Inner Moray Firth Local Development Plan Modelling Report

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Inner Moray Firth
Local Development Plan Modelling Report

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Table of Contents

Executive Summary

Background

The Inner Moray Firth Local Development Plan is aimed at promoting sustainable and economic growth for the area. The development plan reviews the requirement for housing, employment and other purposes, considering their suitability in terms of location and impact on the transport network. By planning these sites with sustainability in mind, the Council aim to minimise / delay the need for future transport infrastructure and maximise the operation of the current network.

In order to understand future development requirements, The Highland Council have set key forecasts for population and housing. It is expected that around 22,000 homes will be required over the next 20 years in the Inner Moray Firth area. At present the Council has collected information on potential development sites which in turn have resulted in a focus on transport issues and how these could be mitigated. Mitigation measures ranged from improved development access locations to large scale infrastructure projects such as the dualling of the A96 between Nairn and Inverness. Therefore, as a starting point, it was essential that a review was undertaken of how the existing network would perform with the proposed levels of development, and when infrastructure may be required.

Brief

AECOM was commissioned by The Highland Council to undertake a transport modelling exercise using the Council's strategic transport model. The main aims of the commission were as follows:

- Assess the potential trip making based on the type and location of each development;
- Present information on the impact of these developments for the forecast years of 2016, 2021 and 2031;
- Include the expected infrastructure for each forecast year; and
- Highlight where transport delays are likely to arise.

The initial model findings were presented at a stakeholder workshop to highlight the issues and generate discussion on measures required to mitigate any transport impacts. The reporting of the model findings is presented within this report.

Modelling Tool

In 2009 AECOM was commissioned to undertake the development of a multi modal transport model, which was capable of modelling private vehicles such as car and goods vehicles as well as public transport such as bus and rail. The model required the following capabilities:

- Trip generation (How many workers are drawn to a given employment centre);
- Trip distribution (How are the generated trips distributed over the various zones in the network);
- Mode Choice (Which form of transport an individual will use); and
- Trip Assignment (The route taken to travel from origin to destination).

The model went through a rigorous audit by Transport Scotland to ensure it was "fit for purpose", e.g. for use in assessing development proposals, local plans and infrastructure improvements etc. The model has been used to assess both the West and East Link proposals, which were undertaken by The Highland Council and Transport Scotland respectively.

The model was developed using a variety of traffic and planning data such as roadside interviews, traffic counts, vehicle journey times, bus frequency / routing information, traffic signal data, census and planning household information. This data was used to develop the model but also to assess its correlation with current (2009) traffic conditions.

The model provides a variety of traffic related information such as:

- Junction performance (graded between A to F depending on level of delay);
- Road Performance (highlights the level of traffic demand against available road capacity); and
- Queuing within the network (highlighting where traffic flows are unable to pass certain pinch points);

It is capable of assessing several network improvements from city bypasses to minor changes to junction flare lengths. It also has limited ability to assess public transport interventions such as new bus or rail services and changes to fare pricing. However, the model is limited with regards to walking and cycling as there was no suitable survey data available to properly integrate these modes into the model.

Development Plan and Infrastructure Scenarios

As highlighted above, The Highland Council has examined the future committed and proposed developments throughout the Inner Moray Firth area and prepared a local development plan which provides for sustainable growth and prosperity. Alongside the requirement to develop the Inner Moray Firth area, a strategy of planned interventions has been drawn up which is proposed to mitigate future development pressures. The interventions are as follows:

Milton of Leys Link Road (Council)*completed 2011; Culloden Road widening (Council); completed 2013 Signalisation of Longman Roundabout completed 2013 and Rose Street (Transport Scotland); Widening of Barn Church Road (Developer); Inshes / Network Upgrade (Council); A96 dualling west of Smithton (Developer); The Dingwall Kinnairdie Link Road and County junction improvements (Council); Conon Rail Halt (Council); completed 2013	Smithton Park & Ride Site (Developer); Raigmore Signalisation (Developer). West Link (Council); Dalcross Rail Halt (Network Rail); A96 dualling between Raigmore and Nairn (Transport Scotland); Nairn and Tornagrain Bypass (Transport Scotland); and East Link Road (Transport Scotland).

Between the 2016 and 2031 models each of the interventions above was introduced to assist in the changing levels of travel demand. It has been estimated that by 2031 the Inner Moray Firth Area will see an increase of 33% in dwellings and a 19% rise in employment compared to 2009 levels.

Modelling Results

The model results present our current best estimation of traffic conditions for the forecast years of 2016, 2021 and 2031. It is possible that the interventions may be delayed, therefore, for each forecast year the interventions from the previous forecast year have been applied to provide a worst case scenario for each forecast projection.

In 2016 developments such as the University of Highland and Islands and the initial development phases to the east and south of Inverness will have started to generate trips. This presents additional pressure in the Inshes and Culloden Road area. Pressure will also continue to build in the other main hotspot areas such as Ness Bridge, Longman roundabout and at Raigmore junction / A96. If the minimum improvements were introduced in 2016, which includes the Culloden Road improvements and the signalisation of Longman Roundabouts, localised relief at these locations would be experienced. It should be noted that Longman Roundabout was recently signalised by Transport Scotland as part of the traffic management works associated with the Kessock Bridge resurfacing works.

The model indicates that conditions at areas such as the Raigmore junction / A96 and the Ness Bridge area would continue to deteriorate in line with the increase in growth. If the full aspirations of the Council were realised in 2016, which would include the Inshes improvements, A96 dualling west of Smithton, Raigmore junction signalisation and Smithton Park and Ride, the congestion levels would reduce, especially around the Inverness east area. Queues could be managed better with the signalisation of Longman and Raigmore junctions, minimising delays to the traffic from the east and north of Inverness. However with little improvement to the city centre the congestion levels are expected to remain high. Looking further afield, the introduction of the Kinnairdie Link and improvements to the County Junction within Dingwall, lead to improvements in the expected level of congestion and the removal of traffic from residential streets.

Moving forward to 2021, further developments to the east and south of Inverness are planned to have been constructed which are expected to exacerbate congestion levels within Inverness. If no further infrastructure improvements are implemented by this time then major delays in the network will continue at Raigmore junction/ A96, Longman roundabout and the city centre. One of the main congestion hotspots is the city centre which now displays long queues which stretch back from Ness Bridge to Kenneth Street and Glenurquhart Road. However, by 2021 it is envisaged that the West Link and Dalcross Rail Halt will be operational. The West Link provides an alternative route for movements to and from South Inverness and the North / West Inverness via a link road connecting Dores Road Roundabout with the A82 and makes a significant contribution to reduced queuing within the city centre. The Dalcross Rail Halt facilitates the growing developments at Tornagrain and Inverness Airport Business Park and provides an alternative means of access to the city centre which should lead to some relief for Raigmore junction and the A96. However, congestion continues to develop around areas which see no improvement such as Longman roundabout and the Inshes area.

The final projecting year of 2031 sees the latter stages in development at Tornagrain, Whiteness, Nairn South and East Inverness. The growth in housing and employment between 2009 and 2031 is forecast to be approximately 33% and 19% respectively. Even with the infrastructure improvements expected in 2021, the network is expected to struggle to cope with predicted traffic demands. The hotspot areas, many of which experience improvements following the introduction of infrastructure now display congestion issues. Areas such as Raigmore junction, the A96 and Longman roundabout all show long delays. The final infrastructure improvements focus on improving the A96 by providing a bypass for Nairn and the newly developed Tornagrain, full dualling along the A96 and the East Link connection which provides an alternative route on to the A9 via a grade separated junction. These improvements provide a significant switch away from a number of key congestion locations such as Nairn, Raigmore junction and Culloden Road. However the attractiveness of the new East Link leads to high demand at the new grade separated junction.

The model provided several key indicators with regards to the highway performance, however the public transport improvements were less noticeable due to limitations within the model. Although the model has rail and bus facilities within the modal choice functions, it is unable to assess walking or cycling trips, these functionality were never required by The Highland Council.

