network was developed for the purposes of scheme testing and business case development.

As a result, the extent of the detailed, simulation area of the highway network is significant; covering almost all of Central Lancashire, and as detailed in Figure 4-D below.

Figure 4-D - Highway Network of the Modelled Area

Outside of the detailed modelled area, typically Motorways, A and B Roads have been modelled, to reflect the more spatially aggregate nature of the zoning system. As this area is some way from the study area, it is only necessary to have enough detail to ensure that trips from these areas enter the study area at the appropriate locations.

Figure 4-E shows the entire CLHTM model network, covering trip distances and costs across the whole of the UK for relevant trips, including the external modelled area.

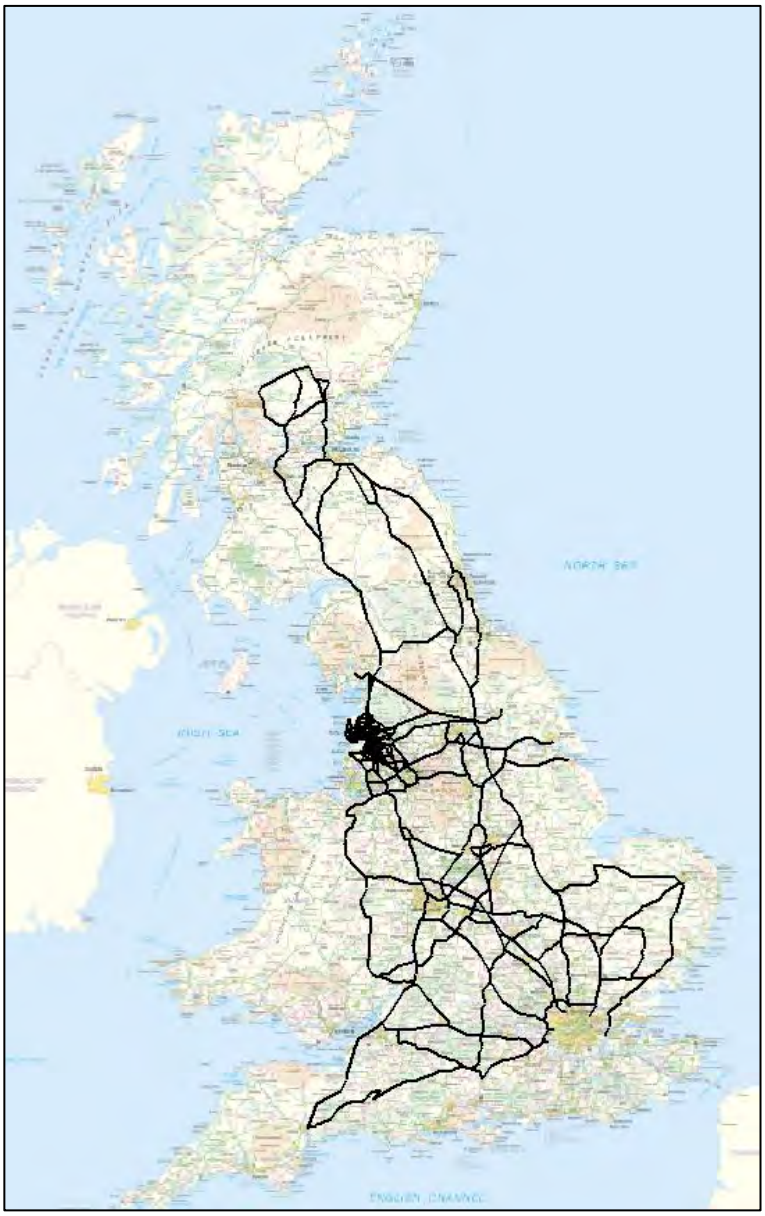

Figure 4-E - Full Model Network

4.4 Centroid Connectors

Zone connectors should represent 'real' junctions within the highway, i.e. not load directly onto links, where possible. In line with WebTAG Unit M3.1 guidance, the number of centroid connectors was minimised to avoid/ reduce convergence issues.

In general, each model zone has one centroid connector, but there are exceptions to this where zones require multiple centroid connectors to accurately represent the loading points to / from the zone, and which are refined in model calibration, and/or where significant delays are noted.

For the purposes of the local land-use testing within the model, and future potential links to demand models, representative costs to / from each of the development zones and locations are specified in the base year model.

Examples of the centroid connectors used in Preston within the detailed modelled area are illustrated by the red lines in Figure 4-F below.

