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A9/A82 Longman Junction

Final MFTM Calibration and Validation Report - 2018

13/06/19

A9/A82 Longman Junction

Project No:	B2325900
Document Title:	Final MFTM Calibration and Validation Report - 2018
Date:	13/06/19
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1. Introduction

1.1 General

Jacobs was commissioned by Transport Scotland to prepare a Design Manual for Roads and Bridges (DMRB) Stage 2 Assessment for the A9/A82 Longman Junction Assessment, and a DMRB Stage 3 Assessment for the A9/A96 Inshes to Smithton Scheme.

The transport modelling and economic appraisal work was undertaken using the Moray Firth Transport Model (MFTM) model. In preparation for these assessments, it was proposed that the MFTM base model be recalibrated and validated to reflect 2018 traffic conditions.

1.2 Report outline

This report provides details on the calibration and validation of the MFTM Base model, including changes to the model coding, matrix development and the level of calibration and validation achieved.

Chapter 2 outlines the general model specification;

Chapter 3 summarises the network and enhancements made for this update, and Chapter 4 covers the changes made to the Public Transport network. Revisions to observed matrices, including matrix estimation changes are given in Chapter 5 and the assignment model is discussed in Chapter 6. Calibration and validation results are given in Chapters 7 and 8 respectively. Chapter 9 summarises the development of the Demand model, which has not been altered during the update of the model, and finally a Summary and Conclusion has been included in Chapter 10.

2. Model Specification

2.1 Scope

The VISUM Model is a 4 Stage multi-modal model, including highway, bus and rail public transport networks. For the purposes of the model update, its focus is on Inverness city centre including Longman, Smithton and Inshes, which covers all major commuting catchments to the city and strategic movements from the rest of Scotland. The model also includes the settlements along the trunk road network as far north as Tain, south to Dalwhinnie, east to Granton on Spey and west of Garve, as shown in Figure 2-1.

Figure 2-1 Network Extents

The demand matrices include all traffic to, from, within and through the study area.

The MFTM 2014 Base model was developed in VISUM version 12.01-02, and this has since been updated to use version 17.01-04. It is supplemented by software scripts written in Python produced by the previous model developer[1].

[1] –AECOM, Moray Firth Transport Model Development Report, September 2010

2.2 Model years

The base model has been recalibrated to represent an average weekday in February 2018.

2.3 Time periods

The model has been developed for the following time periods:

- morning peak, 08:00 - 09:00;
- inter peak average hour, 10:00 - 16:00; and
- evening peak, 17:00 -18:00.

2.4 Model zones and sectors

2.4.1 Extent of zone system

The model zone system remains consistent with that used in the previous version of the model with the exception of Zone 47, which covered Inverness Caledonian Football Stadium and the Landfill site to the east of the A9. This zone has been divided into two zones, moving the Landfill site into a separate zone, Zone 425. Separating this area into two zones allowed a better representation of traffic joining the network along this section of Stadium Road, which may be important when developing the future year models given the development aspirations in the area. Details of how the original zone system was developed can be found in Chapter 3 of the MFTM development report[1]. The zones representing Inverness and surrounding areas are shown in Figure 2-2 and for the rest of Scotland in Figure 2-3.

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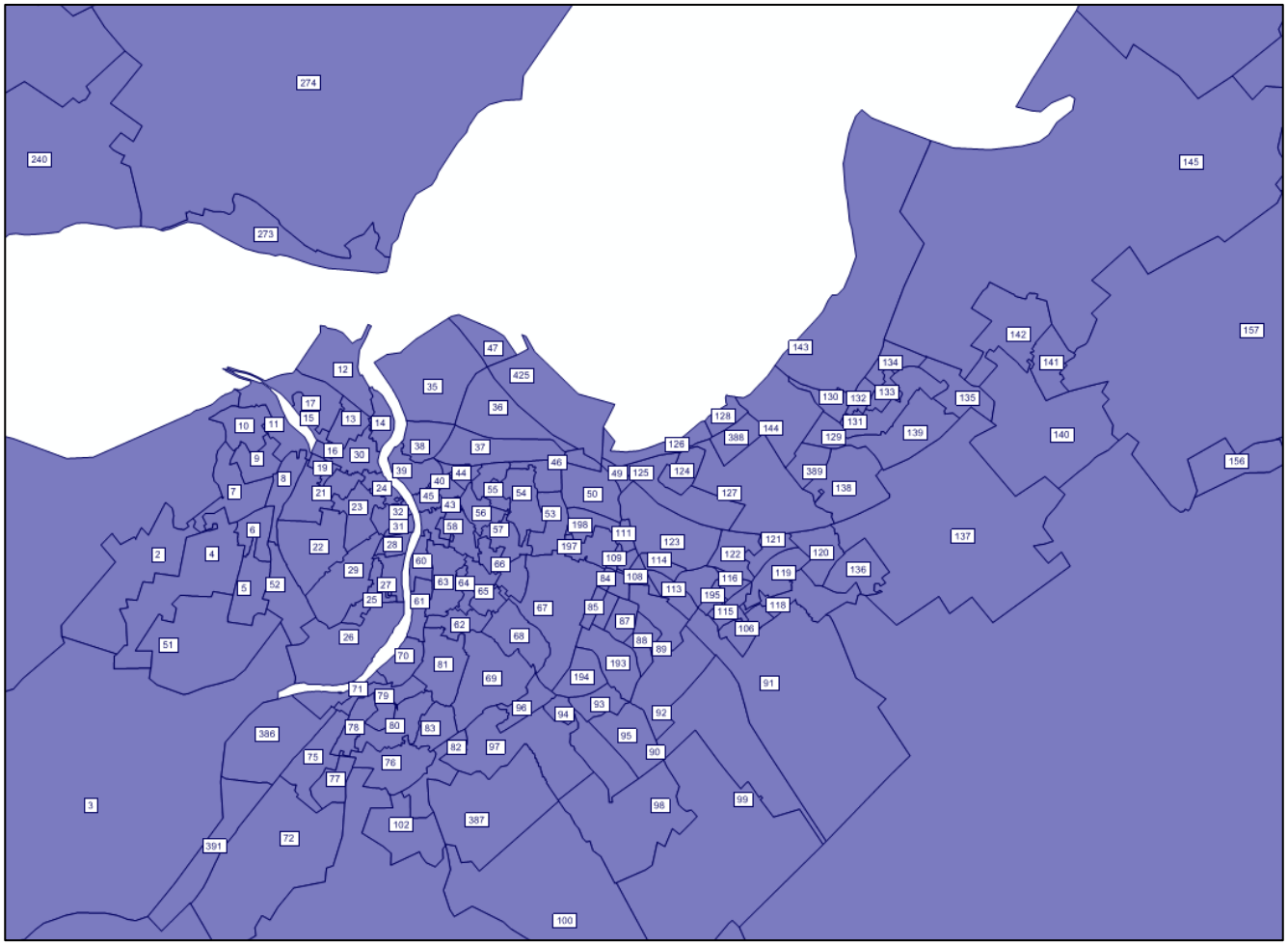

Figure 2-2: Zone system across Inverness

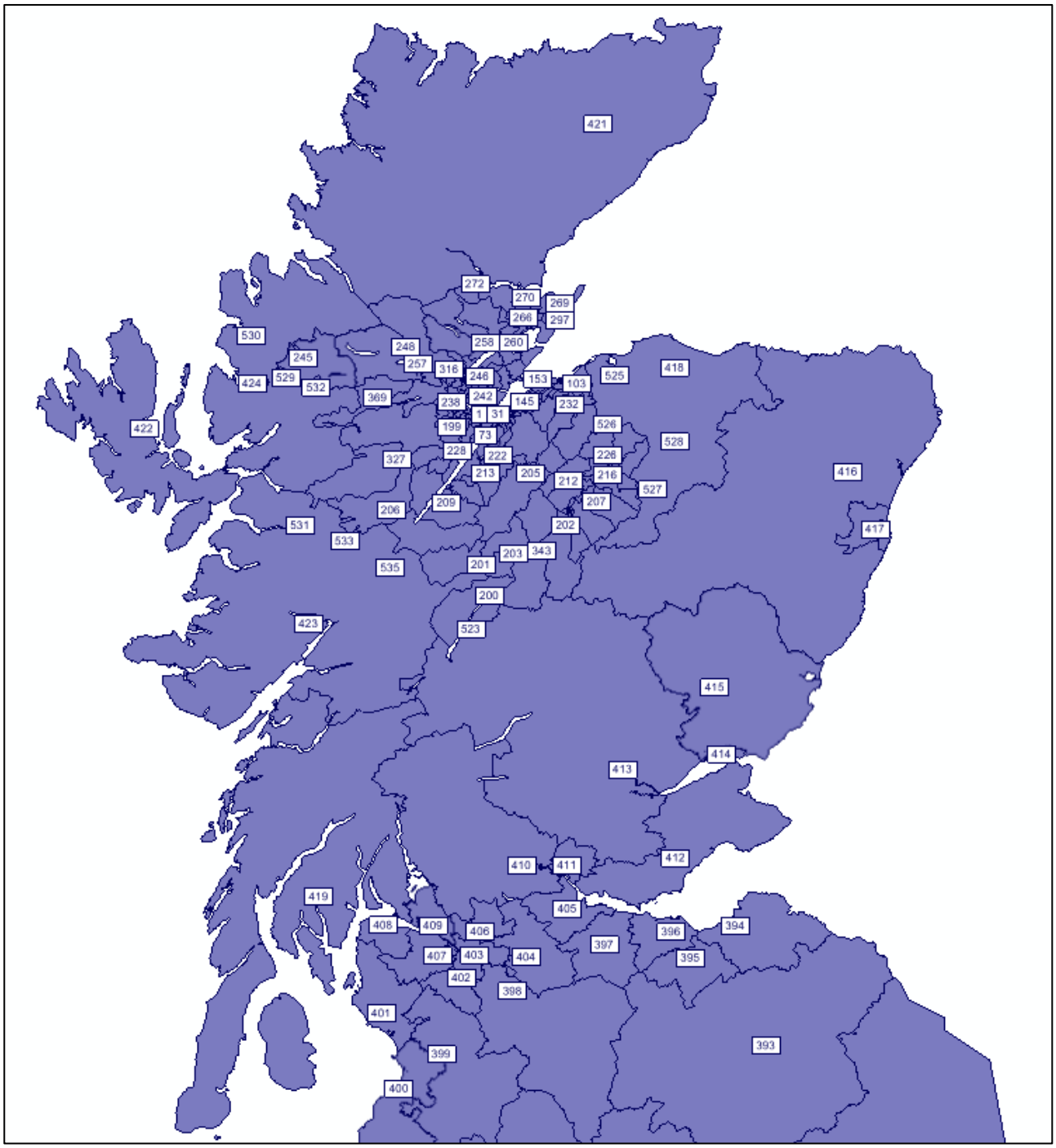

Figure 2-3: Zone system across Scotland

2.4.2 Sector System

To allow for further analysis and reporting as part of the model update, zones have been aggregated into 19 sectors. Sectors covering Inverness are shown in Figure 2-4 and the rest of Scotland are shown in Figure 2-5.

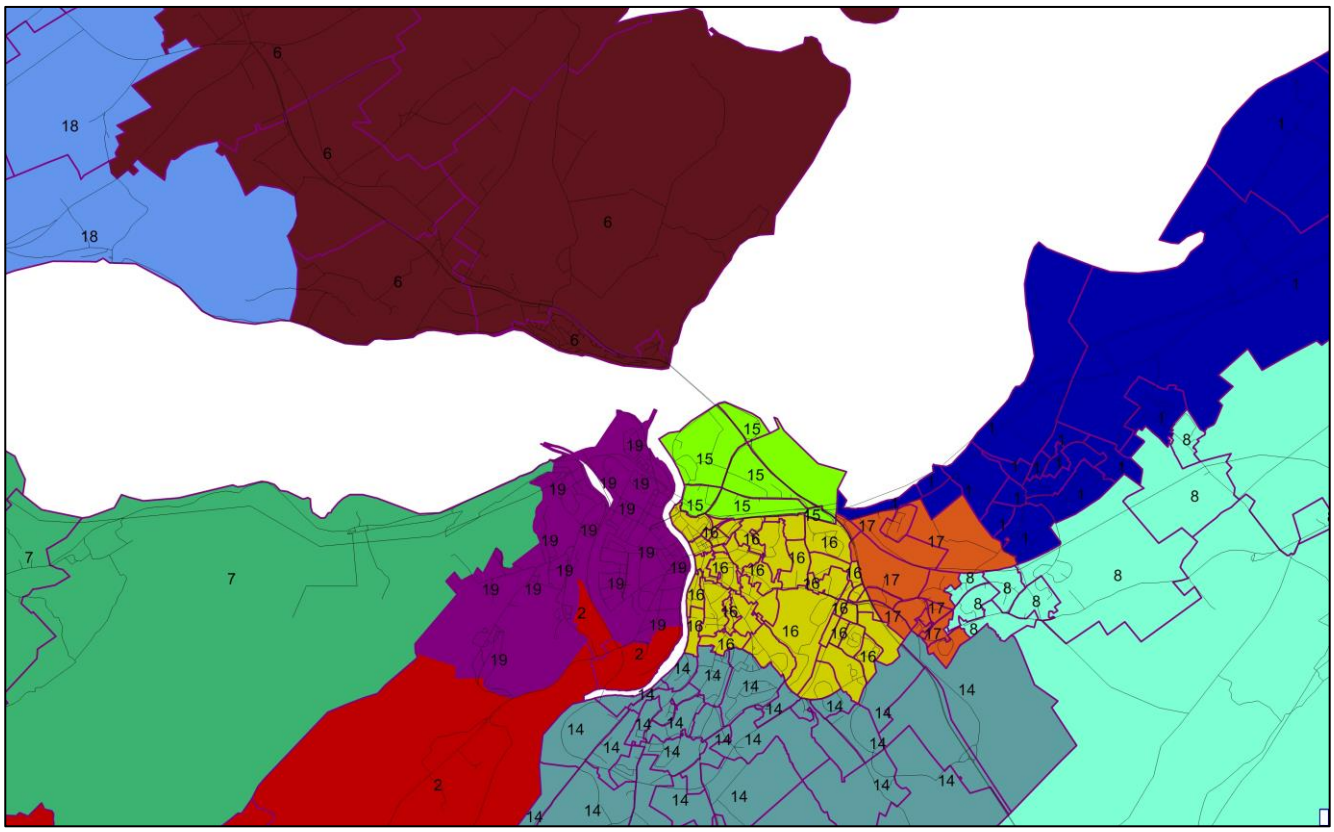

Figure 2-4 Sector system in the Inverness Area

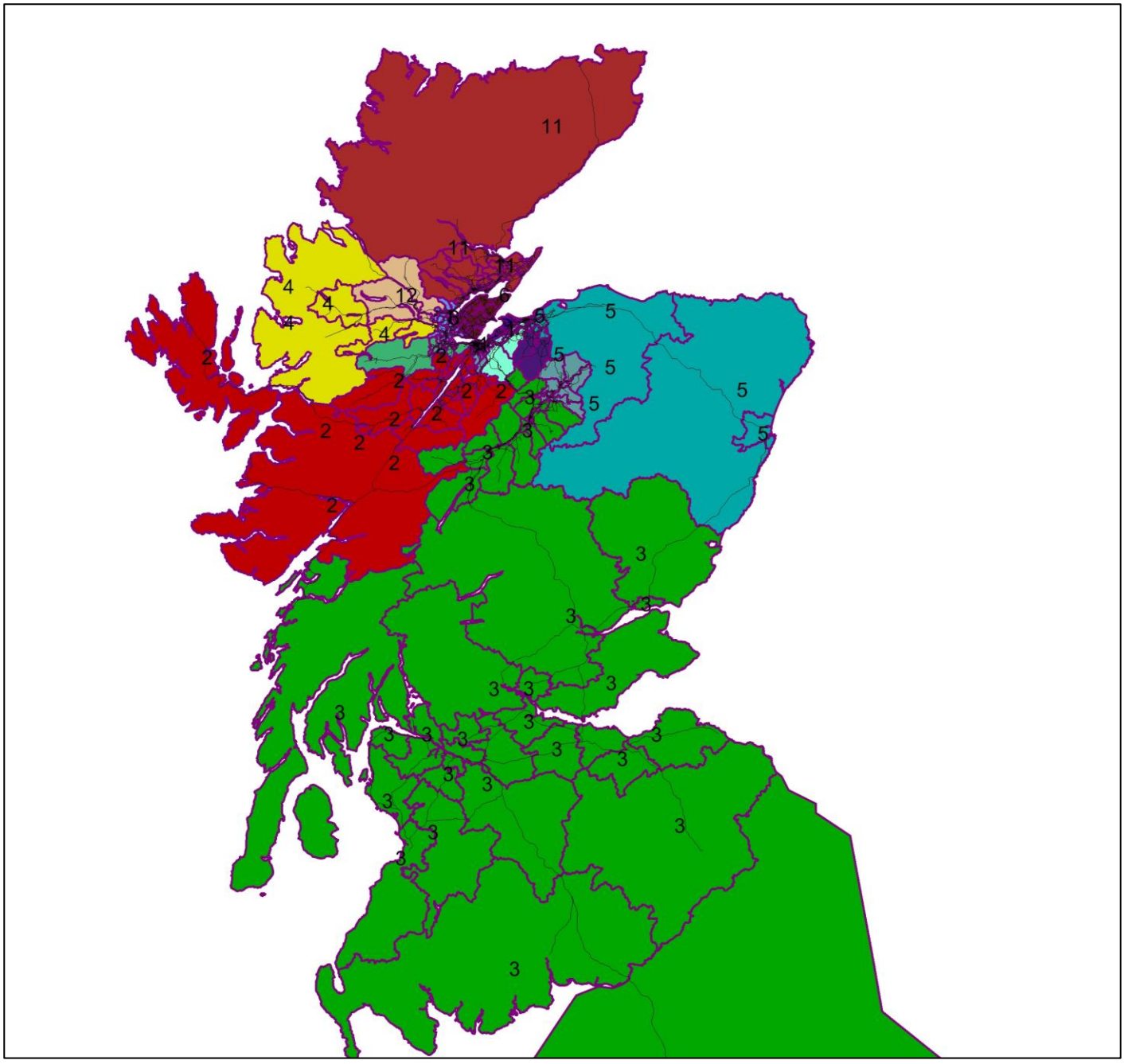

Figure 2-5 Sectors system across Scotland

3. Highway Network Updates

3.1 Introduction

The original base model network was originally developed in 2009 and is detailed in the MFTM Development Report[2] (AECOM 2010), with the A96 corridor updated as part of the 2014 model update, detailed in the MFTM Base Model Update Calibration Report[3] (Jacobs 2017). An extensive network review has since been undertaken, with a particular focus on Inverness City Centre including Longman, and the Smithton and Culloden area. This chapter summarises the key changes and updates implemented in the model networks.

3.2 Modelled Network

The most significant change to the road network between 2014 and 2018 within the study area is the opening of The Highland Councils West Link Phase 1 scheme, providing a new crossing of the River Ness to the southwest of Inverness. This section of the West Link Scheme opened in December 2017 and provides a connection from the A82 to Sir Walter Scott Drive.

The development of the network using ITN layers meant that very small residential streets were also imported. These were removed to reduce ambiguity within the model network. Due to the strategic nature of the model, the key consideration was the zone structure, and the points where the zones loaded onto the network. Upon reviewing the network, in conjunction with the zone loading points, areas of the road network were consolidated, removing a number of redundant links within the modelled area of Inverness.

3.3 Link Types

Link types were reviewed as part of the network checks, and a number were updated to better reflect road characteristics within the city centre. Figure 3-1 below and Table A-1 in Appendix A lists the links that have been subject to a change in Link Type.

Generally, the link type was changed to improve the consistency of link coding on the approach at the junction or to improve the consistency between coded link type and the quality and type of road that exists on the ground.

In the previous version of the model, the link coding on approach to junctions was inconsistent. In some instances, links were coded with the same link type as the rest of the route, meaning a speed flow curve was applied. In other instances, a short link was created on approach to the junction and a link type of 99 was applied, which does not have a speed flow curve applied, allowing the junction to control the speed on the link. The latter approach has now been applied throughout the immediate study area, where traffic on the link has to give way to an opposing traffic movement.

[2] Moray Firth Transport Model V4: Development Report, AECOM, July 20110
[3] B2103500 MFTM Base Model Update Calibration Report Final 18-12-17, Jacobs 2017

As mentioned above there were also instances where different link types had been applied to roads with similar attributes. This has been reviewed and the link types have been altered to make roads with similar attributes consistent.

In the case of Harbour Road, the link type was changed so a speed flow curve could be applied that meant the speeds would be closer to the observed speed. Harbour Road is a unique road within the model area as it has a large number of accesses to industrial units and car show rooms within a short stretch of road, meaning there is a significant amount of stop start traffic along the route with vehicles accessing various sites. In addition, it is common for car transporters to be stopped on the road, delivering vehicles to the showrooms, causing an obstruction to the traffic flow. The speed flow curve implemented on this link attempts to take account of these factors.

Figure 3-1 New Link Types

3.4 Link Capacities

The link capacities have been reviewed to assess how accurately they reflect current road conditions. As a result of this assessment, the capacities have been updated on a number of links. Figure 3-2 and Figure 3-3 show the link capacities originally coded and the updated capacities, for the links that have changed, respectively. Table A-2 in Appendix A lists the links where the capacity has been updated. The updated capacities are based on capacities used in the Transport Model for Scotland, aiming to provide consistency with other models within the LATIS suite.

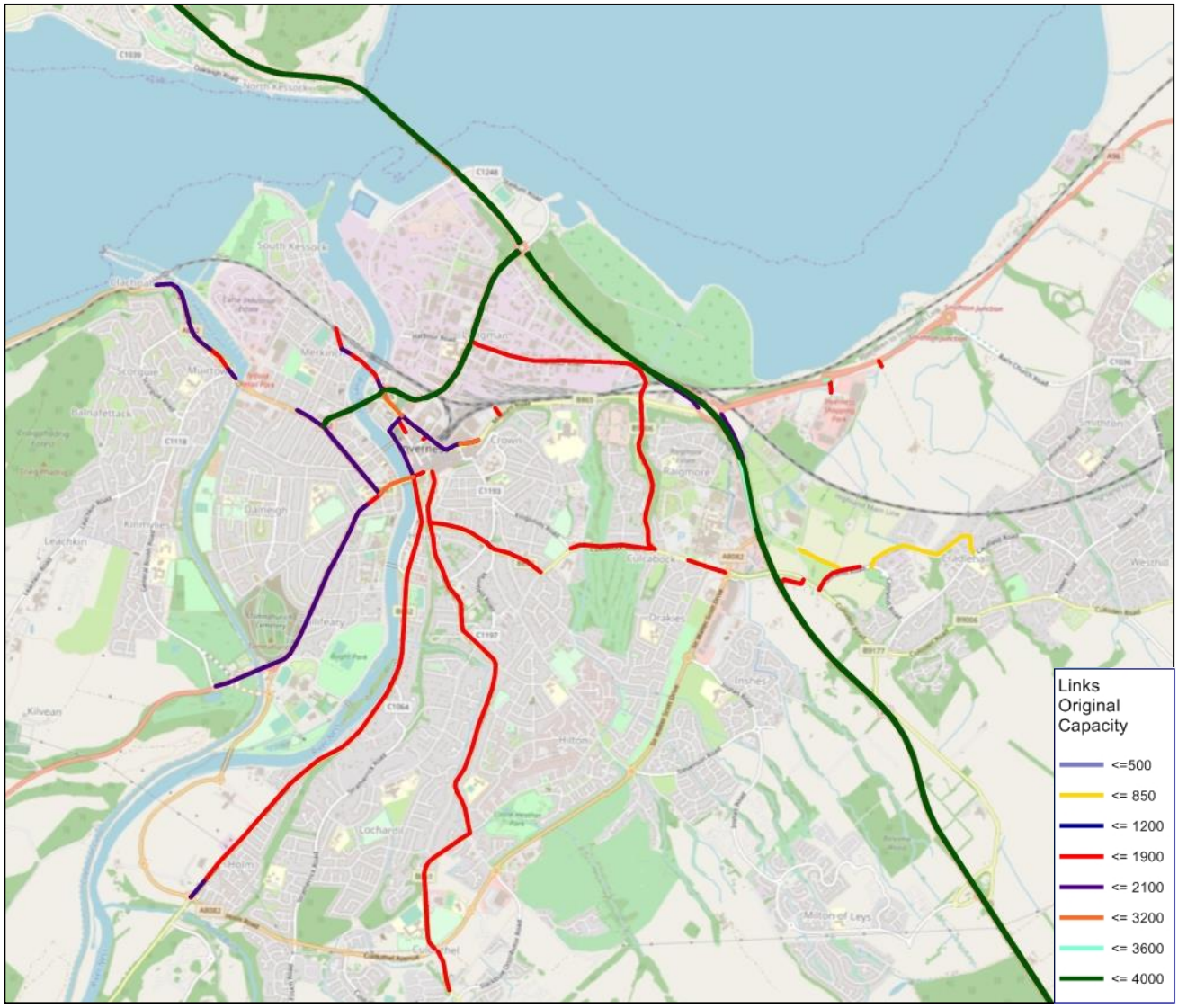

Figure 3-2 Original Link Capacities

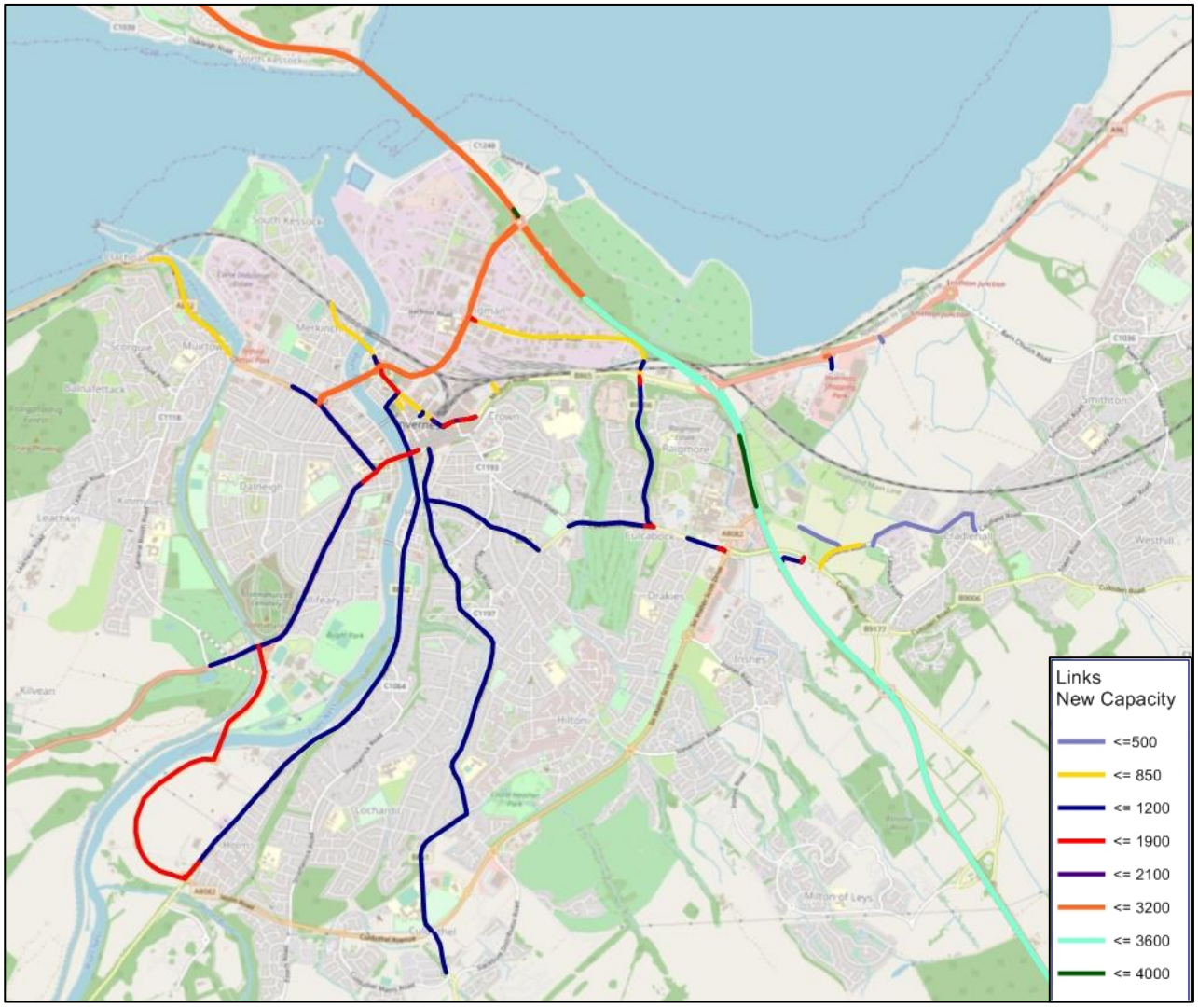

Figure 3-3 Updated Link Capacities

3.5 Free Flow Speed

Changes have been made to the free flow speed on a number of links. These changes have been implemented as the free flow speeds coded in the original base model did not accurately reflect the actual speed limit of the road or in some cases the achievable travel speed on a road based on observed data. For the links that have been modified, the original free flow speeds are shown in Figure 3-4**,** while Figure 3-5 shows the updated free flow speeds now coded in the model. A list of the key links has been included in Table A-3 in Appendix A.

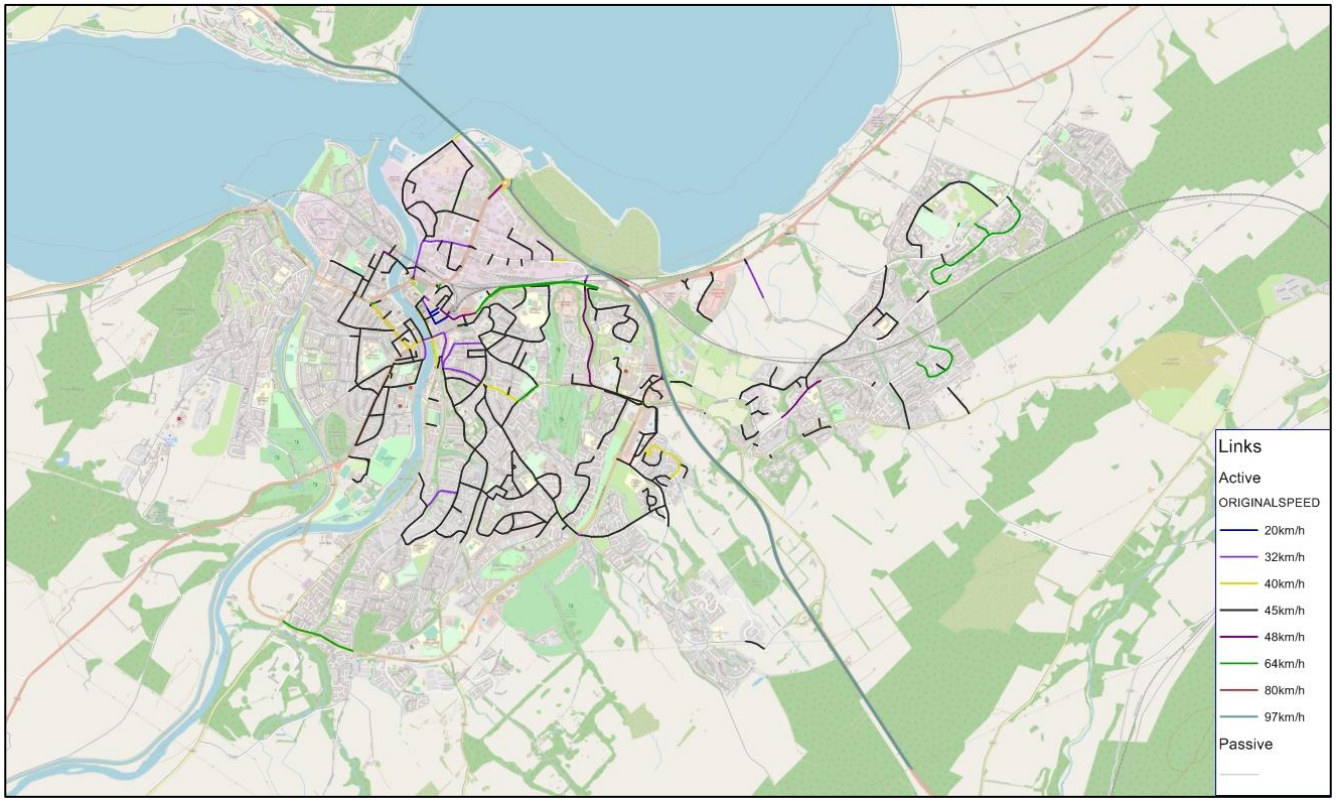

Figure 3-4: Original free flow speeds

Figure 3-5 Updated free flow speeds

3.6 Junction Improvements

The signal times at Longman Roundabout have been updated to better reflect those observed on the ground. Journey time information approaching the junction was checked as part of the validation of the model and is report in Section 8.2 below. The junction coding was checked throughout the study area against Google Streetview to determine the correct control type and the major changes are included within Table A-4 in Appendix A.

3.7 Additional Links and Connectors

In addition to West Link to the southwest of Inverness, a number of minor links have been added to the model. The additional links were included to provide additional detail within the University of Highland and Island (UHI) Campus to reflect where traffic is originating within the campus. Other minor links have also been added to amend how a number of zones connect to the network. Originally, a number of Zone Connectors connected to a node in the middle of a link, this has been changed to create a junction with a short spigot link for the zone to connect to. The additional zone connectors or changes to the location of zone connectors are shown in Figure 3-6 to Figure 3-8.

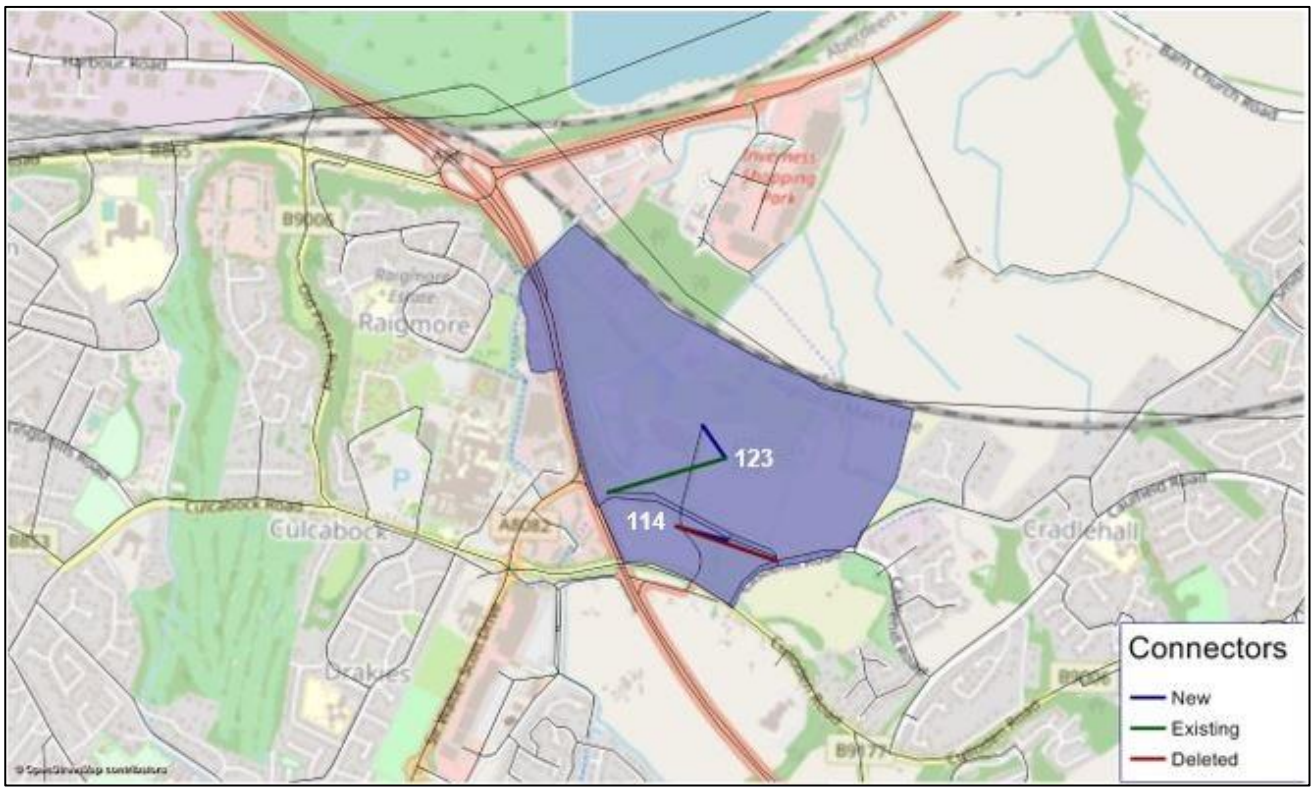

Figure 3-6: Zone connector changes for Zones 123 and 114

Figure 3-7 Zone connector changes for Zones 47 and 425

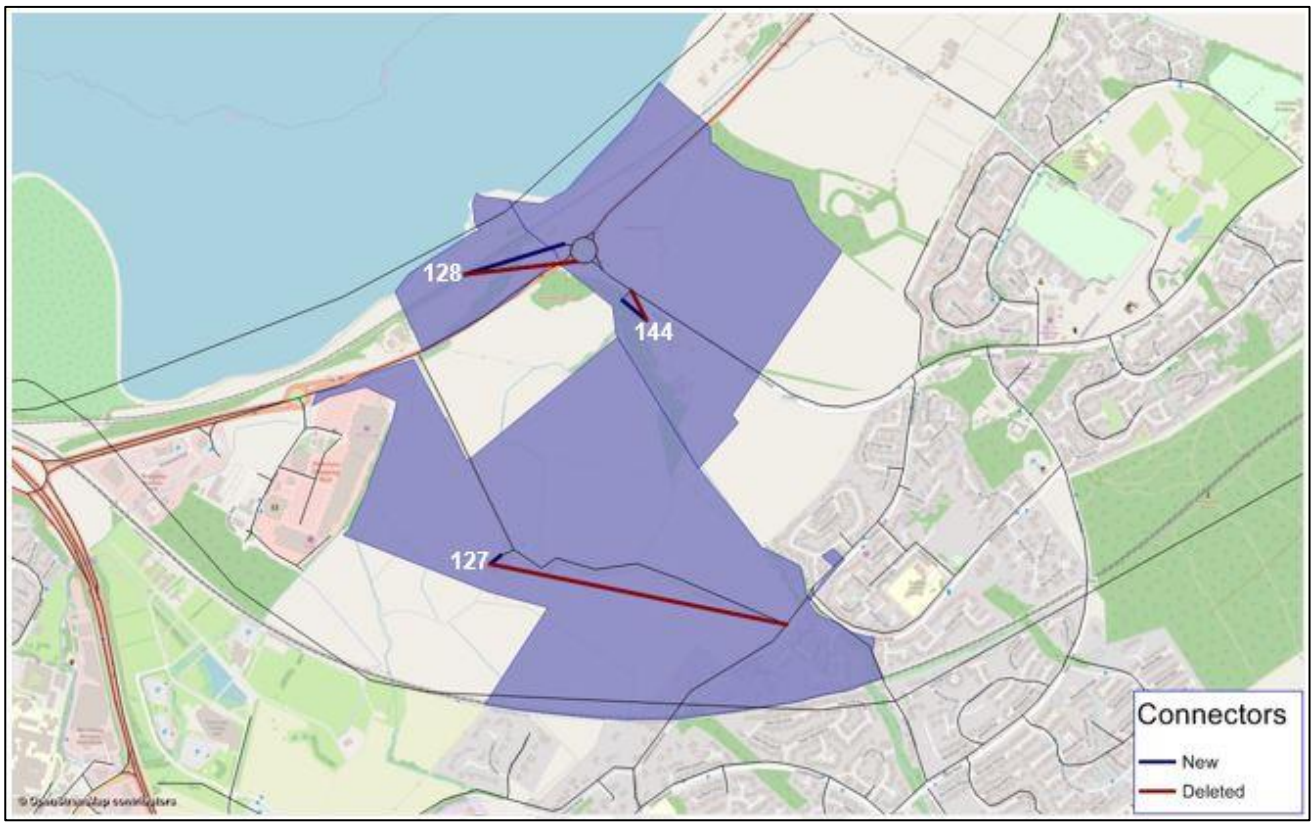

Figure 3-8 Zone connector changes for Zones 128, 144 and 127

3.8 Link Penalties

Link Penalties have been introduced on two routes to represent perceived delay and to reflect observed route choice, to encourage traffic to route along Castlehill Road and Caulfield Road North. This has been applied to reflect local knowledge, where a proportion of local traffic avoids a potential queue on the Culloden Road approach to the Caulfield Road North signalised junction by routing via Castlehill Road and Caulfield Road North.

3.9 Network Summary Statistics

Table 3-1 summarises the number of elements for each of the different components of the high-level model.

Table 3-1 : Network summary statistics

Element	Number
Network nodes	10,128
Network links	23,134
Demand zones	441
Zone Connectors	3,384
Rail stations	4
Bus stops	1,247

4. Public Transport Updates

4.1 Introduction

In addition to the model network review, the public transport network was also reviewed to include updated bus services and to remove out-of-date services. Similar to the model network, particular attention was paid to Inverness City Centre and long-distance bus routes that originate in, terminate in or pass through Inverness. This chapter summarises the key changes and updates implemented for Public Transport.