While there is a significant amount of proposed / committed infrastructure planned for the Moray Firth area, it is not expected to meet the forecast traffic demands. This would suggest that there is a clear requirement for more sustainable solutions to help to minimise the expected traffic impact on the road network. Such as:

- Incorporating bus and cycle lanes into the network;
- Locating park and ride facilities on strategic routes into Inverness;

- Improved bus information via technology;
- Parking strategies etc

Using a “carrot-and-stick” approach which sees investment in greener, sustainable modes of travel while controlling car use through supportive parking polices and limited capacity for private vehicles will inevitable reduce the requirement for future infrastructure or delay their requirement. While improved infrastructure is beneficial to support economic growth for the Highlands, there must be a balance for sustainable development.

1. Introduction

1.1 Aim of this Study

The Highland Council is preparing its first new style area Local Development Plan, known as the Inner Moray Firth Local Development Plan (hereon referred to as the Plan or IMFLDP). The IMFLDP is a land use planning document which aims to promote sustainable economic growth in the Inner Moray Firth area (shown in **Figure 1** below) and to create and maintain high quality places where people want to live, work and visit. To this end the Plan will allocate a range of sites for housing, employment and other uses over the next 10 to 20 years in order to steer development towards the most appropriate locations. In preparing the Plan the Council must understand what transport issues will have to be addressed in the future in order to create successful and sustainable places. This study was therefore commissioned by The Highland Council to analyse the likely implications of development supported in the Plan for the transport network and to help identify the transport infrastructure likely to be required to support future communities.

1.2 Background

Figure 1 - Inner Moray Firth Area

The Highland-wide Local Development Plan set key forecasts for population and housing requirements for the Inner Moray Firth area. It projected an increase of 14,000 jobs in the Inner Moray Firth area over the next 20 years and a corresponding requirement for 22,000 new homes. The IMFLDP must therefore allocate sufficient land to accommodate these forward projections.

At the time of commissioning this transport study a number of stages of preparing the IMFLDP had already been undertaken by the Council, namely:

- A 'Call for Sites' exercise in 2011 – involved asking landowners and communities in the area to inform the Council of sites they would like to see developed and protected; and
- Publication and consultation on the Main Issues Report in April 2012 - based on the results of the 'Call for Sites' and with information from existing Local Plans this report presented the Council's preference for the best options for development and reasonable alternatives.

In considering preferences for sites in the Main Issues Report the Council took account of a number of transport issues such as the relative accessibility of sites by a range of transport modes and the likely capacity of existing transport infrastructure to accommodate additional development. Having identified the preferred and non-preferred locations for development the Council sought to understand the implications of this level of development for the local and strategic transport network. With a number of large scale transport projects proposed at both local and national government levels, and uncertainty over the precise timing of delivery and changes likely to be brought about by these projects, it was important that a number of different scenarios for timing of these transport projects were assessed.

In light of the above, the purpose of this study is to:

- analyse the capacity of the existing transport system to accommodate additional development;
- assess the benefits likely to be gained from politically and/or financially 'committed' transport projects, and;
- forecast the implications of development allocated in the emerging Inner Moray Firth Local Development Plan for the transport network.

This will then give a clear rationale for any transport interventions required. This approach is consistent with the requirements of Transport Scotland's Development Planning and Management Transport Appraisal Guidance[1].

[1] Transport Scotland (2009) Development Planning and Management Transport Appraisal Guidance

1.3 Brief

AECOM was previously commissioned by The Highland Council to develop the Moray Firth Transport Model. The original model, which only encompassed Inverness and the A96 through to Nairn, was used to inform the A96 Corridor Development Framework. The model was expanded to capture the 'Inverness travel to work' catchment area in order to assess the Highland-wide Local Development Plan. The existing transport model included the forecast years 2016, 2021 and 2031 (and beyond); the brief for the current study was to build on this existing modelling platform to measure the likely implications of delivering the housing land requirement specified in the Highland-wide Local Development Plan within the plan period.

The Main Issues Report identifies sites as preferred options for future development, including sites where a change of use is proposed from an existing local plan or local development plan allocation. These developments have been programmed for delivery over four phases (2011-15, 2016-20, 2021-30 and post 2030). The first three phases which deliver the housing requirement were programmed into the model. The Council has also provided estimated timescales for the implementation of transport infrastructure projects that are either politically and/or financially committed at national and/or local level.

As the housing land requirement is specified in the Highland-wide Local Development Plan and the Council's preferences for the scale and location of development were set out in the already published Main Issues Report, a single development plan scenario was tested. The plan data was converted by the model to forecasted trip numbers generated by these development sites over the three phases and assigned to the transport network, taking account of the benefits derived from the 'committed' transport infrastructure.

The initial model findings were presented at stakeholder workshop in November 2012 to highlight the issues and generate discussion on measures required to mitigate any transport impacts.

1.4 Modelling Tool

AECOM was commissioned by The Highland Council to develop a 2009 multi-modal transport model for the 'travel to work' catchment area of the City of Inverness (Moray Firth Transport Model - MFTM). The model uses the PTV VISUM software platform and the supplied models were for 'out of season' average AM and PM peak periods incorporating a variable demand model taking cognizance of the Design Manual for Roads and Bridges (DMRB) WebTAG procedures. The model was operational in 2010 and since then has been used on a number of projects.

The main aspect of the model lies within the demand procedures, which calculates whether a modal shift will occur based on changes in travel costs. Furthermore, the model assesses changes in trip length, due to drivers either moving house or employment location.

With regards to network outputs, the model provides a variety of performance indicators, including:

- level of service;
- end of period queuing;
- volume vs capacity; and
- change in traffic volumes between scenarios.

The model is a strategic model, therefore is suited to large infrastructure improvements such as the construction of the proposed West Link. However, the model also has the capabilities to analyse minor improvements such as increased flare length to junctions, modification to signal timings, increases to bus frequencies etc. The model has its limitations, which mainly relates to mode types which have not been surveyed including cycling and walking, these would require either additional information to be analysed within VISUM or a separate assessment undertaken by officials at the Council.

It must be noted that the future analysis of specific locations would require the production of a local validation on the IMFTM, and if necessary a micro simulation model to assess the impact at key junctions. The model currently being used to assess the Inner Moray Firth local development plan validates at a strategic level.

1.5 Outline Report

The report is structured as follows:

Chapter 2 – Due to improvements to the software, enhanced modelling techniques and requests from The Highland Council a number of alterations have been applied to the model which required documenting. This chapter discusses these changes in detail.

Chapter 3 – Due to changes highlighted above, a re-calibration / validation exercise was required. This chapter discusses the level of calibration and validation achieved.

Chapter 4 – Details on the Inner Moray Firth Local Plan and proposed infrastructure / public transport improvements are documented within this chapter.

Chapter 5 – Discusses the modelling results and highlights areas which are causing major delays. Furthermore the improvements to public transport and their impact are discussed within this chapter.

Chapter 6 – Summarises the findings and concludes the results from our analysis. Recommendations will also be discussed within this chapter.

2 Revisions to the Base Model

2.1 Introduction

The MFTM was developed in 2005 and has been maintained since, during which time a number of innovative modelling techniques and advancements within the software have been developed. Since the previous update in 2009 the model has been utilised on a number of projects which have tested the robustness and capabilities of the model. These projects have identified a number of areas where enhancements could be adopted. The following chapter discusses these enhancements and illustrates their benefit to the model.

2.2 Enhancements to the Model

2.2.1 Kimber Modelling at Roundabouts

Previous versions of VISUM utilised the methodology set out in the Highway Capacity Manual (HCM) for roundabout modelling as used in the US. This adopts a basic approach geometry i.e. number of lanes and also allows modification to gap acceptance and follow up times. A more robust method of modelling roundabouts is to use the 'Kimber' method which is more commonly used in the UK. The 'Kimber' method takes more cognizance of the roundabout geometry, including the diameter of the roundabout, flare lengths, entry width, approach angle etc. This method was recently included in to VISUM and adopted within the assignment procedures, however only key roundabouts were modelled in detail, all other roundabouts were assigned default values. The following roundabouts were modelled:

- Longman Roundabout
- Harbour Road Roundabout
- Shore Street Roundabout
- Telford Roundabout
- Telford / Carsegate Roundabout
- Millburn Roundabout
- The Fluke (Culcabock Road / Old Perth Road) Roundabout
- All Roundabouts on the Southern Distributor Road from Inshes to Dores Road Roundabout
- Inverness Retail Park Roundabout
- Barn Church Roundabout
- A9 / A835 / A832 Roundabout
- A9/A862/Cromarty Bridge – Roundabout south of Alness on the A9
- All Roundabouts associated with the Inverness Airport

The geometry details were measured from CAD drawings. Furthermore, geometries for all new roundabouts, such as the proposed roundabout for the West Link, were extracted from CAD drawings.