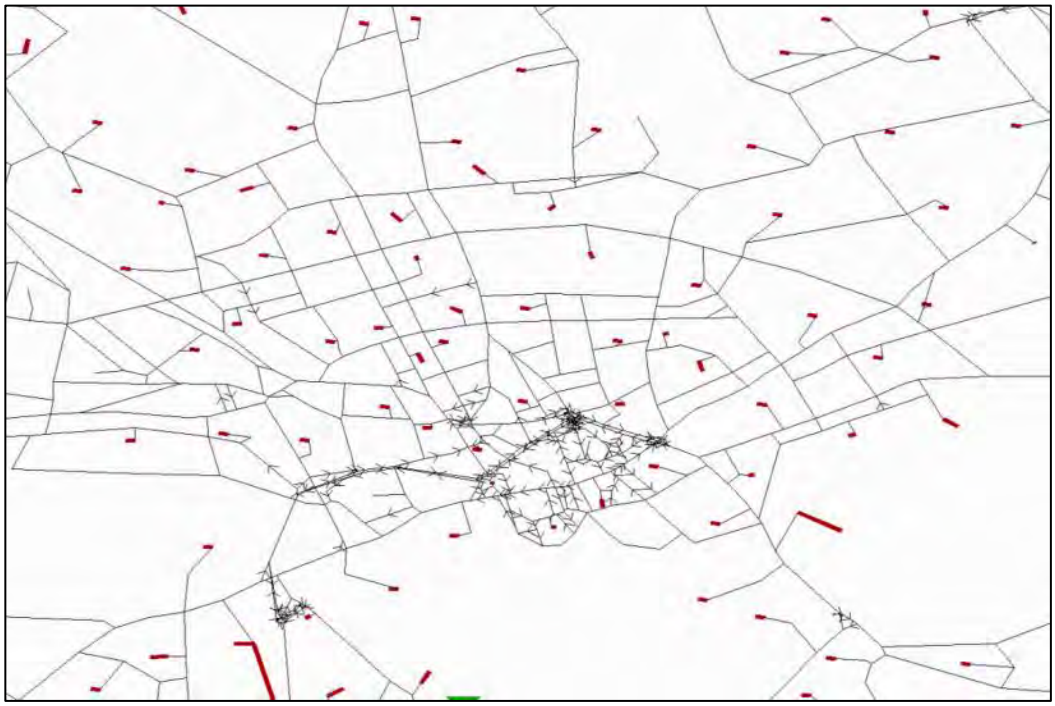

Figure 4-F - Model centroid connectors within Preston City Centre

The loading node where each connector joins the road network was selected, based upon aerial photography, professional judgement and agreed with LCC in terms of local knowledge, and is considered to be the most representative place for demand to enter and exit the network.

For the detailed model area every effort was made to ensure where possible that connectors did not join the network at junctions or directly onto main roads.

4.5 Time Periods

The model was built to represent three time periods, as follows:

- *AM peak hour (8-9am)*
- *PM peak hour (5-6pm)*
- *Average hour in the interpeak (10am-4pm)*

The AM and PM peak time periods were selected in line with WebTAG guidance, and were identified by analysis of Automatic Traffic Counts (ATCs) throughout the modelled area. This showed that the AM and PM peak hours above were the most congested, and with greatest traffic volumes.

The scheme is expected to have the greatest impact on traffic movements during the peak hours when the congestion in the local area is greatest. It therefore follows that the AM and PM peak hours must be modelled.

Although there is less congestion in the interpeak period, it was still considered necessary to model this time period, both to meet guidance, and for the economic and environmental appraisal. There was no perceived need from any stakeholder to model an off-peak or weekend period.

The time periods chosen also provides a suitable basis for the calculation of required AADT's and AAWT's for noise and air quality modelling, and for the calculation of economic impacts.

4.6 User Classes

For the effects on different road users to be established, the model segregates trips by vehicle type and trip purpose.

There were different levels of segregation used at different points of the model building process, as summarised in Table 4-2.

Table 4-2 - Purpose/User Class/Vehicle Class Correspondence

Trip Purpose ID	Purpose	User Class (UC)	Vehicle Class (VC)	PCU Factor
1	Home Based Work (HBW)	UC1	VC1	1.0
2	Home Based Employer's Business (HBEB)	UC2		
3	Non-Home Based Employer's Business (NHBEB)			
4	Home Based Education (HBED)	UC3		
5	Home Based Shopping (HBS)			
6	Home Based Other (HBO)			
7	Non-Home Based Other (NHBO)			
8	LGV	UC4	VC2	1.0
9	HGV	UC5	VC3	2.0

These trip purpose and user class splits are consistent with the guidance contained in TAG Unit M3.1.

Vehicle classes 1 and 2 (cars and LGVs) were assigned a PCU factor of 1.0. HGVs were given a PCU factor of 2.0. This is to reflect the greater size of HGVs in comparison with cars, with the assumption being that each HGV is equivalent to two cars within the assignment.

This value is consistent with guidance in TAG unit M3.1 appendix D, which advises that PCU factor on road types other than motorways and dual carriageways.

Although there are motorways within the study area, the key study area for the PWD scheme around Preston, is made up of single carriageway roads, thus a value of 2.0 was agreed as most appropriate.

4.7 Assignment Methodology

Assignment is the process that traffic models use to predict the routes that road users take between their origin and their destination. Route selection is based on travel costs.

Travel cost (and in particular time) is assumed to depend on the flows in the network. The default assignment procedure within SATURN was used, which is based on Wardrop's Principle of traffic equilibrium. This principle states that "Drivers choose routes such that, at equilibrium, no individual trip maker can reduce his/her cost of travel by unilaterally changing route".

Such a model makes a number of assumptions, in particular: -

- *That network conditions and travel demand do not vary within the modelled period.*
- *That travellers in the network have had a long–term experience with these conditions, so that they perceive the travel costs correctly and know the "best" routes to take.*
- *That all drivers within a particular user class perceive travel costs in the same way. Costs are a combination of time and vehicle running cost, termed 'generalised cost'.*

The model therefore provides a representation of average driver behaviour under long term conditions of recurrent congestion, and uses a particular assignment algorithm known as Frank-Wolfe in order to achieve this in an industry standard manner

4.8 Generalised Cost Formulations and Parameter Values

Within the SATURN assignment two parameters are defined for each user class to calculate generalised cost. This combines journey times, journey distances and any tolls included in the model into a standard unit of generalised time based on these two parameters.

The values of time (VOT) used in the base year model were taken from the TAG data book (December 2017, v1.9.1), which was the latest at the time of the study, based on 2013 values to represent the October 2013 base of the model. The values are provided in Table 4-3.

Calculations were undertaken using perceived values of time and distance, which are important for business travel, and as per guidance and processes advised by both WebTAG and Highways England TAME, using Highways England's VOT/VOC calculation worksheet.

When calculating the VOC, the average speeds for each user class were taken from the previously validated CLHTM model.

In line with TAG unit M3.1, the HGV VOT were doubled to better take into account the driver's and employer's VOT.