4.2 Lines and Route Lines

In order to determine the out-of-date bus services within the public transport network, an online search of bus services operating within Inverness City Centre, and the wider area, was undertaken using the operators' websites. In addition, the Bus Route Lines attribute tool on Basemap DataCutter was employed as a database in ArcGIS to identify every bus service number operating within the Highland area. The services that yielded no results across the operators' websites and within the Bus Route Lines database were subsequently deleted from the model, as this is indicative that they are no longer in operation. Once the out-of-date services were removed from the model, the existing bus stops in Inverness City Centre were checked using Basemap's multi-modal transport tool, TRACC. Any missing bus stops were added to the network, and any redundant bus stops in the model were removed.

Analysis of the remaining bus service routes in the public transport network was undertaken using the DataCutter Bus Line Routes shapefile in ArcGIS. This demonstrated the first departure bus stop location and the final arrival bus stop location, and therefore the complete line route for each service. Existing lines containing the complete routes were copied and edited in VISUM to demonstrate all the line routes for each service; approximately 40 existing bus line routes were edited, as per the operators' timetable and bus stop locations. In addition, new bus services were identified across the region using the DataCutter Bus Line database. Over 30 new bus lines were coded into the public transport network using the bus line tools in VISUM. To this end, the Base Model, Do Minimum Model and Do Something Model consist of 177 bus line routes.

4.3 Timetables

A number of bus services offer variations of routes throughout the three peak periods; that is a service number will remain the same, but it may start or terminate at a different location in the AM peak compared to the PM peak. This was not evident from the Bus Line Route Shapefile obtained from DataCutter, therefore, a variety of data sources were used to identify and add the bus timetables for each service throughout the three peak periods; this information was derived from the multi-modal transport tool TRACC and the operators' timetable sections on their websites.

4.4 Network and Service Validation

The transit tool in Google Maps was employed to validate the bus service numbers and bus stop locations in relation to the departure and arrival points of each new and existing bus service within the public transport network. In addition, new and existing bus service timetables and line routes across the three peak periods were validated using the interactive timetable tool and map on Travelinescotland.com. Observed Matrix Development

4.5 New Count Data

The model update has been targeted to improve the quality of the model and to ensure it best represents the area of Inverness in 2018. To achieve this, a data collection exercise was agreed with Transport Scotland and undertaken in February 2018. This consisted of surveying 24 ATC sites and 20 JTC sites within the city centre shown in Figure 4-1 and Figure 4-2 and a selection of the new count data was used during the matrix estimation process as calibration counts. The remaining count information was kept independent of the data utilised during Matrix Estimation and was retained for model validation purposes. The sites marked with a red circle in Figure 4-1 and Figure 4-2 have been used in calibration, those marked with a blue star were kept independent for validation. Transport Scotland and The Highland Council maintain permanent ATC counters situated around Inverness and on the trunk road network, including the A96, these counts were also utilised in the calibration and validation process, shown in Figure 4-3.

Figure 4-1 ATC and JTC Locations - South of Inverness and City Centre

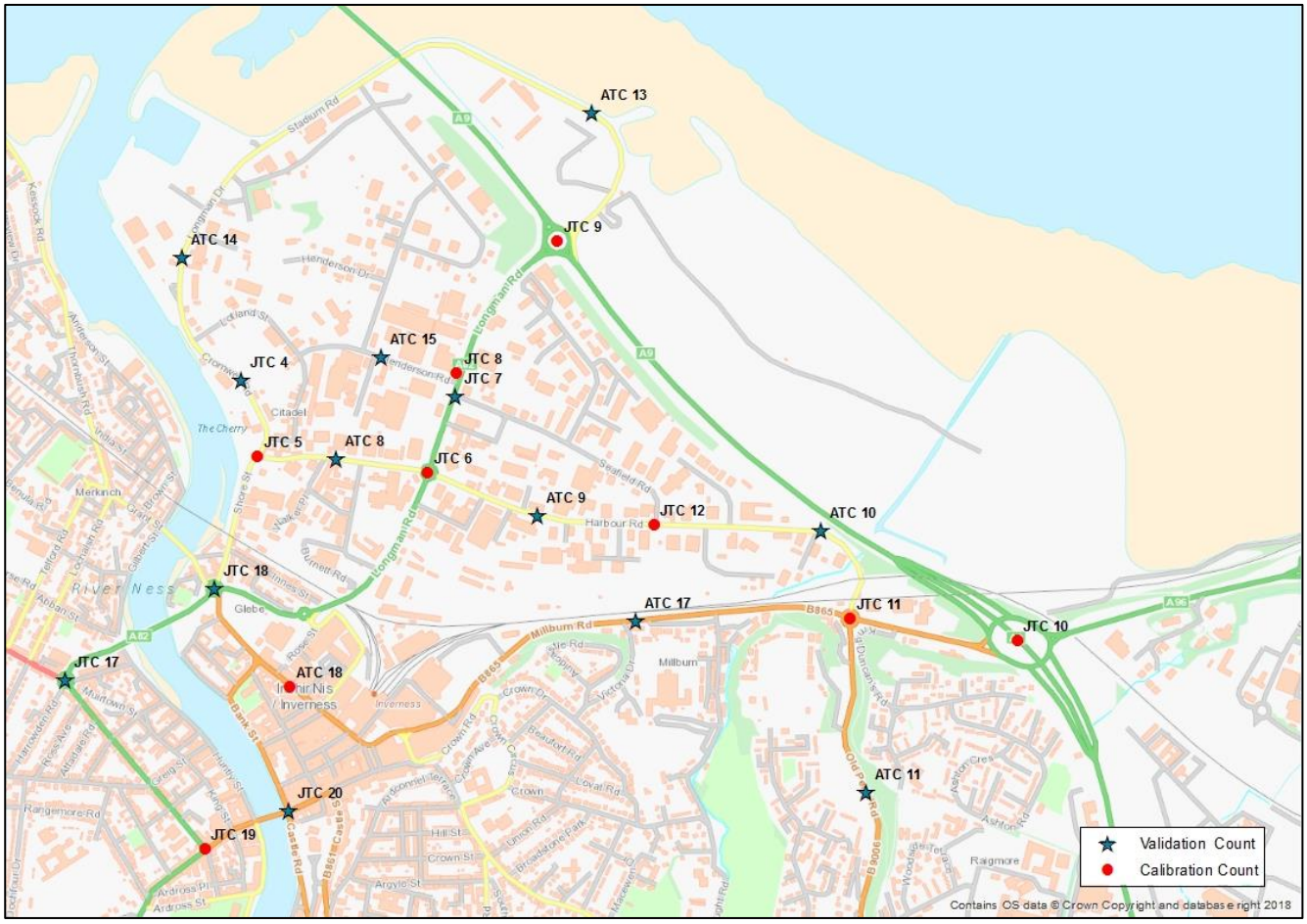

Figure 4-2 ATC and JTC Locations - City Centre and Longman Junction

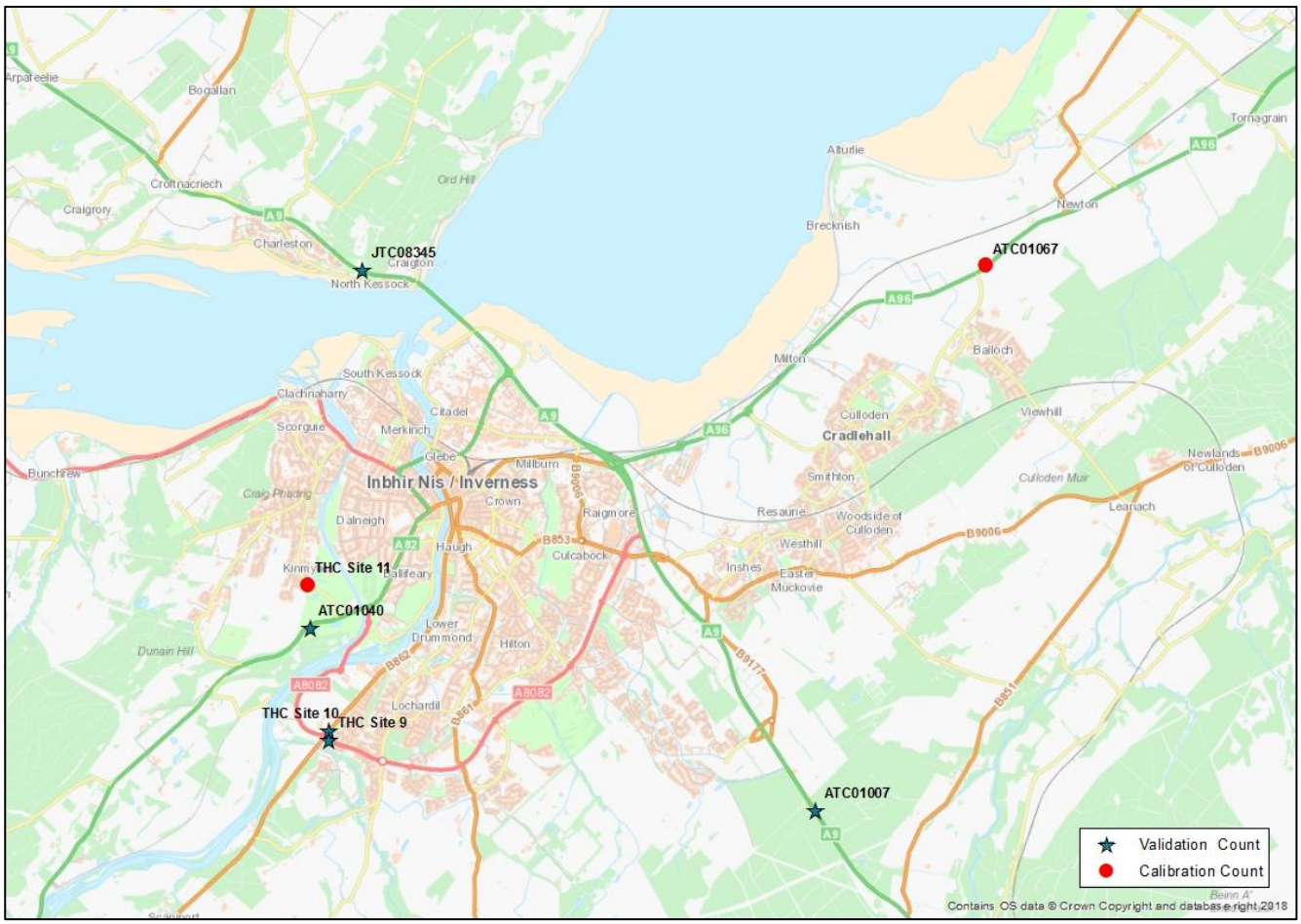

Figure 4-3 Transport Scotland and The Highland Council Permanent Sites

Figure 4-4 Roadside Interview Locations (June 2018)

4.6 Prior Matrix Development

As part of the MFTM base model update, it was determined that the prior matrices used for the original base model should be reviewed and updated where possible. A range of data sources were collected to inform the overall process of producing updated observed prior matrices. These were as follow:

- Business Registered and Employment Survey (BRES) Data;
- Census Population and Housing Data;
- Census Travel to Work Data (at a 2011 Data Zone Level);
- Scottish Household Survey Data; and
- Roadside Interview (RSI) Data (2006 – 2010).

As detailed in section 5.3, RSI surveys were also undertaken in June 2018, with the data received in July 2018. The data was not available at the time the prior matrices were being

developed and was therefore used to validate the trip patterns within the matrices. From the remaining datasets, only the Car Commute prior matrix could be updated as no information was available to update the Car Other Matrix or the Car In Work Matrix.

The Census Travel to work data was used as the basis for the Car Commute Matrix. This data is based on the 2011 Census and is provided at 2011 Data Zone level. It was subsequently converted into the MFTM zone structure based on proportions derived from overlaying the 2011 data zones with the model zones to determine the area of each data zone that would fall within the boundary of each model zone. As the Census Travel to work data surveys how each person travels to work, this had to be converted into vehicle trips. Car occupancy factors obtained from the WebTAG Databook (December 2017)[4] were used to further condense the matrix so that it represented commuting trips across a 24-hour period.

Table 5.1: Peak Period Occupancy Factors

Peak Period	Factor
AM Peak	1.17
PM Peak	1.16

As the travel to work data covers a 24-hour period, there was a requirement to reduce the matrix to reflect a 12-hour period to coincide with the available RSI data. To take account of this, the percentage of shift workers were removed to establish the number of people who travel between 0700 and 1900. The Office of National Statistics records indicates that the number of individuals undertaking shift work within the United Kingdom is approximately 22%. It has been assumed that shift workers will not travel within the peak periods, and that by reducing the 24-hour travel to work matrix by 22%, the remaining commuters will be those that travel between 0700 and 1900.

To reduce the matrix to peak level, historic RSI data was used to calculate the number of commuting trips that occurred within the peak periods. These factors were based on the number of interviews held between a peak-hour specifically for commuting trips by car or taxi. The following factors were applied:

Table 5.1: Peak Period Factors

Peak Period	Factor
AM Peak	0.37
Inter Peak	0.07
PM Peak	0.25

As the travel to work data was recorded in 2011, a factor was derived to apply growth to 2017. The permanent ATC data within the model are was analysed and a growth factor of 1.02 was applied to the data uplift the matrix to 2017 levels, as the last full year of data available at the time of the matrix development.

[4] WebTAG data book December 2017 v1.9.1 table A1.3.3.

As data was unavailable for other vehicles classes, the existing 2009 prior matrices for Car In Work, Car Other, LGV and HGV were used. Matrices from the TMfS cordon models of Inverness and surrounding areas were used to calculate the growth between 2009 and 2017. The prior trips-ends were then multiplied but the resultant growth factors to uplift each matrix to a 2017 base year. Table 5.2 shows the percentage increase applied to matrix:

Table 5.2: Growth Applied to Prior Matrices

Prior Matrix	Percentage Growth for 2009 - 2017		
	AM Peak	Inter Peak	PM Peak
Car in Work	5.7%	4.2%	5.8%
Car Other	9.5%	10.2%	11.7%
LGV	29.2%	29%	27.1%
HGV	19.3%	18.3%	18.6%

4.6.1 Matrix Modifications

As the travel to work data was provided at datazone level and disaggregated to the MFTM zones based on area, it was necessary to make certain modifications to the final prior matrices to better reflect the land use across Inverness. In addition, the Car In Work, Car Other, LGV and HGV prior matrices were based on the original 2009 MFTM prior matrices. Since 2009, there has been a change to the land use in certain zones, which will alter the trip generators and attractors within the area, so modifications to the prior matrices were necessary. The modifications applied varied from site to site but generally the redistribution of trips was based on the number of households and jobs

4.6.1.1 University of Highlands and Islands

The University of Highlands and Islands Campus relocated from a site to the west of Longman Road to a new site to the west of Cradlehall Business Park in 2016, therefore, the number of trips originating and terminating within the new UHI zone (zone 123) required adjustment based on a review of the traffic count data travelling through several junctions adjacent to the campus. A junction turning count was undertaken at the main entrance to the site which allowed the number of trips travelling via this access to be determined. However, there was no count information available for the secondary access. To establish the level of trips access and egressing via the secondary access, count information was taken from JTC 14, located at the Caulfield Road North/Culloden Road Junction, and ATC 23 and 24 which are located on Castlehill Road and Caulfield Road, respectively. A flow bundle was undertaken to determine the origin of the additional trips, allowing the distribution of traffic accessing the campus via Caulfield Road and Castlehill Road to be determined and added to the Car Other matrix.

4.6.1.2 Cradlehall Primary School

The ATC on Caulfield Road (ATC 24) indicated that the modelled traffic volumes passing Cradlehall Primary School were considerably lower than observed. Consideration was given to why vehicles would travel along this route as the most obvious route to Culloden Road is to continue South on Tower Road. One of the main reasons for using Caulfield Road would

be to drop children off at the primary school in the AM peak. The number of trips travelling to Zone 119, which contains Cradlehall Primary School, was lower than would be expected for a school of that size. The Trip Rate Information Computer System (TRICS) was used to determine a likely trip rate for Cradlehall Primary School based on the school roll and the additional trips added to the matrix, and distributed across zones 117, 196, 195, 116, 115, 106, 120, 121 and 122 which represent the school catchment area.

4.6.1.3 Raigmore Hospital

Following an initial run of matrix estimation, traffic flows entering and exiting Raigmore Hospital were compared to traffic counts undertaken in 2014 as this was the most up to date data source available. As this count was collected in 2014, a check was undertaken using the ATCs within the model area to determine the level of growth between 2014 and 2017, as the last full year of data. This indicated that there was no growth within the area, and as such, the 2014 count information was considered a reasonable data source to determine the number of trips travelling to and from both the Raigmore Hospital (Zone 197) and the residential area adjacent to the hospital (Zone 198), as these area share an access.

Comparing the modelled flows with the 2014 turning count information indicated that the level of traffic accessing and egressing the zones were considerably higher than anticipated, resulting in higher than anticipated traffic volumes along the Culloden Road corridor. To rectify this, a percentage reduction was calculated based on the number of trips accessing and egressing the zones in the model compared with the observed 2014 traffic count. The number of trips travelling to Raigmore Hospital were therefore reduced by approximately 40% in the AM Peak, and trips from both Raigmore Hospital and the residential zones were reduced by approximately 60% in the PM Peak.

As mentioned in Section 5.2, during the development of the Car Commute Matrix, shift work was taken account of by applying a factor to the entire matrix based on national averages. A significantly higher number of employees at Raigmore Hospital are likely to work shifts than the national average, which may therefore explain why the level of trips to and from the hospital zone were higher than those observed in 2014.

4.6.1.4 Inshes Retail Park

Matrix adjustments were made to trips originating from zone 107, which represents Inshes Retail Park and Tesco Extra. The travel to work data, used to generate the Car Commute Prior Matrix, would not capture multi-leg journeys as the travel to work data only details where each person lives and works. Zones that contain amenities such as Inshes Retail Park are likely to attract multi-leg journeys and will therefore have a proportion of trips that use this as an intermediate stop within the peak hour model. This zone was highlighted as an issue following a comparison of modelled and observed flows at Inshes Roundabout and on Sir Walter Scott Drive. Modelled and observed flows compared relatively well to on Sir Walter Scott Drive to the south of Eagle Roundabout. This changed on approach to Inshes Roundabout, where the Sir Walter Scott Drive approach in the model was approximately 200 vehicles higher than observed, and the arm approaching Inshes from Tesco was 200 vehicles lower than observed. This indicated there were some multi-leg journeys entering Inshes Retail Park at The Eagle Roundabout before exiting at Inshes Roundabout.

To replicate these multi-leg journeys, approximately 200 trips, that were previously approaching Inshes roundabout from Sir Walter Scott Drive were relocated to have a destination in the Inshes Retail Park, exiting Sir Walter Scott Drive at The Eagle Roundabout. The same number of trips were then added to the origins of Inshes Retail Park, exiting via Inshes Roundabout and terminating at their original destinations. A flow bundle matrix for each user class was used to establish the distribution of trips approaching Inshes Roundabout from Sir Walter Scott Drive and this was used to redistribute trips to the Inshes Retail Park.

4.6.1.5 Seafield Road

The count data on the A82 Longman Road indicated that approximately 200 trips turned left from Seafield Road and made a U-turn at Harbour Road roundabout in order to approach Longman Junction from the southwest. As matrix estimation was undertaken using link flows as targets and not turns, the high U-Turn value was not being taken account of. A flow bundle matrix was calculated for vehicles that travel on Seafield Road to determine the distribution of trips and allow the number of trips travelling towards Longman Junction to be increased to match the count information.

4.6.1.6 Inverness Retail and Business Park

The level of trips travelling to and from Seafield Retail Park is relatively low in the AM Peak. As the majority of these trips are Car Other trips, the trip totals would have been brought forward from the 2009 base model matrices. A review of the 2014 base model showed that there was a significant increase in trips travelling to and from this zone when the model was recalibrated in 2014, with a similar turning pattern to those observed in the JTC undertaken in February 2018. The trip pattern was therefore extracted from the 2014 matrix and added to the 2009 prior matrix.

4.6.1.7 Ashton Farm

Zone 127 encompasses Ashton Farm in the model. As this zone only contains Ashton Farm, it is not anticipated to generate or attract a significant number of trips. As a result of the way the travel to work information was disaggregated, the number of car commute trips travelling to and from Zone 127 is larger than expected, particularly in the PM Peak. A manual change has been applied to relocate these trips into Zones 121 and 122, which represent a residential zone and business park and residential zone respectively. As this was the PM Peak, the origin information was transferred into the business park zone, with the destination trips transferred into both zones based on a 50/50 split as both zones contain residential dwellings.

4.6.1.8 Light and Heavy Good Vehicles

Generally, the LGV and HGV prior matrices were not changed from the 2009 model as there was no data available to update these. However, there were certain zones where the land use had changed, or the available count information indicated that the number of LGVs and HGVs entering or exiting a zone were lower than observed. The two zones that were impacted by this change are Zone 35, which represents Longman Industrial Estate, and Zone 123 which represents the UHI Campus.

The number of LGVs entering and exiting Zone 35 were considerably lower than the observed counts, and considerably lower than what would be expected from an industrial estate of this size. The origin and destination numbers were increased to match the available count information and the distribution seeded, changing all of the zeros to 0.1 to allow Matrix Estimation some flexibility in meeting the count information.

As the land use of Zone 123 was a greenfield site in 2009 the level of LGVs and HGVs travelling to and from this zone were zero. This site is now the location of the UHI, and the level of LGVs and HGVs travelling to and from the site via the main access are known based on count information. This count was used to determine the correct level of goods vehicles, and a distribution was taken from a neighbouring zone, zone 124, which is the Inverness Retail and Business Park.

4.6.1.9 Public Transport

A review of the available data from the Scottish Transport Statistics[5] indicated that bus patronage within the Highland region has remained consistent between 2009 and 2017, with a slight reduction occurring in 2017. As a result of this, and a lack of available data to update the matrix, the public transport matrix remained unchanged from the original 2009 base model.

4.7 Prior Matrix Validation

Roadside Interview (RSI) Surveys were conducted in June 2018 at five locations, as shown in Figure 5-4. This information was used to validate the sector to sector movements of the matrices, as a check that the travel patterns hadn't significantly changed from the 2009 model, particularly for the Car Other and Car In Work matrices as the Car Commute matrices have been updated in the process using the travel to work data. The analysis has been undertaken based on the sector system identified in Figure 2-4 and Figure 2-5. As the RSI locations were chosen to capture the trips into the detailed model area, this does mean that portions of the matrix were not captured by the RSI survey data. The trips that are likely to pass through the areas of interest have been captured by the RSI surveys, hence this data can be used to validate the matrix. To replicate the trip patterns that would be captured by the RSI, a filter matrix was created by undertaking flow bundle on the links that correspond to the RSI locations. This allowed all sector to sector movements that would not pass through the RSI sites to be filtered out of the prior and estimated matrices, before comparison with the RSI matrix.

A comparison between the sector to sector movements for Car In Work, Car Commute, Car Other and LGV has been undertaken and the distribution tables are available in Appendix B. A summary of the comparison for each journey purpose in each peak is detailed below.

[5] Table 2.2b https://www.transport.gov.scot/media/41863/scottish-transport-statistics-2017-with-correction-to-table-214.pdf

Figure 4-5 Roadside Interview Locations (June 2018)

4.7.1 AM Peak

The RSI surveys indicate that the majority of trips are travelling to Sector 16 in the AM Peak for Car In work, Car Commute and Car Other trips, which represents the area around Inshes and the City Centre to the south of the Railway. This compares well with the prior matrices where the main concentration of destinations in Sector 16.

Sector 15 and 19 have the second highest level of trip attractions in the prior matrices. Sector 15 represents the area of Inverness North of the Railway, including Longman Industrial Estate, the Longman Landfill site and Inverness Caledonian Football Stadium and Sector 19 encompasses the areas of Merkinch, South Kessock and Dalneigh, which are a mixture of residential and employment zones, including where The Highland Council's Headquarters are situated. It is evident from the Car Commute RSI matrices that both of these sectors also have a degree of trips attracted to them in the AM Peak. Whilst the Car In Work and Car Other RSI matrices show a degree of correlation with the prior matrices, they do not contain the same level of observed trips as the Car Commute matrix. With the lower levels of Car In Work and Car Other purposes observed from the RSIs, it is more difficult to discern patterns from the RSI matrix and draw comparisons with the prior matrices.

Similarly, the distribution of the prior matrix indicates that Sector 17 is also an attractor of trips from most sectors, albeit a low concentration of trips. This is somewhat evident from the RSI matrices, where Sector 17 is an attractor of trips from some sectors, however the distribution is not as widespread in the RSI information as it is within the prior matrices. This is most likely a result of the sample rate obtained from the RSI. Sector 17 is a likely attractor of trips from a broad range of sectors in the AM Peak as the UHI Campus is located here, and trips have been infilled to this site during the matrix building process based on count information and the prior matrix is therefore considered to be valid.

The available RSI information for LGVs is quite limited with only 54 trips recorded across the four sites. This makes comparison with the prior matrix difficult, however it does indicate a similar pattern to the Car matrices, with large percentages of trips travelling to Sectors 15, 16 and 19.

The rest of the matrices are populated with small percentages between sectors, and this is to be expected as the sample size of the RSI is small and not all trips can be observed. Generally speaking, the RSI replicates the larger sector to sector movements in the AM Peak and indicate that the prior matrices are a valid representation of the trip distribution in the area.

4.7.2 Inter Peak

The Inter Peak RIS matrices show a similar pattern to the AM Peak, which is primarily due to the locations of the RSIs capturing trips entering Inverness. As in the AM Peak, the travel patterns identified within the RSI surveys is similar to those identified within the prior matrices, with the highest proportion of trips travelling to Sector 16, followed by 15, 17 and 19. The correlation between sector to sector travel patterns in the RSI and Prior matrices is particularly strong for the Car Commute journey purpose.

As with the AM Peak, the data does indicate that the sector to sector movements in the prior matrices are valid and a reflect of the RSI.

4.7.3 PM Peak

As the RSI is inbound towards Inverness, the survey does not observe the dominant direction of travel, and the sample rates are slightly lower. This is particularly evident for the Car Commute and Car In Work journey purposes where the observed RSI matrices are sparsely populated, compared to the prior matrices. The do however show a degree of correlation in so far as where observed data was available, the prior matrices showed trips travelling between these sectors. The Car Other matrices has a slightly higher level of observed trips and this again shows a reasonable correlation between the observed data and the Prior matrices.

The dominant movements in the PM Peak are leaving Inverness which has not been captured by the RSI. However, from the available data, the Prior matrices are a reasonable representation of the available observed data.

4.8 Matrix Estimation

In updating the model, the prior matrices have been adjusted by matrix estimation using new count data.

In many modelling packages, the matrix estimation methods employed rely on multiple factoring of a matrix until a solution is derived. Factoring is undertaken in series and because many of the values in the matrix are affected by multiple control counts, the process has to be repeated iteratively until a suitable correlation is found for all the counts. Inevitably, this means that those trips that are affected by fewer control counts (usually the shorter trips) are subject to more extreme aggregate factors and this consequently distorts the trip distribution.

The matrix estimation process in VISUM (TFlowFuzzy) is more complex; it attempts to find suitable factors by considering all control counts simultaneously. The most noticeable advantage of this is that the trip distribution is maintained, whilst still producing a good correlation between the count data and predicted flows.

Due to the available of count data, it was required to combine the three car journey purpose matrices into one and assigned to the network prior to undertaking matrix estimation. The resultant matrix was then divided into journey purpose based on the percentage split of the car prior matrix.

The initial pass of matrix estimation indicated that the car matrix was too high for the observed data, meaning TFlowFuzzy terminated as it couldn't match the counts within the tolerances allowed. As the Car Other and Car In Work matrices were similar to those used in the previous base models, and the Car Commute matrix was created by applying factors to the Travel to Work data, it indicated that the Car Commute matrix was too high. Two tests were therefore undertaken, one reducing the matrix by 10% and another by 20% to determine the reduction required to allow TFlowFuzzy to run. The 20% reduction allowed TFlowFuzzy to run, and as the matrix was reduced further by the matrix estimation process, undertaking tests to apply a reduction lower than 20% were deemed unnecessary.

4.9 Matrix changes

4.9.1 Change in matrix totals

Table 4-1 indicates the change in the Car, LGV and HGV matrix totals, which occurred during the matrix estimation process for the AM Peak. Matrix totals for the Inter Peak and PM Peak are included in Table 4-2 and Table 4-3 respectively.

Table 4-1: Matrix totals AM Peak

	Car Commute	Car In Work	Car Non Work	LGV	HGV
Pre ME	16,798	1,564	4,277	1,860	931
Post ME	14,814	1,470	4,455	2,083	667
Percentage Change	-12%	-6%	4%	12%	-28%

Table 4-2: Matrix totals Inter Peak

	Car Commute	Car In Work	Car Non Work	LGV	HGV
Pre ME	4592	1124	11169	1379	1228
Post ME	6580	1478	14230	1777	718
Percentage Change	43%	31%	27%	29%	-42%

Table 4-3: Matrix totals PM Peak

	Car Commute	Car In Work	Car Non Work	LGV	HGV
Pre ME	12,277	1,326	10,265	1,229	280
Post ME	10,969	1,169	9,516	1,737	311
Percentage Change	-11%	-12%	-7%	41%	11%

4.9.2 Change in Zone to Zone demands

Figure 4-6 to Figure 4-8 show the change in zone to zone trip ends for All Vehicles. Generally, they show a good correlation between pre and post matrix estimation sector totals. It is acknowledged that they are not fully informative as they do not show the relative importance of individual zones. Overall, the zone to zone trip ends are deemed acceptable as the R^2 values are at or approach WebTAG guidance of R^2 in excess of 0.95. The cell to cell values have also been compared and the R^2 values are slightly lower in the Inter Peak and PM Peak, however, are still approaching 0.90.

The slope is low across the AM and PM peak graphs, at around 0.90, this indicates that the size of the matrix decreases between the prior and post ME values. This is most likely a result of the Car Commute prior matrix being high as it was based on factoring the travel to work data.

The slope of the Inter Peak graph is higher at between 2 and 2.5, indicating a large number of trips have been added into the Inter Peak matrices during matrix estimation. This again could be linked to the Car Commute matrix, as the factor for the number of commuting trips was low, and the Car Commuting matrix has the largest percentage increase of all vehicles. Overall, the results are deemed acceptable given the R^2 values.

Table 4-4: Zone to Zone Slope, R^2 and Intercept Values

	WebTAG Criteria	AM	IP	PM
Zone to Zone Cell Values Slope	0.98><1.02	0.85	2.26	0.88
Zone Trip Ends Slope	0.99><1.01	0.91	2.47	0.92
Zone to Zone Cell Values R^2 values	>0.95	0.96	0.89	0.86
Zone Trip Ends R^2 values	>0.98	0.95	0.94	0.96
Zone to Zone Cell Values Intercept	Near 0	-0.01	0.02	0.01
Zone Trip Ends Intercept	Near 0	0.72	2.57	0.58

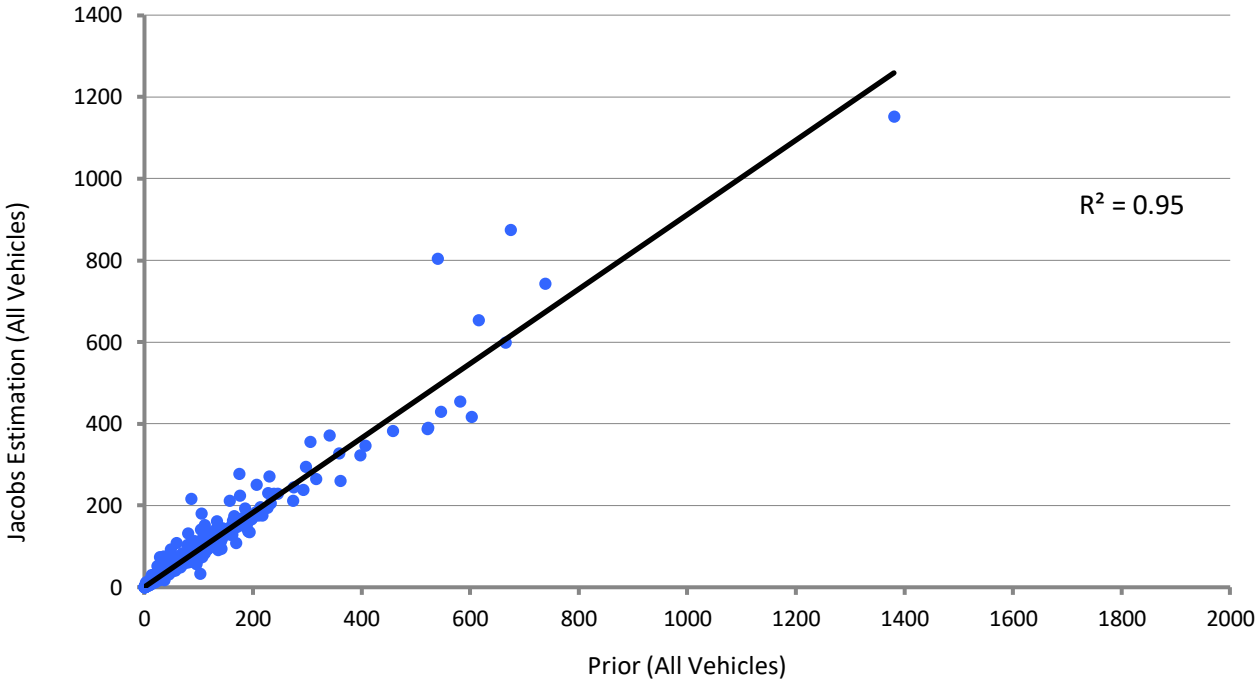

Figure 4-6: Comparison of pre and post-ME total demand (AM peak)

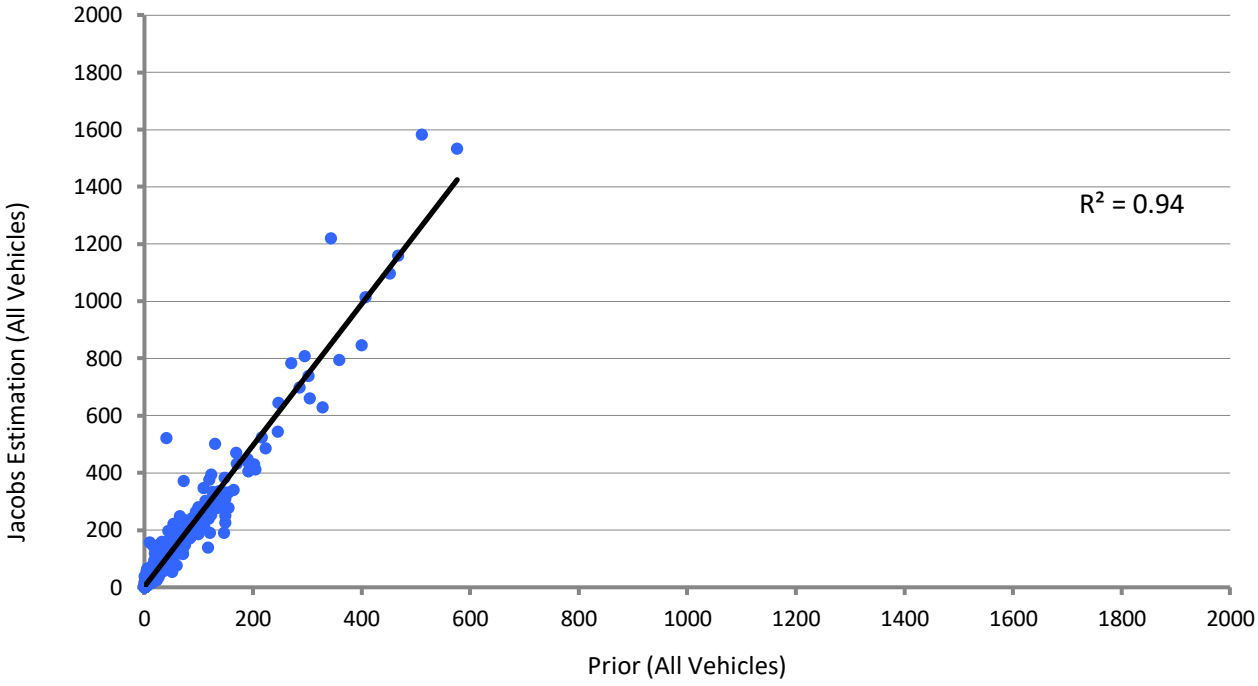

Figure 4-7: Comparison of pre and post-ME total demand (Inter Peak)

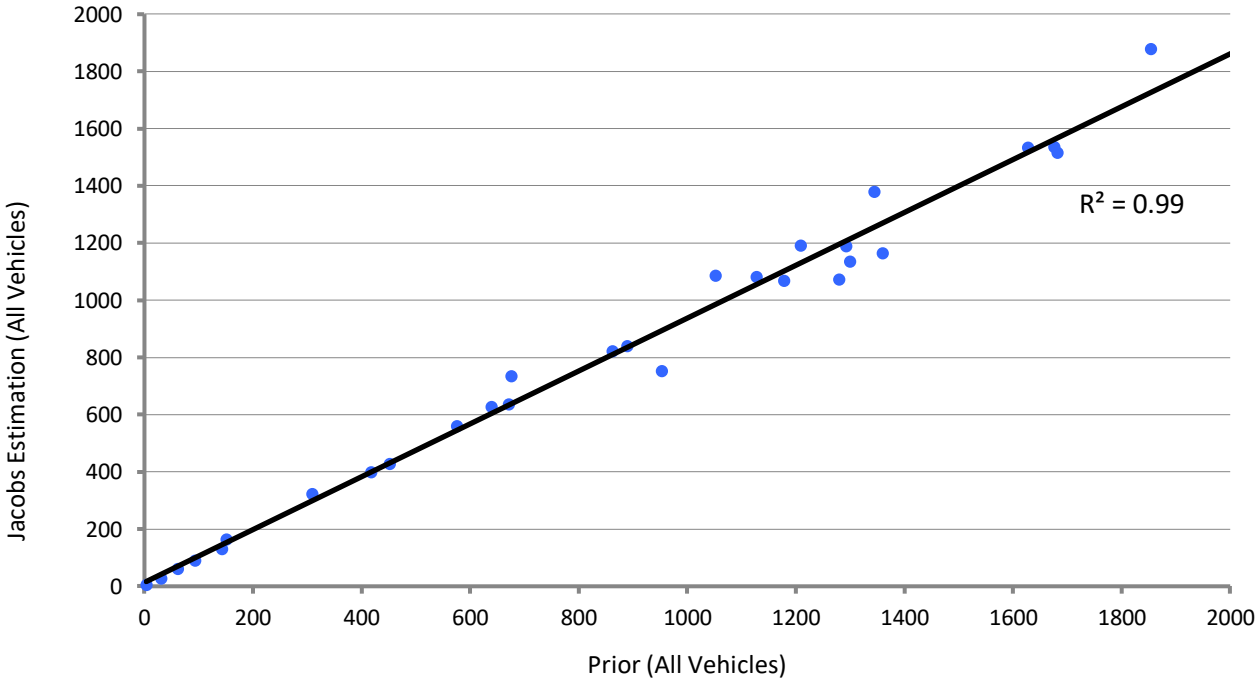

Figure 4-8: Comparison of pre and post-ME total demand (PM peak)

4.9.3 Change in trip length distribution

Figure 4-9 to Figure 4-11 illustrates the pre and post-estimation for All Vehicles trip length distributions; it shows that the matrix estimation process has maintained the existing trip length distribution across the AM and PM Peaks. The Inter Peak trip length distribution has an increase in the number of trips between 3km and 5km, with a reduction in the longer distance trips greater than 10kms. The RSIs used to validate the matrix were undertaken on the periphery of Inverness, and therefore observed longer distance trips. A similar issue occurred when the Inter Peak model was rebased in 2014, and as there was limited observed data was available to inform the prior matrices or adjust the trip length distribution, matrix estimation has added shorter distance trips into the matrix to meet to observed link count data.

WebTAG criteria states that the mean trip length distribution and the standard deviation of the trip length distribution should not change by more the 5% pre and post matrix estimation. The values for each peak and shown in Table 4-5, Table 4-6 and Table 4-7.

Table 4-5 Mean Trip Length Distribution and Standard Deviation Percentage Changes - AM Peak

	All Veh	Car	LGV	HGV
% Change in Mean Trip Length Distribution	-7%	-9%	1%	3%
% Change in Standard Deviation	-4%	-5%	9%	10%

Table 4-6 Mean Trip Length Distribution and Standard Deviation Percentage Changes - Inter Peak

	All Veh	Car	LGV	HGV
% Change in Mean Trip Length Distribution	-20%	-22%	31%	-34%
% Change in Standard Deviation	-11%	-13%	24%	-28%

Table 4-7 Mean Trip Length Distribution and Standard Deviation Percentage Changes - PM Peak

	All Veh	Car	LGV	HGV
% Change in Mean Trip Length Distribution	-2%	-6%	3%	-7%
% Change in Standard Deviation	-2%	-3%	11%	-15%

As shown in the tables above, for All Vehicles the percentage change in the mean trip length distribution and standard deviation is below, or close to, the 5% threshold in the AM and PM Peaks. The Inter Peak has a higher percentage change, and this is a function of Matrix Estimation inserting shorter distance trips as discussed above. Disaggregating this further into vehicles classes, generally a similar pattern is prevalent, where the percentage change of mean trip length is around 5% for the AM and PM Peak and the change in standard

deviation meets the 5% criterion for Cars and is slightly higher for LGV and HGVs, where there is less observed data available. As with All Vehicles, the Inter Peak values are higher than the other time periods, however Matrix Estimation was required to increase the number of trips significantly in the Inter Peak due to a lack of observed data being available, so this is somewhat expected.