2.2.2 Blocking Back

Prior versions of the model only considered queuing once a link capacity had been exceeded; therefore queues were unable to form at junctions. This issue required correction since the majority of capacity restraints within Inverness and surrounding towns come from over saturated junctions. Therefore this was remedied via a minor alteration to the procedure file as recommended by the software developers. Blocking Back is now displayed on links and turns when volumes exceed capacity.

2.2.3 Slip Road Modelling

As recommended by a third party user of the MFTM, alterations were made to all slip roads within the model in order to better replicate delays with regards to merging on dual carriageways. It must be noted that the alterations are an enhancement on the

previous modelling method; however it is not a definitive modelling method for accurately calculating slip road delays. There is currently no definitive methodology for strategic models and therefore micro-simulation is still required.

The alterations which were made consisted of assigning all slip roads as “two way yields” (give-ways), with a critical gap of 3.5 seconds. The two main slip roads which required this were the Raigmore junction slips onto the A9.

2.2.4 Updating to Latest Version of VISUM

AECOM also took the opportunity to update the MFTM to the latest versions of VISUM. PTV has recently updated their software to versions 12, which incorporates a few new features including Scenario Manager allowing the user to manage variations of the same model. The adoption of this new version of the software, which includes a more detailed network checking facility, resulted in the identification of a few locations where network coding requires attention. These were included before commencing the recalibration and validation of the model.

All models in this analysis have been updated to version 12-01-04.

2.2.5 Network Enhancements

Apart from the modifications mentioned above The Highland Council also suggested a number of alterations to the model. These were as follows:

- Public Transport Sensitivity;
- Review signal timings in Dingwall at Tesco / County Junction;
- Recent signalisation of A96 in Nairn using SCOOT (a signal optimisation system);
- Amend link capacity for Fortrose High St (A832) to single track and passing places; and
- A9 junctions; A95 junction at Aviemore, Skiach at Alness/Evanton and A9/B9161 Munlochy junction.

All of the above were implemented however, due to difficulties with the new signal control system within Nairn, the signal timings were not implemented in any of the forecast models. However the absence of the revised timings would be expected have a minimal impact on the results from the model.

3 Re-Calibration and Validation

3.1 Calibration and Validation Results

The enhancements discussed in Chapter 2 have resulted in minor changes to the assignment, mostly due to changes in delays i.e. the junction operation using Kimber instead of HCM. Therefore with the inclusion of the enhancements a review of the calibration and validation was necessary in order to establish that the base model had maintained its integrity. It must be stated that no alterations have been carried out to the base year matrices.

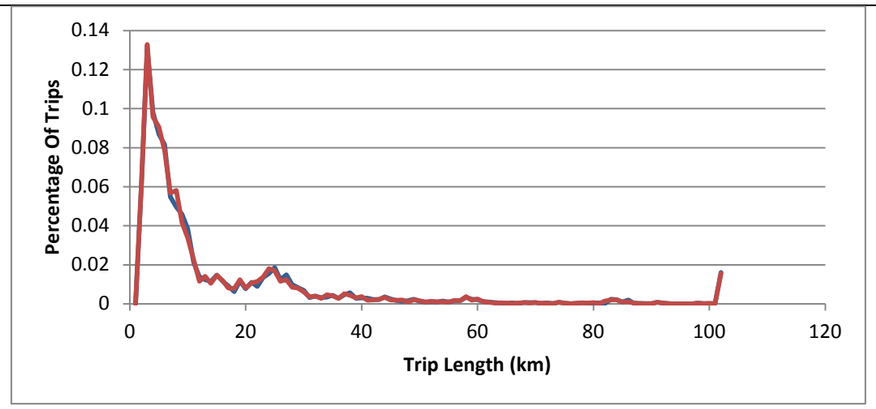
3.2 Trip Length Distribution

It is imperative that the Trip Length Distribution provides similar results between the Prior and a Final matrix, maintaining the integrity of the matrices provides confidence in forecasting subsequent results.

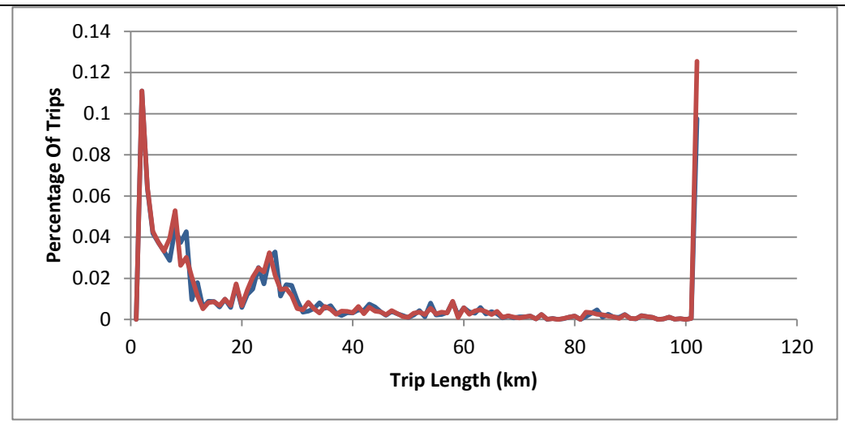
Although there have been no changes to the demand matrices, the trip length distribution may have changed due to the network updates e.g. improved blocking back and enhanced roundabout modelling. The following figures illustrate the changes in trip length distribution between the original validated MFTM base model and the current version of the IMF Development Plan model.

Capabilities on project:
Transportation

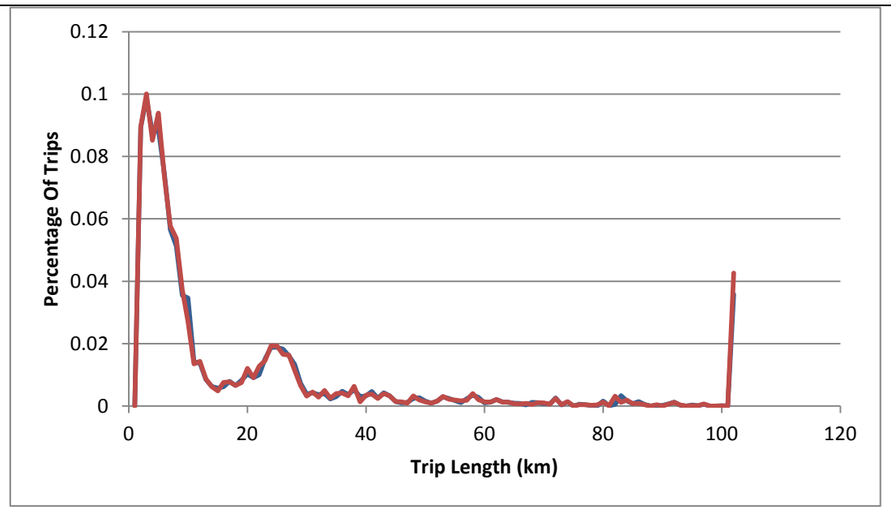
Figure 2 – AM Peak Trip Length Distribution Comparison