Table 4-3 - Generalised Cost Parameters

Vehicle type	Trip Purpose	Time Period	Value of Time / PPM (p/min)	Vehicle operating cost / PPK (p/km)
Car	Commute	AM	19.32	7.86
Car	Business	AM	28.81	13.9
Car	Other	AM	13.33	7.86
LGV	Business	AM	20.37	15.25
HGV	Business	AM	41.35	48.48
Car	Commute	IP	19.64	7.8
Car	Business	IP	29.52	13.73
Car	Other	IP	14.2	7.8
LGV	Business	IP	20.37	15.3
HGV	Business	IP	41.35	48.48
Car	Commute	PM	19.39	7.91
Car	Business	PM	29.23	14.03
Car	Other	PM	13.96	7.91
LGV	Business	PM	20.37	15.24
HGV	Business	PM	41.35	48.48

It is recognised that a new version of TAG databook was released in May 2018. However, given that the model calibration was well underway when the new version became available the decision has been taken not to recalibrate the model, given that the only change would be minor increase to VOC values, as presented in Table 4-4.

Table 4-4 - Generalised Cost Parameters Comparison of Dec.17 and May18 TAG Databook

Vehicle type	Trip Purpose	Time Period	Dec. 2017		May 2018		VOC Diff
			Value of Time / PPM (p/min)	Vehicle operating cost / PPK (p/km)	Value of Time / PPM (p/min)	Vehicle operating cost / PPK (p/km)	
Car	Commute	AM	19.32	7.86	19.32	7.93	0.07
Car	Business	AM	28.81	13.9	28.81	13.96	0.06
Car	Other	AM	13.33	7.86	13.33	7.93	0.07
LGV	Business	AM	20.37	15.25	20.37	15.34	0.09
HGV	Business	AM	41.35	48.48	41.35	48.78	0.30
Car	Commute	IP	19.64	7.8	19.64	7.87	0.07
Car	Business	IP	29.52	13.73	29.52	13.79	0.06
Car	Other	IP	14.2	7.8	14.20	7.87	0.07
LGV	Business	IP	20.37	15.3	20.37	15.39	0.09
HGV	Business	IP	41.35	48.48	41.35	48.78	0.30
Car	Commute	PM	19.39	7.91	19.39	7.98	0.07
Car	Business	PM	29.23	14.03	29.23	14.09	0.06
Car	Other	PM	13.96	7.91	13.96	7.98	0.07
LGV	Business	PM	20.37	15.24	20.37	15.33	0.09
HGV	Business	PM	41.35	48.48	41.35	48.78	0.30

4.9 Capacity Restraint Mechanisms

4.9.1 Links

Capacity restraint on links was modelled through the use of speed flow curves.

The general rule of whether to use a fixed cruise speed on a given link or a speed-flow curve relates to whether the majority of the delay on the link is likely to be as a result of junction delays or weight of traffic on the link. Where the majority of delay is related to the junction, a fixed cruise speed has been coded. Whereas when the delay is likely to be caused by the weight of traffic a speed-flow relationship has been coded.

In general, this rule results in fixed cruise speeds being coded within urban areas, and speed-flow relationships being coded on longer rural links. The application of speed flow curves is discussed further in Chapter 6.

HGV speeds were capped for each capacity index to ensure that HGVs travel at reduced speeds compared to other vehicles on the road network in rural areas, where speeds between vehicle types would be expected to vary more significantly.

4.9.2 Junctions

All junctions within the study area were fully coded in line with the Central Lancashire Model Coding Manual, developed from a range of model development experience in similar areas and for Highways England modelling.

Elements of coding included the junction type, number of lanes, permitted movements and geometric measurement of each junction, to calculate typical capacities and likely ranges of capacity, and thereby turning delays once assigned.

Motorway Network merges were effectively coded using Q nodes that were located 300m downstream from the merging node. A full description of Q nodes can be found in the SATURN User Manual, and also defined in the CLHTM Jacobs Coding Manual.

Further details of the network development and coding can be found in Chapter 6.

5 Calibration and Validation Data

5.1 Introduction

This chapter discusses the observed data used in the calibration and validation of the Central Lancashire Highway model.

This includes the link flow observations used in the calibration and validation of the modelled flows within the highway assignment, and the observed journey time data used for the validation of the modelled times.

5.2 Traffic Counts at Roadside Interview Sites

Roadside Interview Surveys were conducted in order to gather observed trip information.

The scoping of the RSI surveys were discussed and agreed with LCC to ensure all key routes likely to be impacted by future schemes were captured, including key routes to M55 J1, Preston and further west towards M55 J3.

Modelling of the PWD in the old CLTM CUBE model helped to inform which key roads were likely to be impacted by the scheme, and future dependent growth.

Alongside each survey, a two week automated traffic count (ATC), and a single day (the day of the survey) Manual Classified Count (MCC) was collected.

The RSI's collected data from traffic travelling in both directions for key links likely to be impacted by the PWD and CLTM schemes.

This is important in the development of the model, to enhance accuracy and sampling of trips in both directions, and in the context of RSI's typically only be collected in one direction.

The locations of these surveys are illustrated in Figure 5-A and were developed to form a natural cordon around Preston.

Final site locations took into account the ability to conduct RSI's in both directions, police advice, and spare road-space capacity; with some sites therefore straddling the cordon; depending on direction, but with no major road in-between. All sites were approved by the Police, with none missed and all were conducted as per plans proposed and agreed.