Overall, the matrix estimation process has not significantly changed the size and shape of the matrices. The trip length distributions for the updated model closely match the prior and original model distributions and the results are therefore considered to be acceptable.

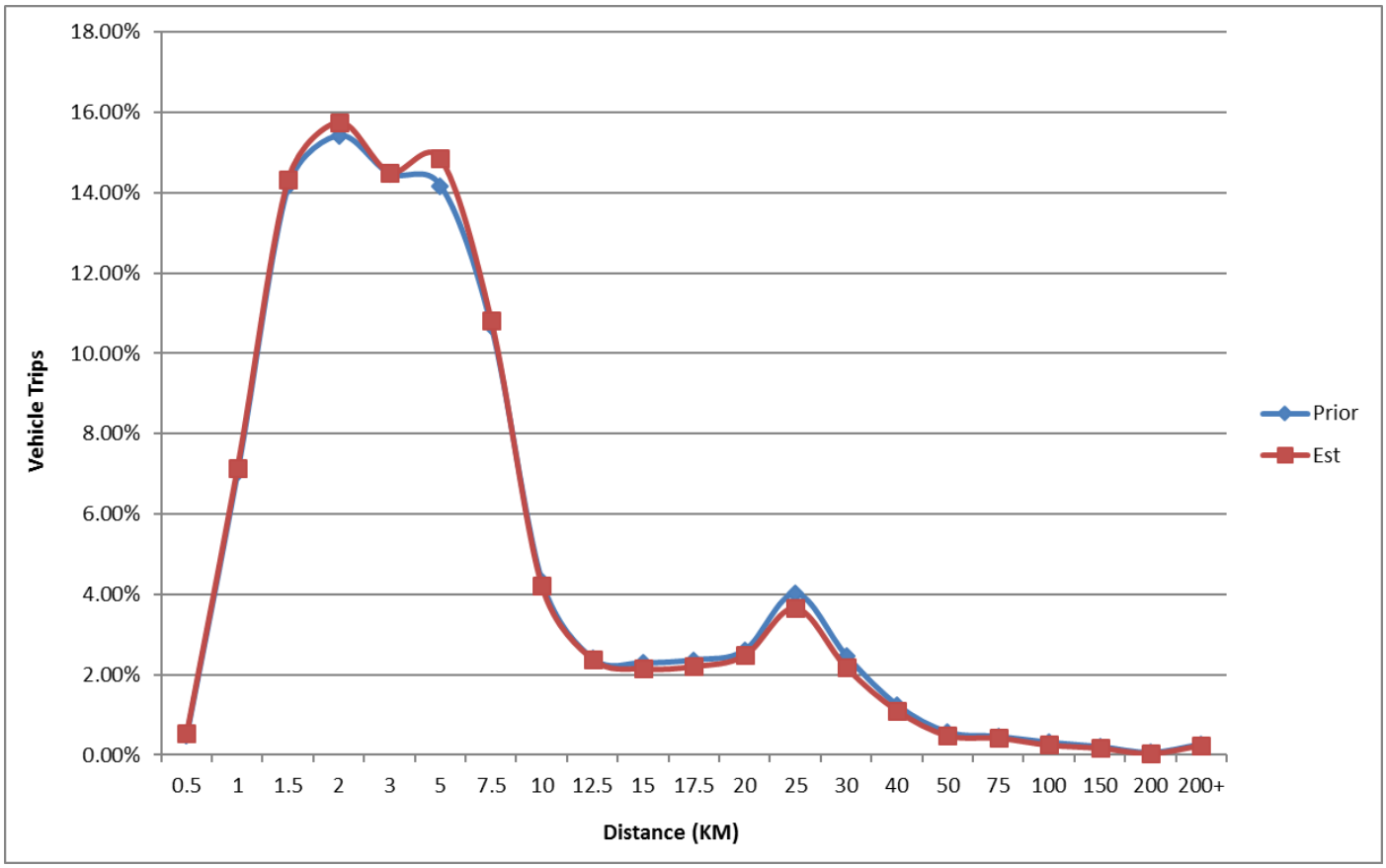

Figure 4-9: Comparison of pre and post-ME trip length distributions (AM peak, All Vehicles)

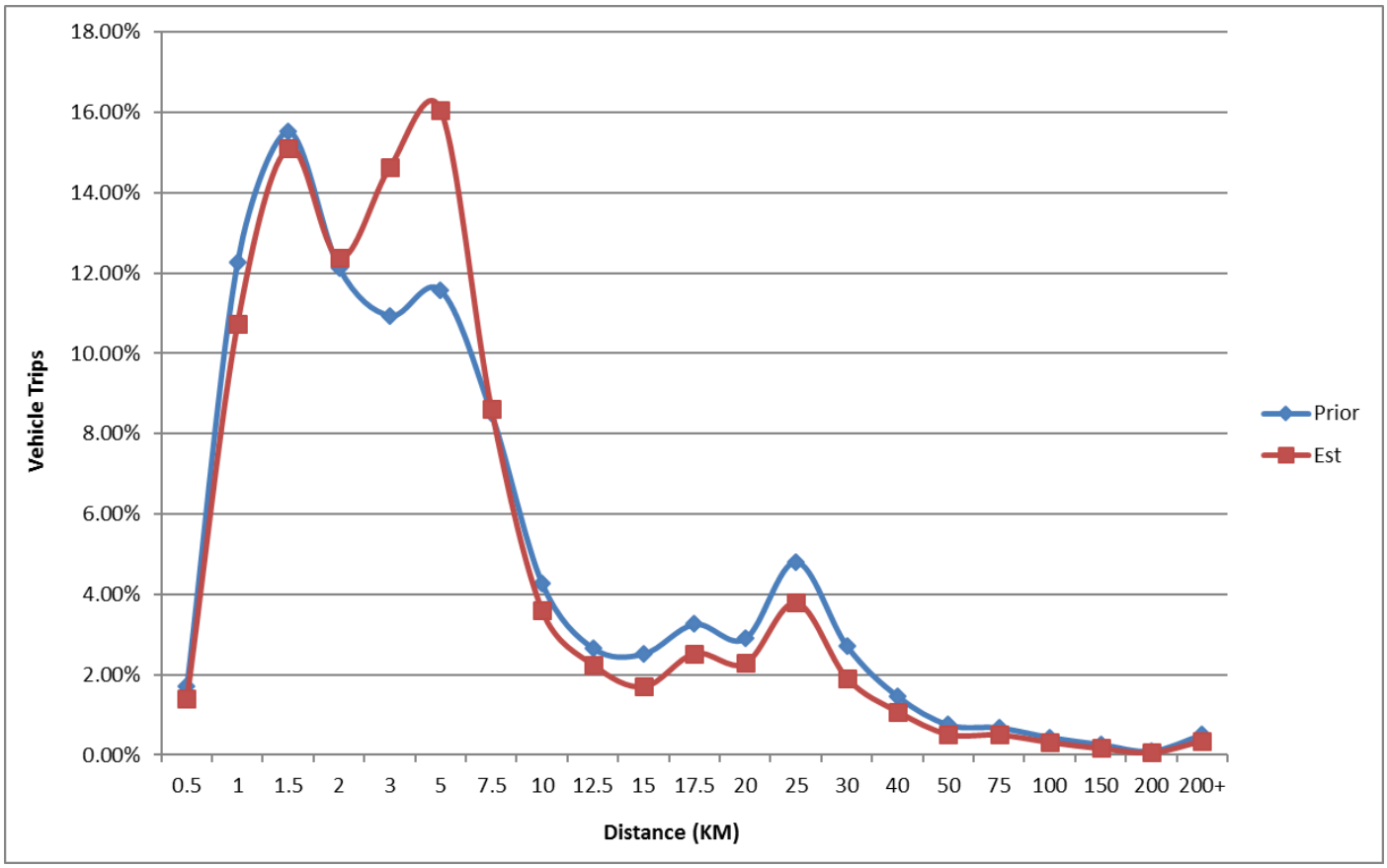

Figure 4-10: Comparison of pre and post-ME trip length distributions (Inter Peak, All Vehicles)

Figure 4-11: Comparison of pre- and post-ME trip length distributions (PM peak, All Vehicles)

4.10 Sectored matrices

4.10.1 Pre and post matrix estimation comparison

Figure 4-12 and Figure 4-13 illustrate the model sector system. A locational description of the sectors is included in Table 4-8.

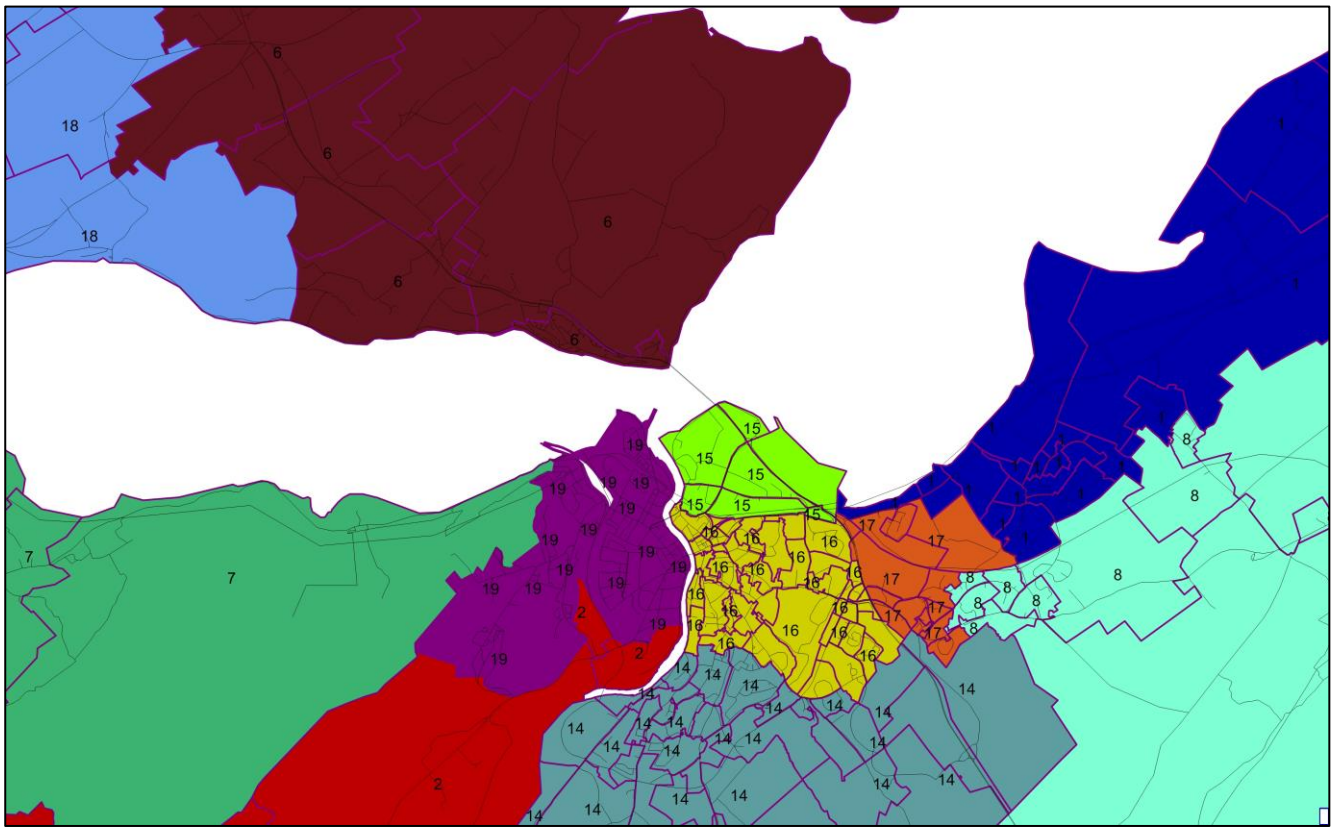

Figure 4-12 Sector system in the Inverness Area

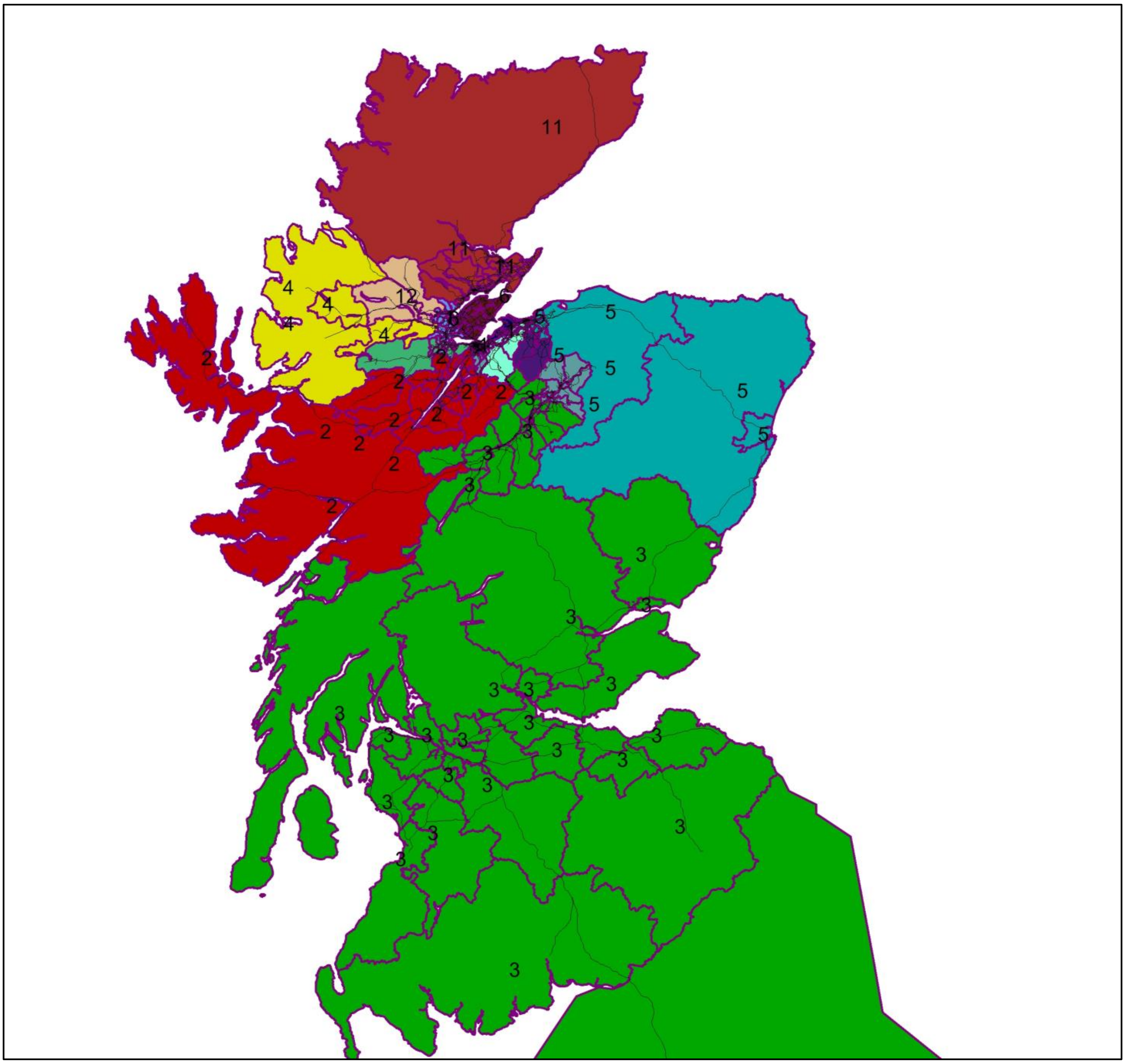

Figure 4-13 Sectors system across Scotland

Table 4-8: Sector locations

Zone	Location	Zone	Location
1	A96 corridor to Nairn	11	Far north of Scotland
2	South Highland	12	Loch Fannich & Luichart
3	Rest of Scotland & UK	13	Grantown-on-Spey & surrounding area
4	Central West Highland	14	Inverness south
5	North east Scotland	15	Inverness north
6	Eastern Black Isle	16	Inverness central
7	Central Highland	17	UHI & Seafield retail park
8	East of Westhill	18	Western Black Isle
9	Nairn & surrounding area	19	Inverness west
10	Inverness station car park		

The change in matrix sector to sector travel demand between pre and post matrix estimation is summarised by percentage change compared to the prior matrix for all traffic in Table 4-9, Table 5-11 and Table 5-13 for the AM Peak, Inter Peak and PM Peak periods respectively. WebTAG states in Table 5 of Unit 3.1[6] that the sector to sector differences should be within 5%. The comparison shows the majority of sectors change by more than 5% across all peaks, as shown by the red values in Table 4-9, Table 4-11 and Table 4-13 below, however the majority of these sector to sector movements show an absolute change less than 50 as shown in Table 4-10, Table 4-12 and Table 4-14. The sector to sector movements that have a larger absolute change than 50 vehicles are highlighted in yellow.

6 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/427124/webtag-tag-unit-m3-1-highway-assignment-modelling.pdf

Table 4-9: AM pre / post ME sector to sector Percentage Change – all vehicles

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	-11	-41	-13	79	-16	49	21	-6	-12	-58	14	97	-14	64	-30	-25	45	78	-38
2	4	-9	-13	-9	-26	-38	-12	8	-40	-21	-15	-30	-10	94	-7	15	-5	-17	-22
3	-10	-4	-8	-55	-8	-29	-23	-10	-11	23	-68	-59	-12	68	-5	8	69	-55	31
4	-28	-12	-22	-15	-34	0	-10	-45	-38	-14	-9	-20	-21	53	-32	-3	-21	-9	-11
5	-18	20	-9	79	-7	37	1	-7	-8	-62	17	80	-8	21	-24	-32	8	87	-28
6	-19	-14	-32	15	-54	-9	-4	-22	-50	-21	-7	-10	-30	30	-24	-15	-27	8	-19
7	-28	-31	64	-6	-53	-11	-8	41	-58	-9	-8	-2	19	-19	-22	-10	1	-6	-5
8	5	-3	-10	-7	-6	-9	-38	14	-7	-22	-37	-37	-2	37	-34	-20	18	-39	-4
9	-14	-27	-11	81	-8	32	-6	-10	-8	-62	12	81	-8	22	-35	-36	4	55	-35
10	32	-17	265	0	29	5	0	265	29	-8	4	0	265	35	-25	62	238	24	-11
11	-51	-16	-45	-10	-63	-12	-5	-42	-64	-39	-8	-22	-52	15	-40	-29	-22	-8	-35
12	17	-21	15	-22	-23	3	-9	-8	-47	-8	-7	-21	0	59	2	51	-16	-6	-22
13	55	0	-10	-57	-9	9	35	34	-7	26	-70	0	-11	102	4	-1	11	-62	31
14	-10	36	-43	-57	-21	-33	-20	-15	-22	-7	-70	-62	-57	9	-17	3	-14	-54	-5
15	11	71	31	24	-40	37	6	39	-23	191	-41	5	24	232	-10	177	126	-32	147
16	-15	37	-10	134	-35	-12	9	31	-38	-6	-39	17	-2	22	-5	8	13	-12	5
17	79	27	-2	-11	2	-57	37	-5	37	18	-55	-52	-15	156	-13	16	29	-32	35
18	-28	-11	-24	-7	-50	-4	-1	-8	-48	-13	-6	-10	-27	-21	-17	-6	-22	-8	-4
19	-32	-39	-12	3	-49	-2	-9	22	-56	-9	-67	-51	196	0	-23	-17	1	-21	-15

Table 4-10: AM pre / post ME sector to sector Absolute Change – all vehicles

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	-25	-12	-4	3	-6	8	1	-2	-4	-2	7	6	-1	32	**-88**	**-100**	**125**	30	-48
2	1	-21	-16	-4	-7	-5	-3	1	-5	0	-16	-3	0	34	-13	36	-2	-9	-26
3	-6	-3	**-74**	-9	-12	-2	-2	-2	-1	0	**-70**	-1	-11	11	-4	10	20	-16	12
4	-2	-5	-5	-3	-4	0	-1	-2	-1	0	-4	-4	-1	1	-9	-1	-1	-4	-2
5	-11	6	-15	2	-5	2	0	-1	-11	-1	6	0	-2	2	-34	-47	3	17	-13
6	-8	-5	-10	1	-14	-18	-1	-2	-4	0	-8	0	0	7	-42	-44	-11	11	-21
7	-4	-10	7	0	-4	-1	-5	2	-2	0	-4	0	0	-4	-15	-13	0	-6	-4
8	6	-1	-3	0	-3	-1	-3	16	-3	-1	-13	-1	0	15	**-70**	**-76**	14	-16	-5
9	-9	-6	-3	4	-10	1	0	-3	-43	-1	4	0	0	4	-39	-47	2	7	-17
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
11	-18	-16	**-57**	-3	-50	-6	-1	-7	-8	-1	**-152**	-1	-4	3	**-82**	**-58**	-10	-29	-40
12	1	-1	1	-3	0	0	0	0	0	0	-1	-5	0	0	0	5	0	-2	-1
13	2	0	-11	-7	-4	0	0	0	-1	0	-9	0	-33	2	1	0	0	-2	4
14	-7	21	-22	-4	-6	-6	-2	-3	-4	0	-44	0	-3	19	**-56**	20	-21	-34	-12
15	13	35	10	12	-30	5	0	5	-6	1	**-74**	0	2	37	-10	**156**	49	-27	**78**
16	-25	**50**	-6	10	-20	-4	2	19	-15	0	-43	0	0	23	-19	**81**	38	-9	13
17	**56**	3	0	0	1	-1	1	-2	3	0	-7	0	0	22	-11	20	34	-3	17
18	-7	-7	-8	-2	-12	-2	-1	-1	-4	0	-14	-2	-1	-14	-41	-15	-11	**-70**	-5
19	-23	-45	-6	0	-18	-1	-2	6	-9	-1	**-58**	-2	8	0	**-96**	**-116**	1	-19	**-80**

From Table 4-9 there are a number of internal sector movements that have between an 8% and 15% change when compared to the prior matrix. Sector 3, 11 and 18 are outwith the area of interest and area where detailed count information was included for matrix estimation, as these represent the Rest of Scotland south of Inverness, the North of Scotland, and the western Black Isle areas respectively, and as such the changes to internal sector to sector movements within these sectors are not of particular concern. Sector 19 (Inverness West) is situated in Inverness to the west of the River Ness and whilst within the study area, the count data controlling the matrix estimation was not focused on this area and it is not anticipated that the model will be used to test any schemes within the sector, therefore an internal sector change of 80 vehicles (15%) is deemed inconsequential.

Sector 16 is situated in Southern Inverness with a number of control counts in the area. This intra sector change within this sector is marginally higher than the acceptable 5% level of change stated in the guidance however, an increase of an additional 3% represents less than 30 vehicles in a sector that contains a large number of housing, employment and retail facilities, and as such is considered acceptable.

There is a significant increase in the number of trips travelling from Sector 15 (Inverness North) to Sector 16 (Inverness Central), with an increase 156 vehicles (177%) following the Matrix Estimation process. This is the largest change in both absolute values and percentage change in the AM Peak. This sector to sector movement is within the RSI cordon so would not be observed by the surveys. As mentioned in Section 5.2, the Car Commute matrix is the only matrix that has been updated with revised observed data obtained via the 2011 Census Travel to Work data, and this user class shows only a slight increase in the level of trips, at approximately 35 vehicles. Due to a lack of data for the other four journey purpose matrices, the matrices have had growth applied to them, however the origin and destination pattern remained the same as the original base model developed in 2009. The RSI information that informed the original matrix development did not capture the movements between these two sectors, and therefore is less robust than other areas of the 2018 prior matrix that have been validated by observed data. As such, the growth between these two sectors is considered acceptable as this is predominantly increasing trips on the local road network to match count data, in a sector to sector movement that has not been validated by observed data.

The remaining changes of note are between Sector 1 (A96 Corridor) and Sectors 15 (Inverness North), 16 (Inverness Central) and 17 (UHI and Seafield Retail Park). Trips originating in Sector 1 and travelling to Sectors 15 and 16 have been reduced by matrix estimation, whilst the number of journeys travelling to Sector 17 have increased. The increase in the number of trips travelling to Sector 17 is most likely due the development of the UHI campus, which has occurred since the 2009 model was originally developed. This may be attracting some trips that would have previously been travelling to the centre of Inverness, particularly Sector 15, where the UHI Campus was originally located. The changes between these sectors have therefore been deemed acceptable due to the change in land use and development that has occurred since the majority of the matrices were developed.

Generally, the pattern of the remaining significant changes shows a reduction of sector to sector trips, which is consistent with what has been mentioned earlier in this report, where by the Car Commute prior matrix was considered to be slightly higher than required.

Table 4-11: IP pre / post ME sector to sector Percentage Change – all vehicles

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	27	47	16	-36	-18	4	-52	73	-13	-67	-26	-45	5	-11	-47	-42	40	-32	20
2	-41	26	8	6	-3	-30	12	13	-18	-5	0	33	13	190	76	48	26	-6	44
3	-2	0	15	-66	18	-57	-20	10	14	59	-59	-72	19	29	1	13	-21	-50	130
4	-44	6	-51	18	-51	21	12	-6	-48	-27	20	18	-61	-33	25	29	-29	13	44
5	1	17	18	-21	19	-23	-43	23	13	-64	-32	-40	12	77	-23	-14	9	-31	-19
6	-56	-6	-57	13	-62	20	0	-52	-56	-37	16	37	-72	-19	8	-30	-34	26	-30
7	-48	8	27	24	-31	0	27	26	-47	147	2	80	47	50	109	77	43	14	16
8	121	-6	14	-52	25	-41	-39	53	18	-41	-45	-70	12	132	4	55	18	-57	60
9	-1	37	13	-40	15	-48	-27	36	20	-47	-36	19	9	49	25	-30	23	-10	11
10	102	-4	5	0	5	-15	0	286	755	399	-32	0	291	465	8	147	279	166	28
11	-62	7	-67	35	-70	9	-1	-59	-70	-5	22	31	-71	-11	-20	-16	-10	13	-23
12	-55	0	-61	38	-59	62	18	-61	-59	162	20	33	0	19	-9	-3	-35	15	27
13	18	20	15	-72	12	-76	111	19	4	-21	-67	79	21	71	-59	-12	-26	-73	49
14	-8	116	-33	-56	12	-60	77	75	-42	12	-38	-52	-18	44	104	200	107	-48	94
15	8	165	44	65	22	-34	72	11	-18	6	-28	101	72	247	79	113	172	-15	146
16	-24	96	17	-17	-12	-21	131	84	-21	43	7	-2	29	169	97	52	67	-14	142
17	265	16	15	85	22	27	40	137	43	-36	-15	-14	-45	65	18	11	9	46	44
18	-48	9	-52	16	-54	31	20	-57	-63	35	13	30	-62	37	19	-8	-44	26	12
19	-37	11	16	-53	-52	-63	23	36	-41	24	-55	-63	-4	108	133	168	82	-33	34

Table 4-12: IP pre / post ME sector to sector Absolute Change – all vehicles

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	**76**	10	9	-1	-5	1	-4	17	-6	-1	-7	0	1	-4	-38	**-124**	**54**	-9	8
2	-14	**55**	6	1	-1	-10	2	2	-2	0	0	3	0	35	44	**76**	9	-3	21
3	-1	0	**199**	-13	14	-10	-2	2	6	0	-35	-2	10	5	0	18	-8	-14	38
4	-3	1	-14	2	-5	2	1	0	-1	0	3	1	-1	-1	9	6	-1	5	6
5	0	6	13	-1	13	-3	-1	3	11	0	-12	0	2	6	-9	-18	2	-4	-5
6	-14	-3	-13	1	-11	**54**	0	-13	-4	0	13	0	-2	-4	6	**-50**	-9	11	-15
7	-6	1	5	3	-2	0	29	2	-2	0	0	1	0	6	31	**65**	6	10	5
8	43	-1	4	-2	6	-9	-4	**84**	3	0	-8	0	0	29	2	**100**	10	-10	26
9	0	7	6	0	16	-3	-1	5	**91**	0	-5	0	1	4	12	-27	16	-1	2
10	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2	8	0	0
11	-17	3	**-60**	7	-32	5	0	-7	-11	0	**267**	5	-5	-2	-21	-22	-3	31	-14
12	-1	0	-2	4	0	1	0	0	0	0	4	10	0	0	0	0	0	3	0
13	1	1	9	-1	3	-1	0	0	0	0	-3	0	**58**	2	-6	-3	-1	-1	2
14	-5	29	-12	-1	2	-27	6	22	-6	0	-11	0	-1	**165**	**56**	**354**	48	-14	**61**
15	7	**60**	24	13	12	-16	14	2	-5	0	-16	14	9	**61**	**289**	**174**	**65**	-7	**107**
16	**-72**	**95**	26	-3	-10	-20	**77**	**125**	-13	1	6	0	4	**114**	**136**	**671**	**63**	-12	**170**
17	**89**	2	6	0	18	7	23	**91**	2	0	-1	0	0	25	2	6	15	**52**	17
18	-11	4	-16	5	-13	8	14	-7	-4	0	24	5	-1	7	13	-11	-8	**174**	7
19	-25	6	7	-3	-12	-16	8	13	-5	1	-26	0	0	37	**141**	**344**	**53**	-14	**272**

Table 4-11 shows that, whilst the percentage change is above the threshold set in WebTAG, the majority of the changes are less the 50 vehicles. The Inter Peak matrix has the most significant changes of all three peak periods when compared to the prior matrix, however a large proportion of the differences are intra sector movements, and the remaining changes that are over 50 vehicles show a similar pattern to a combination of the AM and PM peak changes.

As in the AM Peak, the vast majority of the intra sector movements are outwith the core area of the schemes that this model will be used to assess. Sectors 14, 15, and 16 lie within the core area and are being controlled by the count data as part of matrix estimation.

As there was a lack of observed data for the main Inter Peak journey purposes, the prior matrices were taken from the 2009 base model, and growth was applied to increase the matrix values to a 2018 level. Whilst some changes were made to the prior matrices to take account of land use changes, matrix estimation had to add additional trips into the matrix to bring the matrix values to the level required to meet the count data. As the majority of the count information is located within Sectors 14,15 and 16, matrix estimation has increased the number of trips traveling to, from and within these sectors, which explains why there is a significant change in the number of trips travelling between sectors 14, 15 and 16. Overall, it is felt that the changes to the matrix are acceptable as the traffic volumes within the vicinity of the schemes that this model will be used for are generally correct.

Table 4-13: PM pre / post ME sector to sector Percentage Change – all vehicles

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	-7	-5	23	2	-27	2	-24	-7	-20	-7	-4	48	74	-11	-34	-13	15	0	-21
2	-24	-11	-6	-18	-19	-23	0	22	8	-27	-9	-13	-7	74	139	25	18	-3	-22
3	35	-4	-9	-30	-8	-27	38	38	-10	89	-35	-23	-9	-8	5	18	-15	-29	-22
4	-28	-38	-12	-4	-24	14	11	-24	-47	0	-9	-9	-1	-8	64	55	-53	13	25
5	-2	16	-7	7	-9	-5	-25	-3	-7	-4	-13	-1	-6	-9	-23	-11	23	-5	-11
6	-19	-30	-4	-9	-44	-9	-11	-28	-47	78	-5	-9	13	-2	10	19	-42	-9	6
7	-9	-15	-20	30	42	4	-9	-27	2	0	-3	-9	-6	10	-2	60	4	4	-7
8	14	-3	7	-54	1	-27	-21	0	-22	160	-46	-54	34	-16	-23	-2	49	-35	-10
9	-7	55	-8	-28	-7	-1	-26	-11	-10	-4	-17	-8	-5	14	57	-14	15	-9	-11
10	11	-9	20	-28	-26	-29	-9	-5	-24	-9	-37	-28	20	-1	-6	-10	-42	-27	-10
11	-9	-3	-19	-8	-33	-2	4	-35	-37	102	-9	7	-17	-11	12	23	-24	-2	-7
12	-20	-9	-24	-9	-49	19	24	10	-47	0	-9	-9	0	-10	-9	14	-52	-3	-18
13	26	-4	-9	0	-7	-33	7	32	-9	160	-34	0	-8	-10	-51	159	17	-33	100
14	-15	4	-9	-7	-26	-26	55	-13	-28	-13	-32	-16	-22	10	20	11	-5	-30	6
15	-6	-2	10	32	-23	13	-28	-24	-42	20	2	7	103	-25	-5	6	-36	12	-32
16	-18	16	-3	-26	-40	-15	1	-26	-30	18	-31	-21	-21	5	13	2	-31	-21	-1
17	26	17	63	-18	-22	-32	-27	3	-11	75	28	-31	33	23	-15	7	-12	-20	6
18	-19	-9	-18	-9	-30	-9	-2	-16	-25	78	-3	3	-24	-8	29	1	-49	-9	2
19	-2	-38	-7	-26	-26	-25	-3	-19	-19	-14	-40	-30	5	-4	3	22	-5	-27	-11

Table 4-14: PM pre / post ME sector to sector Absolute Change – all vehicles

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	-15	-2	18	0	-17	1	-5	-7	-15	0	-2	2	3	-12	-10	-34	11	0	-22
2	-13	-23	-5	-1	-8	-10	0	7	3	0	-8	-1	0	**54**	29	35	2	-1	-27
3	17	-4	**-79**	-5	-11	-8	3	9	-4	0	-32	-2	-8	-3	1	10	-3	-10	-11
4	-1	-2	-1	0	-1	1	0	-3	-1	0	-1	-1	0	0	8	6	0	5	3
5	-1	4	-8	0	-7	-2	-2	-1	-10	0	-6	0	-2	-3	-7	-8	17	-1	-5
6	-4	-7	0	-1	-5	-17	-1	-5	-1	0	-6	0	0	0	1	17	-3	-6	3
7	0	-3	-1	2	2	1	-4	-1	0	0	-1	0	0	1	0	16	0	4	-1
8	5	-1	1	-1	0	-3	-1	0	-6	0	-9	0	0	-5	-6	-3	33	-16	-4
9	-2	6	-1	0	-8	0	-1	-3	-49	0	-2	0	0	2	12	-6	7	0	-2
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-2	0	-1
11	-4	-2	-17	-1	-16	-2	2	-7	-7	0	**-134**	1	-1	-5	5	30	-4	-8	-6
12	-1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	-1	0
13	1	0	-8	0	-2	0	0	2	0	0	-1	0	-23	0	-1	8	0	0	3
14	-35	1	-1	0	-4	-5	15	-7	-6	0	-6	0	0	21	6	21	-3	-24	11
15	-14	-3	6	4	-19	18	-13	-30	-31	0	3	0	8	**-64**	-5	21	**-104**	21	**-110**
16	**-99**	37	-4	-6	**-75**	-46	2	**-96**	**-54**	0	**-62**	-2	-3	29	16	17	**-107**	**-66**	-5
17	9	2	13	0	-11	-4	-3	7	-6	0	9	0	0	26	-8	20	-28	-4	10
18	-8	-6	-6	-2	-7	-10	-3	-4	-4	0	-15	1	0	-5	16	1	-12	**-69**	2
19	-2	-44	-3	-2	-12	-27	-2	-27	-15	0	-39	-1	0	-10	3	**85**	-3	-35	**-65**

Table 4-13 shows that, whilst based on a percentage change a large number of sector to sector movements are above the threshold set in WebTAG, the majority of the changes are less the 50 vehicles, and therefore, generally the PM Peak estimated matrix compares well with the prior. As in the AM Peak, the intra sector movements at Sectors 3, 11, 18 and 19 are not of major concern as these are outwith the area of influence of the model.

The majority of the significant changes are originating from Sector 16, and these are all showing a reduction when compared to the prior matrix. This sector has significantly more origin trips in the PM Peak than any other sector in the prior matrix, mainly due to the large employment areas around Raigmore Hospital. As a result, Matrix Estimation has removed a larger number of trips from this sector, compared to the others when reducing the overall matrix totals to meet the observed count information. The total number of trips originating in Sector 16 remains a similar proportion of the total matrix pre and post estimation and this is therefore deemed acceptable.

The other sector to sector movements of note are Sector 15 (Inverness North) to Sector 17 (UHI and Seafield Retail Park), and to Sector 19 (Inverness West), which have a change of 104 and 110 vehicles respectively. The majority of the reduction in trips travelling between Sector 15 and 17 are Car Other trips. As mentioned previously this matrix was not updated with new observed data, there is therefore less confidence in the trip patterns of this matrix. Of the trips originating from Sector 15, trips to Sector 17 reduces from 11% to 8%, which remains a significant percentage of trips from this sector. It is believed that this change is acceptable as the level of trips making this movement post estimation continues to be significant. There is a similar reduction in trips travelling between Sector 15 and Sector 19, where a 3% reduction also occurs. Similarly, there remains a significant number of trips travelling between both of these sectors, and this change has therefore been deemed acceptable.

4.11 Summary

The examination that was conducted on the matrix estimation process outputs shows that in terms of the R^2 analysis there is a high level of calibration across each model period. Similarly, the trip length distribution plots show no significant change between pre and post matrix estimation matrices for the AM and PM peak, and a slight, acceptable change in the Inter Peak.

The sector to sector percentage and absolute change analysis shows that matrix estimation has not significantly adjusted the size and ‘shape’ of each prior matrix, with the AM and PM peak period matrices showing a good level of consistency pre and post estimation. The Inter Peak matrix shows slightly larger changes however this is deemed acceptable due to the lack of data available to alter the original 2009 prior matrices.

As a result, it was considered that the post matrix estimation matrices were appropriate and suitable for use in the updated model as the Base traffic matrices, particularly considering the areas where the proposed schemes are to be tested using this model are located. Care should be taken outwith this area, as the model calibration is primarily focused on Inverness area and the key routes approaching Inverness, including the A9, A82, A96, Millburn Road, Harbour Road, Culloden Road and Tower Road.

5. Assignment model development

5.1 Highway assignment

Highway demand is assigned to the network using the Assignment with ICA method, consistent with the 2014 model. Assignment with ICA is an extension of the Equilibrium Lohse method, including junction delay. In order to maintain consistency, all parameters are unchanged compared with the earlier model.

Generally, the Lohse Equilibrium (Assignment with ICA) procedure:

- provides a stable assignment;
- allows easier interpretation of the impact of network changes; and
- has a faster assignment time to the stochastic procedure.

5.2 Public transport assignment

The public transport is Headway based (without crowding), again, using parameters from the previous 2009 and 2014 models.

5.3 Generalised costs

The impedance parameters given in Table 5-1, Table 5-2 and Table 5-3 were updated during the development of the base model in line with WebTAG[7].

Table 5-1: Impedance Parameters – AM Peak

	Car Commute	Car In Work	Car Non Work	LGV	HGV
Tcur Coefficient (a)	3.434	5.121	2.37	3.536	3.674
Distance Coefficient (b)	0.092	0.121	0.092	0.127	0.633

Table 5-2: Impedance Parameters – Inter Peak

	Car Commute	Car In Work	Car Non Work	LGV	HGV
Tcur Coefficient (a)	3.434	5.121	2.369	3.536	3.674
Distance Coefficient (b)	0.089	0.113	0.088	0.121	0.580

[7] WebTAG Databook December 2017 v1.9

Table 5-3: Impedance Parameters – PM Peak

	Car Commute	Car In Work	Car Non Work	LGV	HGV
Tcur Coefficient (a)	3.446	5.195	2.481	3.536	3.674
Distance Coefficient (b)	0.092	0.1220	0.092	0.127	0.636

5.4 Vehicle operating costs

Vehicle operating costs represent the additional costs of using a private vehicle, including fuel costs, depreciation and wear-and-tear. They are calculated for each link and are used to generate private vehicle costs for the demand (synthetic) model.

Vehicle operating costs have been previously calculated according to WebTAG[8] guidance; they correctly omit non fuel costs for non-work purposes.

Table 5-4 : Vehicle Operating Costs

Fuel costs 2018	**A**	**B**	**C**	**d**
Average Car	74.708	5.223	-0.035	0.0004
Non fuel costs 2018	**A1**	**B1**		
Average Car	3.965	16.394		
Combined costs 2018	**A + B1**	**A1 + B**	**C**	**D**
Average Car	91.102	9.188	-0.035	0.0004

5.5 Model assignment / convergence parameters and statistics

The VISUM model assignment and convergence parameters adopted during the original base model development have been used for the highway assignment. The MFTM Development[9] report states that the ICA assignment process was used, and has the requirements for two levels of convergence:

- Convergence of each highway assignment; and
- Convergence between highway assignments for the ICA calculations.

Though DMRB states that the value of duality gap should be less than 1%, values of typically less than 0.1% are preferred, and would be necessary to develop information for the economic appraisal.

[8] WebTAG Unit 1.3
[9] AECOM, Moray Firth Transport Model Development Report (Section 7.4.9), September 2010

The level of convergence between highway assignments is determined using the following three criteria:

- The turn volumes from the last assignment are close to those from the previous assignment;
- The turn volumes of the last assignment match closely the last smoothed volumes (input to ICA); and
- The final delays of the assignment and those obtained from running ICA are close, i.e., ICA produces delays that are consistent with the assignment result."