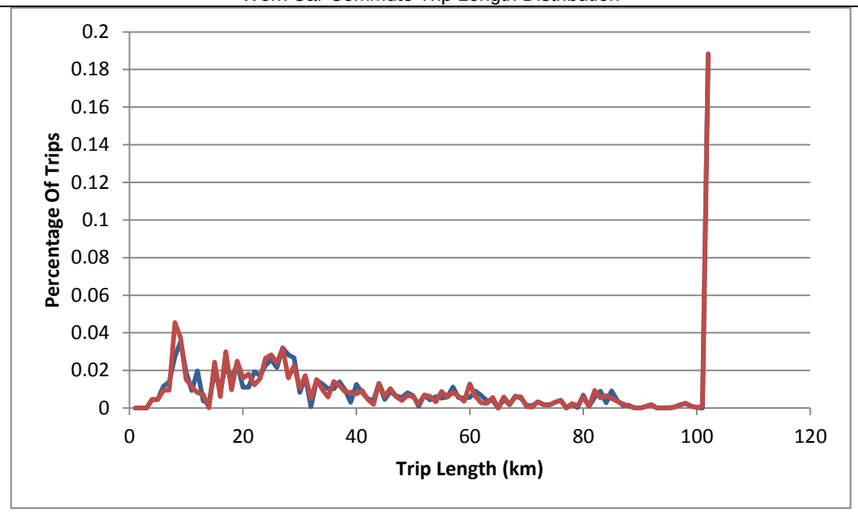
Car Commute Trip Length Distribution



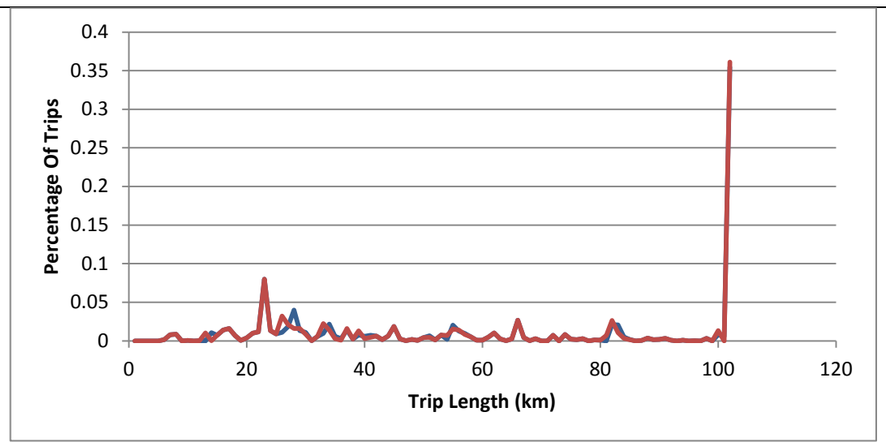
Work Car Commute Trip Length Distribution



Other Car Trip Length Distribution



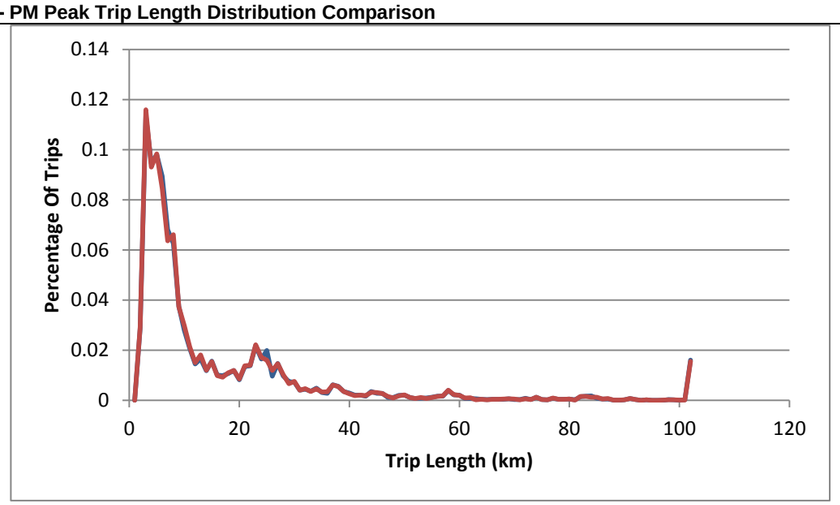
LGV Trip Length Distribution



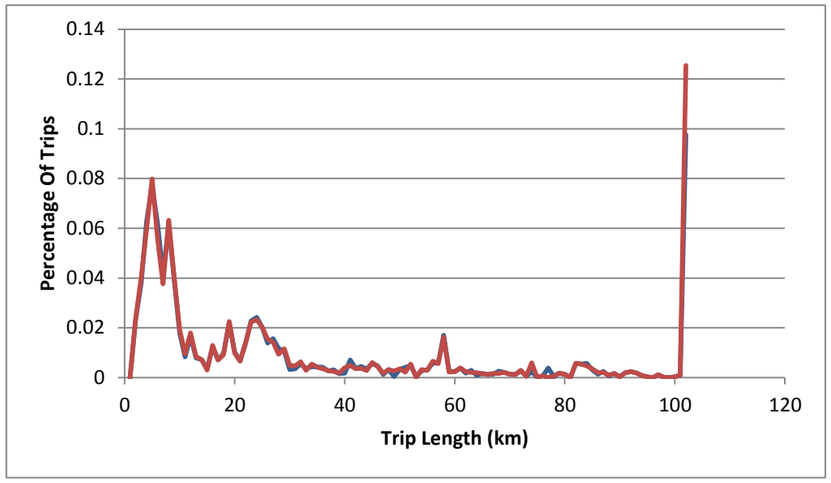
HGV Trip Length Distribution

Capabilities on project:
Transportation

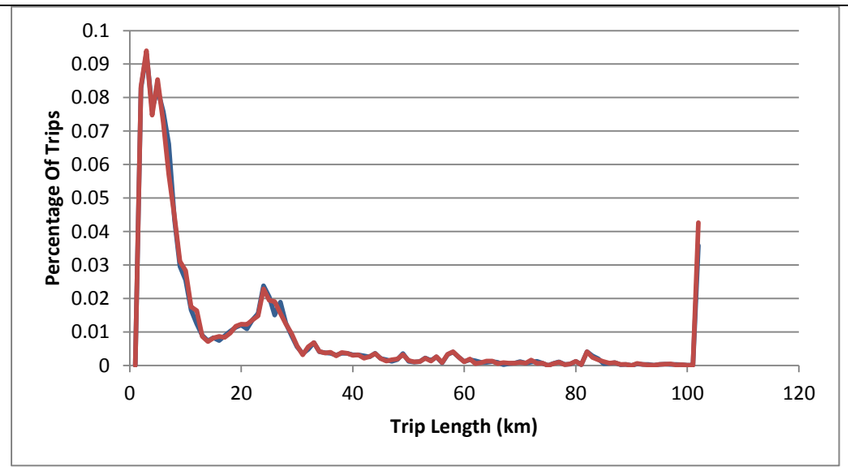
Figure 3 – PM Peak Trip Length Distribution Comparison



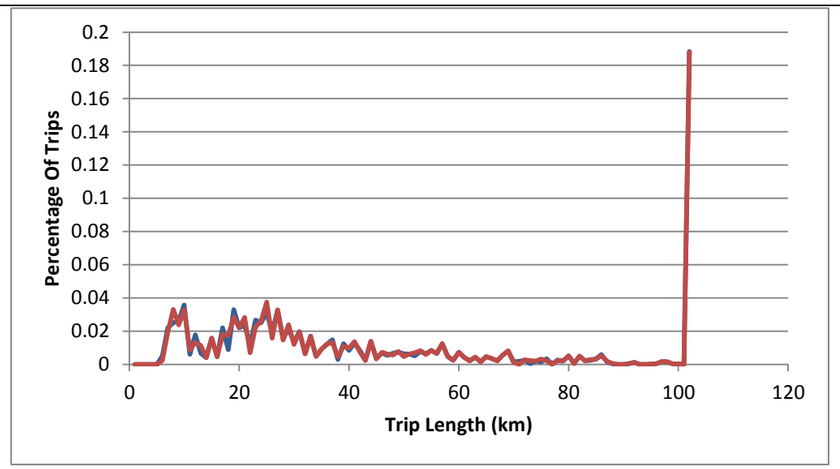
Car Commute Trip Length Distribution



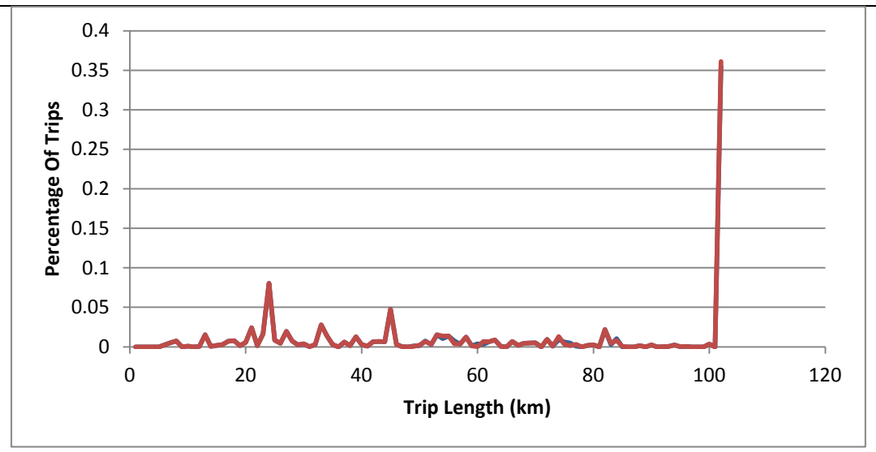
Work Car Commute Trip Length Distribution



Other Car Trip Length Distribution



LGV Trip Length Distribution



HGV Trip Length Distribution

As the figures above illustrate, the additional changes to the model have had little effect on the trip lengths of the 5 vehicle types.