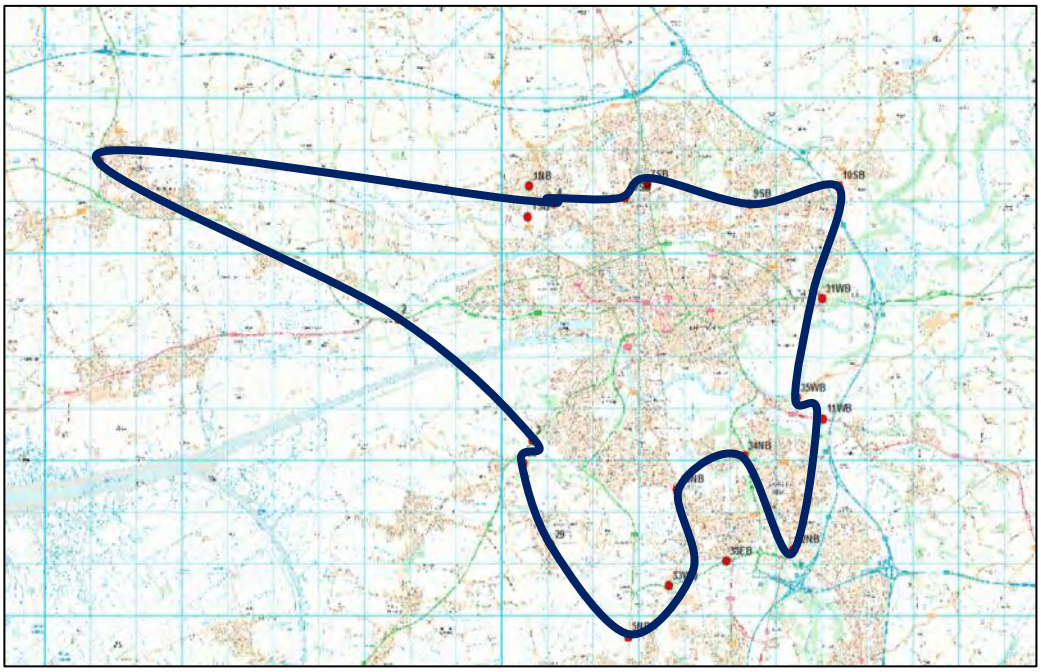

Figure 5-A - RSI Survey Locations

More information on the RSI surveys is provided in Chapter 7.

The surveys were conducted in April and May 2014, with the one day MCC and the two week ATC counts collected at the same time.

5.2.1 TRADS Counts

For count data on the M6, M55 and surrounding motorways, TRADS data was used.

Hourly count data across the whole of 2013 was collected and processed for each of the sites shown in the image below.

As with the ATC data, the counts were checked for consistency, and only Monday-Thursday weekdays were included; with any days of error excluded from the calculations.

Figure 5-B shows an example of the colour formatting used to determine count anomalies.

Hourly Flows

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
Mon 7 Oct	Mon	186	48	65	125	220	502	1327	1791	1737	1888	1893	1546	1395	1340	1351	1593	2104	2261	1353	740	662	553	346	153	25179
Tue 8 Oct	Tue	91	47	44	72	137	417	1236	1996	1911	1646	1274	1159	1226	1251	1345	1516	2195	2287	1372	747	700	648	462	189	23968
Wed 9 Oct	Wed	80	46	45	74	149	384	1234	2020	2008	1677	1294	1322	1228	1256	1373	1547	2356	2194	1372	779	720	587	374	196	24315
Thu 10 Oct	Thu	95	56	57	86	131	360	1196	2012	1977	1660	1336	1328	1200	1247	1386	1740	2326	2399	1431	810	774	589	424	179	24799
Fri 11 Oct	Fri	131	56	72	73	160	345	1079	1851	1815	1781	1943	1638	1585	1662	1801	1952	2261	2011	1285	892	901	900	940	547	27681
Sat 12 Oct	Sat	247	108	70	78	106	163	310	526	822	1164	1476	1356	1366	1419	1232	1423	1503	1758	1444	1431	2450	2724	2311	1487	26974
Sun 13 Oct	Sun	600	157	93	70	93	129	189	323	566	1272	2409	2466	2215	2050	1904	2032	2039	1661	1322	1337	1490	1228	651	324	26620
Mon 14 Oct	Mon	150	65	70	101	196	522	1336	2046	1933	1689	2035	1622	1460	1371	1434	1565	2182	2260	1283	729	733	598	401	221	26002
Tue 15 Oct	Tue	132	57	60	105	154	388	1239	2028	1953	1624	1364	1236	1269	1362	1450	1707	2274	2305	1494	849	804	710	599	270	25433

Figure 5-B - Colour formatting example

In order to classify the data into vehicle types, Monthly Classified data was also collected and processed for October and November 2013, standardising to these months.

Data for the month of April; a similarly neutral month 2013 were also processed in the same way for each site to ensure traffic ratio consistency by vehicle type, and to act as a sense-check.

The locations of the TRADS counts that were used are shown in Figure 5-C. The TRADS sites cover the full extent of the Strategic Road Network across the study area.