The MFTM assignment is deemed to be converged when it meets five criteria. These are:

- GEH between link flows in the previous assignment and current assignment is less than 1 for 95% of all links;
- GEH between turning flows in the previous assignment and current assignment is less than 1 for 99% of all turns;
- GEH between turning flows in current assignment and smoothed ICA turning volumes is less than 1 for 99% of all turns;
- Relative gap between Blocking Back wait time and the Volume Delay Function wait time on links is less than 0.05 for 90% of all links; and
- Relative gap between Blocking Back wait time and Volume Delay Function wait time at turns is less than 0.05 for 99% of all turns.

AM, IP and PM peak models converged after 6, 5 and 16 iterations, respectively. Convergence statistics for the last five iterations in each period are summarised in Appendix D.

6. Road model calibration

6.1 Introduction

The road model vehicle flows have been calibrated across a series of link counts as identified in Figure 4-1, Figure 4-2, and Figure 4-3. In accordance with WebTAG, calibration (and validation) flows are summarised for the peak hour within each model period.

6.2 GEH statistics

Calibration comparisons have been based on GEH statistics which is useful in comparing two different values of flow on a link. The GEH statistic is defined as:

$$\sqrt{\frac{(\text{modelled} - \text{observed})^2}{(0.5\ (\text{observed} + \text{modelled}))}}$$

The reason for introducing such a statistic is the inability of either the absolute difference or the relative difference to cope over a wide range of flows. For example, an absolute difference of 100 pcu/h may be considered a big difference if the flows are of the order of 100 pcu/h, but would be less important for flows of the order of several thousand pcu/h. Equally a 10% error in 100 pcu/h would not be important, whereas a 10% error in, say, 3000 pcu/h might mean the difference between building an extra lane or not.

6.3 WebTAG criteria

WebTAG criteria are strictly validation criteria, however, they have been used to assess the quality of both the model calibration and validation.

When comparing assigned and observed volumes, a GEH parameter of 5 or less would indicate an acceptable fit while links with GEH parameters greater than 10 require closer attention.

The difference statistic is also used; an assignment is assumed to be satisfactory where observed and modelled flows are within:

- 15% for flows between 700 – 2700vph;
- 100vph for flows < 700vph; or
- 400vph for flows > 2,700vph.

6.4 Individual count sites

A summary of the number of individual count sites meeting guidelines is given in Table 7.1.

Table 6-1: Number of highway calibration screenline sites passing WebTAG criteria

Peak	Difference No. Passes	Difference Pass Rate (%)	GEH no Passes <5	GEH <5 (%)	GEH No. passes <10	GEH <10 (%)
AM Peak	88	90%	90	92%	97	99%
Inter Peak	89	89%	91	91%	100	100%
PM Peak	89	89%	92	92%	100	100%

Overall, the model shows a good level of calibration; approximately 92% of the calibration sites meet the WebTAG (GEH<5) while all sites have a GEH<10, with the exception of 1 in the AM Peak. A full list of sites is included as Appendix D.

7. Road Model Validation

Highway model vehicle flows have been validated across a series of screenlines, as follows:

- Screenline 1 – A96 west of Smithton Junction to Culloden Road;
- Screenline 2 – A82 to Telford Street;
- Screenline 3 – A82 Kenneth Street to Old Perth Road; and
- Screenline 4 – A82 Longman Road to Culcabock Road.

All screenlines have been defined specifically to inform the validation in and around Inverness (Figure 6.1). In accordance with WebTAG validation screenline flows are summarised for a peak hour within each model period.

The model has also been validated against observed journey times and highway assignment paths have also been reviewed to ensure routings are appropriate.

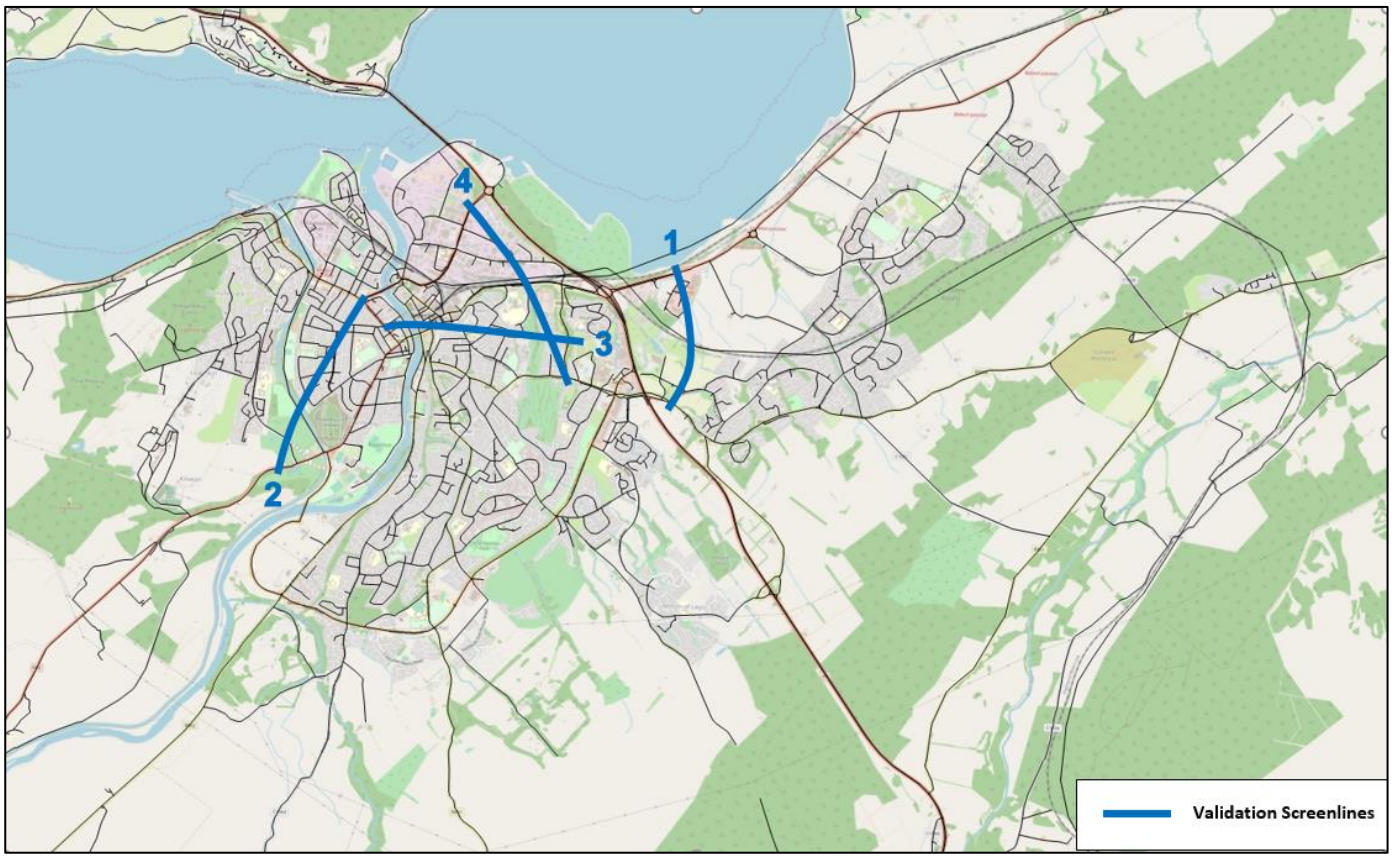

Figure 7-1 Location of the highway validation screenlines in Inverness

7.1 Highway Validation Screenlines

The WebTAG criteria for screenline validation states that the total screenline flow should be within 5% of the observed data in most cases. Previously, the guidance states that the screenline flows should have a GEH of less than 4, and whilst this has been removed from the guidance, it has been retained in the below analysis as it helps to show a goodness of fit.

Figure 7-1 to Table 7-4 show the screenline results for the AM Peak. In most instance the percentage change is higher than 5%, however the flow crossing the screenline is relatively low in some instances, and the absolute difference also therefore relatively low. The GEH of 5 of the 8 screenlines are less the 4, with 2 of the remining screenlines having a GEH of less than 4.5. The final screenline has a GEH of just above 5.

Screenline 1 is above the recommended GEH of 4 in the westbound direction due to the traffic flow on the A96. As this is a strategic model, it does not have the level of detail to represent the dynamic nature of the build-up and dissipation of queues. As such the model may not be representing the behaviour of drivers as they approach the back of the queue at Raigmore Interchange, which would reduce the capacity of the A96 at this location. As a result, the level of traffic in the model travelling on this link, may be higher than observed as the model is not reflecting the slower moving traffic approaching Raigmore Interchange. Overall, the screenlines in the AM peak generally correlates with the observed data in the AM Peak.

Table 7-1 Validation screenline 1 by count site: AM

Screenline	Total	Obs	Mod	Diff	% diff	GEH
A96 west of Seafield	Westbound	1624	1851	227	14%	5.45
A96 west of Seafield	Eastbound	1086	1181	95	9%	2.82
Culloden Road	Westbound	667	696	29	4%	1.11
Culloden Road	Eastbound	426	275	-151	-35%	8.07
Total	**Westbound**	**2291**	**2547**	**256**	**11%**	**5.21**
Total	**Eastbound**	**1512**	**1456**	**-56**	**-4%**	**1.45**

Table 7-2 Validation screenline 2 by count site: AM

Screenline	Total	Obs	Mod	Diff	% diff	GEH
A82	Westbound	282	297	15	5%	0.88
A82	Eastbound	247	351	104	42%	6.03
Telford Street	Westbound	581	494	-87	-15%	3.75
Telford Street	Eastbound	775	816	41	5%	1.45
Total	**Westbound**	**863**	**791**	**-72**	**-8%**	**2.50**
Total	**Eastbound**	**1022**	**1167**	**145**	**14%**	**4.39**

Table 7-3 Validation screenline 3 by count site: AM

Screenline	Total	Obs	Mod	Diff	% diff	GEH
A82 Kenneth Street	Northbound	498	405	-93	-19%	4.38
A82 Kenneth Street	Southbound	450	436	-14	-3%	0.67
Bank Street	Northbound	421	515	94	22%	4.35
Bank Street	Southbound	348	265	-83	-24%	4.74
Old Perth Road	Northbound	355	404	49	14%	2.52
Old Perth Road	Southbound	469	596	127	27%	5.52
Total	**Northbound**	**1274**	**1324**	**50**	**4%**	**1.39**
Total	**Southbound**	**1267**	**1297**	**30**	**2%**	**0.85**

Table 7-4 Validation screenline 4 by count site: AM

Screenline	Total	Obs	Mod	Diff	% diff	GEH
A82 Longman Road	Westbound	1415	1382	-33	-2%	0.89
A82 Longman Road	Eastbound	901	838	-63	-7%	2.15
Harbour Road	Westbound	489	379	-110	-22%	5.26
Harbour Road	Eastbound	591	472	-119	-20%	5.15
Millburn Road	Westbound	527	567	40	8%	1.72
Millburn Road	Eastbound	315	209	-106	-34%	6.56
Culcabock Road	Westbound	393	475	82	21%	3.93
Culcabock Road	Eastbound	640	712	72	11%	2.77
Total	**Westbound**	**2824**	**2803**	**-21**	**-1%**	**0.39**
Total	**Eastbound**	**2447**	**2231**	**-216**	**-9%**	**4.47**

Table 7-5 to Table 7-8 show the screenline results for the Inter Peak. In most instance the percentage change is higher than 5%, however most are less than 10%. As with the AM Peak, the flow crossing the screenlines are relatively low in most instances, and the absolute difference are therefore also relatively low. The GEH of 7 of the 8 screenlines are less the 4, which indicates a good level of correlation between the observed and modelled data. Therefore, it has been deemed that the Inter Peak validation is acceptable.

Table 7-5 Validation screenline 1 by count site: IP

Screenline	Total	Obs	Mod	Diff	% diff	GEH
A96 west of Seafield	Westbound	1261	1443	182	14%	4.95
A96 west of Seafield	Eastbound	1294	1319	25	2%	0.70
Culloden Road	Westbound	535	435	-100	-19%	4.53
Culloden Road	Eastbound	588	541	-47	-8%	1.99
Total	**Westbound**	**1796**	**1878**	**82**	**5%**	**1.92**
Total	**Eastbound**	**1882**	**1860**	**-22**	**-1%**	**0.51**

Table 7-6 Validation screenline 2 by count site: IP

Screenline	Total	Obs	Mod	Diff	% diff	GEH
A82	Westbound	239	315	76	32%	4.57
A82	Eastbound	197	345	148	75%	8.99
Telford Street	Westbound	615	619	4	1%	0.16
Telford Street	Eastbound	613	700	87	14%	3.40
Total	**Westbound**	**854**	**934**	**80**	**9%**	**2.68**
Total	**Eastbound**	**810**	**1045**	**235**	**29%**	**7.72**

Table 7-7 Validation screenline 3 by count site: IP

Screenline	Total	Obs	Mod	Diff	% diff	GEH
A82 Kenneth Street	Northbound	481	390	-91	-19%	4.35
A82 Kenneth Street	Southbound	412	310	-102	-25%	5.36
Bank Street	Northbound	313	532	219	70%	10.65
Bank Street	Southbound	340	354	15	4%	0.78
Old Perth Road	Northbound	357	362	5	1%	0.25
Old Perth Road	Southbound	425	396	-29	-7%	1.43
Total	**Northbound**	**1151**	**1284**	**133**	**12%**	**3.81**
Total	**Southbound**	**1176**	**1060**	**-116**	**-10%**	**3.48**

Table 7-8 Validation screenline 4 by count site: IP

Screenline	Total	Obs	Mod	Diff	% diff	GEH
A82 Longman Road	Westbound	850	859	9	1%	0.32
A82 Longman Road	Eastbound	1003	947	-56	-6%	1.80
Harbour Road	Westbound	611	440	-171	-28%	7.47
Harbour Road	Eastbound	537	345	-192	-36%	9.15
Millburn Road	Westbound	587	655	68	11%	2.71
Millburn Road	Eastbound	535	477	-58	-11%	2.58
Culcabock Road	Westbound	412	379	-33	-8%	1.67
Culcabock Road	Eastbound	401	528	127	32%	5.89
Total	**Westbound**	**2461**	**2333**	**-128**	**-5%**	**2.61**
Total	**Eastbound**	**2477**	**2297**	**-180**	**-7%**	**3.68**

Table 7-9 to Table 7-12 show the screenline results for the PM Peak. In most instance the percentage change is 5% or lower, with 5 of the 8 screenlines meeting this criterion. Two of the three remaining screenlines have a change of 8%, with a relatively small absolute change of less than 100 vehicles. This is reflected in the GEH analysis, where 7 of the 8 screenlines have a GEH of less than 4, with the GEH of the remaining screenline being just over 4. As with the AM and Inter Peak periods, the PM peak therefore correlates well with the observed data.

Table 7-9 Validation screenline 1 by count site: PM

Screenline	Total	Obs	Mod	Diff	% diff	GEH
A96 west of Seafield	Westbound	1363	1472	109	8%	2.90
A96 west of Seafield	Eastbound	1887	2058	171	9%	3.85
Culloden Road	Westbound	472	458	-14	-3%	0.65
Culloden Road	Eastbound	912	819	-93	-10%	3.16
Total	**Westbound**	**1835**	**1930**	**95**	**5%**	**2.19**
Total	**Eastbound**	**2799**	**2877**	**78**	**3%**	**1.46**

Table 7-10 Validation screenline 2 by count site: PM

Screenline	Total	Obs	Mod	Diff	% diff	GEH
A82	Westbound	246	322	76	31%	4.52
A82	Eastbound	263	290	27	10%	1.64
Telford Street	Westbound	670	727	57	9%	2.16
Telford Street	Eastbound	602	504	-98	-16%	4.17
Total	**Westbound**	**916**	**1049**	**133**	**15%**	**4.25**
Total	**Eastbound**	**865**	**794**	**-71**	**-8%**	**2.46**

Table 7-11 Validation screenline 3 by count site: PM

Screenline	Total	Obs	Mod	Diff	% diff	GEH
A82 Kenneth Street	Northbound	459	436	-23	-5%	1.09
A82 Kenneth Street	Southbound	491	401	-90	-18%	4.26
Bank Street	Northbound	289	257	-32	-11%	1.94
Bank Street	Southbound	521	554	33	6%	1.42
Old Perth Road	Northbound	343	489	146	43%	7.17
Old Perth Road	Southbound	487	536	49	10%	2.16
Total	**Northbound**	**1091**	**1182**	**91**	**8%**	**2.71**
Total	**Southbound**	**1499**	**1491**	**-8**	**-1%**	**0.21**

Table 7-12 Validation screenline 4 by count site: PM

Screenline	Total	Obs	Mod	Diff	% diff	GEH
A82 Longman Road	Westbound	771	832	61	8%	2.14
A82 Longman Road	Eastbound	1598	1603	5	0%	0.12
Harbour Road	Westbound	577	534	-43	-7%	1.82
Harbour Road	Eastbound	293	236	-57	-19%	3.48
Millburn Road	Westbound	531	453	-78	-15%	3.52
Millburn Road	Eastbound	514	460	-54	-11%	2.46
Culcabock Road	Westbound	640	638	-2	0%	0.10
Culcabock Road	Eastbound	352	511	159	45%	7.64
Total	**Westbound**	**2520**	**2457**	**-63**	**-2%**	**1.26**
Total	**Eastbound**	**2757**	**2810**	**53**	**2%**	**1.00**

7.2 Journey Times

Historical TomTom journey time data was acquired covering all of 2017 for 11 routes in Inverness to collect data on journey times and speeds. The routes are shown in Figure 8.2 and 8.3. The use of TomTom data is advantageous over moving observer surveys as the datasets typically have a larger sample size, meaning that the data is more robust.

WebTAG states that modelled journey times should be within 15% of observed, or 60 seconds if higher than 15% for 85% of routes. Generally, most routes show a very good relationship between the observed and modelled journey times, with 86% of routes being within 15% or 60 seconds of the observed for the AM Peak, 82% for the Inter Peak and 82% for the PM Peak.

Whilst the Inter Peak and PM Peak are slightly lower than the acceptable WebTAG criteria, the routes that are failing won't have a material impact on the schemes that the model is intended to test, with the exception of the A82 Longman Road Northbound. This route was broken down into five sections, A8082/A82 Roundabout to Kenneth Street/Tomnahurich Street Junction, Kenneth Street/Tomnahurich Street Junction to Telford Roundabout, Telford Roundabout to Shore Street Roundabout, Shore Street Roundabout to Harbour Road Roundabout and Harbour Road Roundabout to Longman Roundabout. This route fails to pass the WebTAG criteria in all three peaks, and consistently across the three peaks, the issue is the first section between the A8082/A82 Roundabout to Kenneth Street/Tomnahurich Street Junction. This section of the A82 is consistently fast as a result of the model failing to replicate the queuing that occurs from the traffic signals at the Kenneth Street/Tomnahurich Street junction. Removing this section of the route would result in a pass in all three peak periods. As the modelled journey time across the rest of the A82, and in particular the section from Shore Street Roundabout to Longman Roundabout, generally reflects the observed data, this has been deemed acceptable.

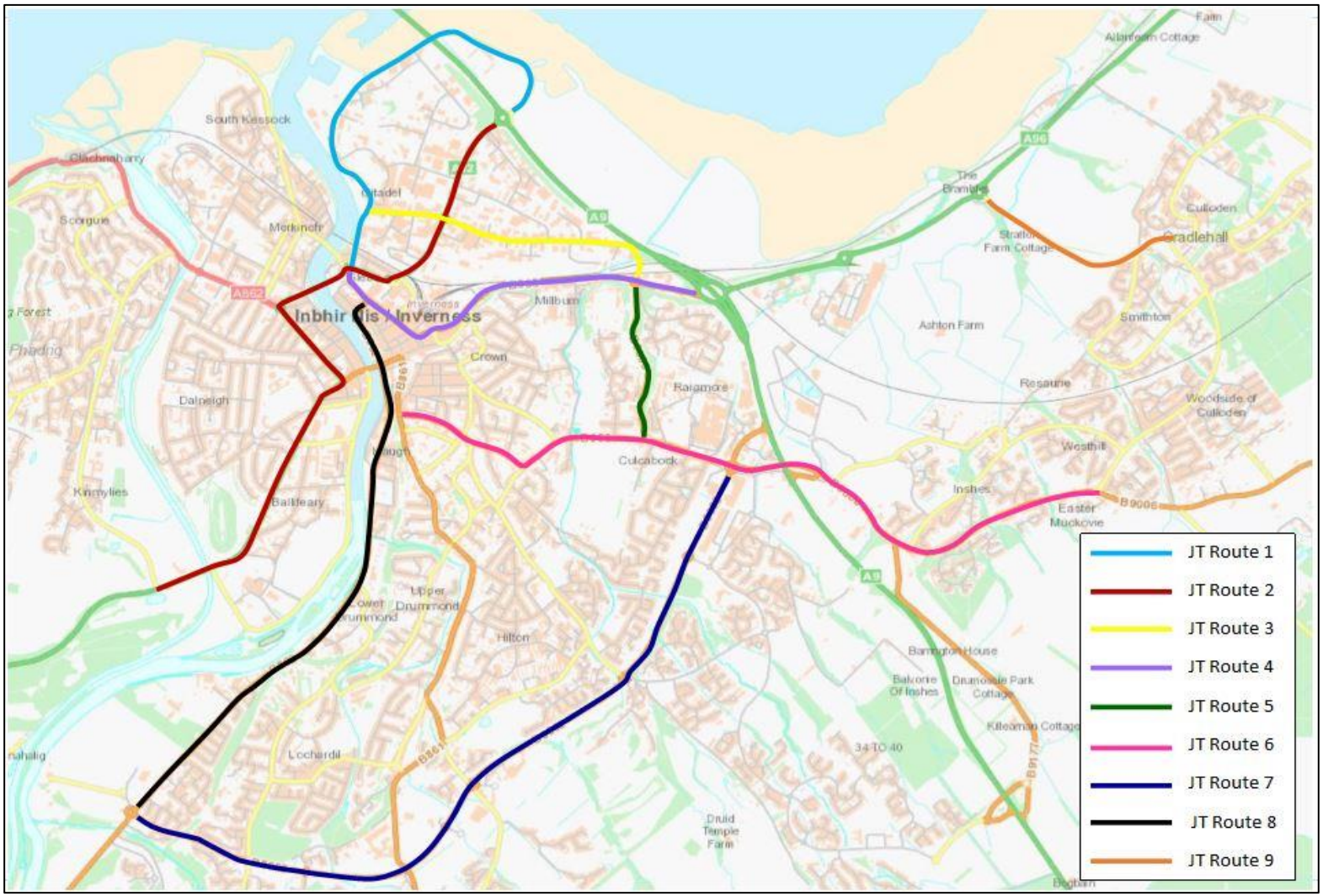

Figure 8.2: 2017 Journey Time Routes

Figure 7-2: A9 2017 Journey Time

Table 7-13: Journey times – AM peak

Route	Direction	Ave Obs Time (s)	Modelled Time (s)	Time Difference(s)	% Difference	Pass/Fail
1 Stadium Road	Northbound	231	247	16	7%	✓
1 Stadium Road	Southbound	242	257	15	6%	✓
2 A82 - Longman Rd	Northbound	610	503	-107	-18%	×
2 Longman Rd – A82	Southbound	596	518	-78	-13%	✓
3 Harbour Road	Eastbound	276	263	-13	-5%	✓
3 Harbour Road	Westbound	261	291	30	11%	✓
4 Millburn Road	Eastbound	426	372	-54	-13%	✓
4 Millburn Road	Westbound	445	391	-54	-12%	✓
5 Old Perth Road	Northbound	120	98	-22	-18%	✓
5 Old Perth Road	Southbound	125	156	31	25%	✓
6 Culloden Road & Culcabock Road	Eastbound	610	519	-91	-15%	✓
6 Culloden Road & Culcabock Road	Westbound	599	531	-68	-11%	✓
7 Sir Walter Scott Drive	Northbound	466	368	-98	-21%	×
7 Sir Walter Scott Drive	Southbound	441	348	-93	-21%	×
8 Holm Rb - Chapel Street	Northbound	488	466	-22	-4%	✓
8 Chapel Street - Holm Rb	Southbound	430	378	-52	-12%	✓
9 Barn Church Road	Eastbound	98	76	-22	-23%	✓
9 Barn Church Road	Westbound	145	149	4	2%	✓
10 A9	Northbound	780	873	93	12%	✓
10 A9	Southbound	839	884	45	5%	✓
11 A96	Eastbound	181	145	-36	-20%	✓

Route	Direction	Ave Obs Time (s)	Modelled Time (s)	Time Difference(s)	% Difference	Pass/Fail
11 A96	Westbound	230	277	47	20%	✓

Table 7-14: Journey times – Inter Peak

Route	Direction	Ave Obs Time (s)	Modelled Time (s)	Time Difference(s)	% Difference	Pass/Fail
1 Stadium Road	Northbound	229	238	9	4%	✓
1 Stadium Road	Southbound	243	249	6	2%	✓
2 A82 - Longman Rd	Northbound	674	521	-153	-23%	×
2 Longman Rd – A82	Southbound	607	523	-84	-14%	✓
3 Harbour Road	Eastbound	315	313	-2	-1%	✓
3 Harbour Road	Westbound	275	272	-3	-1%	✓
4 Millburn Road	Eastbound	498	405	-93	-19%	×
4 Millburn Road	Westbound	495	414	-81	-16%	×
5 Old Perth Road	Northbound	110	96	-14	-13%	✓
5 Old Perth Road	Southbound	127	116	-11	-9%	✓
6 Culloden Road & Culcabock Road	Eastbound	624	745	121	19%	✓
6 Culloden Road & Culcabock Road	Westbound	567	542	-25	-4%	✓
7 Sir Walter Scott Drive	Northbound	424	363	-61	-14%	✓
7 Sir Walter Scott Drive	Southbound	444	351	-93	-21%	×
8 Holm Rb - Chapel Street	Northbound	484	468	-16	-3%	✓
8 Chapel Street - Holm Rb	Southbound	438	382	-56	-13%	✓
9 Barn Church Road	Eastbound	99	84	-15	-15%	✓
9 Barn Church Road	Westbound	95	87	-8	-8%	✓

Route	Direction	Ave Obs Time (s)	Modelled Time (s)	Time Difference(s)	% Difference	Pass/Fail
10 A9	Northbound	780	871	91	12%	✓
10 A9	Southbound	770	831	61	8%	✓
11 A96	Eastbound	185	148	-37	-20%	✓
11 A96	Westbound	218	201	-17	-8%	✓

Table 7-15: Journey times – PM peak

Route	Direction	Ave Obs Time (s)	Modelled Time (s)	Time Difference(s)	% Difference	Pass/Fail
1 Stadium Road	Northbound	225	211	-14	-6%	✓
1 Stadium Road	Southbound	257	202	-55	-21%	✓
2 A82 - Longman Rd	Northbound	671	545	-126	-19%	×
2 Longman Rd – A82	Southbound	617	525	-92	-15%	✓
3 Harbour Road	Eastbound	305	305	0	0%	✓
3 Harbour Road	Westbound	247	289	42	17%	✓
4 Millburn Road	Eastbound	461	427	-34	-7%	✓
4 Millburn Road	Westbound	483	398	-85	-18%	×
5 Old Perth Road	Northbound	100	106	6	5%	✓
5 Old Perth Road	Southbound	124	133	9	7%	✓
6 Culloden Road & Culcabock Road	Eastbound	641	555	-86	-13%	✓
6 Culloden Road & Culcabock Road	Westbound	603	515	-88	-15%	✓
7 Sir Walter Scott Drive	Northbound	418	364	-54	-13%	✓
7 Sir Walter Scott Drive	Southbound	450	379	-71	-16%	×
8 Holm Rb - Chapel Street	Northbound	489	422	-67	-14%	✓

Route	Direction	Ave Obs Time (s)	Modelled Time (s)	Time Difference(s)	% Difference	Pass/Fail
8 Chapel Street - Holm Rb	Southbound	451	408	-43	-10%	✓
9 Barn Church Road	Eastbound	104	109	5	5%	✓
9 Barn Church Road	Westbound	91	82	-9	-10%	✓
10 A9	Northbound	856	967	111	13%	✓
10 A9	Southbound	757	817	60	8%	✓
11 A96	Eastbound	195	203	8	4%	✓
11 A96	Westbound	238	325	87	37%	×

8. Demand model development

The demand model process has not been altered as part of this 2009 or 2014 model recalibration. The demand model development is discussed in Chapter 10 of the MFTM Development Report[1]. A brief summary of the process is in Figure 8-1.

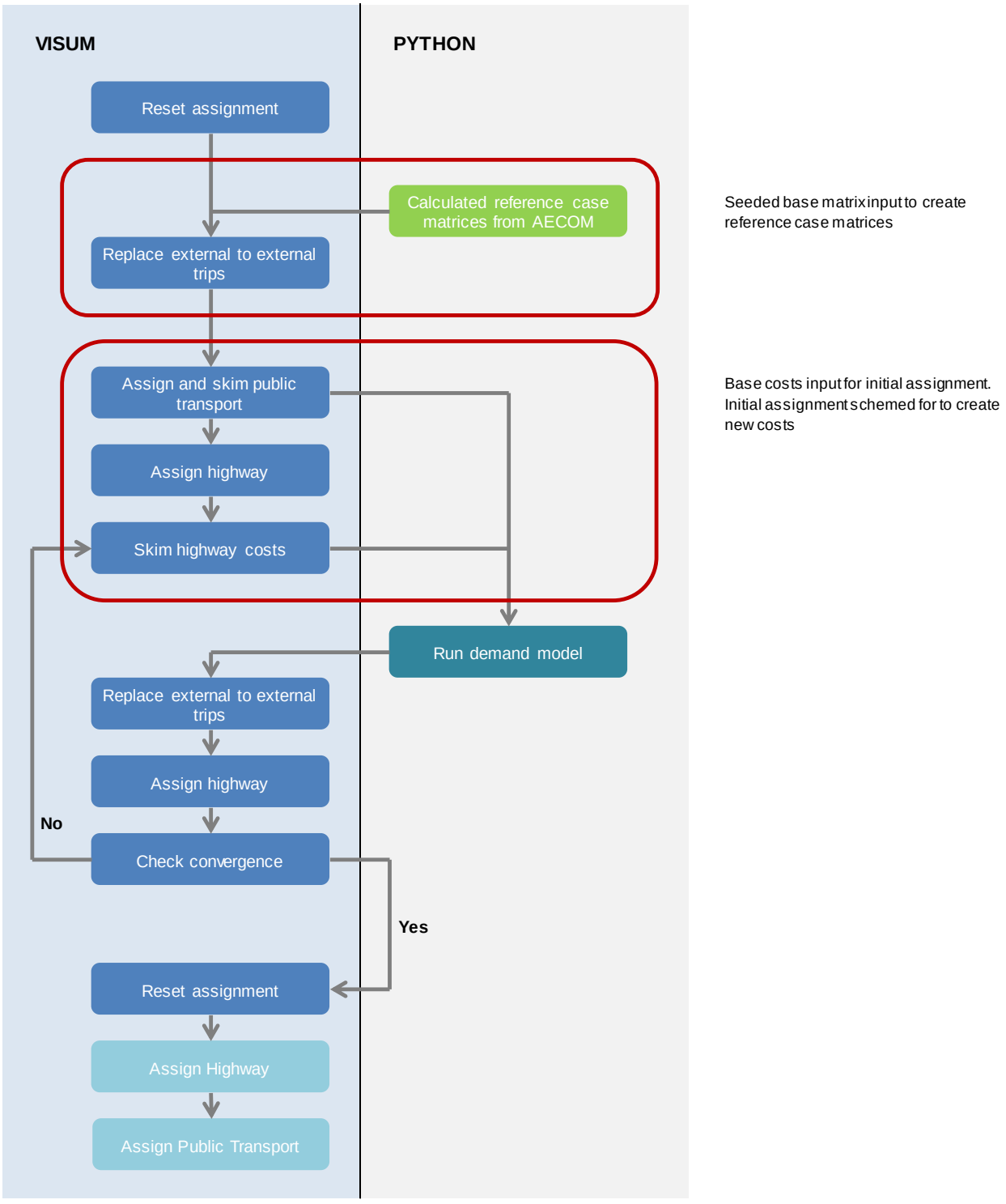

Figure 8-1: MFTM demand procedure

9. Summary and Conclusions

Jacobs has been commissioned to prepare a Design Manual for Roads and Bridges (DMRB) Stage 2 Assessment of the A9/A82 Longman Junction Scheme and the DMB Stage 3 Assessment of the A9/96 Inshes to Smithton scheme.

In preparation for these assessments, it was agreed that the MFTM base be updated to reflect a base year of 2018 and include the West Link Phase 1 scheme.

This report summarises the revised calibration and validation of the Moray Firth Transport Model aimed at improving the network calibration within the study area of both scheme assessments, which is concentrated on Inverness and the immediate surrounding area.

Matrices have been developed from 2011 Census Travel to Work data, supplemented by observed origin destination data collected in 2009 from the original MFTM model development, and validated against RSI data collected in 2018. Matrix estimation has then been undertaken on each time period matrix to better fit observed highway volumes collected in February 2018.

The matrix changes at each stage of the development process have been reported. The sector to sector changes and trip length distribution highlights that the patterns of origins and destinations is similar in both pre and post estimation, and the areas where changes do occur tend to be where the traffic count information is located, which is the controlling factor in matrix estimation.

The model update process including network coding changes, the development of a new Car Commute matrix and the re-estimation of the road-based trip matrices have resulted in a link flow and GEH calibration criteria meet WebTAG criteria at over 89%. The model validates satisfactorily against observed journey times, particularly in the vicinity of the A9/A82 Longman Junction and A9/A96 Inshes to Smithton Scheme.

Validation against remaining counts (not used in the calibration of the model) is also satisfactory, with the screenlines meeting the GEH of less than 4 in most cases, particularly in the Inter Peak and PM Peak models.

In summary, the calibration and validation statistics presented indicate that the base year VISUM model is consistent with WebTAG guidance for link count calibration and journey time validation. Matrix estimation changes between the initial and final versions are considered to be reasonable across all peaks, with the final matrix trip length distribution closely matching the prior values.

Appendix A. Network changes

Table A-1: Link type changes

Link	From node	To node	Previous link type	New link type	Comment / change
19264313	114493377	114493378	11	12	A82 changed to apply a different Speed Flow Curve
19264469	114493463	114493479	45	55	Harbour Road changed for Speed Flow Curve Purposes
19264504	114493479	114493501	45	55	Harbour Road changed for Speed Flow Curve Purposes
19264517	114493472	114493509	11	12	A82 changed to apply a different Speed Flow Curve
19264525	114493501	114493513	45	55	Harbour Road changed for Speed Flow Curve Purposes
19264536	114493513	114493519	45	55	Harbour Road changed for Speed Flow Curve Purposes
19264556	33745	33746	45	46	Link type changed as road is average not wide
19264565	33745	114493532	45	46	Link type changed as road is average not wide
19264572	114493532	114493534	45	46	Link type changed as road is average not wide
19264574	114493533	114493535	45	55	Harbour Road changed for Speed Flow Curve Purposes
19264581	114493535	114493540	45	55	Harbour Road changed for Speed Flow Curve Purposes
19264603	114493534	114493556	45	46	Link type changed as road is average not wide
19264645	114493556	114493578	45	46	Link type changed as road is average not wide
19264661	114493578	114493588	45	46	Link type changed as road is average not wide
19264697	114493588	114493617	45	46	Link type changed as road is average not wide
19264781	114493669	114493668	45	55	Harbour Road changed for Speed Flow Curve Purposes
19264814	114493668	114493693	45	55	Harbour Road changed for Speed Flow Curve Purposes
19264829	114493706	114493707	11	12	A82 changed to apply a different Speed Flow Curve
19264865	114493725	114493726	27	22	Link type changed as road is average not narrow
19264872	114493729	114493707	25	99	Link type changed as it is approaching a junction
19264913	114493725	114493750	27	22	Link type changed as road is average not narrow
19264923	114493756	114493757	11	12	A82 changed to apply a different Speed Flow Curve
19264946	114493778	114493779	11	12	A82 changed to apply a different Speed Flow Curve
19265129	114493853	114493897	47	46	Link type changed as road is average not narrow
19265550	114494161	114494178	21	22	Link type changed as road is average not wide
19265603	114494209	114494196	21	22	Link type changed as road is average not wide
19266087	114494499	114494400	45	47	Link type changed as road is narrow one lane not wide
19266281	114494604	114494628	33	36	Road is 2 lane average not 4 lanes narrow.
19310003	114494142	114497068	21	22	Link type changed as road is average not wide
19310143	114494161	114497068	21	22	Link type changed as road is average not wide
19320037	114493602	114497379	11	12	A82 changed to apply a different Speed Flow Curve

Link	From node	To node	Previous link type	New link type	Comment / change
19321263	114493378	114497383	11	12	A82 changed to apply a different Speed Flow Curve
19321264	114497384	114497385	11	12	A82 changed to apply a different Speed Flow Curve
19321265	114497383	114497385	11	12	A82 changed to apply a different Speed Flow Curve
19332198	114493602	114497418	11	12	A82 changed to apply a different Speed Flow Curve
19332259	114493504	114497421	45	46	Link type changed as road is average not wide
19332275	114497380	114497424	11	12	A82 changed to apply a different Speed Flow Curve
19332377	114493706	114497418	11	12	A82 changed to apply a different Speed Flow Curve
33226945	114493669	114493540	45	55	Harbour Road changed for Speed Flow Curve Purposes
78060617	114497333	114497683	94	11	A96 approach to Raigmore, changed to reflect DC link type. Gives SFC to link
78060621	114497683	114497682	94	11	A96 approach to Raigmore, changed to reflect DC link type. Gives SFC to link
78060622	114493747	114497686	94	11	A96 approach to Raigmore, changed to reflect DC link type. Gives SFC to link
78060623	114497686	114497333	94	11	A96 approach to Raigmore, changed to reflect DC link type. Gives SFC to link
78062612	114493757	114497713	11	12	A82 changed to apply a different Speed Flow Curve
78062614	114493779	114497714	11	12	A82 changed to apply a different Speed Flow Curve
565841048	114497713	114497850	11	12	A82 changed to apply a different Speed Flow Curve
565841049	114497850	114493660	11	12	A82 changed to apply a different Speed Flow Curve
565841052	114493707	114497852	11	12	A82 changed to apply a different Speed Flow Curve
565841053	114497424	114497852	11	12	A82 changed to apply a different Speed Flow Curve
565841055	114493452	114497854	11	12	A82 changed to apply a different Speed Flow Curve
565841056	114497384	114497854	11	12	A82 changed to apply a different Speed Flow Curve
565841057	114493452	114497855	11	12	A82 changed to apply a different Speed Flow Curve
565841058	114493377	114497855	11	12	A82 changed to apply a different Speed Flow Curve
565843205	114579452	114493789	27	26	Link type changed as road is average not narrow
565843206	114493750	114579452	99	22	Link type changed to be consistent with the rest of the link as it is not approaching a junction
565843406	114579531	114493716	11	22	Link is not a DC so has been changed to 4 lanes single
565843598	114494610	114579594	99	35	Link type changed to be consistent with the rest of the link as it is not approaching a junction
565843600	114579595	118701569	11	12	A82 changed to apply a different Speed Flow Curve
565843601	114493696	114579595	11	12	A82 changed to apply a different Speed Flow Curve
565843602	114493696	114579596	11	12	A82 changed to apply a different Speed Flow Curve

Link	From node	To node	Previous link type	New link type	Comment / change
565843603	114579596	118701569	11	12	A82 changed to apply a different Speed Flow Curve
565843604	114493519	114579597	45	55	Harbour Road changed for Speed Flow Curve Purposes
565843606	114493533	114579598	45	55	Harbour Road changed for Speed Flow Curve Purposes
565843607	114579597	114579598	45	55	Harbour Road changed for Speed Flow Curve Purposes
565851557	114579531	114493660	11	12	A82 changed to apply a different Speed Flow Curve
565851560	118701570	114493837	11	12	A82 changed to apply a different Speed Flow Curve
565851578	118701575	114493452	11	12	A82 changed to apply a different Speed Flow Curve
565851579	118701575	114493463	45	55	Harbour Road changed for Speed Flow Curve Purposes
565851581	118701575	114493472	11	12	A82 changed to apply a different Speed Flow Curve
565851584	118701576	114493696	11	12	A82 changed to apply a different Speed Flow Curve
565851600	118701580	114494548	99	25	Link type changed to be consistent with the rest of the link as it is not approaching a junction
565851604	118701580	114579527	38	36	Wrongly coded as a rbt link
565851618	114493504	118701585	99	46	Link type changed to be consistent with the rest of the link as it is not approaching a junction
565851619	33746	118701585	99	46	Link type changed to be consistent with the rest of the link as it is not approaching a junction
565851622	114579533	114579594	99	36	Link type changed to be consistent with the rest of the link as it is not approaching a junction
565851645	114579445	118701597	27	22	Link type changed as road is average not narrow
565851657	114579527	118701602	38	36	Wrongly coded as a rbt link
565851661	118701604	114579447	99	35	Link type changed to be consistent with the rest of the link as it is not approaching a junction
565851667	118701606	114579443	99	35	Link type changed to be consistent with the rest of the link as it is not approaching a junction
565851821	114497333	118701717	25	11	Link type changed to as it is a Dual Carriageway not a single.
565851822	118701578	118701717	25	11	Link type changed to as it is a Dual Carriageway not a single.
565851823	118701718	114497332	26	25	Link type changed as road is wide not average
565851827	118701720	118701718	26	25	Link type changed as road is wide not average
565851828	118701578	118701720	26	25	Link type changed as road is wide not average
565851830	114493819	118701721	21	25	Link is a single carriageway, not dual.
1131704218	124316585	237403894	21	22	Link type changed as road is average not wide
1131704456	35323	114494548	99	25	Link type changed to be consistent with the rest of the link as it is not approaching a junction
1131704631	35369	114579443	99	35	Link type changed to be consistent with the rest of the link as it is not approaching a junction
1131704632	35369	114579447	99	35	Link type changed to be consistent with the rest of the link as it is not approaching a junction
1131704817	35469	114493726	23	22	Link type changed as road is average not narrow
1131704979	33747	114493409	45	46	Link type changed as road is average not wide
1131704980	33747	114497421	45	46	Link type changed as road is average not wide
1131705023	33856	114494178	21	22	Link type changed as road is average not wide