3.2.1 Model Calibration

The DMRB specifies the acceptable criteria to be met when comparing modelled and observed traffic flows and suggests how calibration and validation should relate to the magnitude of the values being compared. A summary of the criteria is included in **Table 1**.

Simply using the percentage difference between observed and modelled data sets can prove to be misleading given the relative value of the difference e.g. 5 to 10 or 500 to 1000 are both 100% different but the latter is clearly of greater significance. The standard method used to compare modelled values against observations on a link involved the calculation of GEH statistic, incorporating both relative and absolute values.

The GEH is a measure of comparability that takes account of, not only the difference between the observed and modelled flows, but also the significance of this difference with respect to the size of the observed flow. The GEH is calculated as follows:

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

Where: M is the modelled flow and O is the observed flow.

A low GEH index indicates a good correlation between the observed and modelled flows. As a general rule, when comparing assigned volumes with observed volumes, a GEH parameter of 5 or less indicates an acceptable fit whilst a value of greater than 10 requires review of the model.

Table 1 – DMRB Criteria

DMRB Criteria and Measures	**Acceptability Guideline**
Individual flows within 15% for flows 700-2700 vph	> 85% of cases
Individual flows within 100 vph for flows <700 vph	
Individual flows within 100 vph for flows >2700 vph	
Total screen-line flows to be within 5%	All (or nearly all) screen-lines
Individual flows - GEH < 5	> 85% of cases
Screenline totals - GEH < 4	All (or nearly all) screen-lines

The tables provided in this chapter for calibration and validation, show, for reference purposes, the results achieved with respect to DMRB for the flow difference, GEH statistic and for both criteria.

The model has been calibrated using traffic counts from an outer cordon count, an inner cordon and from key locations around the Inner Moray Firth Area. The figures below indicate where the cordon points are located.

Figure 4 – Outer Cordon

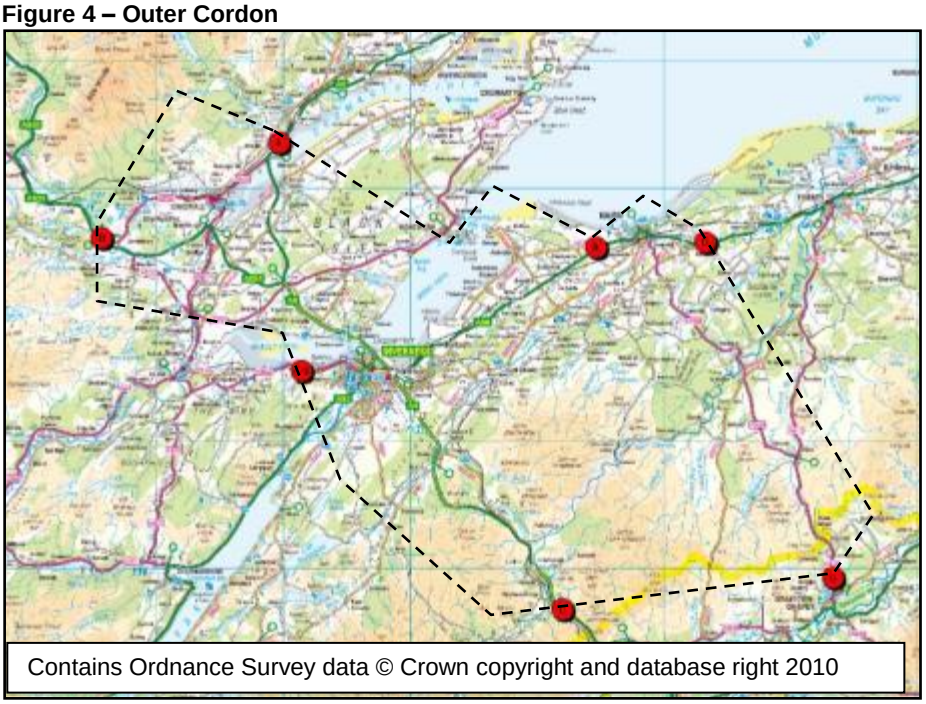
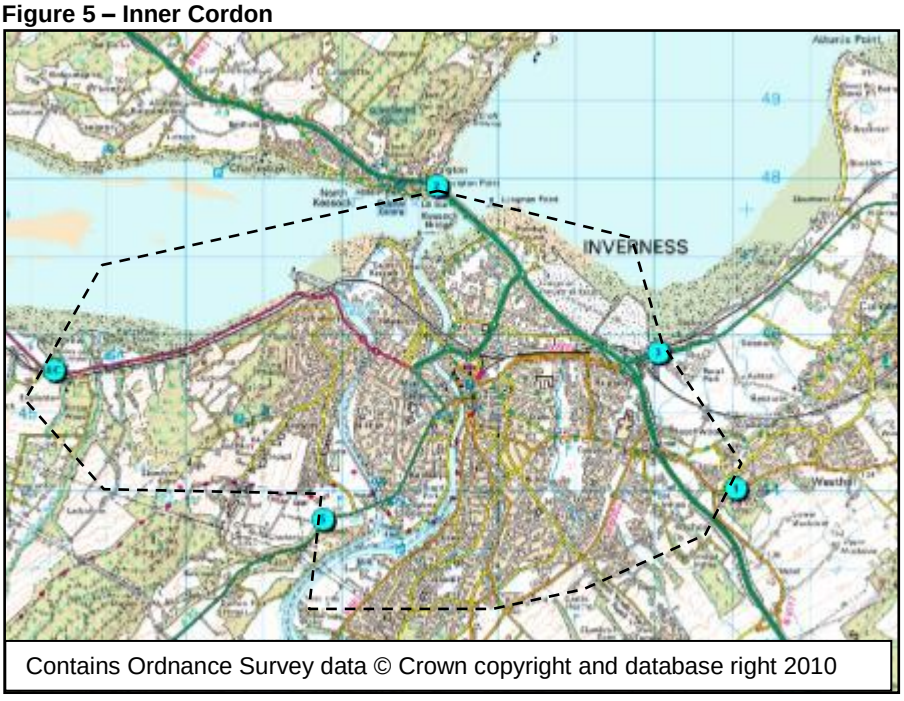


Figure 5 – Inner Cordon



The cordon summary results are highlighted in **Table 2** below.

Table 2 - Cordon Summary

DMRB Criteria	Result Achieved	
Modelled Flows against Observed Flows satisfying DMRB criteria (DMRB Target > 85%)	**AM Peak Hour**	**PM Peak Hour**
Individual flows within 100 vph for flows <700 vph	95%	100%
Individual flows within 15% for flows 700-2700 vph	75%	100%
Individual flows within 400 vph for flows >2700 vph	N/A	N/A
Average GEH	2.12	1.75
GEH Statistic for individual flows	90%	100%
MFTM Requirement	PASS	PASS

Note: In order to pass the DMRB calibration criteria the modelled flow must be within the individual flow rate criteria or the GEH criteria.

As indicated above the PM peak results present 100% in all calibration categories, while the AM marginally failed on 2 count locations resulting in a 95% and 75% pass rate for flows less that 700 vph and 700 to 2700 vph respectively. However both peaks pass the GEH criteria.