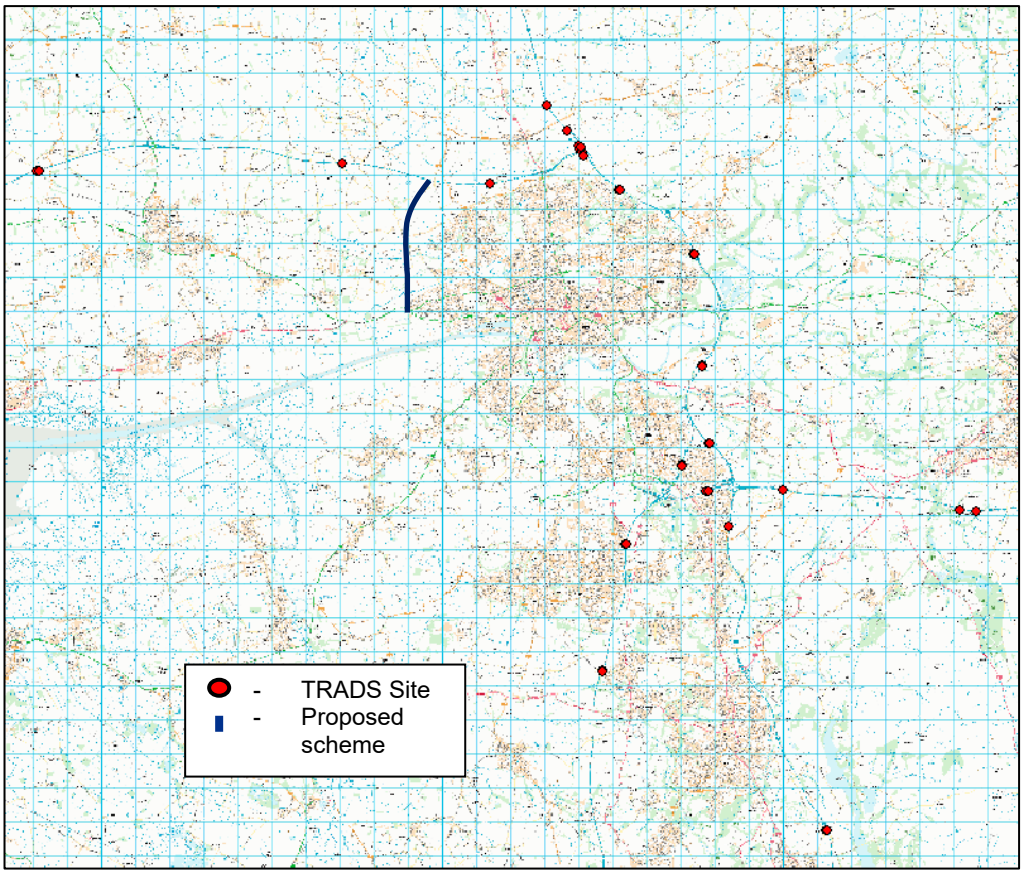

Figure 5-C - Location of TRADS counts

Table 5-1 shows the Strategic Road Network traffic counts used in the calibration and validation process.

Table 5-1 - Highways England Count Sites

Site Name	MP						IP						EP					
	Total Flow	HGV %	Lights	HGV	HGV PCU	Total Vehicles	Total Flow	HGV %	Lights	HGV	HGV PCU	Total Vehicles	Total Flow	HGV %	Lights	HGV	HGV PCU	Total Vehicles
M61 NB J9-M6	2963	10.44%	2654	309	619	2963	2103	13.46%	1820	283	566	2103	2762	6.02%	2650	166	332	2816
M61 SB M6-J9	2471	7.87%	2277	195	389	2471	2134	11.33%	1893	242	484	2134	3271	4.03%	3139	132	264	3271
M61 NB J8-J9	2334	11.09%	2075	259	518	2334	1711	9.96%	1540	170	341	1711	2196	7.89%	2023	173	347	2196
M55 EB J3-J1	2647	7.40%	2451	196	392	2647	1893	13.54%	1637	256	513	1893	2884	4.60%	2751	133	265	2884
M55 WB J1-J3	2749	9.04%	2501	249	497	2749	1856	9.47%	1680	176	351	1856	2793	3.04%	2708	85	170	2793
M65 EB J1-J2	2282	9.85%	2057	225	449	2282	1350	15.94%	1135	215	430	1350	2378	4.68%	2267	111	223	2378
M65 WB J2-J1	2558	8.41%	2343	215	430	2558	1428	15.66%	1205	224	447	1428	2590	4.50%	2473	117	233	2590
M65 EB J2-J3	3017	9.26%	2737	279	559	3017	1741	14.47%	1489	252	504	1741	3149	4.07%	3021	128	257	3149
M65 WB J3-J2	3241	9.37%	2938	304	607	3241	1842	16.32%	1542	301	601	1842	3006	5.92%	2828	178	356	3006
M6 NB J28-J29	4569	11.26%	4054	514	1029	4569	3010	15.86%	2533	477	955	3010	4024	8.12%	3698	327	653	4024
M6 NB J32-J33	2463	15.13%	2090	373	745	2463	2315	14.70%	1975	340	681	2315	2633	9.85%	2373	259	519	2633
M6 SB J33-J32	2274	13.25%	1972	301	602	2274	2389	14.30%	2047	342	683	2389	2810	9.47%	2544	266	532	2810
M6 NB J31A-J32	4870	11.09%	4330	540	1080	4870	3747	11.81%	3305	442	885	3747	4998	6.10%	4693	305	610	4998
M6 SB J32-J31A	3953	12.09%	3475	478	956	3953	3843	16.14%	3223	620	1241	3843	5059	8.92%	4608	451	902	5059
M6 NB J31-J31A	6324	10.94%	5632	692	1383	6324	4321	13.39%	3742	579	1158	4321	5886	6.67%	5493	392	785	5886
M6 SB J31A-J31	5027	12.65%	4391	636	1272	5027	4384	16.71%	3652	733	1466	4384	6479	8.33%	5940	539	1079	6479
M6 NB J30-J31	6595	9.23%	5982	612	1225	6595	4569	11.68%	4035	534	1067	4569	5994	5.86%	5643	351	702	5994
M6 NB J29-J30	3630	13.34%	3146	484	969	3630	2537	15.68%	2139	398	796	2537	3264	8.49%	2987	277	554	3264
M6 SB J29-J28	3449	15.05%	2930	519	1038	3449	3138	18.61%	2554	584	1168	3138	4657	8.66%	4254	403	806	4657