Link	From node	To node	Previous link type	New link type	Comment / change
1131705329	35739	114497383	11	12	A82 changed to apply a different Speed Flow Curve
1131705330	114497856	35739	90	12	A82 changed to apply a different Speed Flow Curve
1131705415	35079	114493472	11	12	A82 changed to apply a different Speed Flow Curve
1131705416	114497379	35079	11	12	A82 changed to apply a different Speed Flow Curve
1131705593	35468	114493509	11	12	A82 changed to apply a different Speed Flow Curve
1131705594	35468	114497380	11	12	A82 changed to apply a different Speed Flow Curve
1131705769	35738	114497383	11	12	A82 changed to apply a different Speed Flow Curve
1131705770	35738	114497857	90	12	A82 changed to apply a different Speed Flow Curve
1131706257	33855	33856	21	22	Link type changed as road is average not wide
1131706258	33855	114494196	21	22	Link type changed as road is average not wide
1131706339	35469	35470	23	22	Link type changed as road is average not narrow
1131706340	35470	114579445	99	22	Link type changed to be consistent with the rest of the link as it is not approaching a junction
1131706344	114493764	34947	46	45	Link type changed as road is wide not average
1131706588	35371	34678	33	32	Link type changed as road is average not narrow
1131706838	114493756	237404015	11	12	A82 changed to apply a different Speed Flow Curve
1131706839	114493837	237404015	11	12	A82 changed to apply a different Speed Flow Curve
1131706840	114493778	237404016	11	12	A82 changed to apply a different Speed Flow Curve
1131706841	237404016	114493837	11	12	A82 changed to apply a different Speed Flow Curve
1131706842	237404017	114497714	11	12	A82 changed to apply a different Speed Flow Curve
1131706843	114493660	237404017	11	12	A82 changed to apply a different Speed Flow Curve
1131706846	114494639	237404019	10	11	Link type changed as road is 2 lanes not 3
1131706847	237404019	114497740	10	11	Link type changed as road is 2 lanes not 3
1131707018	237404109	237404110	25	45	Link is 2 lanes not 4 and is not an A road.
1131707019	237404108	237404109	25	45	Link is 2 lanes not 4 and is not an A road.
1131707041	237404121	114497856	22	12	A82 changed to apply a different Speed Flow Curve
1131707052	237404123	237404127	22	11	Link type changed to as it is a Dual Carriageway not a single.
1131707055	237404124	237404125	25	99	Changed as it is on approach to a junction
1131707066	114497857	237404130	99	12	Link type changed to be consistent with the rest of the link as it is not approaching a junction

Table A-2: Changes to the capacity of a link

Link	From Node	To Node	Previous Capacity	New Capacity
19262953	124313713	114492812	3600	4000
19262991	114492812	114492822	3600	4000

Link	From Node	To Node	Previous Capacity	New Capacity
19263372	114492880	114492865	3600	4000
19263748	114493005	114493004	3200	4000
19263845	114493031	114493030	3200	4000
19263847	114493032	114493033	3200	4000
19264139	114493235	114493243	850	2010
19264139	114493243	114493235	850	2010
19264156	114493254	114493255	850	0
19264156	114493255	114493254	850	0
19264161	114493255	114493259	850	0
19264161	114493259	114493255	850	0
19264313	114493378	114493377	3200	4000
19264397	114493436	114493432	1500	1483
19264469	114493463	114493479	850	1500
19264504	114493479	114493501	850	1500
19264504	114493501	114493479	850	1500
19264517	114493472	114493509	3200	4000
19264517	114493509	114493472	3200	4000
19264525	114493501	114493513	850	1500
19264525	114493513	114493501	850	1500
19264536	114493513	114493519	850	1500
19264536	114493519	114493513	850	1500
19264554	114493503	114493526	850	0
19264556	33745	33746	850	1500
19264556	33746	33745	850	1500
19264565	33745	114493532	850	1500
19264565	114493532	33745	850	1500
19264572	114493532	114493534	850	1500
19264572	114493534	114493532	850	1500
19264574	114493533	114493535	850	1500
19264574	114493535	114493533	850	1500
19264581	114493535	114493540	850	1500
19264581	114493540	114493535	850	1500
19264590	33911	114493523	850	0
19264590	114493523	33911	850	0
19264603	114493534	114493556	850	1500
19264603	114493556	114493534	850	1500
19264615	114493565	114493566	850	1500
19264615	114493566	114493565	850	1500
19264621	33911	114493568	850	0
19264621	114493568	33911	850	0
19264622	114493562	114493568	850	0
19264622	114493568	114493562	850	0
19264645	114493556	114493578	850	1500
19264645	114493578	114493556	850	1500
19264658	114493565	114493585	500	1500
19264658	114493585	114493565	500	1500
19264660	114493588	114493589	850	0
19264660	114493589	114493588	850	0

Link	From Node	To Node	Previous Capacity	New Capacity
19264661	114493578	114493588	850	1500
19264661	114493588	114493578	850	1500
19264665	114493591	114493593	3600	4000
19264666	114493526	114493594	850	0
19264667	114493594	114493595	850	0
19264694	114493613	114493614	850	0
19264694	114493614	114493613	850	0
19264696	114493614	114493616	850	0
19264696	114493616	114493614	850	0
19264697	114493588	114493617	850	1500
19264697	114493617	114493588	850	1500
19264738	114493585	114493643	850	1500
19264738	114493643	114493585	850	1500
19264781	114493668	114493669	1000	1500
19264781	114493669	114493668	500	1500
19264814	114493668	114493693	850	1500
19264814	114493693	114493668	850	1500
19264829	114493706	114493707	3200	4000
19264829	114493707	114493706	3200	4000
19264865	114493725	114493726	1900	2010
19264865	114493726	114493725	1900	2010
19264873	114493713	114493729	1800	850
19264890	114493729	114493738	1800	850
19264913	114493725	114493750	1900	2010
19264913	114493750	114493725	1000	1700
19264923	114493756	114493757	3200	4000
19264946	114493779	114493778	3200	4000
19265088	114493852	114493853	1000	2010
19265088	114493853	114493852	1000	2010
19265090	35370	114493855	850	2010
19265090	114493855	35370	850	2010
19265115	114493852	114493881	1000	2010
19265115	114493881	114493852	1000	2010
19265129	114493853	114493897	850	1700
19265135	114493875	114493902	850	2010
19265135	114493902	114493875	850	2010
19265155	114493902	114493916	850	1000
19265155	114493916	114493902	850	2010
19265190	114493936	114493916	1000	1700
19265196	114493901	114493939	1000	2010
19265196	114493939	114493901	1000	2010
19265264	114493939	114493980	1000	2010
19265264	114493980	114493939	1000	2010
19265450	114494104	114494103	3600	4000
19265454	114494107	114494108	4000	3250
19265479	114494057	114494130	850	500
19265479	114494130	114494057	850	500
19265494	114493993	114494142	1000	2010

Link	From Node	To Node	Previous Capacity	New Capacity
19265494	114494142	114493993	1000	2010
19265521	114494129	114494158	1000	2010
19265521	114494158	114494129	1000	2010
19265550	114494161	114494178	1900	3050
19265550	114494178	114494161	1900	3050
19265603	114494196	114494209	1900	3050
19265603	114494209	114494196	1900	3050
19265633	114494226	114494230	850	0
19265785	114494260	114494285	1000	1700
19265785	114494285	114494260	1000	1700
19265841	114494308	114494319	1000	2010
19265841	114494319	114494308	1000	2010
19265854	114494319	114494328	1000	2010
19265854	114494328	114494319	1000	2010
19265855	114494327	114494329	1000	1700
19265855	114494329	114494327	1000	1700
19265876	114494328	114494342	1000	2010
19265876	114494342	114494328	1000	2010
19265880	114494285	114494345	1000	1700
19265880	114494345	114494285	1000	1700
19265886	114494329	114494350	1000	1700
19265886	114494350	114494329	1000	1700
19265890	114494345	114494352	1000	1700
19265890	114494352	114494345	1000	1700
19265901	114494352	114494361	1000	1700
19265923	114494380	114494382	850	1500
19265923	114494382	114494380	850	1500
19265931	114494379	114494387	1000	1700
19265949	114494380	114494400	850	1500
19265949	114494400	114494380	850	1500
19265957	114494409	114494410	1500	1700
19265961	114494352	114494413	1000	1700
19265961	114494413	114494352	1000	1700
19265970	114494420	114494410	3600	4000
19265971	114494420	114494409	1500	1700
19265991	114494400	114494433	500	850
19265991	114494433	114494400	500	850
19266012	114494350	114494447	1000	1700
19266012	114494447	114494350	1000	1700
19266019	114494409	233196177	1500	1700
19266019	233196177	114494409	1500	1700
19266024	114494453	114494458	1000	1500
19266024	114494458	114494453	1000	1500
19266034	114494443	114494465	1000	1700
19266037	114494424	114494466	850	0
19266037	114494466	114494424	850	0
19266051	114494458	114494476	1000	1500
19266051	114494476	114494458	1000	1500

Link	From Node	To Node	Previous Capacity	New Capacity
19266056	114494478	233196177	1500	1700
19266056	233196177	114494478	1500	1700
19266058	114494465	114494480	1000	1700
19266058	114494480	114494465	1000	1700
19266069	114494466	114494488	850	0
19266069	114494488	114494466	850	0
19266074	114494465	114494491	850	0
19266087	114494400	114494499	500	850
19266087	114494499	114494400	500	850
19266089	114494480	114494500	1000	1700
19266089	114494500	114494480	1000	1700
19266110	33988	114494507	1000	1700
19266110	114494507	33988	1000	1700
19266134	114494507	114494517	1000	1700
19266134	114494517	114494507	1000	1700
19266140	114494500	114494522	1000	1700
19266140	114494522	114494500	1000	1700
19266170	114494517	114494541	1000	1700
19266170	114494541	114494517	1000	1700
19266188	114494552	114494420	3600	4000
19266212	114494522	114494570	1000	1700
19266212	114494570	114494522	1000	1700
19266218	114494541	114494575	1000	1700
19266218	114494575	114494541	1000	1700
19266247	114494596	114494595	3600	4000
19266270	114494575	114494617	1000	1700
19266270	114494617	114494575	1000	1700
19266281	114494604	114494628	1000	1700
19266281	114494628	114494604	1900	1700
19266282	114494612	114494628	1000	1700
19266282	114494628	114494612	1000	1700
19266294	114494612	114494639	1000	1700
19266295	114494595	114494639	3600	4000
19266373	114494606	114494695	1000	1700
19266373	114494695	114494606	1000	1700
19266443	114494695	114494746	1000	1700
19266443	114494746	114494695	1000	1700
19266475	114494746	114494767	1000	1700
19266475	114494767	114494746	1000	1700
19266511	114494789	114494790	1000	1700
19266511	114494790	114494789	1000	1700
19266550	114494790	114494818	1000	1700
19266550	114494818	114494790	1000	1700
19266556	114494818	114494820	1000	1700
19266556	114494820	114494818	1000	1700
19266753	114494906	114494920	1000	1700
19266753	114494920	114494906	1000	1700
19266827	114494965	114494966	1000	1700

Link	From Node	To Node	Previous Capacity	New Capacity
19266827	114494966	114494965	1000	1700
19266951	114494920	114495025	1000	1700
19266951	114495025	114494920	1000	1700
19267084	114495082	114495114	1000	1700
19267084	114495114	114495082	1000	1700
19267096	114495025	114495123	1000	1700
19267096	114495123	114495025	1000	1700
19267101	114495125	114495126	1500	1483
19267161	114495123	114495158	1000	1700
19267161	114495158	114495123	1000	1700
19267224	114495158	114495194	1000	1700
19267224	114495194	114495158	1000	1700
19267232	114495201	114495202	1000	1700
19267232	114495202	114495201	1000	1700
19267239	114495194	114495208	1000	1700
19267239	114495208	114495194	1000	1700
19267253	114495208	114495216	1000	1700
19267253	114495216	114495208	1000	1700
19267260	114495201	114495222	1000	1700
19267260	114495222	114495201	1000	1700
19267264	114495222	114495224	1000	1700
19267264	114495224	114495222	1000	1700
19267316	114495251	114495265	1000	1700
19267316	114495265	114495251	1000	1700
19267342	114495216	114495279	1000	1700
19267342	114495279	114495216	1000	1700
19267347	114495279	114495282	1000	1700
19267347	114495282	114495279	1000	1700
19267357	114495282	114495287	1000	1700
19267357	114495287	114495282	1000	1700
19267363	114495287	114495290	1000	1700
19267363	114495290	114495287	1000	1700
19267406	114495290	114495324	1000	1700
19267406	114495324	114495290	1000	1700
19267456	114495340	114495357	1000	1700
19267456	114495357	114495340	1000	1700
19267518	114495403	114495402	3600	4000
19267541	114495407	114495420	3600	4000
19267948	114495565	114495558	3600	4000
19267949	114495559	114495566	3600	4000
19268133	114495631	114495610	3600	4000
19268134	114495609	114495632	3600	4000
19268230	114495632	114495658	3600	4000
19268232	114495659	114495631	3600	4000
19309936	114495558	114495532	3600	4000
19309937	114495533	114495559	3600	4000
19310003	114494142	114497068	1900	3050
19310003	114497068	114494142	1900	3050

Link	From Node	To Node	Previous Capacity	New Capacity
19310078	114494177	114494310	850	0
19310102	114494530	114497091	1000	1700
19310102	114497091	114494530	1000	1700
19310143	114494161	114497068	1900	3050
19310143	114497068	114494161	1900	3050
19310190	114494034	114494038	1000	2010
19310190	114494038	114494034	1000	2010
19310191	114494033	114497106	850	0
19310191	114497106	114494033	850	0
19310944	114493004	114492939	3200	4000
19311394	114493243	114493500	850	2010
19311394	114493500	114493243	850	2010
19316957	114493610	114493611	850	2010
19316957	114493611	114493610	850	2010
19316958	114493611	114493612	850	2010
19316958	114493612	114493611	850	2010
19317038	114494410	114494107	4000	3250
19317086	114495402	114497324	3600	4000
19317900	114493030	114497326	3200	4000
19317905	114493855	114497329	850	2010
19317905	114497329	114493855	850	2010
19317908	35374	114494034	1000	2010
19317908	114494034	35374	1900	2010
19317941	114494108	114493591	3600	4000
19317942	114493592	114494104	3600	4000
19318946	114493014	114493031	3200	4000
19318948	114493033	114493013	3200	4000
19319911	114497324	114497370	3600	4000
19319912	114497370	114494552	3600	4000
19319913	114497371	114494596	3600	4000
19319914	114494103	114497371	3600	4000
19319915	114497373	114497372	3600	4000
19319916	114497372	114495407	3600	4000
19319918	114497374	114495403	3600	4000
19319971	114497375	114493592	3600	4000
19320037	114493602	114497379	3200	4000
19320045	114497382	114497381	3200	4000
19320046	114492940	114497382	3200	4000
19321263	114497383	114493378	3200	4000
19321264	114497384	114497385	3200	4000
19321264	114497385	114497384	3200	4000
19321265	114497385	114497383	3200	4000
19332161	114494605	114497410	1300	1700
19332161	114497410	114494605	1300	1700
19332198	114497418	114493602	3200	4000
19332228	114497417	114493432	1500	1481
19332230	114493731	114493905	850	0
19332230	114493905	114493731	850	0

Link	From Node	To Node	Previous Capacity	New Capacity
19332234	114493797	114494104	3400	2100
19332251	114493999	114494038	1000	2010
19332251	114494038	114493999	1000	2010
19332252	114493853	114497329	1000	2010
19332252	114497329	114493853	1000	2010
19332254	114493980	114494066	1000	2010
19332254	114494066	114493980	1000	2010
19332259	114493504	114497421	850	1500
19332259	114497421	114493504	850	1500
19332272	114493755	114493593	3400	2100
19332275	114497380	114497424	3200	4000
19332377	114493706	114497418	3200	4000
33226913	114492914	114492916	3600	4000
33226914	114492915	114492913	3600	4000
33226917	114497170	114492914	3600	4000
33226918	114492913	114497169	3600	4000
33226920	114492939	114492915	3600	4000
33226945	114493540	114493669	850	1500
33226945	114493669	114493540	850	1500
33226954	114493593	114497464	3600	4000
33227001	114492866	114492881	3600	4000
33227002	114492822	114492866	3600	4000
33227003	114492865	114492824	3600	4000
78056166	114497498	114497499	850	0
78056166	114497499	114497498	850	0
78056167	114497499	114497500	850	0
78056167	114497500	114497499	850	0
78056412	114497571	114497572	850	0
78056412	114497572	114497571	850	0
78056454	114495114	114497599	1000	1700
78056454	114497599	114495114	1000	1700
78060742	114497436	114497696	1500	2010
78060742	114497696	114497436	1500	2010
78060770	114495532	114497706	3600	4000
78060771	114497706	114497374	3600	4000
78060772	114497707	114495533	3600	4000
78060773	114495420	114497707	3600	4000
78060781	114495399	114497711	1000	1700
78060781	114497711	114495399	1000	1700
78062612	114493757	114497713	3200	4000
78062614	114497714	114493779	3200	4000
78069000	114495658	114497739	3600	4000
78069001	114497062	114497739	3600	4000
78069001	114497739	114497062	3600	4000
78069007	114497740	114497373	3600	4000
78069009	114497464	114497741	3600	4000
78069019	114492916	114497742	3600	4000
78069020	114497742	114492940	3600	4000

Link	From Node	To Node	Previous Capacity	New Capacity
78069023	114497326	114497743	3200	4000
565841046	114494209	114497849	1000	2010
565841046	114497849	114494209	1000	2010
565841047	114494158	114497849	1000	2010
565841047	114497849	114494158	1000	2010
565841048	114497713	114497850	3200	4000
565841049	114497850	114493660	3200	4000
565841052	114497852	114493707	3200	4000
565841053	114497424	114497852	3200	4000
565841055	114493452	114497854	3200	4000
565841055	114497854	114493452	3200	4000
565841056	114497384	114497854	3200	4000
565841056	114497854	114497384	3200	4000
565841057	114497855	114493452	3200	4000
565841058	114493377	114497855	3200	4000
565842923	114497869	114493616	850	0
565842924	114493595	114497870	850	0
565842925	114497870	114493512	850	0
565843045	114494433	114497950	500	850
565843045	114497950	114494433	500	850
565843046	114494561	114497950	500	850
565843046	114497950	114494561	500	850
565843150	114579424	114497328	3200	4000
565843153	114497741	114579426	3200	4000
565843154	114498008	114493833	850	1700
565843169	114493881	114579432	1000	2010
565843169	114579432	114493881	1000	2010
565843170	114493993	114579432	1000	2010
565843170	114579432	114493993	1000	2010
565843175	114494453	114579435	1000	1500
565843175	114579435	114494453	1000	1500
565843201	114494342	114579450	1000	2010
565843201	114579450	114494342	1000	2010
565843205	114493789	114579452	1000	2010
565843205	114579452	114493789	1000	2010
565843206	114493750	114579452	1900	2010
565843206	114579452	114493750	1000	1700
565843213	114497336	114579456	1000	1700
565843213	114579456	114497336	1000	1700
565843214	114497335	114579456	1000	1700
565843214	114579456	114497335	1000	1700
565843237	114493999	114579468	1000	2010
565843238	114493916	114579468	850	2010
565843238	114579468	114493916	850	2010
565843239	114579469	114579468	850	833
565843246	114493610	114579474	850	2010
565843246	114579474	114493610	850	2010
565843326	114493612	114579504	850	2010

Link	From Node	To Node	Previous Capacity	New Capacity
565843326	114579504	114493612	850	2010
565843360	114579513	114579516	1000	2010
565843360	114579516	114579513	1000	2010
565843382	114494469	114579525	1500	1700
565843382	114579525	114494469	1500	1700
565843385	114579519	114579525	1500	1700
565843385	114579525	114579519	1500	1700
565843406	114493716	114579531	1900	3200
565843406	114579531	114493716	1900	3200
565843600	118701569	114579595	3200	4000
565843601	114579595	114493696	3200	4000
565843602	114493696	114579596	3200	4000
565843603	114579596	118701569	3200	4000
565843604	114493519	114579597	850	1500
565843604	114579597	114493519	850	1500
565843606	114493533	114579598	850	1500
565843606	114579598	114493533	850	1500
565843607	114579597	114579598	850	1500
565843607	114579598	114579597	850	1500
565851555	114579481	114579531	1900	1500
565851556	114579531	114579478	1000	1500
565851557	114579531	114493660	3200	4000
565851560	118701570	114493837	3200	4000
565851563	114579492	118701570	1500	1488
565851564	114579493	118701570	1000	2010
565851564	118701570	114579493	1000	2010
565851565	114579508	118701571	1000	2010
565851565	118701571	114579508	1000	2010
565851566	114579511	118701571	2100	2700
565851566	118701571	114579511	2100	1900
565851567	114579513	118701571	1000	2010
565851567	118701571	114579513	1000	2010
565851568	114579507	118701571	850	2010
565851568	118701571	114579507	850	2010
565851569	114579522	118701572	1000	1700
565851569	118701572	114579522	1000	1700
565851570	114579519	118701572	1500	1700
565851570	118701572	114579519	1500	1900
565851571	114579517	118701572	1000	1700
565851571	118701572	114579517	1000	1700
565851573	114579535	118701573	1500	1900
565851573	118701573	114579535	1500	2010
565851575	114497971	118701574	1500	1900
565851575	118701574	114497971	1500	1900
565851576	118701574	114579588	1000	1700
565851577	114579592	118701574	1500	1900
565851577	118701574	114579592	1500	2010
565851578	114493452	118701575	3200	4000

Link	From Node	To Node	Previous Capacity	New Capacity
565851578	118701575	114493452	3200	4000
565851579	118701575	114493463	1000	1500
565851581	114493472	118701575	3200	2700
565851581	118701575	114493472	3200	4000
565851582	118701576	114493713	1900	850
565851583	114493706	118701576	3200	2010
565851583	118701576	114493706	3200	2010
565851584	118701576	114493696	3200	4000
565851590	114579558	114497752	850	1700
565851592	114579559	114579558	1500	1700
565851600	118701580	114494548	1500	1700
565851604	118701580	114579527	1000	1700
565851614	114493901	114579485	1000	2010
565851614	114579485	114493901	1000	2010
565851615	114497601	114497971	1500	2010
565851615	114497971	114497601	1500	2010
565851616	114495368	114579592	1500	2010
565851616	114579592	114495368	1500	2010
565851617	114493617	114579478	1000	2010
565851617	114579478	114493617	1000	2010
565851618	114493504	118701585	850	2010
565851618	118701585	114493504	850	2010
565851619	33746	118701585	850	2010
565851619	118701585	33746	850	2010
565851621	114497637	114579535	1500	2010
565851621	114579535	114497637	1500	2010
565851622	114579594	114579533	1000	1700
565851630	114494574	34114	1300	1700
565851635	114579558	118701592	1500	1700
565851641	114579508	118701594	1000	2010
565851641	118701594	114579508	1000	2010
565851643	114579474	118701596	850	2010
565851643	118701596	114579474	850	2010
565851644	114579507	118701596	850	2010
565851644	118701596	114579507	850	2010
565851645	114579445	118701597	1900	2010
565851645	118701597	114579445	1900	2010
565851649	114494320	118701598	1000	1700
565851649	118701598	114494320	1000	1700
565851650	114579517	118701598	1000	1700
565851650	118701598	114579517	1000	1700
565851654	114579522	118701600	1000	1700
565851654	118701600	114579522	1000	1700
565851657	114579527	118701602	1000	1700
565851658	118701604	114579539	1000	1700
565851672	114579547	118701607	1500	1700
565851680	118701610	114579558	1500	1700
565851682	118701612	114579559	1500	1700

Link	From Node	To Node	Previous Capacity	New Capacity
565851685	114579570	118701614	1500	1700
565851691	114579570	118701616	1000	1700
565851694	114579570	118701618	1500	1700
565851696	114579570	118701619	1000	1700
565851697	114497178	118701619	1000	1700
565851697	118701619	114497178	1000	1700
565851704	114579588	118701624	1000	1700
565851717	114497332	118701629	2000	1900
565851717	118701629	114497332	3000	3050
565851720	114493789	118701633	1000	2010
565851720	118701633	114493789	1000	2010
565851724	114579493	118701633	1000	2010
565851724	118701633	114579493	1000	2010
565851805	114493963	118701709	1000	2010
565851805	118701709	114493963	1900	3200
565851806	114497101	118701709	1900	3200
565851806	118701709	114497101	1000	2010
565851808	114493963	118701711	2000	2010
565851808	118701711	114493963	1900	2010
565851822	118701578	118701717	3200	3050
565851822	118701717	118701578	3200	3600
565851823	114497332	118701718	3000	3050
565851823	118701718	114497332	2000	2010
565851825	114497336	118701719	1000	1700
565851825	118701719	114497336	1000	1700
565851826	118701578	118701719	1000	1700
565851827	118701720	118701718	2000	2010
565851828	118701578	118701720	2100	3050
565851830	114493819	118701721	2000	3050
565851830	118701721	114493819	1900	3050
565851831	118701629	118701722	2000	1900
565851832	118701722	114493819	2000	3050
565851834	114493819	118701723	150	850
565851834	118701723	114493819	150	1900
772398559	124316542	124316541	3600	4000
1131703757	237403633	237403634	850	0
1131703757	237403634	237403633	850	0
1131703761	237403625	237403636	500	850
1131703761	237403636	237403625	500	850
1131703797	233199408	237403649	850	0
1131703797	237403649	233199408	850	0
1131704026	114497335	237403821	1000	1700
1131704026	237403821	114497335	1000	1700
1131704036	114497498	237403823	850	0
1131704036	237403823	114497498	850	0
1131704040	114494561	237403625	500	850
1131704040	237403625	114494561	500	850
1131704042	114494560	237403624	850	1500

Link	From Node	To Node	Previous Capacity	New Capacity
1131704042	237403624	114494560	850	1500
1131704053	114497637	237403826	1500	2010
1131704053	237403826	114497637	1500	2010
1131704102	114494130	237403844	850	0
1131704102	237403844	114494130	850	0
1131704103	114494382	237403844	850	1500
1131704103	237403844	114494382	850	1500
1131704105	114494387	237403845	1000	1700
1131704107	124316541	114495659	3600	4000
1131704108	124438497	237403846	3600	4000
1131704108	237403846	124438497	3600	4000
1131704161	124410847	237403869	3400	3050
1131704161	237403869	124410847	3400	3050
1131704162	124410846	237403869	3400	3050
1131704162	237403869	124410846	3400	3050
1131704215	114497062	237403892	3600	4000
1131704216	237403894	124316542	3600	4000
1131704218	124316585	237403894	2800	2100
1131704218	237403894	124316585	2800	2100
1131704219	237403892	237403894	3600	4000
1131704232	33474	114494729	1000	1700
1131704232	114494729	33474	1000	1700
1131704261	34432	114494260	1000	1700
1131704261	114494260	34432	1000	1700
1131704291	33476	114494729	1000	1700
1131704291	114494729	33476	1000	1700
1131704309	33732	114494443	1000	1700
1131704310	237403845	33732	1000	1700
1131704319	35742	114492814	3600	4000
1131704320	114492824	35742	3600	4000
1131704325	33963	114495324	1000	1700
1131704325	114495324	33963	1000	1700
1131704326	33963	114495340	1000	1700
1131704326	114495340	33963	1000	1700
1131704379	33679	114494320	1000	1700
1131704379	114494320	33679	1000	1700
1131704381	114494361	33731	1000	1700
1131704382	33731	114494379	1000	1700
1131704455	35323	114494478	1500	1700
1131704455	114494478	35323	1500	1700
1131704456	35323	114494548	1500	1700
1131704456	114494548	35323	1500	1700
1131704520	33961	114494906	1000	1700
1131704520	114494906	33961	1000	1700
1131704565	35370	35388	850	2010
1131704565	35388	35370	850	2010
1131704608	35471	114579504	850	1700
1131704608	114579504	35471	850	1700

Link	From Node	To Node	Previous Capacity	New Capacity
1131704627	33980	114495265	1000	1700
1131704627	114495265	33980	1000	1700
1131704647	33982	114495224	1000	1700
1131704647	114495224	33982	1000	1700
1131704661	124313874	35715	3600	4000
1131704662	35715	124438497	3600	4000
1131704676	34198	114494129	1000	2010
1131704676	114494129	34198	1000	2010
1131704769	34115	114497410	1300	1700
1131704769	114497410	34115	1300	1700
1131704770	34114	34115	1300	1700
1131704770	34115	34114	1300	1700
1131704815	33819	114494675	1000	2010
1131704815	114494675	33819	1000	2010
1131704817	35469	114493726	1900	2010
1131704817	114493726	35469	1900	2010
1131704871	33986	114494965	1000	1700
1131704871	114494965	33986	1000	1700
1131704872	33986	114495075	1000	1700
1131704872	114495075	33986	1000	1700
1131704873	34704	114495285	1000	1700
1131704873	114495285	34704	1000	1700
1131704891	35375	114494767	1000	1700
1131704891	114494767	35375	1000	1700
1131704914	33459	114493875	850	1787
1131704914	114493875	33459	850	2010
1131704979	33747	114493409	850	1500
1131704979	114493409	33747	850	1500
1131704980	33747	114497421	850	1500
1131704980	114497421	33747	850	1500
1131704981	35380	118701588	1000	1700
1131704981	118701588	35380	1000	1700
1131704982	35380	237403835	1000	1700
1131704982	237403835	35380	1000	1700
1131704989	33820	114494525	1000	2010
1131704989	114494525	33820	1000	2010
1131704991	33679	35393	1000	1700
1131704991	35393	33679	1000	1700
1131705023	33856	114494178	1900	3050
1131705023	114494178	33856	1900	3050
1131705041	33985	114495202	1000	1700
1131705041	114495202	33985	1000	1700
1131705042	33985	114497599	1000	1700
1131705042	114497599	33985	1000	1700
1131705047	33920	114494413	1000	1700
1131705047	114494413	33920	1000	1700
1131705105	33817	114494833	1000	2010
1131705105	114494833	33817	1000	2010

Link	From Node	To Node	Previous Capacity	New Capacity
1131705131	33812	114494923	1000	2010
1131705131	114494923	33812	1000	2010
1131705173	34197	34198	1000	2010
1131705173	34198	34197	1000	2010
1131705174	34197	114494066	1000	2010
1131705174	114494066	34197	1000	2010
1131705196	34701	114495368	1000	1700
1131705196	114495368	34701	1000	1700
1131705197	33843	114494308	1000	2010
1131705197	114494308	33843	1000	2010
1131705217	33919	35374	1000	2010
1131705217	35374	33919	1900	2010
1131705221	114494087	35371	1900	1700
1131705261	33843	33844	1000	2010
1131705261	33844	33843	1000	2010
1131705262	33844	114494310	1000	2010
1131705262	114494310	33844	1000	2010
1131705297	34116	114493014	3200	4000
1131705298	114497381	34116	3200	4000
1131705319	114492881	35741	3600	4000
1131705320	35741	114497170	3600	4000
1131705322	33823	114579450	1000	2010
1131705322	114579450	33823	1000	2010
1131705325	33965	114497711	1000	1700
1131705325	114497711	33965	1000	1700
1131705329	35739	114497383	3200	4000
1131705330	114497856	35739	3200	4000
1131705361	35340	114494142	1000	1700
1131705361	114494142	35340	1000	1700
1131705362	35340	114494327	1000	1700
1131705362	114494327	35340	1000	1700
1131705377	33650	33820	1000	2010
1131705377	33820	33650	1000	2010
1131705378	33650	114494675	1000	2010
1131705378	114494675	33650	1000	2010
1131705382	35474	114493500	850	2010
1131705382	114493500	35474	850	2010
1131705415	35079	114493472	3200	4000
1131705416	114497379	35079	3200	4000
1131705475	33473	33474	1000	1700
1131705475	33474	33473	1000	1700
1131705476	33473	114494617	1000	1700
1131705476	114494617	33473	1000	1700
1131705479	33475	33476	1000	1700
1131705479	33476	33475	1000	1700
1131705480	33475	33477	1000	1700
1131705480	33477	33475	1000	1700
1131705497	35740	114492880	3600	4000

Link	From Node	To Node	Previous Capacity	New Capacity
1131705498	114497169	35740	3600	4000
1131705504	33967	114497178	1000	1700
1131705504	114497178	33967	1000	1700
1131705565	114493722	114493723	850	0
1131705593	114493509	35468	3200	4000
1131705594	35468	114497380	3200	4000
1131705628	33818	114494833	1000	2010
1131705628	114494833	33818	1000	2010
1131705659	35714	124313713	3600	4000
1131705660	124438497	35714	3600	4000
1131705669	33472	114494447	1000	1700
1131705669	114494447	33472	1000	1700
1131705670	33472	33988	1000	1700
1131705670	33988	33472	1000	1700
1131705678	35367	114493916	850	0
1131705683	33811	33812	1000	2010
1131705683	33812	33811	1000	2010
1131705684	33811	114494924	1000	2010
1131705684	114494924	33811	1000	2010
1131705701	33821	114494489	1000	2010
1131705701	114494489	33821	1000	2010
1131705702	33821	114494525	1000	2010
1131705702	114494525	33821	1000	2010
1131705711	33920	33960	1000	1700
1131705711	33960	33920	1000	1700
1131705712	33960	114494606	1000	1700
1131705712	114494606	33960	1000	1700
1131705715	33822	33823	1000	2010
1131705715	33823	33822	1000	2010
1131705716	33822	114494489	1000	2010
1131705716	114494489	33822	1000	2010
1131705723	33921	35375	1000	1700
1131705723	35375	33921	1000	1700
1131705724	33921	114494789	1000	1700
1131705724	114494789	33921	1000	1700
1131705731	33965	33966	1000	1700
1131705731	33966	33965	1000	1700
1131705732	33966	118701616	1000	1700
1131705732	118701616	33966	1000	1700
1131705769	114497383	35738	3200	4000
1131705770	35738	114497857	3200	4000
1131705829	33680	35393	1000	1700
1131705829	35393	33680	1000	1700
1131705830	33680	237403835	1000	1700
1131705830	237403835	33680	1000	1700
1131705891	33961	33962	1000	1700
1131705891	33962	33961	1000	1700
1131705892	33962	114494861	1000	1700

Link	From Node	To Node	Previous Capacity	New Capacity
1131705892	114494861	33962	1000	1700
1131705895	33874	114494622	850	0
1131705895	114494622	33874	850	0
1131705899	35473	35474	850	2010
1131705899	35474	35473	850	2010
1131705900	35473	114493499	850	2010
1131705900	114493499	35473	850	2010
1131705913	33816	33817	1000	2010
1131705913	33817	33816	1000	2010
1131705914	33816	114494924	1000	2010
1131705914	114494924	33816	1000	2010
1131705945	33477	33478	1000	1700
1131705945	33478	33477	1000	1700
1131705946	33478	114494966	1000	1700
1131705946	114494966	33478	1000	1700
1131705948	33742	118701628	1000	1700
1131705948	118701628	33742	1000	1700
1131705951	34117	114493005	3200	4000
1131705952	114493013	34117	3200	4000
1131705965	114495566	35078	3600	4000
1131705966	35078	114495609	3600	4000
1131706085	34704	34705	1000	1700
1131706085	34705	34704	1000	1700
1131706086	34705	114495330	1000	1700
1131706086	114495330	34705	1000	1700
1131706183	33742	34431	1000	1700
1131706183	34431	33742	1000	1700
1131706184	34431	34432	1000	1700
1131706184	34432	34431	1000	1700
1131706195	34701	34702	1000	1700
1131706195	34702	34701	1000	1700
1131706196	34702	114495330	1000	1700
1131706196	114495330	34702	1000	1700
1131706227	33987	114495075	1000	1700
1131706227	114495075	33987	1000	1700
1131706228	33987	114495082	1000	1700
1131706228	114495082	33987	1000	1700
1131706257	33855	33856	1900	3050
1131706257	33856	33855	1900	3050
1131706258	33855	114494196	1900	3050
1131706258	114494196	33855	1900	3050
1131706283	33918	33919	1000	2010
1131706283	33919	33918	1900	2010
1131706284	33918	118701711	1900	2010
1131706284	118701711	33918	1000	2010
1131706285	33982	33983	1000	1700
1131706285	33983	33982	1000	1700
1131706286	33983	114495251	1000	1700

Link	From Node	To Node	Previous Capacity	New Capacity
1131706286	114495251	33983	1000	1700
1131706309	114494413	33740	1500	0
1131706310	33740	114494484	1500	0
1131706339	35469	35470	1900	2010
1131706339	35470	35469	1900	2010
1131706340	35470	114579445	1900	2010
1131706340	114579445	35470	1900	2010
1131706344	34947	114493764	1500	850
1131706344	114493764	34947	1500	850
1131706546	114492814	35743	3600	4000
1131706547	35743	124313874	3600	4000
1131706566	33981	114495285	1000	1700
1131706566	114495285	33981	1000	1700
1131706567	33980	33981	1000	1700
1131706567	33981	33980	1000	1700
1131706570	33964	114495399	1000	1700
1131706570	114495399	33964	1000	1700
1131706571	33964	114495357	1000	1700
1131706571	114495357	33964	1000	1700
1131706588	35371	34678	1900	1700
1131706589	34678	114494142	1900	1700
1131706589	114494142	34678	1000	1700
1131706590	33958	114494861	1000	1700
1131706590	114494861	33958	1000	1700
1131706591	33958	114494820	1000	1700
1131706591	114494820	33958	1000	1700
1131706610	35472	114493499	850	1700
1131706610	114493499	35472	850	1700
1131706611	35471	35472	850	1700
1131706611	35472	35471	850	1700
1131706618	114495610	35078	3600	4000
1131706619	35078	114495565	3600	4000
1131706674	237403904	35367	850	0
1131706675	114493876	237403904	850	0
1131706784	114494560	237403967	850	1500
1131706784	237403967	114494560	850	1500
1131706785	114494652	237403967	850	1500
1131706785	237403967	114494652	850	1500
1131706838	237404015	114493756	3200	4000
1131706839	114493837	237404015	3200	4000
1131706840	114493778	237404016	3200	4000
1131706841	237404016	114493837	3200	4000
1131706842	237404017	114497714	3200	4000
1131706843	114493660	237404017	3200	4000
1131706844	118701721	237404018	2000	1700
1131706844	237404018	118701721	1900	1700
1131706845	114493395	237404018	1900	1700
1131706846	114494639	237404019	3600	4000

Link	From Node	To Node	Previous Capacity	New Capacity
1131706847	237404019	114497740	3600	4000
1131706849	118701602	237404021	1000	1700
1131706849	237404021	118701602	1000	1700
1131706850	114494530	237404021	1000	1700
1131706850	237404021	114494530	1000	1700
1131706927	114494605	237404073	1300	1700
1131706927	237404073	114494605	1300	1700
1131707015	114493388	114493395	1900	1700
1131707041	237404121	114497856	3200	4000
1131707042	114579426	237404122	3200	4000
1131707047	237404124	114579424	3200	4000
1131707052	237404123	237404127	3200	4000
1131707054	237404120	237404124	3000	2700
1131707055	237404124	237404125	1900	2700
1131707056	237404125	237404128	3000	2700
1131707063	237404126	237404129	1000	1900
1131707065	237404130	237404120	3200	4000
1131707066	114497857	237404130	3200	4000

Table A-3: Speed Change

Section	Dir	From Node	To Node	New Speed	Previous Speed	Comment
A82 Longman Approach	EB	237404130	237404120	80	48	
A82 Longman Approach	EB	114497857	237404130	80	48	
A9 between Raigmore and Longman	NB	114493593	114497464	113	97	
A9 between Raigmore and Longman	NB	114497464	114497741	113	97	
A9 between Raigmore and Longman	NB	114497741	114579426	80	97	Speed limit changes on approach to Longman
A9 North of Longman	NB	114493005	114493004	80	97	
A9 North of Longman	NB	114493032	114493033	80	97	
A9 North of Longman	NB	114493004	114492939	80	97	
A9 North of Longman	NB	114497328	114493032	80	97	
A9 North of Longman	NB	114493033	114493013	80	97	
A9 North of Longman	NB	114579424	114497328	80	97	
A9 North of Longman	NB	34117	114493005	80	97	
A9 North of Longman	NB	114493013	34117	80	97	
A9 North of Longman	NB	237404124	114579424	80	97	
A9 North of Longman	SB	114493031	114493030	80	89	
A9 North of Longman	SB	114493030	114497326	80	89	
A9 North of Longman	SB	114493014	114493031	80	89	
A9 North of Longman	SB	114497326	114497743	80	89	
A9 North of Longman	SB	34116	114493014	80	89	
A9 North of Longman	SB	114497743	237404125	80	89	
A9 North of Longman	SB	114497382	114497381	80	97	
A9 North of Longman	SB	114492940	114497382	80	97	
A9 North of Longman	SB	114497381	34116	80	97	

