale and additional count data has been used to provide better model fit in both Halifax town centre and Elland.

8.1.5 To ensure compliance with modelling guidance, the models have been developed in accordance with the Department for Transport (DfT) Web based Transport Analysis Guidance (WebTAG) on http://www.dft.gov.uk/webtag. This provides detailed guidance on appraisal of transport projects and wider advice on scoping and carrying out transport studies.

8.1.6 The highway model calibration process was undertaken successfully and has produced a reasonable standard of outputs for all time periods. In all peaks at least 30 out of 32 (94%) of screenlines (calibration and validation combined) have a GEH value under 4, the combined link calibration and validation performance has a GEH of less than five for 83%of links in AM, 87% in inter peak and 83% in PM, and journey time routes meet WebTAG criteria in all peaks.

8.1.7 The technical information demonstrated in this report has shown that the CSTM is an adequate representation of base year traffic conditions for all time period. It can be concluded that overall the CSTM is considered to be a robust tool and is suitable to be used for traffic forecasting, development and scheme appraisal, and hence is to be considered fit for purpose.

8.2 ASSESSMENT OF FITNESS FOR PURPOSE

8.2.1 The model performs well against the model standards previously set out and this should serve to give confidence and provide reassurance that the model is representative of current conditions. It is recognised that link flow and screenline validation along with aspects of matrix integrity do not meet criteria set out in WebTAG.

8.2.2 The model's primary use is as a tool for assessment of Local Plan developments. The strong performance on OD routing checks and journey time validation indicate that overall the network as a whole is well represented. Areas of weaker link calibration and / or validation will be examined dependent upon the scale and location of developments to be tested for Local Plan assessment. Targeted improvements can be made if necessary.

8.2.3 The model may also be used for transport scheme testing on the A629 between Ainley Top and Halifax. Generally the fit of observed flow to modelled flow is good on this corridor and the modelled journey time profile fits with observed even through areas of significant congestion such as Ainley Top and Calder Hebble junction. This statement is true for all time periods.

8.2.4 The model has been demonstrated to have been constructed in a manner consistent with guidance and hits an acceptable level of calibration/validation for all aspects of the model build. It is therefore expected that a high degree of confidence may be placed in the model for the purposes of scheme assessment, appraisal, economic and environmental appraisal.

Appendix A

SPEED FLOW CURVES

Appendix B

DATA COLLECTION

Appendix C

LINK PERFORMANCE

APPENDIX C-1

LINK CALIBRATION

APPENDIX C-2

LINK VALIDATION

Appendix D

SCREENLINE PERFORMANCE

APPENDIX D-1

SCREENLINE CALIBRATION

APPENDIX D-2

SCREENLINE VALIDATION

Appendix E

JOURNEY TIME VALIDATION

APPENDIX E-1

JOURNEY TIME ROUTES

APPENDIX E-2

AM PERFORMANCE

APPENDIX E-3

INTER PEAK PERFORMANCE

APPENDIX E-4

PM PERFORMANCE

Appendix F

MATRIX INTEGRITY

APPENDIX F-1

SECTOR TO SECTOR MOVEMENTS

APPENDIX F-2

TRIP LENGTH DISTRIBUTION PLOTS

Appendix G

ROUTING CHECKS

APPENDIX G-1

AM ROUTING CHECKS

APPENDIX G-2

INTER PEAK ROUTING CHECKS

APPENDIX G-3

PM ROUTING CHECKS

Appendix H

ZONE PLOTS