M6 SB J31-J30	5173	11.32%	4587	586	1172	5173	4719	15.36%	3994	725	1450	4719	6944	7.49%	6424	520	1040	6944
M61 SB J9-J8	2916	8.16%	2678	238	476	2916	2415	11.97%	2126	289	578	2415	3712	4.07%	3561	151	302	3712
M6 SB J30-J29	2713	12.62%	2371	342	685	2713	2551	16.25%	2136	414	829	2551	3703	9.06%	3368	336	671	3703
M6 NB J27-J28	4139	13.23%	3592	547	1095	4139	2901	18.78%	2357	545	1090	2901	3847	9.99%	3462	384	769	3847
M6 SB J28-J27	3242	14.73%	2764	478	955	3242	3009	17.57%	2480	529	1057	3009	4273	8.40%	3914	359	718	4273
M55 EB-M6J32 NB	425	6.31%	398	27	54	425	381	8.26%	349	31	63	381	581	2.41%	567	14	28	581
M6J32 SB - M55 WB	659	5.96%	620	39	79	659	409	11.92%	360	49	97	409	530	5.21%	503	28	55	530
M55 EB - M6 J32SB	2284	7.09%	2122	162	324	2284	1828	12.43%	1601	227	454	1828	2721	4.43%	2601	121	241	2721
M6 J32 - M55 WB	2876	8.99%	2617	259	517	2876	1847	9.49%	1672	175	351	1847	2994	2.97%	2906	89	178	2994
M55 EB J4-J3	1479	7.20%	1373	106	213	1479	1220	10.00%	1098	122	244	1220	1958	2.79%	1903	55	109	1958
M55 WB J3-J4	2021	7.62%	1867	154	308	2021	1268	8.22%	1164	104	209	1268	1719	2.89%	1669	50	99	1719
M6 NB within J33	1919	17.59%	1581	337	675	1919	1942	15.43%	1643	300	600	1942	2130	11.49%	1886	245	489	2130
M6 SB within J33	1770	17.66%	1457	313	625	1770	2133	16.57%	1779	353	707	2133	2276	12.13%	2000	276	552	2276
M65 EB J3-J4	3299	7.99%	3036	264	527	3299	1615	14.64%	1379	237	473	1615	2845	4.38%	2720	125	249	2845
M65 WB J3-J4	2901	8.42%	2657	244	488	2901	1724	13.87%	1485	239	478	1724	3072	4.37%	2938	134	269	3072
M6 NB J26 - J27	3782	13.10%	3287	495	991	3782	3088	16.45%	2580	508	1016	3088	4469	7.49%	4134	335	669	4469
M6 SB J27 - J26	3687	12.91%	3211	476	952	3687	3136	16.35%	2624	513	1026	3136	4130	8.54%	3778	353	705	4130
M6 NB within J32	1996	16.71%	1662	333	667	1996	1897	15.75%	1599	299	598	1897	2006	11.81%	1769	237	474	2006
M6 SB within J32	1622	18.74%	1318	304	608	1622	1988	18.48%	1621	367	735	1988	2293	13.38%	1987	307	614	2293
M61 SB J8-6 ("10/30014241+30014240)	3046	9.07%	2770	276	552	3046	2188	12.97%	1905	284	567	2188	3405	4.78%	3242	163	326	3405
M61 NB J6-8 ("10/30014238+30014238)	2881	8.68%	2631	250	500	2881	2299	13.78%	1982	317	633	2299	3515	5.05%	3338	177	355	3515
M55 Within J1 Eastbound	1847	7.00%	1718	129	259	1847	1469	11.95%	1293	176	351	1469	2248	4.11%	2156	92	185	2248
M55 Within J1 Westbound	2209	10.21%	1984	226	451	2209	1550	9.90%	1397	153	307	1550	2055	3.54%	1982	73	146	2055