Section	Dir	From Node	To Node	New Speed	Previous Speed	Comment
A9 Raigmore Merge	SB	114493797	114494104	113	97	Slip road is National Speed limit
A9 Diverge	SB	114493592	114493715	113	80	No Speed limit change between Mainline and diverge
A9 Diverge	SB	114497375	114493592	113	97	
A9 South of Raigmore	SB	114494596	114494595	113	89	
A9 South of Raigmore	SB	114497371	114494596	113	89	
A9 South of Raigmore	SB	114494104	114494103	113	97	
A9 South of Raigmore	SB	114494595	114494639	113	97	
A9 South of Raigmore	SB	114495407	114495420	113	97	
A9 South of Raigmore	SB	114494103	114497371	113	97	
A9 South of Raigmore	SB	114497373	114497372	113	97	
A9 South of Raigmore	SB	114497372	114495407	113	97	
A9 South of Raigmore	SB	114495420	114497707	113	97	
A9 South of Raigmore	SB	114497740	114497373	113	97	
A9 South of Raigmore	SB	114494639	237404019	113	97	Speed limit on the A9 on this section is 113kph
A9 South of Raigmore	SB	237404019	114497740	113	97	
A9 South of Raigmore	NB	114494107	114494108	113	97	
A9 South of Raigmore	NB	114494420	114494410	113	97	
A9 South of Raigmore	NB	114494552	114494420	113	97	
A9 South of Raigmore	NB	114495403	114495402	113	97	
A9 South of Raigmore	NB	114494410	114494107	113	97	
A9 South of Raigmore	NB	114495402	114497324	113	97	
A9 South of Raigmore	NB	114497324	114497370	113	97	
A9 South of Raigmore	NB	114497370	114494552	113	97	
A9 South of Raigmore	NB	114497374	114495403	113	97	
A9 South of Raigmore	NB	114497706	114497374	113	97	
A9 through Raigmore	SB	114493592	114494104	113	97	
A9 through Raigmore	NB	114494108	114493591	113	97	
Approach to Inshes Slips	EB/WB	114494409	233196177	97	45	National Speed Limit is 97kph
Approach to Inshes Slips	EB/WB	233196177	114494409	97	45	
Culcabock Road	EB/WB	114494453	114579435	48	45	
Culcabock Road	EB/WB	114579435	114494453	48	45	
Culcabock Road	EB/WB	114579522	118701572	48	45	
Culcabock Road	EB/WB	118701572	114579522	48	45	
Culcabock Road	EB/WB	114579435	118701600	48	45	
Culcabock Road	EB/WB	118701600	114579435	48	45	
Culcabock Road	EB/WB	114579522	118701600	48	45	
Culcabock Road	EB/WB	118701600	114579522	48	45	
Culloden Road	EB/WB	114494497	114494498	48	45	
Culloden Road	EB/WB	114494498	114494497	48	45	
Culloden Road	EB/WB	114494498	114497091	48	45	
Culloden Road	EB/WB	114497091	114494498	48	45	
Culloden Road	EB/WB	114494530	114497091	48	45	
Culloden Road	EB/WB	114497091	114494530	48	45	
Culloden Road	EB/WB	114579527	118701580	48	45	
Culloden Road	EB/WB	118701580	114579527	48	45	
Culloden Road	EB/WB	114579527	118701602	48	45	

Section	Dir	From Node	To Node	New Speed	Previous Speed	Comment
Culloden Road	EB/WB	118701602	114579527	48	45	
Culloden Road	EB/WB	118701602	237404021	48	45	
Culloden Road	EB/WB	237404021	118701602	48	45	
Culloden Road	EB/WB	114494530	237404021	48	45	
Culloden Road	EB/WB	237404021	114494530	48	45	
Inshes Diverge	NB	114494420	114494409	97	45	
Inshes Merge	NB	114494409	114494410	97	48	
Longman Drive	NB/SB	114493180	114493188	48	45	
Longman Drive	NB/SB	114493188	114493180	48	45	
Longman Drive	NB/SB	114493188	114493198	48	45	
Longman Drive	NB/SB	114493198	114493188	48	45	
Longman Drive	NB/SB	114493198	114493240	48	45	
Longman Drive	NB/SB	114493240	114493198	48	45	
Longman Drive	NB/SB	114493240	114493401	48	45	
Longman Drive	NB/SB	114493401	114493240	48	45	
Longman Drive	NB/SB	114493401	114493432	48	45	
Longman Drive	NB/SB	114493432	114493401	48	45	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	WB	114493833	114493865	48	50	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	WB	114493790	114493833	48	50	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	WB	114493865	33651	48	50	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	WB	33651	114497101	48	50	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	WB	114493728	114493684	48	64	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	WB	114493723	114493731	48	64	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	WB	114493731	114493790	48	64	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	WB	118701579	114493728	48	64	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	WB	114493684	114493708	48	64	Speed Limit is 48kph
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	WB	114493708	34691	48	64	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	WB	34691	114493723	48	64	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	EB	114493833	114498009	48	50	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	EB	114498009	114493791	48	50	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	EB	114493865	114579429	48	50	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	EB	114579429	114493833	48	50	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	EB	33651	114493865	48	50	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	EB	114497101	33651	48	50	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	EB	114493685	114493728	48	64	

Section	Dir	From Node	To Node	New Speed	Previous Speed	Comment
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	EB	114493732	114497378	48	64	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	EB	114497378	114493690	48	64	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	EB	114493791	114493732	48	64	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	EB	114493728	118701579	48	64	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	EB	114493690	33917	48	64	
Millburn Road west of Harbour Road to the Eastfield Shopping Centre Car Park	EB	33917	114493685	48	64	
Millburn Road East of Harbour Road	EB	33652	114497377	48	64	
Millburn Road East of Harbour Road	EB	114493701	33652	48	64	
Millburn Road East of Harbour Road	EB	118701579	114493701	48	64	Speed Limit is 48kph
Millburn Road East of Harbour Rd	EB/WB	114493745	33653	48	64	
Millburn Road East of Harbour Rd	EB/WB	114493701	118701579	48	64	
Millburn Road East of Harbour Rd	EB/WB	33653	114493701	48	64	
Old Perth Road approach to Millburn Rd RBT	NB	114493734	118701579	48	19	
Old Perth Road approach to Millburn Rd RBT	NB	118701588	114493734	48	19	
Old Perth Road	SB	118701579	114493734	48	45	
Old Perth Road	SB	114493734	118701588	48	45	
Old Perth Road	SB	114494320	118701598	48	47	
Old Perth Road	SB	33679	114494320	48	47	
Old Perth Road	SB	118701588	35380	48	47	
Old Perth Road	SB	35380	237403835	48	47	
Old Perth Road	SB	35393	33679	48	47	
Old Perth Road	SB	33680	35393	48	47	
Old Perth Road	SB	237403835	33680	48	47	
OPR/Culloden Road	EB/WB	114494469	33682	48	40	
OPR/Culloden Road	EB/WB	114494469	114579525	48	45	
OPR/Culloden Road	EB/WB	114579525	114494469	48	45	
OPR/Culloden Road	EB/WB	114579519	114579525	48	45	
OPR/Culloden Road	EB/WB	114579525	114579519	48	45	
OPR/Culloden Road	EB/WB	114579519	118701572	48	45	
OPR/Culloden Road	EB/WB	118701572	114579519	48	45	
OPR/Culloden Road	EB/WB	33681	114494493	48	45	
OPR/Culloden Road	EB/WB	114494493	33681	48	45	
OPR/Culloden Road	EB/WB	33681	33682	48	45	
OPR/Culloden Road	EB/WB	33682	33681	48	45	
OPR/Culloden Road	EB/WB	33682	114494469	48	45	
Seg left at Longman	SB	237404126	237404127	80	97	
Shore Street	NB/SB	114493606	114579481	48	32	
Shore Street	NB/SB	114579481	114493606	48	32	
Shore Street	NB/SB	114493606	114497417	48	32	Speed Limit is 48kph
Shore Street	NB/SB	114497417	114493606	48	32	
Shore Street	NB/SB	114493432	114497417	48	32	
Shore Street	NB/SB	114497417	114493432	48	32	
Shore Street	NB/SB	114579481	114579531	48	45	

Section	Dir	From Node	To Node	New Speed	Previous Speed	Comment
Shore Street	NB/SB	114579531	114579481	48	45	
Stadium Road	NB/SB	114497157	114497327	48	40	
Stadium Road	NB/SB	114497327	114497157	48	40	
Stadium Road	NB/SB	114493180	114497158	48	45	
Stadium Road	NB/SB	114497158	114493180	48	45	
Stadium Road	NB/SB	114497157	114497158	48	45	
Stadium Road	NB/SB	114497158	114497157	48	45	
Sir Walter Scott Drive between Inshes RBT and LifeScan	NB/SB	114494478	233196177	48	45	
Sir Walter Scott Drive between Inshes RBT and LifeScan	NB/SB	233196177	114494478	48	45	
Sir Walter Scott Drive between Inshes RBT and LifeScan	NB/SB	35323	114494478	48	45	
Sir Walter Scott Drive between Inshes RBT and LifeScan	NB/SB	114494478	35323	48	45	
Sir Walter Scott Drive between Inshes RBT and LifeScan	NB/SB	35323	114494548	48	45	
Sir Walter Scott Drive between Inshes RBT and LifeScan	NB/SB	114494548	35323	48	45	

Table A-4: Junction Change

Junction	Node	Comment
Shore Street/Harbour Road	114493432	Previously coded as signalised, but a roundabout on the ground
A9 Northbound Merge at Inshes Junction	114494410	(PM Only) Merge was previously coded as uncontrolled but should a two-way yield to reflect the need to merge.
A9 Southbound Merge at Inshes Junction	114494639	(PM Only) Merge was previously coded as uncontrolled but should a two-way yield to reflect the need to merge.
Node on the A9 South of Inshes Junction	237404019	PM Only) Node of the A9 was coded as Two-Way Stop, changed to Uncontrolled

Appendix B. Prior Matrix Validation

Table B-1: Sectored RSI Matrix -Car In Work Distribution - AM Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		22%				11%										22%	33%		11%
2	6%	6%	6%			6%					6%					67%			6%
3																			
4																			
5	13%					13%					13%			6%	6%	25%	19%	6%	
6		10%														90%			
7																100%			
8																			
9																100%			
10																			
11																100%			
12																100%			
13		100%																	
14	9%	3%	6%		6%			3%	3%		11%				6%	43%		9%	3%
15																			
16	17%				17%				17%		17%				17%		17%		
17																			
18									29%							71%			
19		50%														50%			

Table B-2: Sectored Prior Matrix - Car In Work Distribution - AM Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		4%				2%	3%				2%			8%	37%	19%	1%	1%	23%
2	13%	8%	2%		1%			2%			9%			2%	25%	22%	2%	5%	9%
3	14%															86%			
4	13%	6%			10%										21%	35%			15%
5	14%	10%		1%		1%	1%				9%				13%	28%	5%	5%	13%
6	2%	3%	5%		5%		3%	3%	1%					3%	30%	27%	1%		17%
7																98%	2%		
8											4%				17%	58%	6%	8%	7%
9		7%					2%				9%			4%	29%	48%	1%	1%	
10																			
11	6%	8%	3%		6%			3%	1%					2%	25%	20%	4%		24%
12		36%													32%	32%	1%		
13																			
14	6%		5%		2%			3%	2%		7%				10%	47%	7%	3%	9%
15																			
16	15%							1%			8%				5%	57%	7%	3%	4%
17																			
18	4%	13%	3%		2%			1%	1%					2%	27%	26%	7%		15%
19																84%	16%		

Table B-3: Sectored RSI Matrix -Car Commute Distribution - AM Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	4%	4%						4%						8%	15%	58%			8%
2		3%	3%	3%	3%	3%		3%	5%						11%	45%	8%		16%
3																			
4																100%			
5		3%						3%			5%			3%	13%	62%	5%		8%
6			9%		9%				9%						14%	55%			5%
7																100%			
8																67%		17%	17%
9						6%	3%	3%							15%	52%	3%	6%	12%
10																			
11					9%									9%	9%	45%	9%		18%
12																100%			
13																			
14	6%	3%			3%						3%				16%	53%	9%	3%	3%
15																			
16	25%															75%			
17																100%			
18			6%												22%	72%			
19								20%								60%	20%		

Table B-4: Sectored Prior Matrix - Car Commute Distribution - AM Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		3%	3%			1%					4%			4%	26%	34%	12%	3%	11%
2	2%	24%	13%		3%			1%	1%		7%			3%	11%	17%	3%	5%	10%
3	52%															48%			
4	2%	33%	17%		6%			1%	2%				2%	1%	12%	14%	3%		9%
5	14%	4%				1%					7%				20%	31%	8%	3%	11%
6	5%	6%	4%		3%		1%	1%	1%					4%	21%	30%	8%		15%
7	10%		8%													67%	16%		
8						1%					4%				26%	41%	11%	4%	14%
9	13%	4%		1%		1%					5%			4%	21%	26%	10%	3%	12%
10																			
11	4%	11%	13%		10%			1%	1%				1%	3%	18%	23%	5%		10%
12	2%	7%	6%		2%			7%							19%	29%	7%		21%
13																			
14	3%		2%		2%			1%	1%		3%				20%	41%	10%	3%	14%
15																			
16	6%							1%			3%				18%	40%	16%	4%	11%
17																			
18	3%	5%	4%		4%			1%	1%					3%	26%	30%	7%		15%
19																77%	23%		

Table B-5: Sectored RSI Matrix -Car Other Distribution - AM Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1																75%			25%
2		7%			7%											71%	14%		
3		33%														67%			
4															50%				50%
5		14%				14%									7%	57%	7%		
6																100%			
7																			
8															50%	50%			
9			13%												13%	63%	13%		
10																			
11																100%			
12																			
13																			
14																100%			
15																			
16						25%			25%		25%					25%			
17																			
18																			
19			50%													50%			

Table B-6: Sectored Prior Matrix – Car Other Distribution - AM Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		2%	1%								1%			4%	4%	30%	57%	1%	
2	1%	12%	3%		2%			2%	1%		5%			4%	10%	41%	2%	6%	11%
3																100%			
4	17%	11%	19%		1%			4%							4%	22%	6%		16%
5	7%	13%		2%		2%					5%				8%	34%	20%	5%	4%
6	4%	2%	4%		3%		3%	1%	1%					2%	15%	56%			9%
7																96%	4%		
8						3%					3%				11%	65%	5%	2%	11%
9	11%	6%		3%		1%	2%				5%			3%	9%	24%	33%	1%	3%
10																			
11	4%	3%	12%		4%			2%						2%	14%	33%	2%		23%
12	33%	13%	6%		1%										10%	30%			6%
13																			
14	5%		3%		1%	3%		2%	1%		1%				10%	48%	5%	2%	19%
15																			
16	7%							2%			2%				12%	52%	8%	2%	15%
17																			
18	1%	8%	7%		1%			2%						4%	14%	49%	3%		11%
19																89%	11%		

Table B-7: Sectored RSI Matrix -LGV Distribution - AM Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1							11%								33%	33%			22%
2	50%																		50%
3		8%				8%					15%			8%		54%		8%	
4															100%				
5											33%				33%	33%			
6																			
7				50%		50%													
8																100%			
9		25%		25%							50%								
10																			
11			17%		17%											50%			17%
12																100%			
13																			
14															100%				
15																			
16			50%																50%
17																			
18			17%						17%							67%			
19	100%																		

Table B-8: Sectored Prior Matrix - LGV Distribution - AM Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1			2%	1%		3%					7%			2%	42%	16%	3%	8%	16%
2	3%										12%			4%	49%	17%		4%	10%
3	6%															94%			
4	11%		3%		19%										58%	8%			
5	1%	2%					1%				7%				71%	9%		2%	6%
6	11%	5%	3%		1%		6%		3%						32%	33%			6%
7	19%		15%													65%			
8						9%					3%				39%	21%		16%	13%
9	20%	2%									2%				41%	20%		5%	11%
10																			
11	2%	1%	5%		2%			3%	1%					1%	63%	11%	1%		11%
12	14%		36%		11%										39%				
13																			
14	16%		9%		2%	7%			2%		15%				12%	19%		18%	
15																			
16	15%							23%			25%				11%	16%		4%	5%
17																			
18	1%	9%	3%		1%			2%	2%					3%	43%	20%	1%		16%
19																100%			

Table B-9: Sectored RSI Matrix -Car In Work Distribution – Inter Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1			19%			13%					19%			6%	6%	25%		13%	
2	8%													8%	8%	77%			
3											25%			25%		50%			
4			33%													67%			
5			3%	3%			6%				3%			10%	10%	52%	6%	3%	3%
6																100%			
7																100%			
8															20%	60%		20%	
9	5%	5%									5%					74%			11%
10																			
11																100%			
12																			
13																			
14								13%								75%	13%		
15																			
16						25%									25%	50%			
17																			
18																			
19														50%		50%			

Table B-10: Sectored Prior Matrix - Car In Work Distribution – Inter Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		5%	11%			3%					7%			5%	24%	38%		4%	3%
2	1%	2%	9%		4%	5%			2%		11%			3%	16%	25%	3%	11%	7%
3						2%										62%	10%		26%
4	2%	18%	10%		8%			3%						3%	14%	31%			13%
5		12%		2%		4%	1%				11%			2%	19%	35%	2%	7%	5%
6	8%	8%	2%		6%		2%	5%							24%	46%			
7	5%		19%					7%							12%	57%			
8						9%					1%				10%	49%	5%	9%	18%
9		8%					9%				9%			5%	26%	26%	7%	2%	8%
10																			
11	13%	7%	15%		9%				2%				3%	2%	15%	19%	1%		13%
12			32%												34%	26%			9%
13																			
14	16%		9%		5%				11%		2%		7%		16%	17%	3%	14%	
15																			
16	16%		11%		7%			4%			4%				16%	31%	3%		9%
17																			
18	5%	5%	5%		3%			4%	2%					7%	18%	21%	3%		27%
19														14%		86%			

Table B-11: Sectored RSI Matrix -Car Commute Distribution – Inter Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		4%	4%			2%	2%				4%			6%	15%	39%	10%	4%	11%
2	2%	26%	13%		3%	1%		1%	1%		8%			3%	6%	18%	3%	5%	9%
3						3%										56%	18%		23%
4	2%	37%	20%		6%			1%						2%	6%	15%	4%		7%
5		6%				1%					10%			4%	13%	40%	8%	4%	12%
6	5%	5%	5%		4%		3%	3%	2%					5%	11%	32%	7%		17%
7	10%		7%					1%							18%	52%	11%		
8						3%					6%				16%	47%	10%	4%	14%
9		5%				1%					8%			6%	15%	37%	9%	4%	15%
10																			
11	5%	12%	15%		12%			1%	1%				1%	4%	10%	24%	6%		9%
12			13%												19%	44%			25%
13																			
14	5%		3%		3%	3%		3%	1%		5%		1%		14%	48%	8%	6%	
15																			
16	7%		4%		2%			4%			4%				10%	47%	6%		15%
17																			
18	4%	5%	6%		4%			1%	1%					6%	15%	35%	9%		13%
19														14%		86%			

Table B-12: Sectored Prior Matrix - Car Commute Distribution – Inter Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		3%	4%			3%	1%				3%			5%	6%	37%	28%	4%	5%
2	4%	4%	20%		3%	3%		2%	2%		5%			2%	4%	39%	1%	4%	7%
3						11%										71%	7%		12%
4	5%	28%	14%		3%			4%						4%	2%	34%	2%		5%
5		13%		1%		8%	3%				7%			31%	2%	25%	4%	3%	2%
6	2%	12%	5%		3%		3%	3%	1%					6%	8%	42%	4%		11%
7	8%		4%					9%							10%	66%	3%		
8						5%					1%				9%	63%	7%	8%	7%
9		10%				4%	4%				5%			3%	7%	50%	8%	2%	5%
10																			
11	5%	10%	6%		6%			3%	3%				4%	3%	8%	38%	4%		11%
12																50%			50%
13																			
14	12%		6%		3%	11%		5%	2%		4%				4%	47%	2%	4%	
15																			
16	17%		4%		4%			8%			2%				12%	44%	4%		5%
17																			
18	6%	10%	4%		3%			3%	1%					4%	10%	47%	2%		9%
19														15%		85%			

Table B-13: Sectored RSI Matrix -Car Other Distribution – Inter Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	2%		3%			5%	2%	3%			11%			3%	3%	52%	5%	7%	3%
2	6%	2%	7%		6%			1%			1%		1%	1%	1%	72%	2%		2%
3					14%						14%					71%			
4																100%			
5	1%	3%	3%	2%		5%	1%	1%			11%			2%	2%	66%	1%	3%	
6			50%													50%			
7								50%							50%				
8		7%				7%									7%	71%	7%		
9	2%	6%	3%			3%	2%	2%			3%			2%		75%	3%		
10																			
11																100%			
12																			
13																100%			
14	4%		4%		5%	2%		2%	7%		2%				5%	63%	4%	2%	2%
15																			
16	6%				6%						6%				6%	59%		18%	
17																			
18			50%													50%			
19	29%													14%	14%	43%			

Table B-14: Sectored Prior Matrix – Car Other Distribution – Inter Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		1%	4%			3%	1%				2%			9%	22%	39%	9%	4%	5%
2	2%	1%	3%		2%	10%		3%	2%		5%			2%	30%	18%	3%	12%	7%
3						7%										66%	12%		15%
4		14%	11%		17%			3%							24%	27%	4%		
5		5%		4%		7%	1%				8%				23%	29%	3%	6%	15%
6	2%	13%	5%		4%		11%	3%	2%					5%	51%	3%	2%		
7	10%		7%					4%							55%	23%			
8											2%				3%	72%			23%
9		30%									10%				14%	23%	5%	3%	14%
10																			
11	1%	3%	12%		8%			1%	4%					4%	39%	14%	2%		12%
12															73%	27%			
13																			
14	15%		13%		10%	12%		15%			16%		6%					12%	
15																			
16	6%		11%		4%			6%			6%				9%	58%			
17																			
18	5%	11%			6%				3%					5%	25%	29%			16%
19														45%		55%			

Table B-15: Sectored RSI Matrix -LGV Distribution – Inter Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		8%									8%			8%	33%	42%			
2			3%		3%									9%	3%	63%	3%	6%	9%
3															50%	50%			
4																			
5			17%								11%			6%	6%	44%		11%	6%
6																			
7																100%			
8											33%				33%	33%			
9	11%		11%												22%	44%			11%
10																			
11																100%			
12																			
13																			
14	17%				33%				17%							17%		17%	
15																			
16			25%												50%				25%
17																			
18																			
19																			

Table B-16: Sectored Prior Matrix - LGV Distribution – Inter Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		1%	4%			3%	1%				2%			9%	22%	39%	9%	4%	5%
2	2%	1%	3%	3%	2%	9%		3%	2%		5%			2%	29%	17%	2%	12%	7%
3	6%				9%	3%			9%		11%				29%	24%	4%		6%
4		14%	11%		17%			3%							24%	27%	4%		
5	9%	5%		3%		6%	1%				7%				21%	26%	3%	5%	14%
6	2%	13%	5%		4%		11%	3%	2%					5%	51%	3%	2%		
7	9%		6%		1%			4%						9%	49%	21%			
8		10%					3%				1%			10%	2%	56%			18%
9	16%	25%									9%				12%	19%	4%	3%	12%
10																			
11	1%	3%	11%		7%		7%	1%	3%					4%	36%	13%	2%		11%
12															73%	27%			
13																			
14	13%		11%		9%	11%	11%	13%			14%		6%					11%	
15																			
16	5%		10%	1%	3%	1%	2%	5%	4%		5%		1%		8%	49%		6%	
17																			
18	4%	9%			5%		17%		3%					4%	21%	24%			13%
19	14%	9%	8%		9%		9%	13%	5%		16%		4%					13%	

Table B-17: Sectored RSI Matrix -Car In Work Distribution - PM Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1											8%			8%	8%	54%	8%	8%	8%
2	8%				8%			8%	8%		8%		8%			31%			23%
3					100%														
4			100%																
5						23%								15%		38%			23%
6																			
7																			
8							13%									63%			25%
9														33%		33%		17%	17%
10																			
11																			
12																			
13																			
14					25%						25%					50%			
15																			
16																			
17																			
18																			
19																			

Table B-18: Sectored Prior Matrix - Car In Work Distribution - PM Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		1%	8%	2%		9%	8%				5%			13%	11%	21%	7%	10%	5%
2	19%	6%	3%		7%	3%		4%	1%		13%			4%	4%	23%	1%		13%
3	19%					48%		18%									15%		
4		17%			9%			9%					13%		26%	17%			9%
5		1%		1%		17%	1%				14%				20%	15%	17%	4%	11%
6	7%	19%			2%		2%							7%	7%	37%	3%		15%
7			58%		8%				10%							24%			
8						3%									24%	26%	43%	4%	
9	26%					7%					4%			5%	11%	26%	14%		5%
10																			
11	12%	8%	8%		14%		9%	2%	3%				1%	7%	7%	19%	3%		8%
12																100%			
13																			
14	20%		11%		4%	4%		9%	2%		8%				2%	19%	12%	8%	
15			30%											70%					
16	14%				6%	8%		12%	3%		6%				2%	19%	10%	8%	13%
17																			
18	4%	9%	9%		8%			4%	1%					7%	23%	27%	6%		2%
19								16%						19%		24%			40%

Table B-19: Sectored RSI Matrix -Car Commute Distribution - PM Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		3%	3%			3%	3%				7%			17%	3%	33%	3%	13%	10%
2		17%			8%	17%		8%	8%					8%		8%			25%
3	50%															50%			
4																			
5	6%		3%			9%	3%	3%			13%			6%		28%		13%	16%
6																			
7																			
8		17%									17%			33%		17%			17%
9	5%	5%	5%			5%	5%				10%			19%		38%		5%	5%
10																			
11																			
12																			
13																			
14	27%							27%								27%		9%	9%
15																			
16			25%		25%			25%							25%				
17																			
18																			
19								67%								33%			

Table B-20: Sectored Prior Matrix - Car Commute Distribution - PM Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		5%	17%			7%	3%				5%			15%	1%	21%	4%	5%	16%
2	4%	31%	14%		6%	4%		3%	2%		10%			9%	1%	6%	1%		11%
3	47%					23%		20%									10%		
4	7%	13%	11%		1%			4%						21%	21%	17%			4%
5		15%		1%		10%	5%				21%				2%	15%	3%	11%	18%
6	10%	9%	6%		6%		5%	4%	3%					10%	5%	21%	2%		18%
7	18%		15%		16%			15%	1%							35%			
8						12%	4%								12%	36%	24%	14%	
9	24%	7%				3%	1%				4%			15%		20%	9%	5%	11%
10																			
11	6%	18%	21%		4%		5%	5%	4%					11%	3%	11%	1%		10%
12	49%		21%					8%								12%			10%
13																			
14	29%		3%		4%	6%		8%	6%		6%				2%	24%	4%	7%	
15			11%											89%					
16	12%				5%	7%		10%	4%		6%				1%	24%	5%	7%	21%
17																			
18	8%	15%	7%		4%			6%	4%					13%	10%	15%	6%		13%
19								12%						28%		21%			40%

Table C9-21: Sectored RSI Matrix -Car Other Distribution - PM Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		12%	12%								6%			6%		41%	12%	6%	6%
2	3%	8%	5%					5%	5%					5%	3%	68%			
3		13%												13%		63%			13%
4																			
5	3%	8%				5%	3%	3%			13%					51%	3%	10%	3%
6																			
7																			
8						25%										75%			
9		4%	4%			14%	4%	7%			4%					46%	11%	4%	4%
10																			
11																			
12																			
13																			
14	13%				3%	7%		17%							3%	43%	13%		
15																			
16	11%					11%			11%							44%	11%		11%
17																			
18																			
19																100%			

Table B-22: Sectored Prior Matrix – Car Other Distribution - PM Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		2%		1%		3%	1%				4%	1%		8%	5%	46%	16%	3%	10%
2	2%	13%			2%	6%		5%	7%		5%			7%	5%	29%	2%		18%
3	26%					13%		30%									30%		
4	12%	5%	16%		5%			19%					4%		5%	16%			16%
5		3%		2%		8%	2%				6%	3%			4%	26%	31%	7%	6%
6	9%	7%	2%		4%		2%	7%						8%	4%	41%	3%		12%
7	4%		6%		8%			13%	2%							68%			
8						2%	3%								3%	48%	26%	19%	
9	5%	2%				6%	4%				7%			2%	7%	25%	38%		4%
10																			
11	4%	9%	6%		9%		4%	2%	3%				1%	2%	4%	33%	4%		18%
12	22%		8%					11%								49%			11%
13																			
14	35%				1%	1%		7%	2%						5%	28%	11%	11%	
15			20%											80%					
16	13%				4%	7%		7%	4%		3%				4%	26%	12%	8%	11%
17																			
18	8%	12%	6%		4%			2%	2%					7%	5%	34%	4%		17%
19								4%						13%		35%			48%

Table B-23: Sectored RSI Matrix -LGV Distribution - PM Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1		20%						20%			20%							20%	20%
2	12%	12%			12%									12%		24%	6%		24%
3																		50%	50%
4																			
5	8%	8%		8%				15%			8%					46%			8%
6																			
7																			
8																			
9		20%									20%			20%		20%		20%	
10																			
11																			
12																			
13																			
14	10%		10%		10%			20%	10%						10%	30%			
15																			
16																			
17																			
18																			
19																			

Table B-24: Sectored Prior Matrix - LGV Distribution - PM Peak

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1			2%			19%					4%	2%		23%		25%		12%	12%
2	38%		2%		4%	8%			1%		8%			6%	3%	17%			11%
3	45%					27%											27%		
4			6%		6%			22%							26%	13%			26%
5		4%		5%		12%	2%				13%	3%			12%	9%	27%	1%	13%
6			10%		1%			10%						20%					59%
7								7%	29%							64%			
8						8%									30%	57%		5%	
9		19%				8%					11%				50%				13%
10																			
11	6%	14%	6%		9%		9%	2%	1%				2%	11%	14%	12%	2%		14%
12																			
13																			
14	33%		21%		3%						5%							38%	
15			100%																
16	18%				4%	28%		7%	12%		14%							18%	
17																			
18	12%	11%	1%		7%			13%	8%					20%		2%			26%
19								100%											

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Appendix C. Convergence statistics – Last 5 Iterations

Table C-1 AM convergence summary

Iteration	Share of Links acceptable GEH	Share of Turns acceptable GEH	Share of turns acceptable GEH with ICA	Share of Links with Acceptable Rel. Gap in wait times	Share of Turns with Acceptable Rel. Gap in wait times
2	0.789051	0.815374	0.936085	0.997142	0.945338
3	0.945432	0.953594	0.984199	0.998035	0.970249
4	0.984907	0.984342	0.994021	0.998660	0.982918
5	0.986604	0.989751	0.996868	0.998839	0.991886
6	0.995267	0.994591	0.998149	0.999018	0.996441

Table C-2 IP convergence summary

Iteration	Share of Links acceptable GEH	Share of Turns acceptable GEH	Share of turns acceptable GEH with ICA	Share of Links with Acceptable Rel. Gap in wait times	Share of Turns with Acceptable Rel. Gap in wait times
1	0.081808	0.220751	1.000000	0.991784	0.548392
2	0.796642	0.828779	0.952605	0.997678	0.950897
3	0.972314	0.970111	0.990891	0.998571	0.980359
4	0.989015	0.987048	0.997153	0.999107	0.992314
5	0.995177	0.993168	0.998434	0.999375	0.996584

Table C-3 PM convergence summary

Iteration	Share of Links acceptable GEH	Share of Turns acceptable GEH	Share of turns acceptable GEH with ICA	Share of Links with Acceptable Rel. Gap in wait times	Share of Turns with Acceptable Rel. Gap in wait times
12	0.989011	0.988897	0.997438	0.999017	0.998149
13	0.990351	0.989181	0.997580	0.999107	0.999004
14	0.990172	0.989324	0.997011	0.999196	0.998861
15	0.990708	0.989039	0.998007	0.999107	0.999146
16	0.991423	0.990036	0.997722	0.999107	0.999004

Appendix D. Calibration counts

Table D-9 : Calibration AM

				Cars							Total						
Description	**Dir**	**A node**	**B node**	**Obs**	**Mod**	**Diff**	**% Diff**	**Link Flow**	**GEH**	**GEH < 5**	**Obs**	**Mod**	**Diff**	**% Diff**	**Link Flow**	**GEH**	**GEH < 5**
West Link (Holm Roundabout)	WB	118701574	812212125	341	297	-44	-13%	Pass	2.46	Pass	381	321	-60	-16%	Pass	3.20	Pass
West Link (Holm Roundabout)	EB	812212125	118701574	209	167	-42	-20%	Pass	3.06	Pass	239	186	-53	-22%	Pass	3.64	Pass
A96 (West of Nairn)	EB	118701247	118701248	280	293	13	5%	Pass	0.77	Pass	348	390	42	12%	Pass	2.16	Pass
A96 (West of Nairn)	WB	118701248	118701247	543	566	23	4%	Pass	0.97	Pass	676	690	14	2%	Pass	0.53	Pass
Henderson Road	EB	114493260	114497383	128	129	1	1%	Pass	0.09	Pass	333	301	-32	-10%	Pass	1.80	Pass
Henderson Road	WB	114497383	114493260	154	167	13	8%	Pass	1.03	Pass	249	273	24	10%	Pass	1.49	Pass
Cromwell Road (North of Harbour Road)	SB	114493401	114493432	120	177	57	48%	Pass	4.68	Pass	295	306	11	4%	Pass	0.63	Pass
Cromwell Road (North of Harbour Road)	NB	114493432	114493401	421	400	-21	-5%	Pass	1.04	Pass	626	552	-74	-12%	Pass	3.05	Pass
Harbour Road (East of Cromwell Road)	EB	114493432	114493436	125	102	-23	-18%	Pass	2.16	Pass	235	147	-88	-37%	Pass	6.37	Fail
Harbour Road (East of Cromwell Road)	WB	114493436	114493432	119	153	34	29%	Pass	2.92	Pass	210	216	6	3%	Pass	0.41	Pass
Seafield Road	SB	114493410	114493533	81	58	-23	-28%	Pass	2.76	Pass	149	88	-61	-41%	Pass	5.60	Fail
Seafield Road	NB	114493533	114493410	148	154	6	4%	Pass	0.49	Pass	249	192	-57	-23%	Pass	3.84	Pass

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
Harbour Road East of Seafield Road	EB	114493533	114493535	362	322	-40	-11%	Pass	2.16	Pass	503	437	-66	-13%	Pass	3.04	Pass
Harbour Road East of Seafield Road	WB	114493535	114493533	542	638	96	18%	Pass	3.95	Pass	709	761	52	7%	Pass	1.92	Pass
Millburn Road (exit of Raigmore Interchange)	WB	114493802	114493745	1157	1338	181	16%	Fail	5.12	Fail	1317	1543	226	17%	Fail	5.98	Fail
Tomnahurich Street (East of A82)	SB	114494196	114494209	268	316	48	18%	Pass	2.81	Pass	326	361	35	11%	Pass	1.89	Pass
Tomnahurich Street (East of A82)	NB	114494209	114494196	454	492	38	8%	Pass	1.75	Pass	535	545	10	2%	Pass	0.43	Pass
B9006 (A9 slip to Culloden Road)	SB	114494604	114494628	32	37	5	16%	Pass	0.85	Pass	42	53	11	26%	Pass	1.60	Pass
B9006 (A9 slip to Culloden Road)	NB	114494628	114494604	795	769	-26	-3%	Pass	0.93	Pass	879	821	-58	-7%	Pass	1.99	Pass
Culloden Road	EB	114494604	114494652	356	240	-116	-33%	Fail	6.72	Fail	426	275	-151	-35%	Fail	8.07	Fail
Culloden Road	WB	114494652	114494604	597	606	9	2%	Pass	0.37	Pass	666	696	30	5%	Pass	1.15	Pass
A96 Balloch Distr to Newton of Petty (B9039)	WB	114492912	114497069	750	750	0	0%	Pass	0.01	Pass	890	936	46	5%	Pass	1.51	Pass
A96 Balloch Distr to Newton of Petty (B9039)	EB	114497069	114492912	478	517	39	8%	Pass	1.76	Pass	641	742	101	16%	Fail	3.85	Pass
Kenneth Street	NB	114494309	114494209	89	85	-4	-4%	Pass	0.43	Pass	110	92	-18	-16%	Pass	1.79	Pass

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
Tomnahurich Street (West of A82)	WB	114494209	114494310	359	374	15	4%	Pass	0.78	Pass	462	464	2	0%	Pass	0.09	Pass
Tomnahurich Street (West of A82)	EB	114494310	114494209	424	431	7	2%	Pass	0.34	Pass	510	537	27	5%	Pass	1.18	Pass
Millburn Road (entry to Raigmore Interchange)	EB	114497377	114493754	386	480	94	24%	Pass	4.52	Pass	537	653	116	22%	Fail	4.76	Pass
Longman Road (north of Seafield Road)	SB	114497383	114493378	1214	1256	42	3%	Pass	1.20	Pass	1576	1546	-30	-2%	Pass	0.76	Pass
Longman Road (north of Seafield Road)	NB	114497385	114497383	641	634	-7	-1%	Pass	0.28	Pass	1049	976	-73	-7%	Pass	2.29	Pass
Shore Street	SB	114493432	114497417	171	235	64	37%	Pass	4.49	Pass	340	318	-22	-6%	Pass	1.21	Pass
Shore Street	NB	114497417	114493432	478	406	-72	-15%	Pass	3.42	Pass	696	495	-201	-29%	Fail	8.24	Fail
A9 South On Slip	SB	114493797	114494104	221	329	108	49%	Fail	6.51	Fail	299	373	74	25%	Pass	4.04	Pass
A9 South Off Slip	NB	114494108	114493824	462	509	47	10%	Pass	2.13	Pass	552	592	40	7%	Pass	1.67	Pass
A9 North On Slip	NB	114493755	114493593	598	568	-30	-5%	Pass	1.24	Pass	775	665	-110	-14%	Pass	4.10	Pass
A9 North Off Slip	SB	114493592	114493715	542	637	95	18%	Pass	3.91	Pass	765	827	62	8%	Pass	2.20	Pass
A96 East of Raigmore	WB	114497682	114493785	1333	1484	151	11%	Pass	4.02	Pass	1616	1689	73	5%	Pass	1.80	Pass
A96 East of Raigmore	EB	114493747	114497686	747	874	127	17%	Fail	4.46	Pass	1079	1181	102	9%	Pass	3.03	Pass
Kenneth Street (A82)	NB	114494209	114497849	295	323	28	9%	Pass	1.59	Pass	362	407	45	12%	Pass	2.29	Pass

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
Kenneth Street (A82)	SB	114497849	114494209	327	356	29	9%	Pass	1.57	Pass	413	426	13	3%	Pass	0.63	Pass
Caulfield Road	SB	114494499	114497960	434	401	-33	-8%	Pass	1.63	Pass	454	371	-83	-18%	Pass	4.07	Pass
Caulfield Road	NB	114497960	114494499	106	101	-5	-5%	Pass	0.49	Pass	117	128	11	9%	Pass	0.99	Pass
A9 South of Longman Junction	NB	114497741	114579426	1087	1131	44	4%	Pass	1.32	Pass	1448	1382	-66	-5%	Pass	1.75	Pass
Harbour Road (West of Seafield Road)	WB	114493533	114579598	463	539	76	16%	Pass	3.40	Pass	605	640	35	6%	Pass	1.40	Pass
Harbour Road (West of Seafield Road)	EB	114579598	114493533	350	319	-31	-9%	Pass	1.69	Pass	499	421	-78	-16%	Pass	3.64	Pass
B862 (South of Holm Roundabout)	NB	114497971	118701574	161	173	12	7%	Pass	0.93	Pass	194	210	16	8%	Pass	1.13	Pass
B862 (South of Holm Roundabout)	SB	118701574	114497971	66	85	19	29%	Pass	2.19	Pass	88	114	26	30%	Pass	2.59	Pass
Holm Road (B8082)	WB	114579588	118701574	390	351	-39	-10%	Pass	2.03	Pass	455	370	-85	-19%	Pass	4.19	Pass
Holm Road (B8082)	EB	118701574	114579588	387	353	-34	-9%	Pass	1.77	Pass	443	386	-57	-13%	Pass	2.80	Pass
Dores Rd (North of Holm Roundabout)	SB	114579592	118701574	126	126	0	0%	Pass	0.00	Pass	149	147	-2	-1%	Pass	0.16	Pass
Dores Rd (North of Holm Roundabout)	NB	118701574	114579592	93	93	0	0%	Pass	0.00	Pass	120	102	-18	-15%	Pass	1.71	Pass
Harbour Road (North of Millburn Road)	SB	114493693	118701579	256	286	30	12%	Pass	1.82	Pass	363	390	27	7%	Pass	1.39	Pass