The following table present more details on the cordon calibration results

Table 3 - AM Peak Outer Cordon

Location	Direction	Count	Model	GEH
A96 West of Nairn	W	644	592	2.1
A96 West of Nairn	E	409	459	2.4
A835 South Of Contin	E	143	179	2.8
A835 South Of Contin	N	175	224	3.5
A862 at Bunchrew Campsite	W	113	107	0.6
A862 at Bunchrew Campsite	E	468	402	3.2
A96 west of Forres	W	345	314	1.7
A96 west of Forres	E	377	368	0.5
A9 Tomatin	S	272	253	1.2
A9 Tomatin	N	379	401	1.1
A9 Ardullie	N	594	571	1.0
A9 Ardullie	W	671	673	0.1
A939 Granton	N	81	106	2.6
A939 Granton	S	79	79	0.0

Capabilities on project:
Transportation

Table 4 - AM Peak Inner Cordon

Location	Direction	Count	Model	GEH
B9006 West	W	544	652	4.4
B9006 West	E	206	157	3.6
A9/ north approach to Kessock Bridge	S	1607	1687	2.0
A9/ north approach to Kessock Bridge	N	968	909	1.9
A96 Seafield	W	1522	1613	2.3
A96 Seafield	E	717	827	4.0
A862 at Bunchrew Campsite	W	113	107	0.6
A862 at Bunchrew Campsite	E	468	402	3.2
A82/ General Booth Rd	W	286	331	2.6
A82/ General Booth Rd	E	206	155	3.8

Table 5 - PM Outer Cordon

Location	Direction	Count	Model	GEH
A96 West of Nairn	W	458	476	0.8
A96 West of Nairn	E	676	671	0.2
A835 South Of Contin	E	187	246	4.0
A835 South Of Contin	N	150	196	3.5
A862 at Bunchrew Campsite	W	354	395	2.1
A862 at Bunchrew Campsite	E	121	94	2.6
A96 west of Forres	W	422	417	0.2
A96 west of Forres	E	415	405	0.5
A9 Tomatin	S	402	387	0.8
A9 Tomatin	N	360	434	3.7
A9 Ardullie	N	804	818	0.5
A9 Ardullie	W	647	640	0.3
A939 Granton	N	74	76	0.2
A939 Granton	S	82	73	1.0

Table 6 - PM Inner Cordon

Location	Direction	Count	Model	GEH
B9006 West	W	276	268	0.5
B9006 West	E	547	623	3.1
A9/ north approach to Kessock Bridge	S	1059	1086	0.8
A9/ north approach to Kessock Bridge	N	1787	1664	3.0
A96 Seafield	W	923	854	2.3
A96 Seafield	E	1593	1498	2.4
A862 at Bunchrew Campsite	W	354	395	2.1
A862 at Bunchrew Campsite	E	121	94	2.6
A82/ General Booth Rd	W	211	195	1.1
A82/ General Booth Rd	E	288	230	3.6

Further to the screenline counts, a select number of individual link flows were also used to check the calibration. Again due to the minor changes, being applied to the revised model, the calibration results remain consistent with the original base model audited by Transport Scotland.

3.3 Model Validation

An additional measure of the overall performance and robustness of the model is to consider particular journeys through the assigned network and compare the known observed travel times with those predicted by the model. This combines the delays which are simulated along each link and turn along the route presenting a good indication of the comparison between modelled and actual journey movements. Guidance from the Client was received as to how Journey Time Validation should be undertaken:

> *"For journey times the emphasis is more on the journey time / distance comparisons rather than the meeting the whole journey time DMRB comparison. These graphs do not have a pass / fail criteria and as such we would anticipate a collaborative discussion at the time on where there are differences, how these relate to the quality of the observed information and local knowledge."*

With this in mind our attention has been focused on the profile of the surveyed and modelled journey time, however to satisfy any external audit we have presented a comparison of the total journey times against DMRB criteria.

The journey time routes in the MFTM model were collected for the development of the model from 11 November 2009 to 26 November. Journey time analysis was split into two distinct sectors i) Inner journey routes ii) Outer journey routes. They were carried out over a long period in order to avoid clashing with other surveys (RSIs etc) being carried out as part of the MFTM survey programme. The list of the journey time survey routes is shown below in **Table 7**. Diagrams of the journey time route are presented in Appendix A.

Table 7 – Journey Time Routes

Code	Journey Time Route	Survey Date
Route 1 Inner	A862 Delmore to Inshes Roundabout.	16/11/2009
Route 2 Inner	General Booth Road to Longman roundabout.	19/11/2009
Route 3Inner	Telford Street to Raigmore.	11/11/2009
Route 4 Inner	Culloden Rd / A9 slips to Millbank on-ramp.	12/11/2009
Route 1 Outer	A9 / A862 to A9 / B9169.	17/11/20009
Route 2 Outer	A835 / A9 to A835 / A832.	18/11/20009
Route 3 Outer	A862 / A835 to A862 / B9164.	23/11/2009
Route 4 Outer	A831 / A862 to 862 where High Street Ends and becomes Clachnaharry Road.	26/11/2009
Route 5 Outer	Forres Road/A939 to Raigmore via the A96.	16-18/6/2009

Table 7 presents the 95% Confidence Intervals for the Journey Time Routes, to allow an assessment of the routes we should have more, and less, confidence in.

Table 8 - Journey Time Route 95% Confidence Intervals

Code	Direction 1	AM Peak	PM Peak	Direction 2	AM Peak	PM Peak
Route 1 Inner	East	±19%	±22%	West	±6%	±12%
Route 2 Inner	North	±26%	±23%	South	±14%	±14%
Route 3Inner	East	±16%	±22%	West	±8%	±8%
Route 4 Inner	North	±14%	±24%	South	±22%	±15%
Route 1 Outer	North	±4%	±6%	South	±5%	±4%
Route 2 Outer	North	±7%	±8%	South	±7%	±3%
Route 3 Outer	North	±2%	±6%	South	±4%	±6%
Route 4 Outer	East	±7%	±6%	West	±6%	±5%
Route 5 Outer	East	±37%	±30%	West	±54%	±53%

It can be seen that the 'Inner' routes are much more variable than the 'Outer', with the exception of Route 5 Outer, which runs along the A96. This route exhibits extremely large variations in journey time. This should be borne in mind when considering the model results.

The journey time graphs for each of the measured routes are shown below in Appendix A and summarised in **Table 9**.

Table 9 - Journey Time Overview

	AM PEAK	PM PEAK
Journey Route	**DMRB criteria PASS / FAIL**	**DMRB criteria PASS / FAIL**
Route 1 EB Inner	-19%	-17%
Route 1 WB Inner	-13%	-13%
Route 2 EB inner	-23%	-6%
Route 2 WB Inner	-10%	-13%
Route 3 EB Inner	2%	-2%
Route 3 WB Inner	14%	-25%
Route 4 NB Inner	-8%	-5%
Route 4 SB Inner	-7%	8%
Route 1 SB Outer	-6%	1%
Route 1 NB Outer	-9%	1%
Route 2 NB Outer	-7%	-2%
Route 2 SB Outer	-6%	-8%

Route 3 SB Outer	-4%	1%
Route 3 NB Outer	0%	1%
Route 4 EB Outer	3%	7%
Route 4 WB Outer	2%	3%
Route 5 EB	10%	0%
Route 5 WB	3%	-1%

Journey Time validation has achieved 89% validation for both AM and PM peaks. The AM peak failed on the Route 1 eastbound which travels from Clachnaharry Road through the city centre via Kenneth Street to Old Perth Road and Route 2 eastbound along A82 from Glenurquhart Road to Longman Roundabout. Although these two journey time routes have failed, the profile with regards to Route 1 eastbound is consistent with the survey, suggesting there is no area which significantly changes between modelled and survey, however with regards to Route 2 the majority of the route correlates well with the model, however indicates fewer delays through Friars Lane area.

The PM peak journey times fail on Route 1 similar to the AM peak, however it also fails on Route 3 westbound which travels from Raigmore junction to Telford Roundabout via Academy Street. Route 1 is similar to the AM peak comparison, where the journey time route gradually deviates over the entire route with no specific location causing the discrepancy. Route 3 on the other hand indicates fewer delays through Academy Street, whereas the rest of the route is similar to the survey.

4 Development of the Local Development Plan and Proposed / Committed Infrastructure

4.1 Introduction

To effectively deliver the level of development supported by the Inner Moray Firth Local Development Plan, adequate infrastructure must be available. This chapter details the emerging Inner Moray Firth Local Development Plan to highlight the areas where development is supported then discusses the proposed infrastructure and public transport improvements which have been identified to mitigate against the development pressures.

4.2 Local Development Plan

The IMFLDP will guide the future use of land in this area. It will show where development, including regeneration, should happen and where it should not. To this end it will allocate a range of sites for housing, employment and other uses for a ten year period and provide an indication of the possible scale and location of development for up to 20 years. All sites supported in the Main Issues Report and/or contained within the Council's Housing Land Audit have been reviewed to establish potential site capacities and delivery timescales within four defined time periods:

- 2011 - 2015;
- 2016 - 2020;
- 2021 -2030; and
- Post 2031.