5.2.2 Local Traffic counts

In addition to TRADS count data, local automatic traffic count data was obtained for the local road network.

The majority of these counts were undertaken for two weeks in either 2012 or 2013 to ensure watertight screenlines, or to update counts that were not available from the original dataset. This range of dates underlies the 2013 base of the model.

Given a number of traffic counts were not of significant duration, or there were otherwise potential gaps in screenlines, a number of either replicate, or additional traffic counts were specified during 2014.

These were undertaken to follow WebTAG guidance in terms of traffic counts being of 2-week duration, and are shown in Figure 5-D.

Figure 5-D - Local Counts

The daily flow profile of these counts are provided in Figure 5-E to Figure 5-H below for each vehicle class and the total. The highest flows happen at 08:00-09:00 in the morning peak period and 17:00-18:00 in the evening peak period.

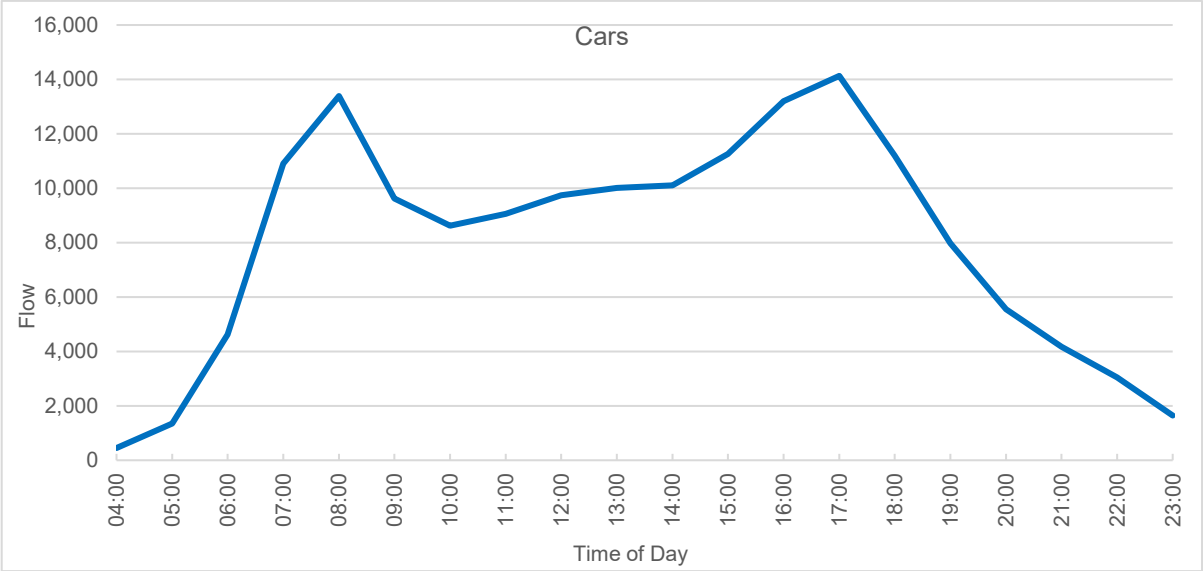

Figure 5-E – Car Daily Flow Profile

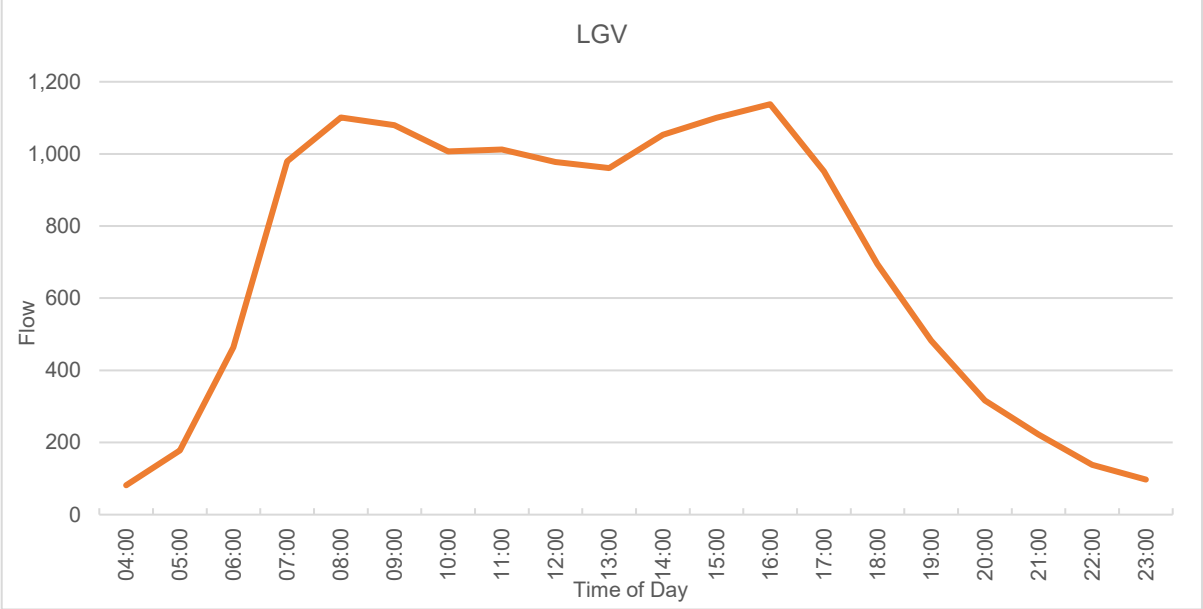

Figure 5-F – LGV Daily Flow Profile

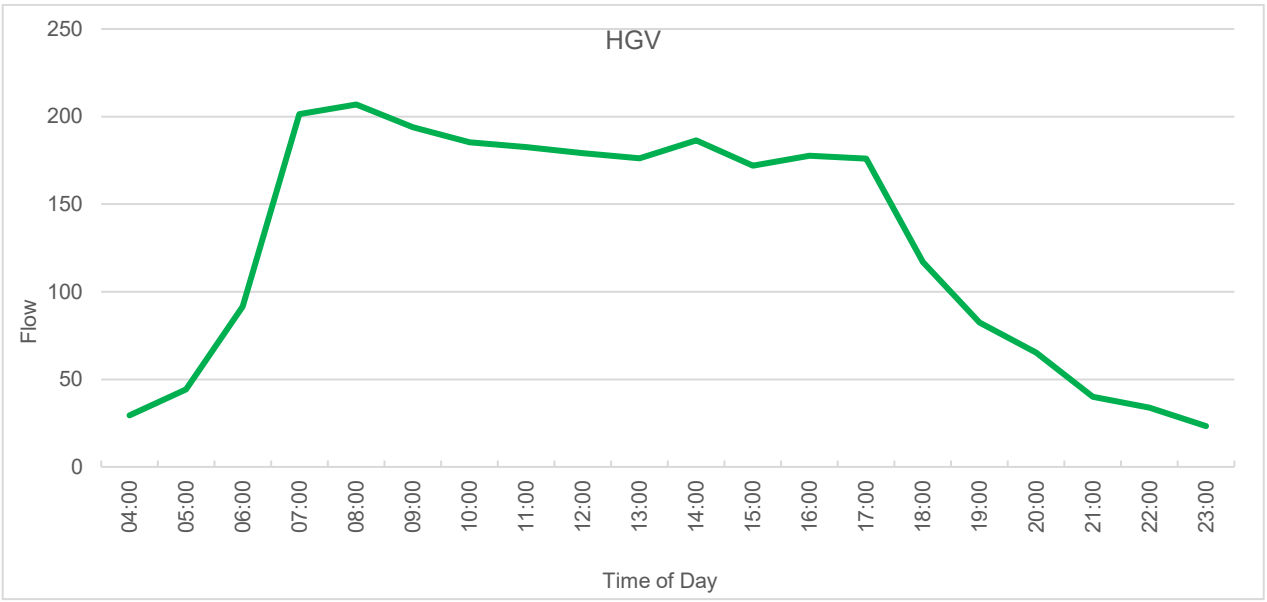

Figure 5-G – HGV Daily Flow Profile