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
Millburn Road (West of Harbour Road)	WB	118701579	114493728	529	555	26	5%	Pass	1.12	Pass	625	637	12	2%	Pass	0.48	Pass
Millburn Road (West of Harbour Road)	EB	114493728	118701579	363	282	-81	-22%	Pass	4.51	Pass	471	352	-119	-25%	Fail	5.87	Fail
Old Perth Road (South of Millburn Roundabout)	NB	114493734	118701579	314	351	37	12%	Pass	2.03	Pass	383	398	15	4%	Pass	0.76	Pass
Old Perth Road (South of Millburn Roundabout)	SB	118701579	114493734	482	541	59	12%	Pass	2.61	Pass	551	596	45	8%	Pass	1.88	Pass
Sir Walter Scott Drive (North of Inshes Roundabout)	SB	114494548	118701580	213	208	-5	-2%	Pass	0.34	Pass	260	257	-3	-1%	Pass	0.19	Pass
Sir Walter Scott Drive (North of Inshes Roundabout)	NB	118701580	114494548	911	1082	171	19%	Fail	5.42	Fail	1026	1200	174	17%	Fail	5.22	Fail
Tesco Access (South of Culloden Rd)	NB	114494578	118701580	425	412	-13	-3%	Pass	0.64	Pass	462	434	-28	-6%	Pass	1.32	Pass
Tesco Access (South of Culloden Rd)	SB	118701580	114494578	179	190	11	6%	Pass	0.81	Pass	210	220	10	5%	Pass	0.68	Pass
Old Perth Road (B9006)	EB	114579527	118701580	436	404	-32	-7%	Pass	1.56	Pass	504	465	-39	-8%	Pass	1.77	Pass
Old Perth Road (B9006)	WB	118701580	114579527	808	635	-173	-21%	Fail	6.44	Fail	891	696	-195	-22%	Fail	6.92	Fail

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
Old Perth Road (Southwest access to Police Scotland)	NB	114494564	118701580	79	69	-10	-13%	Pass	1.16	Pass	93	73	-20	-22%	Pass	2.20	Pass
Old Perth Road (Southwest access to Police Scotland)	SB	118701580	114494564	75	76	1	1%	Pass	0.12	Pass	86	77	-9	-10%	Pass	1.00	Pass
Sir Walter Scott Drive (South of Inshes Roundabout)	SB	118701580	118701586	418	378	-40	-10%	Pass	2.01	Pass	483	418	-65	-13%	Pass	3.06	Pass
Sir Walter Scott Drive (South of Inshes Roundabout)	NB	118701586	118701580	523	546	23	4%	Pass	0.99	Pass	586	584	-2	0%	Pass	0.08	Pass
B8082 (East of Slackbuie Avenue)	WB	118701612	118701715	413	373	-40	-10%	Pass	2.01	Pass	450	401	-49	-11%	Pass	2.39	Pass
B8082 (East of Slackbuie Avenue)	EB	118701715	118701612	491	463	-28	-6%	Pass	1.29	Pass	519	484	-35	-7%	Pass	1.55	Pass
General Booth Road	SB	34692	118701635	60	43	-17	-29%	Pass	2.42	Pass	76	58	-18	-24%	Pass	2.20	Pass
General Booth Road	NB	118701635	34692	126	117	-9	-7%	Pass	0.77	Pass	158	125	-33	-21%	Pass	2.77	Pass
B9177	SB	34527	114497074	149	28	-121	-81%	Fail	12.88	Fail	163	39	-124	-76%	Fail	12.35	Fail
B9177	NB	114497074	34527	106	82	-24	-23%	Pass	2.49	Pass	114	94	-20	-18%	Pass	1.97	Pass

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
Longman Road (North of Seafield Road)	SB	35739	114497383	1136	1145	9	1%	Pass	0.27	Pass	1402	1380	-22	-2%	Pass	0.59	Pass
Longman Road (North of Seafield Road)	NB	114497383	35738	537	484	-53	-10%	Pass	2.35	Pass	959	838	-121	-13%	Pass	4.04	Pass
A835	SB	124438054	124438086	488	466	-22	-5%	Pass	1.02	Pass	608	569	-39	-6%	Pass	1.60	Pass
A835	NB	124438086	124438054	406	405	-1	0%	Pass	0.06	Pass	506	542	36	7%	Pass	1.59	Pass
Castlehill Road	NB	34803	237403627	404	459	55	14%	Pass	2.63	Pass	417	459	42	10%	Pass	2.00	Pass
Castlehill Road	SB	237403627	34803	63	71	8	12%	Pass	0.93	Pass	71	107	36	50%	Pass	3.80	Pass
Culloden Road (West of UHI Access)	WB	114494604	237404073	1202	1130	-72	-6%	Pass	2.11	Pass	1338	1258	-80	-6%	Pass	2.22	Pass
Culloden Road (West of UHI Access)	EB	237404073	114494604	476	407	-69	-14%	Pass	3.28	Pass	545	459	-86	-16%	Pass	3.84	Pass
UHI Primary Access	NB	114494604	237404078	500	553	53	11%	Pass	2.31	Pass	529	572	43	8%	Pass	1.83	Pass
UHI Primary Access	SB	237404078	114494604	222	179	-43	-19%	Pass	3.04	Pass	245	181	-64	-26%	Pass	4.39	Pass
Barn Church Road	NB	114579459	237404109	555	739	185	33%	Fail	7.25	Fail	589	690	101	17%	Fail	4.01	Pass
Barn Church Road	SB	237404109	114579459	199	235	36	18%	Pass	2.45	Pass	226	292	66	29%	Pass	4.09	Pass
A9 North	NB	237404124	114579424	667	691	24	4%	Pass	0.92	Pass	1053	1118	65	6%	Pass	1.97	Pass
A9 North	SB	114497743	237404125	1625	1722	97	6%	Pass	2.37	Pass	1880	2071	191	10%	Pass	4.30	Pass
A9 South	SB	237404127	237404131	1303	1325	22	2%	Pass	0.61	Pass	1690	1647	-43	-3%	Pass	1.05	Pass
Stadium Road	EB	237404126	812212129	288	282	-6	-2%	Pass	0.36	Pass	393	386	-7	-2%	Pass	0.35	Pass
Stadium Road	WB	812212129	237404126	151	107	-44	-29%	Pass	3.87	Pass	252	240	-12	-5%	Pass	0.77	Pass
A82 (North of Harbour Road)	SB	114493452	118701575	1108	1136	28	3%	Pass	0.84	Pass	1501	1428	-73	-5%	Pass	1.91	Pass

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
A82 (North of Harbour Road)	NB	118701575	114493452	680	634	-46	-7%	Pass	1.79	Pass	1077	976	-101	-9%	Pass	3.15	Pass
Harbour Road (West of A82)	EB	114493465	118701575	112	106	-6	-5%	Pass	0.57	Pass	225	166	-59	-26%	Pass	4.22	Pass
Harbour Road (West of A82)	WB	118701575	114493465	187	264	77	41%	Pass	5.13	Fail	292	344	52	18%	Pass	2.92	Pass
Academy Street	NB	35370	114493855	307	198	-109	-36%	Fail	6.86	Fail	366	245	-121	-33%	Fail	6.94	Fail
Academy Street	SB	114493855	35370	227	225	-2	-1%	Pass	0.13	Pass	251	249	-2	-1%	Pass	0.13	Pass
A9 North of Tore	SB	34539	124435273	477	540	63	13%	Pass	2.81	Pass	593	657	64	11%	Pass	2.55	Pass
A9 North of Tore	NB	124435273	34539	317	314	-3	-1%	Pass	0.15	Pass	394	442	48	12%	Pass	2.34	Pass
Eastfield Way	SB	118701578	118701719	334	326	-8	-2%	Pass	0.44	Pass	430	359	-71	-17%	Pass	3.57	Pass
Eastfield Way	NB	118701719	118701578	196	185	-11	-6%	Pass	0.80	Pass	284	206	-78	-27%	Pass	4.98	Pass
	Total Model Pass								89	91						88	90

Table D-2: Calibration IP

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
West Link (Holm Roundabout)	WB	118701574	812212125	210	199	-11	-5%	Pass	0.78	Pass	237	207	-30	-13%	Pass	2.02	Pass
West Link (Holm Roundabout)	EB	812212125	118701574	243	224	-19	-8%	Pass	1.23	Pass	273	238	-35	-13%	Pass	2.19	Pass
A96 (West of Nairn)	EB	118701247	118701248	355	383	28	8%	Pass	1.46	Pass	435	481	46	11%	Pass	2.16	Pass
A96 (West of Nairn)	WB	118701248	118701247	396	408	12	3%	Pass	0.62	Pass	485	506	21	4%	Pass	0.96	Pass
Henderson Road	EB	114493260	114497383	253	229	-24	-9%	Pass	1.53	Pass	393	377	-16	-4%	Pass	0.80	Pass
Henderson Road	WB	114497383	114493260	129	132	3	2%	Pass	0.25	Pass	206	231	25	12%	Pass	1.69	Pass
Cromwell Road (North of Harbour Road)	SB	114493401	114493432	210	133	-77	-37%	Pass	5.90	Fail	332	176	-156	-47%	Fail	9.76	Fail
Cromwell Road (North of Harbour Road)	NB	114493432	114493401	251	171	-80	-32%	Pass	5.50	Fail	413	237	-176	-43%	Fail	9.78	Fail
Harbour Road (East of Cromwell Road)	EB	114493432	114493436	156	171	15	10%	Pass	1.20	Pass	229	179	-50	-22%	Pass	3.51	Pass
Harbour Road (East of Cromwell Road)	WB	114493436	114493432	143	109	-34	-24%	Pass	2.99	Pass	228	165	-63	-28%	Pass	4.52	Pass
Seafield Road	SB	114493410	114493533	114	114	0	0%	Pass	0.03	Pass	174	140	-34	-20%	Pass	2.74	Pass
Seafield Road	NB	114493533	114493410	122	122	0	0%	Pass	0.02	Pass	188	145	-43	-23%	Pass	3.34	Pass
Harbour Road East of Seafield Road	EB	114493533	114493535	424	424	0	0%	Pass	0.02	Pass	552	481	-71	-13%	Pass	3.12	Pass
Harbour Road East of Seafield Road	WB	114493535	114493533	478	531	53	11%	Pass	2.37	Pass	616	649	34	5%	Pass	1.33	Pass
Millburn Road (exit of Raigmore Interchange)	WB	114493802	114493745	796	869	73	9%	Pass	2.54	Pass	934	1054	120	13%	Pass	3.81	Pass
Tomnahurich Street (East of A82)	SB	114494196	114494209	247	275	28	11%	Pass	1.73	Pass	293	321	28	10%	Pass	1.62	Pass
Tomnahurich Street (East of A82)	NB	114494209	114494196	474	373	-101	-21%	Fail	4.91	Pass	536	409	-127	-24%	Fail	5.86	Fail
B9006 (A9 slip to Culloden Road)	SB	114494604	114494628	65	58	-7	-11%	Pass	0.87	Pass	81	80	-1	-1%	Pass	0.13	Pass

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
B9006 (A9 slip to Culloden Road)	NB	114494628	114494604	528	594	66	12%	Pass	2.78	Pass	609	659	50	8%	Pass	1.99	Pass
Culloden Road	EB	114494604	114494652	528	438	-90	-17%	Pass	4.08	Pass	591	478	-113	-19%	Fail	4.87	Pass
Culloden Road	WB	114494652	114494604	478	376	-102	-21%	Fail	4.93	Pass	535	427	-108	-20%	Fail	4.93	Pass
A96 Balloch Distr to Newton of Petty (B9039)	WB	114492912	114497069	537	543	6	1%	Pass	0.28	Pass	673	726	53	8%	Pass	1.99	Pass
A96 Balloch Distr to Newton of Petty (B9039)	EB	114497069	114492912	513	537	24	5%	Pass	1.06	Pass	643	699	56	9%	Pass	2.15	Pass
Kenneth Street	NB	114494309	114494209	134	97	-37	-27%	Pass	3.41	Pass	152	103	-49	-32%	Pass	4.30	Pass
Tomnahurich Street (West of A82)	WB	114494209	114494310	337	325	-12	-4%	Pass	0.66	Pass	405	375	-30	-7%	Pass	1.54	Pass
Tomnahurich Street (West of A82)	EB	114494310	114494209	360	372	12	3%	Pass	0.61	Pass	436	442	6	1%	Pass	0.30	Pass
Millburn Road (entry to Raigmore Interchange)	EB	114497377	114493754	616	685	69	11%	Pass	2.72	Pass	724	792	69	9%	Pass	2.49	Pass
Longman Road (north of Seafield Road)	SB	114497383	114493378	841	749	-92	-11%	Pass	3.26	Pass	1122	984	-138	-12%	Pass	4.25	Pass
Longman Road (north of Seafield Road)	NB	114497385	114497383	750	627	-123	-16%	Fail	4.69	Pass	994	891	-103	-10%	Pass	3.35	Pass
Shore Street	SB	114493432	114497417	239	221	-18	-7%	Pass	1.17	Pass	360	290	-70	-19%	Pass	3.89	Pass
Shore Street	NB	114497417	114493432	292	319	27	9%	Pass	1.53	Pass	443	365	-78	-18%	Pass	3.87	Pass
A9 South On Slip	SB	114493797	114494104	343	381	38	11%	Pass	1.99	Pass	416	469	53	13%	Pass	2.51	Pass
A9 South Off Slip	NB	114494108	114493824	417	448	31	7%	Pass	1.47	Pass	494	535	41	8%	Pass	1.82	Pass
A9 North On Slip	NB	114493755	114493593	452	352	-100	-22%	Fail	5.00	Fail	584	434	-150	-26%	Fail	6.66	Fail
A9 North Off Slip	SB	114493592	114493715	587	491	-96	-16%	Pass	4.15	Pass	750	655	-95	-13%	Pass	3.60	Pass
A96 East of Raigmore	WB	114497682	114493785	1023	1078	55	5%	Pass	1.69	Pass	1258	1307	49	4%	Pass	1.37	Pass
A96 East of Raigmore	EB	114493747	114497686	1052	1100	48	5%	Pass	1.45	Pass	1291	1331	40	3%	Pass	1.10	Pass
Kenneth Street (A82)	NB	114494209	114497849	304	353	49	16%	Pass	2.69	Pass	376	414	38	10%	Pass	1.89	Pass
Kenneth Street (A82)	SB	114497849	114494209	374	307	-67	-18%	Pass	3.64	Pass	438	333	-105	-24%	Fail	5.36	Fail
Caulfield Road	SB	114494499	114497960	115	133	18	16%	Pass	1.62	Pass	122	134	12	10%	Pass	1.07	Pass

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
Caulfield Road	NB	114497960	114494499	131	112	-19	-15%	Pass	1.75	Pass	140	113	-27	-19%	Pass	2.39	Pass
A9 South of Longman Junction	NB	114497741	114579426	925	800	-125	-14%	Pass	4.26	Pass	1178	1000	-178	-15%	Fail	5.40	Fail
Harbour Road (West of Seafield Road)	WB	114493533	114579598	445	495	50	11%	Pass	2.31	Pass	562	602	40	7%	Pass	1.67	Pass
Harbour Road (West of Seafield Road)	EB	114579598	114493533	399	397	-2	0%	Pass	0.08	Pass	512	440	-72	-14%	Pass	3.29	Pass
B862 (South of Holm Roundabout)	NB	114497971	118701574	88	91	3	3%	Pass	0.30	Pass	114	127	13	11%	Pass	1.15	Pass
B862 (South of Holm Roundabout)	SB	118701574	114497971	89	94	5	5%	Pass	0.49	Pass	112	122	11	9%	Pass	0.97	Pass
Holm Road (B8082)	WB	114579588	118701574	305	290	-15	-5%	Pass	0.85	Pass	346	313	-33	-10%	Pass	1.82	Pass
Holm Road (B8082)	EB	118701574	114579588	338	333	-5	-2%	Pass	0.29	Pass	385	367	-18	-5%	Pass	0.94	Pass
Dores Rd (North of Holm Roundabout)	SB	114579592	118701574	126	128	2	2%	Pass	0.19	Pass	146	147	1	1%	Pass	0.10	Pass
Dores Rd (North of Holm Roundabout)	NB	118701574	114579592	122	112	-10	-8%	Pass	0.95	Pass	144	137	-7	-5%	Pass	0.59	Pass
Harbour Road (North of Millburn Road)	SB	114493693	118701579	420	415	-5	-1%	Pass	0.26	Pass	519	468	-51	-10%	Pass	2.29	Pass
Millburn Road (West of Harbour Road)	WB	118701579	114493728	589	573	-16	-3%	Pass	0.66	Pass	674	650	-24	-4%	Pass	0.93	Pass
Millburn Road (West of Harbour Road)	EB	114493728	118701579	522	459	-63	-12%	Pass	2.84	Pass	595	504	-91	-15%	Pass	3.88	Pass
Old Perth Road (South of Millburn Roundabout)	NB	114493734	118701579	337	318	-19	-6%	Pass	1.07	Pass	392	337	-55	-14%	Pass	2.86	Pass
Old Perth Road (South of Millburn Roundabout)	SB	118701579	114493734	388	338	-50	-13%	Pass	2.61	Pass	460	376	-84	-18%	Pass	4.10	Pass
Sir Walter Scott Drive (North of Inshes Roundabout)	SB	114494548	118701580	150	147	-3	-2%	Pass	0.25	Pass	180	173	-7	-4%	Pass	0.55	Pass
Sir Walter Scott Drive (North of Inshes Roundabout)	NB	118701580	114494548	707	690	-17	-2%	Pass	0.65	Pass	824	783	-41	-5%	Pass	1.44	Pass

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
Tesco Access (South of Culloden Rd)	NB	114494578	118701580	449	399	-50	-11%	Pass	2.40	Pass	490	425	-65	-13%	Pass	3.02	Pass
Tesco Access (South of Culloden Rd)	SB	118701580	114494578	464	401	-63	-14%	Pass	3.04	Pass	500	436	-64	-13%	Pass	2.97	Pass
Old Perth Road (B9006)	EB	114579527	118701580	573	376	-197	-34%	Fail	9.05	Fail	651	425	-226	-35%	Fail	9.74	Fail
Old Perth Road (B9006)	WB	118701580	114579527	535	471	-64	-12%	Pass	2.84	Pass	609	520	-89	-15%	Pass	3.75	Pass
Old Perth Road (Southwest access to Police Scotland)	NB	114494564	118701580	75	66	-9	-12%	Pass	1.09	Pass	88	74	-14	-16%	Pass	1.56	Pass
Old Perth Road (Southwest access to Police Scotland)	SB	118701580	114494564	65	58	-7	-11%	Pass	0.89	Pass	75	58	-17	-23%	Pass	2.12	Pass
Sir Walter Scott Drive (South of Inshes Roundabout)	SB	118701580	118701586	411	356	-55	-13%	Pass	2.79	Pass	477	401	-76	-16%	Pass	3.64	Pass
Sir Walter Scott Drive (South of Inshes Roundabout)	NB	118701586	118701580	486	480	-6	-1%	Pass	0.27	Pass	568	539	-29	-5%	Pass	1.23	Pass
B8082 (East of Slackbuie Avenue)	WB	118701612	118701715	466	411	-55	-12%	Pass	2.63	Pass	493	437	-56	-11%	Pass	2.58	Pass
B8082 (East of Slackbuie Avenue)	EB	118701715	118701612	481	450	-31	-6%	Pass	1.45	Pass	512	484	-28	-6%	Pass	1.26	Pass
General Booth Road	SB	34692	118701635	65	94	29	44%	Pass	3.24	Pass	79	106	27	34%	Pass	2.77	Pass
General Booth Road	NB	118701635	34692	143	145	2	1%	Pass	0.16	Pass	175	157	-18	-10%	Pass	1.36	Pass
B9177	SB	34527	114497074	58	54	-4	-8%	Pass	0.59	Pass	64	61	-3	-5%	Pass	0.38	Pass
B9177	NB	114497074	34527	56	51	-5	-9%	Pass	0.71	Pass	61	57	-4	-7%	Pass	0.57	Pass
Longman Road (North of Seafield Road)	SB	35739	114497383	725	597	-128	-18%	Fail	4.97	Pass	933	794	-139	-15%	Pass	4.72	Pass
Longman Road (North of Seafield Road)	NB	114497383	35738	758	574	-184	-24%	Fail	7.11	Fail	992	846	-146	-15%	Pass	4.80	Pass
A835	SB	124438054	124438086	324	327	3	1%	Pass	0.16	Pass	397	413	16	4%	Pass	0.79	Pass
A835	NB	124438086	124438054	326	303	-23	-7%	Pass	1.31	Pass	400	378	-22	-5%	Pass	1.11	Pass

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
Castlehill Road	NB	34803	237403627	65	58	-7	-10%	Pass	0.86	Pass	70	62	-8	-11%	Pass	0.96	Pass
Castlehill Road	SB	237403627	34803	77	54	-23	-30%	Pass	2.84	Pass	83	55	-28	-33%	Pass	3.33	Pass
Culloden Road (West of UHI Access)	WB	114494604	237404073	949	911	-37	-4%	Pass	1.23	Pass	1073	1022	-51	-5%	Pass	1.58	Pass
Culloden Road (West of UHI Access)	EB	237404073	114494604	503	402	-101	-20%	Fail	4.74	Pass	568	459	-109	-19%	Fail	4.82	Pass
UHI Primary Access	NB	114494604	237404078	101	98	-3	-2%	Pass	0.25	Pass	113	98	-15	-13%	Pass	1.46	Pass
UHI Primary Access	SB	237404078	114494604	133	132	-1	-1%	Pass	0.06	Pass	146	132	-14	-9%	Pass	1.16	Pass
Barn Church Road	NB	114579459	237404109	366	375	9	2%	Pass	0.46	Pass	396	412	16	4%	Pass	0.79	Pass
Barn Church Road	SB	237404109	114579459	346	326	-20	-6%	Pass	1.07	Pass	372	357	-15	-4%	Pass	0.78	Pass
A9 North	NB	237404124	114579424	770	747	-23	-3%	Pass	0.84	Pass	983	1007	25	2%	Pass	0.78	Pass
A9 North	SB	114497743	237404125	806	924	119	15%	Pass	4.03	Pass	1051	1236	185	18%	Fail	5.46	Fail
A9 South	SB	237404127	237404131	1058	995	-63	-6%	Pass	1.95	Pass	1343	1287	-56	-4%	Pass	1.55	Pass
Stadium Road	EB	237404126	812212129	104	83	-21	-20%	Pass	2.17	Pass	199	166	-33	-16%	Pass	2.42	Pass
Stadium Road	WB	812212129	237404126	159	123	-36	-23%	Pass	3.06	Pass	235	171	-64	-27%	Pass	4.50	Pass
A82 (North of Harbour Road)	SB	114493452	118701575	853	772	-81	-10%	Pass	2.85	Pass	1143	989	-154	-13%	Pass	4.73	Pass
A82 (North of Harbour Road)	NB	118701575	114493452	768	627	-141	-18%	Fail	5.33	Fail	1025	891	-134	-13%	Pass	4.32	Pass
Harbour Road (West of A82)	EB	114493465	118701575	197	261	64	33%	Pass	4.24	Pass	277	309	32	12%	Pass	1.87	Pass
Harbour Road (West of A82)	WB	118701575	114493465	185	173	-12	-6%	Pass	0.90	Pass	278	275	-3	-1%	Pass	0.19	Pass
Academy Street	NB	35370	114493855	344	313	-31	-9%	Pass	1.71	Pass	344	339	-5	-1%	Pass	0.27	Pass
Academy Street	SB	114493855	35370	302	230	-72	-24%	Pass	4.42	Pass	302	237	-65	-22%	Pass	3.96	Pass
A9 North of Tore	SB	34539	124435273	318	306	-12	-4%	Pass	0.68	Pass	390	404	14	4%	Pass	0.72	Pass
A9 North of Tore	NB	124435273	34539	256	244	-12	-5%	Pass	0.78	Pass	314	324	10	3%	Pass	0.55	Pass
Tower Road	SB	33559	114497346	276	254	-22	-8%	Pass	1.38	Pass	296	263	-33	-11%	Pass	1.95	Pass
Tower Road	NB	114497346	33559	280	249	-31	-11%	Pass	1.92	Pass	302	257	-45	-15%	Pass	2.71	Pass
Eastfield Way	SB	118701578	118701719	689	608	-81	-12%	Pass	3.19	Pass	764	666	-98	-13%	Pass	3.68	Pass
Eastfield Way	NB	118701719	118701578	666	575	-91	-14%	Pass	3.66	Pass	740	607	-133	-18%	Fail	5.13	Fail

				Cars							Total						
Description	**Dir**	**A node**	**B node**	**Obs**	**Mod**	**Diff**	**% Diff**	**Link Flow**	**GEH**	**GEH < 5**	**Obs**	**Mod**	**Diff**	**% Diff**	**Link Flow**	**GEH**	**GEH < 5**
Total Model Pass									91	93						89	91

Table D-3: PM calibration

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
West Link (Holm Roundabout)	WB	118701574	812212125	362	295	-67	-19%	Pass	3.70	Pass	418	336	-82	-20%	Pass	4.22	Pass
West Link (Holm Roundabout)	EB	812212125	118701574	463	366	-97	-21%	Pass	4.76	Pass	513	382	-131	-26%	Fail	6.19	Fail
A96 (West of Nairn)	EB	118701247	118701248	508	544	36	7%	Pass	1.57	Pass	632	651	19	3%	Pass	0.74	Pass
A96 (West of Nairn)	WB	118701248	118701247	419	433	14	3%	Pass	0.67	Pass	522	539	17	3%	Pass	0.74	Pass
Henderson Road	EB	114493260	114497383	340	279	-61	-18%	Pass	3.47	Pass	423	346	-77	-18%	Pass	3.93	Pass
Henderson Road	WB	114497383	114493260	65	51	-14	-22%	Pass	1.84	Pass	91	73	-18	-20%	Pass	1.99	Pass
Cromwell Road (North of Harbour Road)	SB	114493401	114493432	306	306	0	0%	Pass	0.00	Pass	389	350	-39	-10%	Pass	2.03	Pass
Cromwell Road (North of Harbour Road)	NB	114493432	114493401	393	298	-95	-24%	Pass	5.11	Fail	509	335	-174	-34%	Fail	8.47	Fail
Harbour Road (East of Cromwell Road)	EB	114493432	114493436	112	130	18	16%	Pass	1.64	Pass	144	148	4	3%	Pass	0.33	Pass
Harbour Road (East of Cromwell Road)	WB	114493436	114493432	209	306	97	46%	Pass	6.04	Fail	264	326	62	23%	Pass	3.61	Pass
Seafield Road	SB	114493410	114493533	108	122	14	13%	Pass	1.31	Pass	140	140	0	0%	Pass	0.00	Pass
Seafield Road	NB	114493533	114493410	57	51	-6	-11%	Pass	0.82	Pass	69	58	-11	-16%	Pass	1.38	Pass
Harbour Road East of Seafield Road	EB	114493533	114493535	409	450	41	10%	Pass	1.98	Pass	485	526	41	8%	Pass	1.82	Pass
Harbour Road East of Seafield Road	WB	114493535	114493533	467	399	-68	-15%	Pass	3.27	Pass	557	472	-85	-15%	Pass	3.75	Pass
Millburn Road (exit of Raigmore Interchange)	WB	114493802	114493745	873	867	-6	-1%	Pass	0.20	Pass	1034	1014	-20	-2%	Pass	0.63	Pass
Tomnahurich Street (East of A82)	SB	114494196	114494209	318	362	44	14%	Pass	2.39	Pass	373	391	18	5%	Pass	0.92	Pass
Tomnahurich Street (East of A82)	NB	114494209	114494196	452	453	1	0%	Pass	0.05	Pass	513	473	-40	-8%	Pass	1.80	Pass
B9006 (A9 slip to Culloden Road)	SB	114494604	114494628	66	62	-4	-6%	Pass	0.50	Pass	72	69	-3	-4%	Pass	0.36	Pass

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
B9006 (A9 slip to Culloden Road)	NB	114494628	114494604	660	634	-26	-4%	Pass	1.02	Pass	750	709	-41	-5%	Pass	1.52	Pass
Culloden Road	EB	114494604	114494652	799	729	-70	-9%	Pass	2.53	Pass	909	819	-90	-10%	Pass	3.06	Pass
Culloden Road	WB	114494652	114494604	430	414	-16	-4%	Pass	0.78	Pass	472	458	-14	-3%	Pass	0.65	Pass
A96 Balloch Distr to Newton of Petty (B9039)	WB	114492912	114497069	712	697	-15	-2%	Pass	0.55	Pass	846	843	-3	0%	Pass	0.09	Pass
A96 Balloch Distr to Newton of Petty (B9039)	EB	114497069	114492912	759	794	35	5%	Pass	1.25	Pass	849	936	87	10%	Pass	2.90	Pass
Kenneth Street	NB	114494309	114494209	200	161	-39	-20%	Pass	2.90	Pass	205	161	-44	-21%	Pass	3.25	Pass
Tomnahurich Street (West of A82)	WB	114494209	114494310	466	466	0	0%	Pass	0.00	Pass	537	543	6	1%	Pass	0.26	Pass
Tomnahurich Street (West of A82)	EB	114494310	114494209	337	373	36	11%	Pass	1.91	Pass	399	427	28	7%	Pass	1.38	Pass
Millburn Road (entry to Raigmore Interchange)	EB	114497377	114493754	889	1029	140	16%	Fail	4.52	Pass	982	1163	181	18%	Fail	5.53	Fail
Longman Road (north of Seafield Road)	SB	114497383	114493378	699	763	64	9%	Pass	2.37	Pass	904	952	48	5%	Pass	1.58	Pass
Longman Road (north of Seafield Road)	NB	114497385	114497383	1182	1291	109	9%	Pass	3.10	Pass	1339	1449	110	8%	Pass	2.95	Pass
Shore Street	SB	114493432	114497417	435	526	91	21%	Pass	4.15	Pass	533	558	25	5%	Pass	1.07	Pass
Shore Street	NB	114497417	114493432	425	341	-84	-20%	Pass	4.29	Pass	533	366	-167	-31%	Fail	7.88	Fail
A9 South On Slip	SB	114493797	114494104	396	409	13	3%	Pass	0.65	Pass	459	456	-3	-1%	Pass	0.14	Pass
A9 South Off Slip	NB	114494108	114493824	458	377	-81	-18%	Pass	3.96	Pass	518	412	-106	-20%	Fail	4.92	Pass
A9 North On Slip	NB	114493755	114493593	533	493	-40	-8%	Pass	1.77	Pass	649	575	-74	-11%	Pass	2.99	Pass
A9 North Off Slip	SB	114493592	114493715	1002	983	-19	-2%	Pass	0.60	Pass	1207	1132	-75	-6%	Pass	2.19	Pass
A96 East of Raigmore	WB	114497682	114493785	1140	1220	80	7%	Pass	2.33	Pass	1361	1397	36	3%	Pass	0.97	Pass
A96 East of Raigmore	EB	114493747	114497686	1687	1839	152	9%	Pass	3.62	Pass	1926	2058	132	7%	Pass	2.96	Pass
Kenneth Street (A82)	NB	114494209	114497849	340	395	55	16%	Pass	2.87	Pass	395	440	45	11%	Pass	2.20	Pass
Kenneth Street (A82)	SB	114497849	114494209	403	417	14	3%	Pass	0.69	Pass	468	477	9	2%	Pass	0.41	Pass
Caulfield Road	SB	114494499	114497960	114	153	39	34%	Pass	3.36	Pass	121	158	37	31%	Pass	3.13	Pass

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
Caulfield Road	NB	114497960	114494499	267	173	-94	-35%	Pass	6.34	Fail	277	180	-97	-35%	Pass	6.42	Fail
A9 South of Longman Junction	NB	114497741	114579426	1159	1185	26	2%	Pass	0.76	Pass	1396	1373	-23	-2%	Pass	0.62	Pass
Harbour Road (West of Seafield Road)	WB	114493533	114579598	437	377	-60	-14%	Pass	2.97	Pass	520	441	-79	-15%	Pass	3.60	Pass
Harbour Road (West of Seafield Road)	EB	114579598	114493533	328	354	26	8%	Pass	1.41	Pass	377	413	36	10%	Pass	1.81	Pass
B862 (South of Holm Roundabout)	NB	114497971	118701574	86	120	34	40%	Pass	3.35	Pass	100	143	43	43%	Pass	3.90	Pass
B862 (South of Holm Roundabout)	SB	118701574	114497971	116	131	15	13%	Pass	1.35	Pass	134	150	16	12%	Pass	1.34	Pass
Holm Road (B8082)	WB	114579588	118701574	429	371	-58	-14%	Pass	2.90	Pass	496	421	-75	-15%	Pass	3.50	Pass
Holm Road (B8082)	EB	118701574	114579588	568	442	-126	-22%	Fail	5.61	Fail	618	476	-142	-23%	Fail	6.07	Fail
Dores Rd (North of Holm Roundabout)	SB	114579592	118701574	194	169	-25	-13%	Pass	1.86	Pass	210	183	-27	-13%	Pass	1.93	Pass
Dores Rd (North of Holm Roundabout)	NB	118701574	114579592	150	148	-2	-1%	Pass	0.16	Pass	165	156	-9	-5%	Pass	0.71	Pass
Harbour Road (North of Millburn Road)	SB	114493693	118701579	575	468	-107	-19%	Fail	4.69	Pass	652	547	-105	-16%	Fail	4.29	Pass
Millburn Road (West of Harbour Road)	WB	118701579	114493728	700	507	-193	-28%	Fail	7.86	Fail	816	561	-255	-31%	Fail	9.72	Fail
Millburn Road (West of Harbour Road)	EB	114493728	118701579	525	491	-34	-6%	Pass	1.51	Pass	590	525	-65	-11%	Pass	2.75	Pass
Old Perth Road (South of Millburn Roundabout)	NB	114493734	118701579	358	467	109	30%	Fail	5.37	Fail	399	489	90	23%	Pass	4.27	Pass
Old Perth Road (South of Millburn Roundabout)	SB	118701579	114493734	435	512	77	18%	Pass	3.54	Pass	480	536	56	12%	Pass	2.48	Pass
Sir Walter Scott Drive (North of Inshes Roundabout)	SB	114494548	118701580	299	329	30	10%	Pass	1.69	Pass	313	353	40	13%	Pass	2.19	Pass
Sir Walter Scott Drive (North of Inshes Roundabout)	NB	118701580	114494548	731	710	-21	-3%	Pass	0.78	Pass	828	778	-50	-6%	Pass	1.76	Pass

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
Tesco Access (South of Culloden Rd)	NB	114494578	118701580	370	368	-2	-1%	Pass	0.10	Pass	401	388	-13	-3%	Pass	0.65	Pass
Tesco Access (South of Culloden Rd)	SB	118701580	114494578	435	364	-71	-16%	Pass	3.55	Pass	459	369	-90	-20%	Pass	4.42	Pass
Old Perth Road (B9006)	EB	114579527	118701580	631	565	-66	-10%	Pass	2.70	Pass	698	597	-101	-14%	Fail	3.97	Pass
Old Perth Road (B9006)	WB	118701580	114579527	396	392	-4	-1%	Pass	0.20	Pass	436	436	0	0%	Pass	0.00	Pass
Old Perth Road (Southwest access to Police Scotland)	NB	114494564	118701580	116	75	-41	-35%	Pass	4.20	Pass	131	82	-49	-37%	Pass	4.75	Pass
Old Perth Road (Southwest access to Police Scotland)	SB	118701580	114494564	83	62	-21	-25%	Pass	2.47	Pass	96	62	-34	-35%	Pass	3.83	Pass
Sir Walter Scott Drive (South of Inshes Roundabout)	SB	118701580	118701586	663	609	-54	-8%	Pass	2.14	Pass	730	662	-68	-9%	Pass	2.58	Pass
Sir Walter Scott Drive (South of Inshes Roundabout)	NB	118701586	118701580	527	451	-76	-14%	Pass	3.44	Pass	615	500	-115	-19%	Fail	4.87	Pass
B8082 (East of Slackbuie Avenue)	WB	118701612	118701715	716	519	-197	-27%	Fail	7.91	Fail	744	546	-198	-27%	Fail	7.79	Fail
B8082 (East of Slackbuie Avenue)	EB	118701715	118701612	592	408	-184	-31%	Fail	8.23	Fail	621	436	-185	-30%	Fail	8.05	Fail
General Booth Road	SB	34692	118701635	69	79	10	15%	Pass	1.17	Pass	80	79	-1	-1%	Pass	0.11	Pass
General Booth Road	NB	118701635	34692	291	261	-30	-10%	Pass	1.78	Pass	337	298	-39	-12%	Pass	2.19	Pass
B9177	SB	34527	114497074	130	72	-58	-45%	Pass	5.81	Fail	139	84	-55	-40%	Pass	5.24	Fail
B9177	NB	114497074	34527	98	61	-37	-38%	Pass	4.17	Pass	105	71	-34	-32%	Pass	3.61	Pass
Longman Road (North of Seafield Road)	SB	35739	114497383	617	656	39	6%	Pass	1.55	Pass	801	832	31	4%	Pass	1.08	Pass
Longman Road (North of Seafield Road)	NB	114497383	35738	1375	1409	34	2%	Pass	0.91	Pass	1568	1603	35	2%	Pass	0.88	Pass
A835	SB	124438054	124438086	468	364	-104	-22%	Fail	5.11	Fail	583	509	-74	-13%	Pass	3.16	Pass
A835	NB	124438086	124438054	490	444	-46	-9%	Pass	2.14	Pass	610	494	-116	-19%	Fail	4.95	Pass

				Cars							Total						
Description	Dir	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
Castlehill Road	NB	34803	237403627	63	46	-17	-27%	Pass	2.35	Pass	68	55	-13	-19%	Pass	1.68	Pass
Castlehill Road	SB	237403627	34803	226	184	-42	-19%	Pass	2.96	Pass	232	184	-48	-21%	Pass	3.35	Pass
Culloden Road (West of UHI Access)	WB	114494604	237404073	1006	946	-60	-6%	Pass	1.92	Pass	1115	1038	-77	-7%	Pass	2.35	Pass
Culloden Road (West of UHI Access)	EB	237404073	114494604	662	595	-67	-10%	Pass	2.67	Pass	744	651	-93	-13%	Pass	3.52	Pass
UHI Primary Access	NB	114494604	237404078	86	104	18	21%	Pass	1.85	Pass	94	104	10	11%	Pass	1.01	Pass
UHI Primary Access	SB	237404078	114494604	205	196	-9	-4%	Pass	0.64	Pass	224	213	-11	-5%	Pass	0.74	Pass
Barn Church Road	NB	114579459	237404109	370	426	56	15%	Pass	2.81	Pass	390	447	57	15%	Pass	2.81	Pass
Barn Church Road	SB	237404109	114579459	687	772	85	12%	Pass	3.13	Pass	720	818	98	14%	Pass	3.53	Pass
A9 North	NB	237404124	114579424	1656	1745	89	5%	Pass	2.16	Pass	1908	2055	147	8%	Pass	3.30	Pass
A9 North	SB	114497743	237404125	901	966	65	7%	Pass	2.13	Pass	1205	1315	110	9%	Pass	3.10	Pass
A9 South	SB	237404127	237404131	1695	1617	-78	-5%	Pass	1.92	Pass	2046	1891	-155	-8%	Pass	3.49	Pass
Stadium Road	EB	237404126	812212129	67	63	-4	-6%	Pass	0.50	Pass	137	96	-41	-30%	Pass	3.80	Pass
Stadium Road	WB	812212129	237404126	549	528	-21	-4%	Pass	0.90	Pass	657	594	-63	-10%	Pass	2.52	Pass
A82 (North of Harbour Road)	SB	114493452	118701575	911	945	34	4%	Pass	1.12	Pass	1144	1156	12	1%	Pass	0.35	Pass
A82 (North of Harbour Road)	NB	118701575	114493452	1191	1291	100	8%	Pass	2.84	Pass	1353	1449	96	7%	Pass	2.56	Pass
Harbour Road (West of A82)	EB	114493465	118701575	189	222	33	17%	Pass	2.30	Pass	231	249	18	8%	Pass	1.16	Pass
Harbour Road (West of A82)	WB	118701575	114493465	173	279	106	61%	Fail	7.05	Fail	228	322	94	41%	Pass	5.67	Fail
Academy Street	NB	35370	114493855	406	364	-42	-10%	Pass	2.15	Pass	439	381	-58	-13%	Pass	2.86	Pass
Academy Street	SB	114493855	35370	320	255	-65	-20%	Pass	3.83	Pass	333	257	-76	-23%	Pass	4.45	Pass
A9 North of Tore	SB	34539	124435273	437	438	1	0%	Pass	0.04	Pass	544	578	34	6%	Pass	1.42	Pass
A9 North of Tore	NB	124435273	34539	519	509	-10	-2%	Pass	0.43	Pass	646	648	2	0%	Pass	0.09	Pass
Tower Road	SB	33559	114497346	372	304	-68	-18%	Pass	3.67	Pass	392	330	-62	-16%	Pass	3.26	Pass
Tower Road	NB	114497346	33559	422	327	-95	-23%	Pass	4.91	Pass	440	352	-88	-20%	Pass	4.44	Pass
Eastfield Way	SB	118701578	118701719	765	730	-35	-5%	Pass	1.28	Pass	848	737	-111	-13%	Pass	3.94	Pass
Eastfield Way	NB	118701719	118701578	801	748	-53	-7%	Pass	1.90	Pass	901	784	-117	-13%	Pass	4.03	Pass