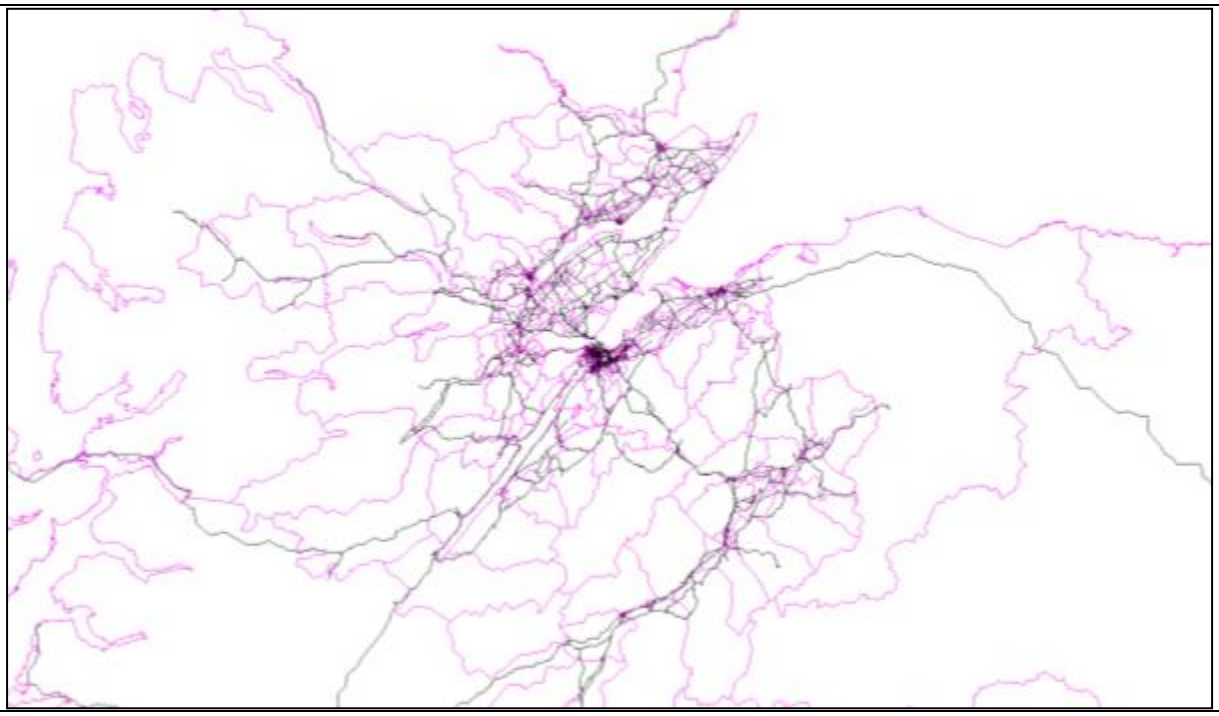
Although these phases have been identified the main aim of this study was to analyse and understand the likely impacts of this scale of development not the timescales for delivering it. The study was commissioned after the publication of the Main Issues Report which showed preferred and non-preferred locations for development. In light of this, the Council opted to examine the impacts of the scale and location of development supported in the identified preferred sites and phased these developments to be consistent with meeting the housing land requirement within the plan period rather than testing a range of development scenarios.

The IMFTM uses planning data, providing employment, households, and population levels to forecast changes in trip making over time within, and 'to and from' the internal demand model area. The data was prepared by The Highland Council, and supplied as:

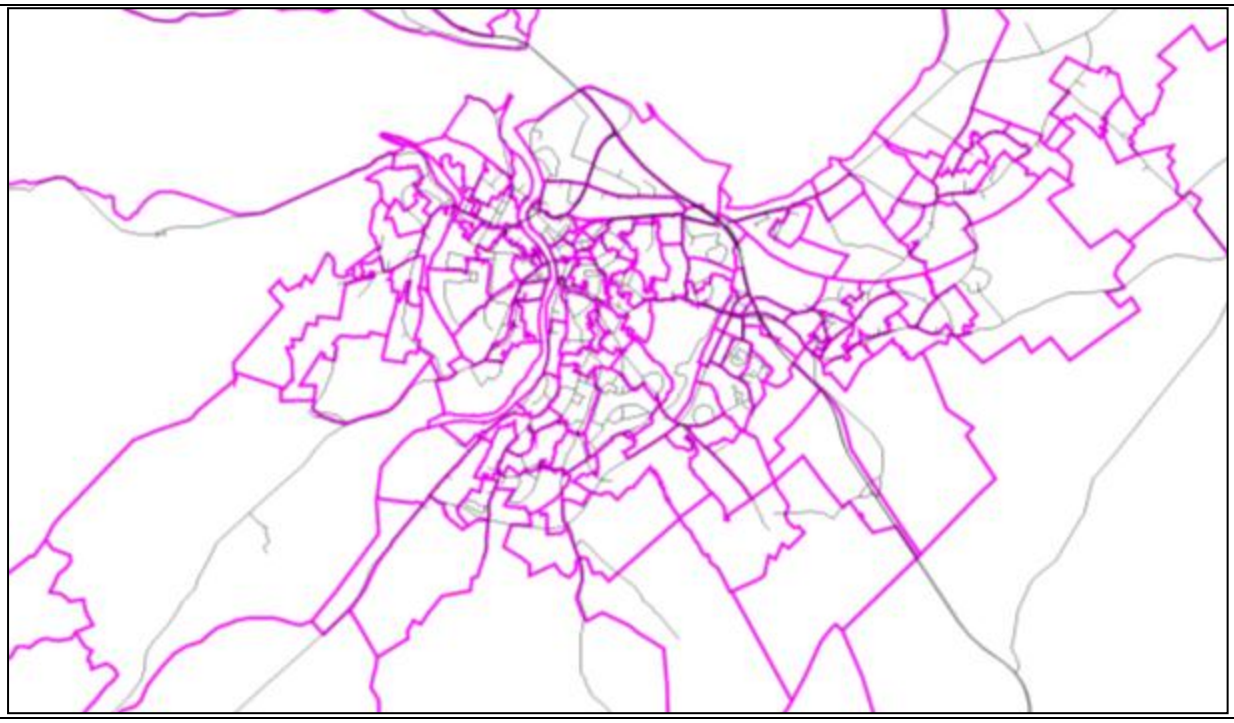
- number of jobs split by 12 categories consistent with the National Trip End Model (NTEM);
- number of households and second homes; and
- population split by 11 categories consistent with NTEM.

The data was supplied in the geographic units known as 'data zones' that make up the IMFTM. These are shown in **Figure 6 - MFTM Zone System, Wide Area view**