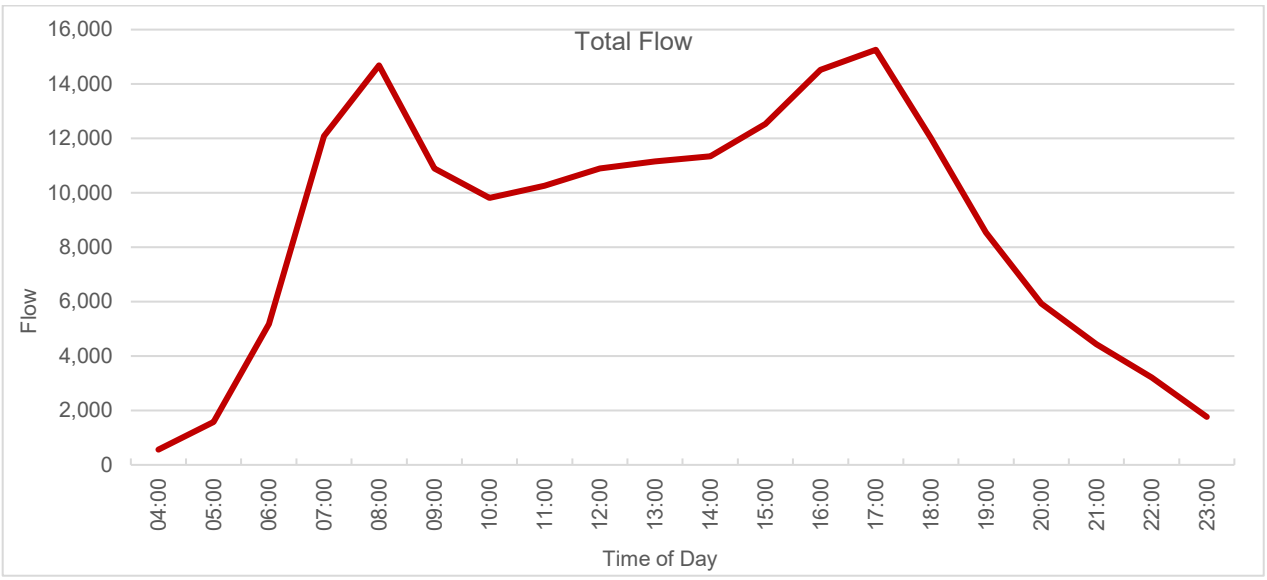

Figure 5-H – Total Daily Flow Profile

In order to ensure count consistency; the full count data set were profiled by month and year to develop a series of seasonality adjustment factors, that were used in the final derivation of the count dataset - such that all counts were reflective of a neutral average October 2013 base. The result of this assessment for roads inside Preston are provided in Table 5-2.

Table 5-2 – Preston Road Seasonality Factors

Preston Av.	2012 N/E	2012 S/W	2013 N/E	2013 S/W	2014 N/E	2014 S/W
08:00-09:00	0.98	0.98	0.95	0.97	0.88	0.93
10:00-16:00	1.04	1.05	1.02	1.03	0.97	0.98
17:00-18:00	0.99	0.99	0.98	0.97	0.93	1.03

Figure 5-I shows the local traffic counts that were used in the calibration and validation process in addition to the Highway England Counts in the previous section.

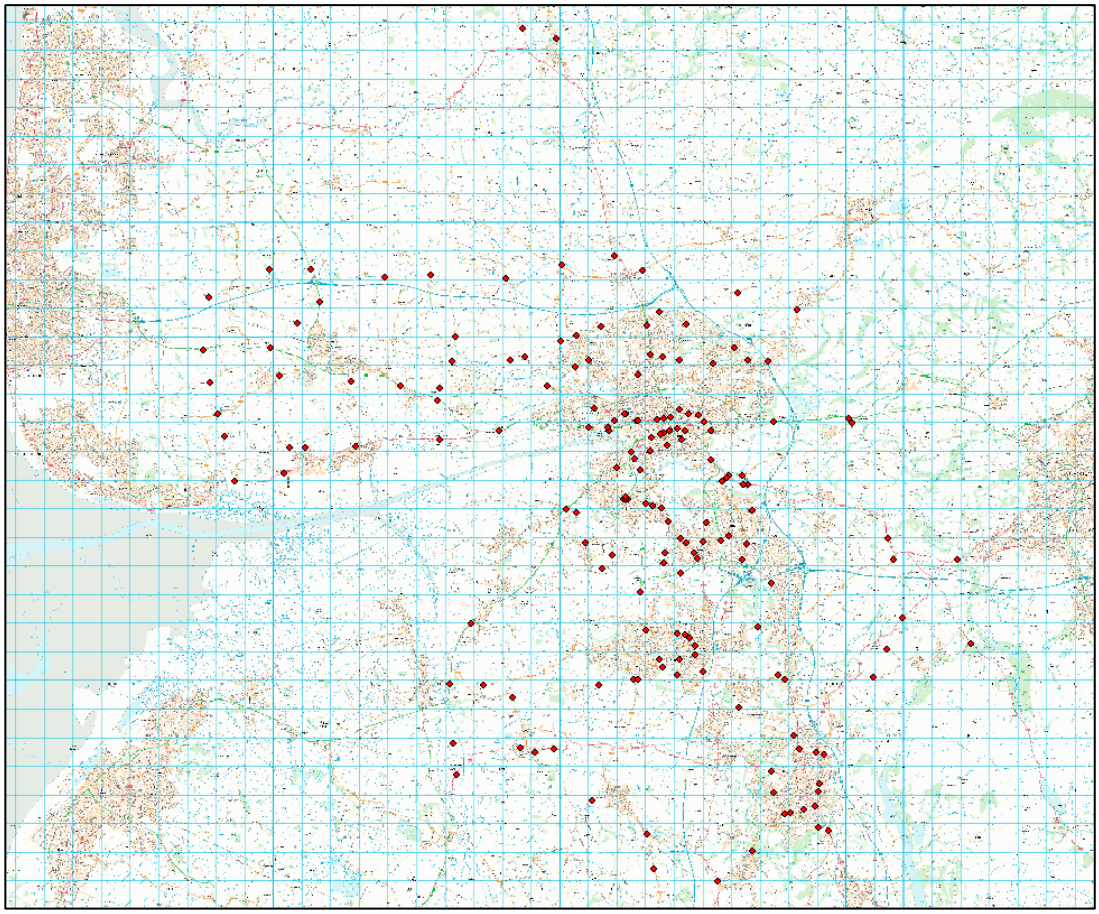

Figure 5-I - Local Traffic Counts

5.3 Traffic counts for Calibration

In order to check how well the model replicates real world traffic flows, it is necessary to compare modelled flows against traffic counts.

To this end, traffic counts need to be split into three criteria in order to meet WebTAG M-3 Guidance:

- *RSI Traffic Counts*