				Cars							Total						
Description	**Dir**	**A node**	**B node**	**Obs**	**Mod**	**Diff**	**% Diff**	**Link Flow**	**GEH**	**GEH < 5**	**Obs**	**Mod**	**Diff**	**% Diff**	**Link Flow**	**GEH**	**GEH < 5**
Total Model Pass									89	93						89	92

Appendix E. Validation counts

Table E-1: Validation AM

			Cars							Total						
Link	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
565851822	118701578	118701717	1334	1623	289	22%	Fail	7.52	Fail	1624	1852	228	14%	Pass	5.47	Fail
565851822	118701717	118701578	741	874	133	18%	Fail	4.68	Pass	1086	1181	95	9%	Pass	2.82	Pass
565851828	118701578	118701720	515	675	160	31%	Fail	6.56	Fail	826	967	141	17%	Fail	4.71	Pass
565851828	118701720	118701578	1246	1565	319	26%	Fail	8.51	Fail	1510	1791	281	19%	Fail	6.92	Fail
18	812212120	812212121	341	294	-47	-14%	Pass	2.64	Pass	361	318	-43	-12%	Pass	2.34	Pass
18	812212121	812212120	216	149	-67	-31%	Pass	4.93	Pass	232	168	-64	-27%	Pass	4.49	Pass
19263748	114493005	114493004	840	691	-149	-18%	Fail	5.38	Fail	1045	1118	73	7%	Pass	2.21	Pass
19264071	114493188	114493198	160	176	17	10%	Pass	1.27	Pass	219	249	30	14%	Pass	1.94	Pass
19264071	114493198	114493188	267	201	-66	-25%	Pass	4.32	Pass	333	260	-73	-22%	Pass	4.25	Pass
19264163	114493254	114493260	181	129	-52	-29%	Fail	4.16	Pass	282	301	19	7%	Pass	1.12	Pass
19264163	114493260	114493254	167	167	0	0%	Fail	0.01	Pass	221	273	53	24%	Pass	3.34	Pass
19264313	114493378	114493377	1132	1136	4	0%	Pass	0.12	Pass	1512	1428	-84	-6%	Pass	2.19	Pass
19264346	114493240	114493401	93	131	38	41%	Pass	3.59	Pass	197	190	-7	-4%	Pass	0.50	Pass
19264346	114493401	114493240	250	176	-74	-30%	Pass	5.07	Fail	367	214	-153	-42%	Fail	8.98	Fail
19264353	114493401	114493403	179	224	45	25%	Pass	3.17	Pass	278	338	60	22%	Pass	3.42	Pass
19264353	114493403	114493401	35	48	13	37%	Pass	2.02	Pass	118	116	-2	-2%	Pass	0.18	Pass
19264390	114493401	114493432	120	177	57	48%	Pass	4.68	Pass	295	306	11	4%	Pass	0.63	Pass
19264390	114493432	114493401	421	400	-21	-5%	Pass	1.04	Pass	625	552	-73	-12%	Pass	3.01	Pass
19264404	114493436	114493442	167	106	-61	-36%	Pass	5.19	Fail	231	166	-65	-28%	Pass	4.58	Pass
19264404	114493442	114493436	201	264	63	31%	Pass	4.15	Pass	268	344	76	29%	Pass	4.37	Pass
1131706378	35330	118701614	436	338	-98	-23%	Pass	5.00	Fail	465	370	-95	-20%	Pass	4.63	Pass
1131706378	118701614	35330	316	265	-51	-16%	Pass	2.97	Pass	349	279	-70	-20%	Pass	3.94	Pass
19310003	114494142	114497068	530	490	-40	-8%	Pass	1.77	Pass	612	541	-71	-12%	Pass	2.96	Pass
19310003	114497068	114494142	376	490	114	30%	Fail	5.48	Fail	441	542	101	23%	Fail	4.56	Pass
1131705361	35340	114494142	245	254	9	4%	Pass	0.57	Pass	287	278	-9	-3%	Pass	0.54	Pass
1131705361	114494142	35340	57	54	-3	-5%	Pass	0.40	Pass	81	83	2	2%	Pass	0.22	Pass
1131706589	34678	114494142	417	486	69	17%	Pass	3.25	Pass	486	521	35	7%	Pass	1.56	Pass
1131706589	114494142	34678	369	425	56	15%	Pass	2.81	Pass	448	472	24	5%	Pass	1.12	Pass
19265494	114493993	114494142	252	194	-58	-23%	Pass	3.88	Pass	348	265	-83	-24%	Pass	4.74	Pass

			Cars							Total						
Link	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
19265494	114494142	114493993	334	453	119	36%	Fail	6.00	Fail	421	511	90	21%	Pass	4.17	Pass
19266311	114494604	114494652	356	240	-116	-33%	Fail	6.72	Fail	426	275	-151	-35%	Fail	8.07	Fail
19266311	114494652	114494604	598	606	8	1%	Pass	0.33	Pass	667	696	29	4%	Pass	1.11	Pass
19267161	114495123	114495158	117	51	-66	-56%	Pass	7.20	Fail	132	58	-74	-56%	Pass	7.58	Fail
19267161	114495158	114495123	174	116	-58	-33%	Pass	4.80	Pass	188	123	-65	-35%	Pass	5.24	Fail
19313243	118701136	118701525	335	329	-6	-2%	Pass	0.32	Pass	417	407	-10	-2%	Pass	0.48	Pass
19313243	118701525	118701136	262	278	16	6%	Pass	0.94	Pass	327	356	29	9%	Pass	1.58	Pass
19319997	114497378	114493690	257	170	-87	-34%	Pass	5.97	Fail	315	207	-108	-34%	Fail	6.70	Fail
1131705662	124436121	35584	549	738	189	35%	Fail	7.47	Fail	683	896	213	31%	Fail	7.58	Fail
19321264	114497384	114497385	641	634	-7	-1%	Pass	0.28	Pass	1049	976	-73	-7%	Pass	2.29	Pass
33226945	114493540	114493669	346	286	-60	-17%	Pass	3.38	Pass	405	390	-15	-4%	Pass	0.77	Pass
33226945	114493669	114493540	683	656	-27	-4%	Pass	1.04	Pass	765	768	3	0%	Pass	0.12	Pass
33226947	114493378	114493411	138	164	26	19%	Pass	2.12	Pass	236	225	-11	-5%	Pass	0.72	Pass
33226947	114493411	114493378	56	43	-13	-23%	Pass	1.85	Pass	179	107	-72	-40%	Pass	6.02	Fail
78060770	114495532	114497706	401	500	99	25%	Pass	4.67	Pass	499	702	203	41%	Fail	8.28	Fail
78060772	114497707	114495533	349	317	-32	-9%	Pass	1.78	Pass	435	468	33	8%	Pass	1.56	Pass
565841047	114494158	114497849	305	356	51	17%	Pass	2.79	Pass	383	426	43	11%	Pass	2.12	Pass
565841047	114497849	114494158	327	323	-4	-1%	Pass	0.25	Pass	384	407	23	6%	Pass	1.14	Pass
565843175	114494453	114579435	554	636	82	15%	Pass	3.37	Pass	640	713	73	11%	Pass	2.80	Pass
565843175	114579435	114494453	356	430	74	21%	Pass	3.71	Pass	393	475	82	21%	Pass	3.93	Pass
565843406	114493716	114579531	394	307	-87	-22%	Pass	4.65	Pass	508	369	-139	-27%	Fail	6.64	Fail
565843406	114579531	114493716	338	403	65	19%	Pass	3.38	Pass	479	472	-7	-1%	Pass	0.32	Pass
565843604	114493519	114579597	515	374	-141	-27%	Fail	6.67	Fail	591	473	-118	-20%	Fail	5.10	Fail
565843604	114579597	114493519	421	293	-128	-30%	Fail	6.77	Fail	489	385	-104	-21%	Fail	4.95	Pass
565851555	114579481	114579531	154	247	93	60%	Pass	6.57	Fail	313	331	18	6%	Pass	1.00	Pass
565851555	114579531	114579481	497	523	26	5%	Pass	1.15	Pass	708	615	-93	-13%	Pass	3.62	Pass
565851556	114579478	114579531	333	297	-36	-11%	Pass	2.03	Pass	476	332	-144	-30%	Fail	7.16	Fail
565851556	114579531	114579478	299	180	-119	-40%	Fail	7.69	Fail	418	238	-180	-43%	Fail	9.94	Fail
565851557	114493660	114579531	889	953	64	7%	Pass	2.11	Pass	1116	1190	74	7%	Pass	2.18	Pass
565851557	114579531	114493660	653	641	-12	-2%	Pass	0.47	Pass	853	752	-101	-12%	Pass	3.57	Pass
565851559	114579531	118701569	759	733	-26	-3%	Pass	0.95	Pass	957	942	-15	-2%	Pass	0.49	Pass

			Cars							Total						
Link	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
565851559	118701569	114579531	776	678	-98	-13%	Pass	3.63	Pass	1002	798	-204	-20%	Fail	6.80	Fail
565851560	114493837	118701570	649	641	-8	-1%	Fail	0.31	Pass	845	752	-93	-11%	Pass	3.29	Pass
565851560	118701570	114493837	912	953	41	4%	Pass	1.34	Pass	1139	1190	51	4%	Pass	1.49	Pass
565851561	114579485	118701570	403	312	-91	-23%	Pass	4.81	Pass	498	410	-88	-18%	Pass	4.13	Pass
565851561	118701570	114579485	356	370	14	4%	Pass	0.73	Pass	450	437	-13	-3%	Pass	0.62	Pass
565851562	114579491	118701570	9	42	33	367%	Pass	6.53	Fail	9	57	48	533%	Pass	8.36	Fail
565851562	118701570	114579491	59	63	4	7%	Pass	0.51	Pass	64	74	10	16%	Pass	1.20	Pass
565851563	114579492	118701570	132	231	99	75%	Pass	7.35	Fail	168	261	93	55%	Pass	6.35	Fail
565851563	118701570	114579492	48	80	32	67%	Pass	4.00	Pass	61	97	36	59%	Pass	4.05	Pass
565851564	114579493	118701570	630	684	54	9%	Pass	2.11	Pass	775	816	41	5%	Pass	1.45	Pass
565851564	118701570	114579493	448	444	-4	-1%	Pass	0.19	Pass	581	499	-82	-14%	Pass	3.53	Pass
565851611	114492828	118701583	321	305	-16	-5%	Pass	0.92	Pass	400	422	22	6%	Pass	1.09	Pass
565851611	118701583	114492828	591	546	-45	-8%	Pass	1.88	Pass	735	685	-50	-7%	Pass	1.89	Pass
565851616	114495368	114579592	203	126	-77	-38%	Pass	5.97	Fail	261	147	-114	-44%	Fail	8.00	Fail
565851616	114579592	114495368	103	93	-10	-10%	Pass	1.03	Pass	122	102	-20	-16%	Pass	1.89	Pass
565851622	114579533	114579594	530	546	16	3%	Pass	0.70	Pass	570	584	14	2%	Pass	0.57	Pass
565851622	114579594	114579533	351	378	27	8%	Pass	1.41	Pass	386	418	32	8%	Pass	1.60	Pass
565851704	114579588	118701624	403	353	-50	-13%	Pass	2.60	Pass	436	386	-50	-11%	Pass	2.45	Pass
565851704	118701624	114579588	380	351	-29	-8%	Pass	1.52	Pass	409	370	-39	-10%	Pass	2.00	Pass
1131704455	35323	114494478	912	1082	170	19%	Fail	5.39	Fail	982	1200	219	22%	Fail	6.62	Fail
1131704455	114494478	35323	253	208	-45	-18%	Pass	2.98	Pass	271	257	-14	-5%	Pass	0.86	Pass
565851677	118701609	118701610	538	471	-67	-12%	Pass	2.99	Pass	587	507	-80	-14%	Pass	3.41	Pass
565851677	118701610	118701609	640	525	-115	-18%	Fail	4.77	Pass	677	556	-121	-18%	Fail	4.87	Pass
1131705653	33925	33926	478	426	-52	-11%	Pass	2.45	Pass	510	519	9	2%	Pass	0.38	Pass
1131705653	33926	33925	246	117	-129	-52%	Fail	9.59	Fail	273	148	-125	-46%	Fail	8.62	Fail
1131705770	35738	114497857	724	484	-240	-33%	Fail	9.77	Fail	901	838	-63	-7%	Pass	2.15	Pass
1131705330	114497856	35739	1137	1145	8	1%	Pass	0.24	Pass	1415	1380	-35	-2%	Pass	0.94	Pass
1131705782	33559	114497346	423	327	-96	-23%	Pass	4.94	Pass	450	380	-70	-16%	Pass	3.45	Pass
1131705782	114497346	33559	381	314	-67	-18%	Pass	3.58	Pass	407	361	-46	-11%	Pass	2.33	Pass
1131705830	33680	237403835	313	351	38	12%	Pass	2.09	Pass	355	398	43	12%	Pass	2.22	Pass
1131705830	237403835	33680	423	541	118	28%	Fail	5.39	Fail	469	596	127	27%	Fail	5.52	Fail

			Cars							Total						
Link	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
1131706023	114495162	114497696	198	259	61	31%	Pass	4.02	Pass	247	351	104	42%	Fail	6.03	Fail
1131706023	114497696	114495162	227	228	1	1%	Pass	0.10	Pass	282	297	15	5%	Pass	0.88	Pass
1131706427	34691	114493723	451	497	46	10%	Pass	2.12	Pass	527	565	38	7%	Pass	1.64	Pass
1131706785	114494652	237403967	172	190	18	10%	Pass	1.34	Pass	190	196	6	3%	Pass	0.43	Pass
1131706785	237403967	114494652	164	246	82	50%	Pass	5.73	Fail	178	247	69	39%	Pass	4.73	Pass
1131707068	237404131	114497375	1338	1325	-13	-1%	Pass	0.36	Pass	1666	1647	-19	-1%	Pass	0.46	Pass
78069009	114497464	114497741	1108	1131	23	2%	Pass	0.68	Pass	1380	1382	2	0%	Pass	0.06	Pass
2131706901	114497325	812212128	132	156	23	18%	Pass	1.93	Pass	184	281	96	52%	Pass	6.29	Fail
2131706901	812212128	114497325	311	298	-13	-4%	Pass	0.75	Pass	375	395	19	5%	Pass	0.97	Pass
Total Model Pass								73	83						74	80

Table E-2: Validation IP

			Cars							Total						
Link	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
565851822	118701578	118701717	1026	1108	82	8%	Pass	2.51	Pass	1261	1338	77	6%	Pass	2.14	Pass
565851822	118701717	118701578	1050	1100	50	5%	Pass	1.52	Pass	1294	1331	37	3%	Pass	1.03	Pass
565851828	118701578	118701720	744	870	127	17%	Fail	4.45	Pass	957	1079	122	13%	Pass	3.82	Pass
565851828	118701720	118701578	743	911	168	23%	Fail	5.85	Fail	949	1145	196	21%	Fail	6.07	Fail
18	812212120	812212121	231	198	-33	-14%	Pass	2.25	Pass	246	205	-41	-17%	Pass	2.73	Pass
18	812212121	812212120	256	210	-46	-18%	Pass	2.99	Pass	271	224	-47	-17%	Pass	2.99	Pass
19263748	114493005	114493004	891	747	-144	-16%	Fail	5.02	Fail	1092	1007	-85	-8%	Pass	2.61	Pass
19264071	114493188	114493198	132	117	-15	-12%	Pass	1.39	Pass	183	150	-33	-18%	Fail	2.56	Pass
19264071	114493198	114493188	189	137	-52	-28%	Pass	4.11	Pass	245	176	-69	-28%	Pass	4.74	Pass
19264163	114493254	114493260	224	229	5	2%	Pass	0.32	Pass	298	377	79	27%	Fail	4.32	Pass
19264163	114493260	114493254	191	132	-59	-31%	Pass	4.65	Pass	235	231	-4	-2%	Pass	0.27	Pass
19264313	114493378	114493377	855	772	-83	-10%	Pass	2.89	Pass	1136	989	-147	-13%	Pass	4.49	Pass
19264346	114493240	114493401	105	116	11	10%	Pass	1.05	Pass	171	149	-22	-13%	Fail	1.76	Pass
19264346	114493401	114493240	158	126	-32	-20%	Pass	2.71	Pass	251	162	-89	-35%	Pass	6.16	Fail
19264353	114493401	114493403	106	45	-61	-58%	Pass	7.02	Fail	184	76	-108	-59%	Fail	9.47	Fail
19264353	114493403	114493401	118	17	-101	-86%	Fail	12.27	Fail	181	27	-154	-85%	Pass	15.11	Fail
19264390	114493401	114493432	211	133	-78	-37%	Pass	5.91	Fail	332	176	-156	-47%	Pass	9.79	Fail
19264390	114493432	114493401	252	171	-81	-32%	Pass	5.58	Fail	414	237	-177	-43%	Fail	9.81	Fail
19264404	114493436	114493442	223	261	38	17%	Pass	2.42	Pass	264	309	45	17%	Pass	2.66	Pass
19264404	114493442	114493436	194	173	-21	-11%	Pass	1.53	Pass	259	275	16	6%	Pass	1.00	Pass
1131706378	35330	118701614	358	380	22	6%	Pass	1.13	Pass	385	417	32	8%	Pass	1.62	Pass
1131706378	118701614	35330	335	292	-43	-13%	Pass	2.41	Pass	356	319	-37	-10%	Pass	2.03	Pass
19310003	114494142	114497068	408	354	-54	-13%	Pass	2.76	Pass	467	403	-64	-14%	Pass	3.08	Pass
19310003	114497068	114494142	377	372	-5	-1%	Pass	0.23	Pass	432	407	-25	-6%	Pass	1.22	Pass
1131705361	35340	114494142	130	178	48	37%	Pass	3.87	Pass	157	195	38	24%	Pass	2.86	Pass
1131705361	114494142	35340	85	66	-19	-22%	Pass	2.19	Pass	101	78	-23	-22%	Pass	2.38	Pass
1131706589	34678	114494142	331	283	-48	-14%	Pass	2.72	Pass	382	314	-68	-18%	Pass	3.62	Pass
1131706589	114494142	34678	372	336	-36	-10%	Pass	1.92	Pass	429	362	-67	-16%	Pass	3.38	Pass
19265494	114493993	114494142	278	262	-16	-6%	Pass	0.95	Pass	340	295	-45	-13%	Pass	2.50	Pass

			Cars							Total						
Link	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
19265494	114494142	114493993	250	338	88	35%	Pass	5.14	Fail	313	368	55	18%	Pass	2.98	Pass
19266311	114494604	114494652	526	438	-88	-17%	Pass	4.02	Pass	588	478	-110	-19%	Fail	4.78	Pass
19266311	114494652	114494604	477	376	-101	-21%	Fail	4.91	Pass	535	427	-108	-20%	Fail	4.91	Pass
19267161	114495123	114495158	134	34	-100	-75%	Pass	10.89	Fail	143	37	-106	-74%	Fail	11.19	Fail
19267161	114495158	114495123	119	252	133	112%	Fail	9.76	Fail	127	256	129	101%	Fail	9.29	Fail
19313243	118701136	118701525	307	171	-136	-44%	Fail	8.81	Fail	376	238	-138	-37%	Fail	7.90	Fail
19313243	118701525	118701136	296	357	61	21%	Pass	3.36	Pass	363	433	70	19%	Pass	3.51	Pass
19319997	114497378	114493690	482	445	-37	-8%	Pass	1.71	Pass	535	484	-51	-10%	Pass	2.27	Pass
1131705662	124436121	35584	431	741	310	72%	Fail	12.83	Fail	528	922	394	75%	Fail	14.65	Fail
19321264	114497384	114497385	750	627	-123	-16%	Fail	4.69	Pass	994	891	-103	-10%	Pass	3.35	Pass
33226945	114493540	114493669	488	415	-73	-15%	Pass	3.42	Pass	536	468	-68	-13%	Pass	3.05	Pass
33226945	114493669	114493540	549	517	-32	-6%	Pass	1.39	Pass	610	635	25	4%	Pass	1.01	Pass
33226947	114493378	114493411	90	73	-17	-19%	Pass	1.92	Pass	169	106	-63	-37%	Pass	5.40	Fail
33226947	114493411	114493378	104	96	-8	-8%	Pass	0.80	Pass	183	111	-72	-39%	Pass	5.94	Fail
78060770	114495532	114497706	290	508	218	75%	Fail	10.90	Fail	356	652	296	83%	Fail	13.20	Fail
78060772	114497707	114495533	409	398	-11	-3%	Pass	0.56	Pass	502	580	78	16%	Pass	3.37	Pass
565841047	114494158	114497849	331	307	-24	-7%	Pass	1.33	Pass	394	333	-61	-15%	Pass	3.20	Pass
565841047	114497849	114494158	412	353	-59	-14%	Pass	3.01	Pass	468	414	-54	-11%	Pass	2.55	Pass
565843175	114494453	114579435	353	522	169	48%	Fail	8.08	Fail	401	553	152	38%	Fail	6.96	Fail
565843175	114579435	114494453	362	327	-35	-10%	Pass	1.88	Pass	412	364	-48	-12%	Pass	2.45	Pass
565843406	114493716	114579531	323	317	-6	-2%	Pass	0.34	Pass	400	344	-56	-14%	Pass	2.91	Pass
565843406	114579531	114493716	386	418	32	8%	Pass	1.60	Pass	479	456	-23	-5%	Pass	1.06	Pass
565843604	114493519	114579597	480	553	73	15%	Pass	3.23	Pass	537	619	82	15%	Pass	3.40	Pass
565843604	114579597	114493519	548	307	-241	-44%	Fail	11.66	Fail	611	418	-193	-32%	Fail	8.52	Fail
565851555	114579481	114579531	242	261	19	8%	Pass	1.21	Pass	366	344	-22	-6%	Pass	1.14	Pass
565851555	114579531	114579481	296	447	151	51%	Fail	7.83	Fail	443	501	58	13%	Pass	2.66	Pass
565851556	114579478	114579531	298	300	2	1%	Pass	0.11	Pass	400	313	-87	-22%	Pass	4.61	Pass
565851556	114579531	114579478	309	191	-118	-38%	Fail	7.47	Fail	412	217	-195	-47%	Fail	10.98	Fail
565851557	114493660	114579531	703	988	285	41%	Fail	9.81	Fail	868	1138	270	31%	Fail	8.53	Fail
565851557	114579531	114493660	666	801	135	20%	Fail	4.99	Pass	819	932	113	14%	Pass	3.83	Pass
565851559	114579531	118701569	625	786	161	26%	Fail	6.06	Fail	768	915	147	19%	Fail	5.06	Fail

			Cars							Total						
Link	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
565851559	118701569	114579531	716	775	59	8%	Pass	2.15	Pass	887	882	-5	-1%	Pass	0.18	Pass
565851560	114493837	118701570	664	801	137	21%	Fail	5.06	Fail	816	932	117	14%	Pass	3.94	Pass
565851560	118701570	114493837	703	988	285	41%	Fail	9.80	Fail	869	1138	269	31%	Fail	8.48	Fail
565851561	114579485	118701570	396	355	-41	-10%	Pass	2.10	Pass	481	416	-65	-13%	Pass	3.05	Pass
565851561	118701570	114579485	344	488	144	42%	Fail	7.06	Fail	412	513	101	25%	Fail	4.70	Pass
565851562	114579491	118701570	10	123	113	1151%	Fail	13.89	Fail	12	126	115	996%	Fail	13.81	Fail
565851562	118701570	114579491	50	73	23	46%	Pass	2.91	Pass	60	80	20	34%	Pass	2.41	Pass
565851563	114579492	118701570	95	168	73	77%	Pass	6.38	Fail	114	179	66	58%	Pass	5.42	Fail
565851563	118701570	114579492	67	176	109	164%	Fail	9.93	Fail	78	220	142	182%	Fail	11.63	Fail
565851564	114579493	118701570	504	767	263	52%	Fail	10.45	Fail	613	867	254	41%	Fail	9.34	Fail
565851564	118701570	114579493	504	491	-13	-3%	Pass	0.59	Pass	615	570	-45	-7%	Pass	1.85	Pass
565851611	114492828	118701583	367	379	12	3%	Pass	0.61	Pass	399	503	104	26%	Fail	4.90	Pass
565851611	118701583	114492828	376	384	8	2%	Pass	0.41	Pass	436	498	62	14%	Pass	2.87	Pass
565851616	114495368	114579592	246	128	-118	-48%	Fail	8.60	Fail	289	147	-142	-49%	Fail	9.60	Fail
565851616	114579592	114495368	123	112	-11	-9%	Pass	1.01	Pass	143	137	-5	-4%	Pass	0.47	Pass
565851622	114579533	114579594	525	480	-45	-9%	Pass	2.02	Pass	571	539	-32	-6%	Pass	1.38	Pass
565851622	114579594	114579533	465	356	-109	-23%	Fail	5.37	Fail	503	401	-102	-20%	Fail	4.79	Pass
565851704	114579588	118701624	337	333	-4	-1%	Pass	0.23	Pass	359	367	8	2%	Pass	0.44	Pass
565851704	118701624	114579588	358	290	-68	-19%	Pass	3.77	Pass	382	313	-69	-18%	Pass	3.72	Pass
1131704455	35323	114494478	750	690	-60	-8%	Pass	2.25	Pass	809	783	-26	-3%	Pass	0.93	Pass
1131704455	114494478	35323	179	147	-32	-18%	Pass	2.53	Pass	193	173	-20	-10%	Pass	1.48	Pass
565851677	118701609	118701610	535	451	-84	-16%	Pass	3.78	Pass	567	495	-72	-13%	Pass	3.13	Pass
565851677	118701610	118701609	555	475	-80	-14%	Pass	3.51	Pass	591	528	-63	-11%	Pass	2.67	Pass
1131705653	33925	33926	435	334	-101	-23%	Fail	5.14	Fail	463	386	-77	-17%	Pass	3.75	Pass
1131705653	33926	33925	462	333	-129	-28%	Fail	6.47	Fail	493	373	-120	-24%	Fail	5.79	Fail
1131705770	35738	114497857	819	574	-245	-30%	Fail	9.27	Fail	1003	846	-157	-16%	Fail	5.17	Fail
1131705330	114497856	35739	693	597	-96	-14%	Pass	3.80	Pass	850	794	-56	-7%	Pass	1.94	Pass
1131705830	33680	237403835	325	318	-7	-2%	Pass	0.37	Pass	357	337	-20	-6%	Pass	1.09	Pass
1131705830	237403835	33680	388	338	-50	-13%	Pass	2.62	Pass	425	376	-49	-12%	Pass	2.45	Pass
1131706023	114495162	114497696	161	307	146	91%	Fail	9.56	Fail	197	378	181	92%	Fail	10.67	Fail
1131706023	114497696	114495162	195	234	39	20%	Pass	2.66	Pass	239	314	75	31%	Pass	4.51	Pass

			Cars							Total						
Link	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
1131706427	34691	114493723	533	525	-8	-1%	Pass	0.34	Pass	587	593	6	1%	Pass	0.23	Pass
1131706785	114494652	237403967	100	112	12	12%	Pass	1.15	Pass	112	113	1	1%	Pass	0.09	Pass
1131706785	237403967	114494652	79	50	-29	-37%	Pass	3.61	Pass	88	51	-37	-42%	Pass	4.42	Pass
1131707068	237404131	114497375	1042	995	-47	-4%	Pass	1.46	Pass	1277	1287	10	1%	Pass	0.29	Pass
78069009	114497464	114497741	968	800	-168	-17%	Fail	5.66	Fail	1187	1000	-187	-16%	Fail	5.64	Fail
2131706901	114497325	812212128	205	147	-58	-28%	Pass	4.36	Pass	263	198	-65	-25%	Pass	4.28	Pass
2131706901	812212128	114497325	155	100	-55	-36%	Pass	4.89	Pass	220	182	-38	-17%	Pass	2.71	Pass
Total Model Pass								69	79						72	79

Table E-3: Validation PM

			Cars							Total						
Link	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
565851822	118701578	118701717	1131	1276	145	13%	Pass	4.18	Pass	1363	1472	109	8%	Pass	2.90	Pass
565851822	118701717	118701578	1637	1839	202	12%	Pass	4.85	Pass	1887	2058	171	9%	Pass	3.85	Pass
565851828	118701578	118701720	1365	1629	264	19%	Fail	6.82	Fail	1590	1848	258	16%	Fail	6.22	Fail
565851828	118701720	118701578	823	1047	224	27%	Fail	7.33	Fail	1013	1215	202	20%	Fail	6.05	Fail
18	812212120	812212121	387	285	-102	-26%	Fail	5.56	Fail	405	326	-79	-19%	Pass	4.11	Pass
18	812212121	812212120	446	359	-87	-20%	Pass	4.34	Pass	464	375	-89	-19%	Pass	4.34	Pass
19263748	114493005	114493004	1615	1745	130	8%	Pass	3.18	Pass	2010	2055	45	2%	Pass	1.00	Pass
19264071	114493188	114493198	110	193	83	75%	Pass	6.71	Fail	130	224	94	72%	Pass	7.03	Fail
19264071	114493198	114493188	343	300	-43	-13%	Pass	2.40	Pass	382	327	-55	-14%	Pass	2.91	Pass
19264163	114493254	114493260	217	279	62	29%	Pass	3.96	Pass	246	346	100	40%	Pass	5.79	Fail
19264163	114493260	114493254	88	51	-37	-42%	Pass	4.43	Pass	106	73	-33	-31%	Pass	3.49	Pass
19264313	114493378	114493377	885	945	60	7%	Pass	1.98	Pass	1108	1156	48	4%	Pass	1.43	Pass
19264346	114493240	114493401	156	187	31	20%	Pass	2.37	Pass	207	210	3	1%	Pass	0.21	Pass
19264346	114493401	114493240	331	236	-95	-29%	Pass	5.64	Fail	406	244	-162	-40%	Fail	8.99	Fail
19264353	114493401	114493403	67	63	-4	-6%	Pass	0.50	Pass	108	91	-17	-16%	Pass	1.70	Pass
19264353	114493403	114493401	154	120	-34	-22%	Pass	2.90	Pass	187	140	-47	-25%	Pass	3.68	Pass
19264390	114493401	114493432	306	306	0	0%	Pass	0.00	Pass	389	350	-39	-10%	Pass	2.03	Pass
19264390	114493432	114493401	394	298	-96	-24%	Pass	5.16	Fail	509	335	-174	-34%	Fail	8.47	Fail
19264404	114493436	114493442	173	222	49	29%	Pass	3.52	Pass	192	249	57	30%	Pass	3.83	Pass
19264404	114493442	114493436	178	279	101	57%	Fail	6.69	Fail	206	322	116	56%	Fail	7.11	Fail
1131706378	35330	118701614	480	385	-95	-20%	Pass	4.55	Pass	507	405	-102	-20%	Fail	4.78	Pass
1131706378	118701614	35330	555	411	-144	-26%	Fail	6.55	Fail	582	449	-133	-23%	Fail	5.87	Fail
19310003	114494142	114497068	520	527	7	1%	Pass	0.31	Pass	592	558	-34	-6%	Pass	1.42	Pass
19310003	114497068	114494142	352	460	108	31%	Fail	5.36	Fail	403	480	77	19%	Pass	3.66	Pass
1131705361	35340	114494142	147	175	28	19%	Pass	2.21	Pass	169	182	13	8%	Pass	0.98	Pass
1131705361	114494142	35340	192	154	-38	-20%	Pass	2.89	Pass	214	166	-48	-22%	Pass	3.48	Pass
1131706589	34678	114494142	417	342	-75	-18%	Pass	3.85	Pass	464	364	-100	-22%	Pass	4.91	Pass
1131706589	114494142	34678	409	587	178	44%	Fail	7.98	Fail	462	599	137	30%	Fail	5.95	Fail
19265494	114493993	114494142	449	527	78	17%	Pass	3.53	Pass	521	554	33	6%	Pass	1.42	Pass

			Cars							Total						
Link	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
19265494	114494142	114493993	244	235	-9	-4%	Pass	0.58	Pass	289	257	-32	-11%	Pass	1.94	Pass
19266311	114494604	114494652	799	729	-70	-9%	Pass	2.53	Pass	912	819	-93	-10%	Pass	3.16	Pass
19266311	114494652	114494604	430	414	-16	-4%	Pass	0.78	Pass	472	458	-14	-3%	Pass	0.65	Pass
19267161	114495123	114495158	198	84	-114	-58%	Fail	9.59	Fail	206	84	-122	-59%	Fail	10.16	Fail
19267161	114495158	114495123	129	88	-41	-32%	Pass	3.96	Pass	136	94	-42	-31%	Pass	3.91	Pass
19313243	118701136	118701525	349	352	3	1%	Pass	0.15	Pass	435	429	-6	-1%	Pass	0.27	Pass
19313243	118701525	118701136	366	305	-61	-17%	Pass	3.32	Pass	455	373	-82	-18%	Pass	4.05	Pass
19319997	114497378	114493690	469	432	-37	-8%	Pass	1.75	Pass	514	460	-54	-11%	Pass	2.46	Pass
1131705662	124436121	35584	522	681	159	30%	Fail	6.49	Fail	650	930	280	43%	Fail	9.97	Fail
19321264	114497384	114497385	1182	1291	109	9%	Pass	3.10	Pass	1339	1449	110	8%	Pass	2.95	Pass
33226945	114493540	114493669	528	468	-60	-11%	Pass	2.68	Pass	558	547	-11	-2%	Pass	0.45	Pass
33226945	114493669	114493540	375	355	-20	-5%	Pass	1.04	Pass	406	422	16	4%	Pass	0.78	Pass
33226947	114493378	114493411	32	38	6	19%	Pass	1.01	Pass	60	44	-16	-27%	Pass	2.22	Pass
33226947	114493411	114493378	218	220	2	1%	Pass	0.14	Pass	264	249	-15	-6%	Pass	0.94	Pass
78060770	114495532	114497706	329	330	1	0%	Pass	0.05	Pass	410	446	36	9%	Pass	1.75	Pass
78060772	114497707	114495533	427	459	32	7%	Pass	1.51	Pass	532	570	38	7%	Pass	1.63	Pass
565841047	114494158	114497849	226	417	191	84%	Fail	10.64	Fail	265	477	212	80%	Fail	10.98	Fail
565841047	114497849	114494158	382	395	13	3%	Pass	0.68	Pass	419	440	21	5%	Pass	1.02	Pass
565843175	114494453	114579435	318	499	181	57%	Fail	8.93	Fail	352	511	159	45%	Fail	7.64	Fail
565843175	114579435	114494453	582	579	-3	0%	Pass	0.11	Pass	640	638	-2	0%	Pass	0.10	Pass
565843406	114493716	114579531	360	354	-6	-2%	Pass	0.32	Pass	427	371	-56	-13%	Pass	2.80	Pass
565843406	114579531	114493716	567	522	-45	-8%	Pass	1.93	Pass	650	539	-111	-17%	Fail	4.55	Pass
565843604	114493519	114579597	271	201	-70	-26%	Pass	4.56	Pass	293	236	-57	-19%	Pass	3.48	Pass
565843604	114579597	114493519	536	483	-53	-10%	Pass	2.33	Pass	577	534	-43	-7%	Pass	1.82	Pass
565851555	114579481	114579531	465	528	63	14%	Pass	2.83	Pass	572	559	-13	-2%	Pass	0.55	Pass
565851555	114579531	114579481	418	332	-86	-21%	Pass	4.44	Pass	526	355	-171	-33%	Fail	8.15	Fail
565851556	114579478	114579531	481	307	-174	-36%	Fail	8.77	Fail	550	339	-211	-38%	Fail	10.01	Fail
565851556	114579531	114579478	499	323	-176	-35%	Fail	8.68	Fail	587	346	-241	-41%	Fail	11.16	Fail
565851557	114493660	114579531	812	782	-30	-4%	Pass	1.06	Pass	909	866	-43	-5%	Pass	1.44	Pass
565851557	114579531	114493660	877	1034	157	18%	Fail	5.08	Fail	1032	1199	167	16%	Fail	5.00	Fail
565851559	114579531	118701569	691	658	-33	-5%	Pass	1.27	Pass	754	755	1	0%	Pass	0.04	Pass

			Cars							Total						
Link	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
565851559	118701569	114579531	934	895	-39	-4%	Pass	1.29	Pass	1091	1060	-31	-3%	Pass	0.95	Pass
565851560	114493837	118701570	885	1034	149	17%	Fail	4.81	Pass	1042	1199	157	15%	Fail	4.69	Pass
565851560	118701570	114493837	785	782	-3	0%	Pass	0.11	Pass	882	866	-16	-2%	Pass	0.54	Pass
565851561	114579485	118701570	402	380	-22	-5%	Pass	1.11	Pass	459	436	-23	-5%	Pass	1.09	Pass
565851561	118701570	114579485	420	335	-85	-20%	Pass	4.37	Pass	491	401	-90	-18%	Pass	4.26	Pass
565851562	114579491	118701570	22	55	33	150%	Pass	5.32	Fail	23	64	41	178%	Pass	6.22	Fail
565851562	118701570	114579491	88	69	-19	-22%	Pass	2.14	Pass	102	88	-14	-14%	Pass	1.44	Pass
565851563	114579492	118701570	121	101	-20	-17%	Pass	1.90	Pass	137	113	-24	-18%	Pass	2.15	Pass
565851563	118701570	114579492	93	214	121	130%	Fail	9.77	Fail	118	235	117	99%	Fail	8.81	Fail
565851564	114579493	118701570	521	480	-41	-8%	Pass	1.83	Pass	602	504	-98	-16%	Pass	4.17	Pass
565851564	118701570	114579493	565	653	88	16%	Pass	3.57	Pass	670	727	57	9%	Pass	2.16	Pass
565851611	114492828	118701583	639	571	-68	-11%	Pass	2.77	Pass	699	671	-28	-4%	Pass	1.07	Pass
565851611	118701583	114492828	430	423	-7	-2%	Pass	0.33	Pass	465	548	83	18%	Pass	3.68	Pass
565851616	114495368	114579592	330	169	-161	-49%	Fail	10.20	Fail	363	183	-180	-50%	Fail	10.92	Fail
565851616	114579592	114495368	153	148	-5	-3%	Pass	0.40	Pass	166	156	-10	-6%	Pass	0.75	Pass
565851622	114579533	114579594	565	451	-114	-20%	Fail	5.04	Fail	600	500	-100	-17%	Pass	4.25	Pass
565851622	114579594	114579533	687	609	-78	-11%	Pass	3.08	Pass	726	662	-64	-9%	Pass	2.44	Pass
565851704	114579588	118701624	524	442	-82	-16%	Pass	3.73	Pass	549	476	-73	-13%	Pass	3.24	Pass
565851704	118701624	114579588	580	371	-209	-36%	Fail	9.57	Fail	605	421	-184	-30%	Fail	8.13	Fail
1131704455	35323	114494478	779	710	-69	-9%	Pass	2.53	Pass	815	778	-37	-5%	Pass	1.31	Pass
1131704455	114494478	35323	313	329	16	5%	Pass	0.87	Pass	327	353	26	8%	Pass	1.42	Pass
565851677	118701609	118701610	850	550	-300	-35%	Fail	11.34	Fail	884	585	-299	-34%	Fail	11.02	Fail
565851677	118701610	118701609	674	500	-174	-26%	Fail	7.20	Fail	707	529	-178	-25%	Fail	7.17	Fail
1131705653	33925	33926	370	384	14	4%	Pass	0.70	Pass	391	429	38	10%	Pass	1.87	Pass
1131705653	33926	33925	660	595	-65	-10%	Pass	2.60	Pass	696	687	-9	-1%	Pass	0.35	Pass
1131705770	35738	114497857	1284	1409	125	10%	Pass	3.41	Pass	1598	1603	5	0%	Pass	0.12	Pass
1131705330	114497856	35739	620	656	36	6%	Pass	1.44	Pass	771	832	61	8%	Pass	2.14	Pass
1131705830	33680	237403835	317	467	150	47%	Fail	7.55	Fail	343	489	146	43%	Fail	7.17	Fail
1131705830	237403835	33680	453	512	59	13%	Pass	2.70	Pass	487	536	49	10%	Pass	2.16	Pass
1131706023	114495162	114497696	211	220	9	4%	Pass	0.61	Pass	263	290	27	10%	Pass	1.64	Pass
1131706023	114497696	114495162	197	245	48	24%	Pass	3.20	Pass	246	322	76	31%	Pass	4.52	Pass

			Cars							Total						
Link	A node	B node	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5	Obs	Mod	Diff	% Diff	Link Flow	GEH	GEH < 5
1131706427	34691	114493723	484	429	-55	-11%	Pass	2.56	Pass	531	453	-78	-15%	Pass	3.52	Pass
1131706785	114494652	237403967	191	155	-36	-19%	Pass	2.74	Pass	213	155	-58	-27%	Pass	4.28	Pass
1131706785	237403967	114494652	151	52	-99	-66%	Pass	9.83	Fail	158	52	-106	-67%	Fail	10.34	Fail
1131707068	237404131	114497375	1556	1617	61	4%	Pass	1.54	Pass	1937	1891	-46	-2%	Pass	1.04	Pass
78069009	114497464	114497741	1111	1185	74	7%	Pass	2.17	Pass	1384	1383	-1	0%	Pass	0.01	Pass
2131706901	114497325	812212128	506	502	-4	-1%	Pass	0.20	Pass	557	567	10	2%	Pass	0.41	Pass
2131706901	812212128	114497325	88	71	-17	-19%	Pass	1.85	Pass	121	104	-17	-14%	Pass	1.64	Pass
Total Model Pass								72	77						73	76