Capabilities on project:
Transportation



Wider Area View



Inverness Area

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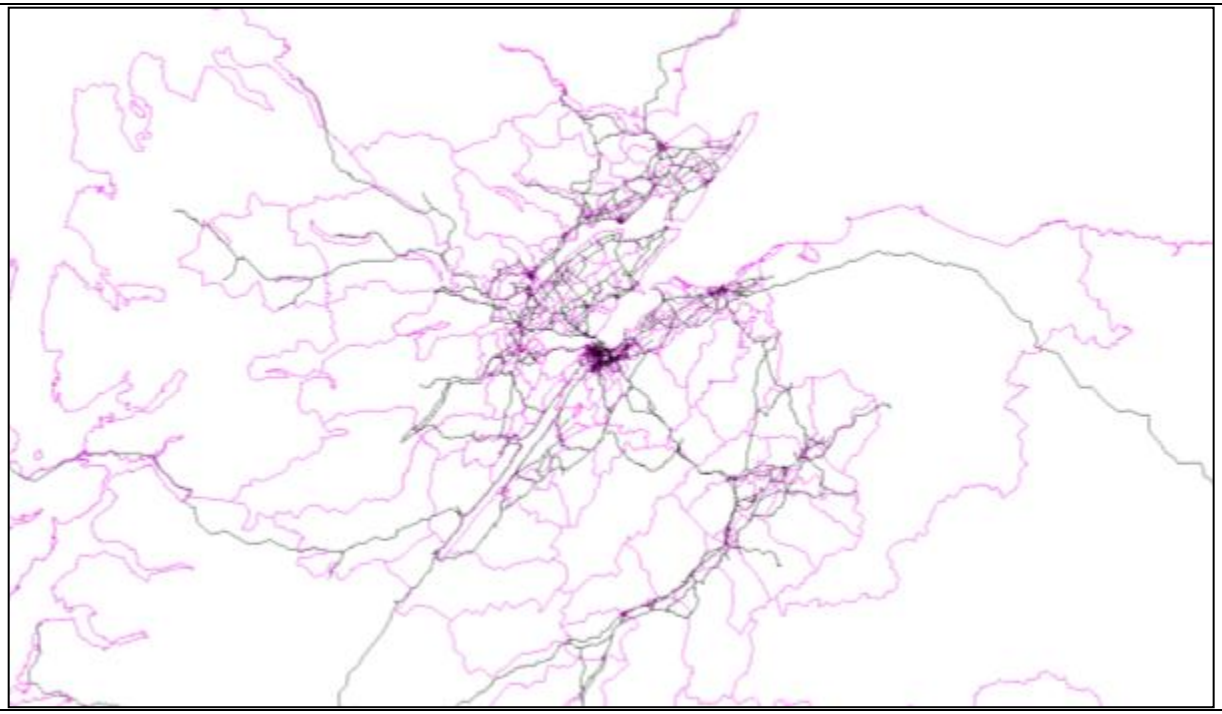
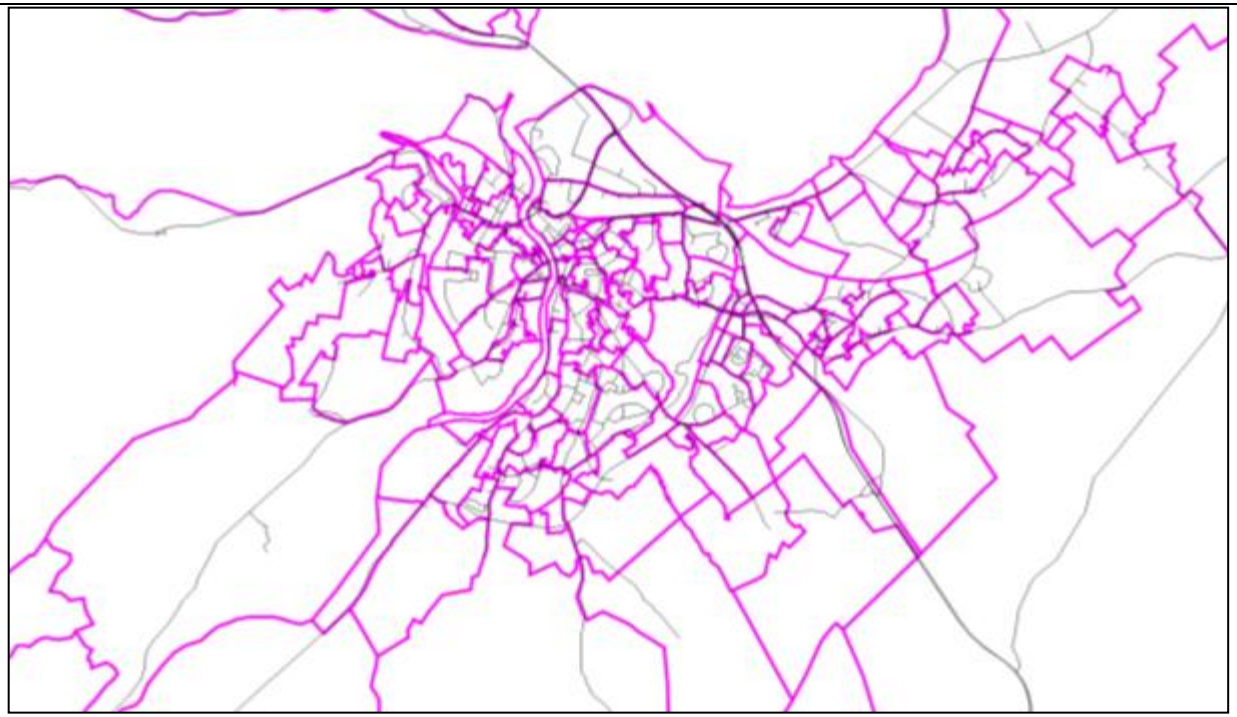
Capabilities on project:
Transportation

Figure 6 - MFTM Zone System, Wide Area view



Wider Area View

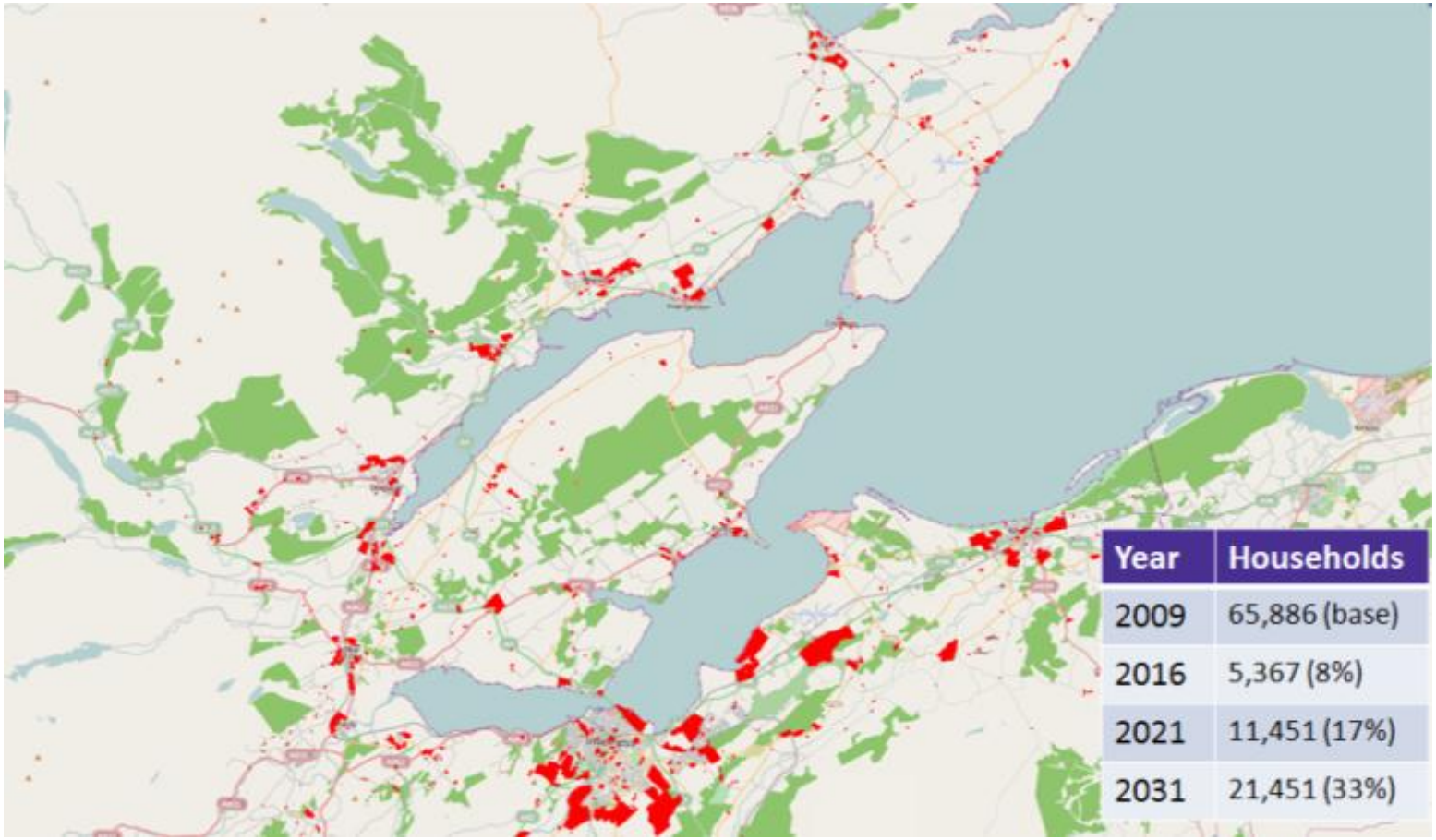
Capabilities on project:
Transportation



Inverness Area

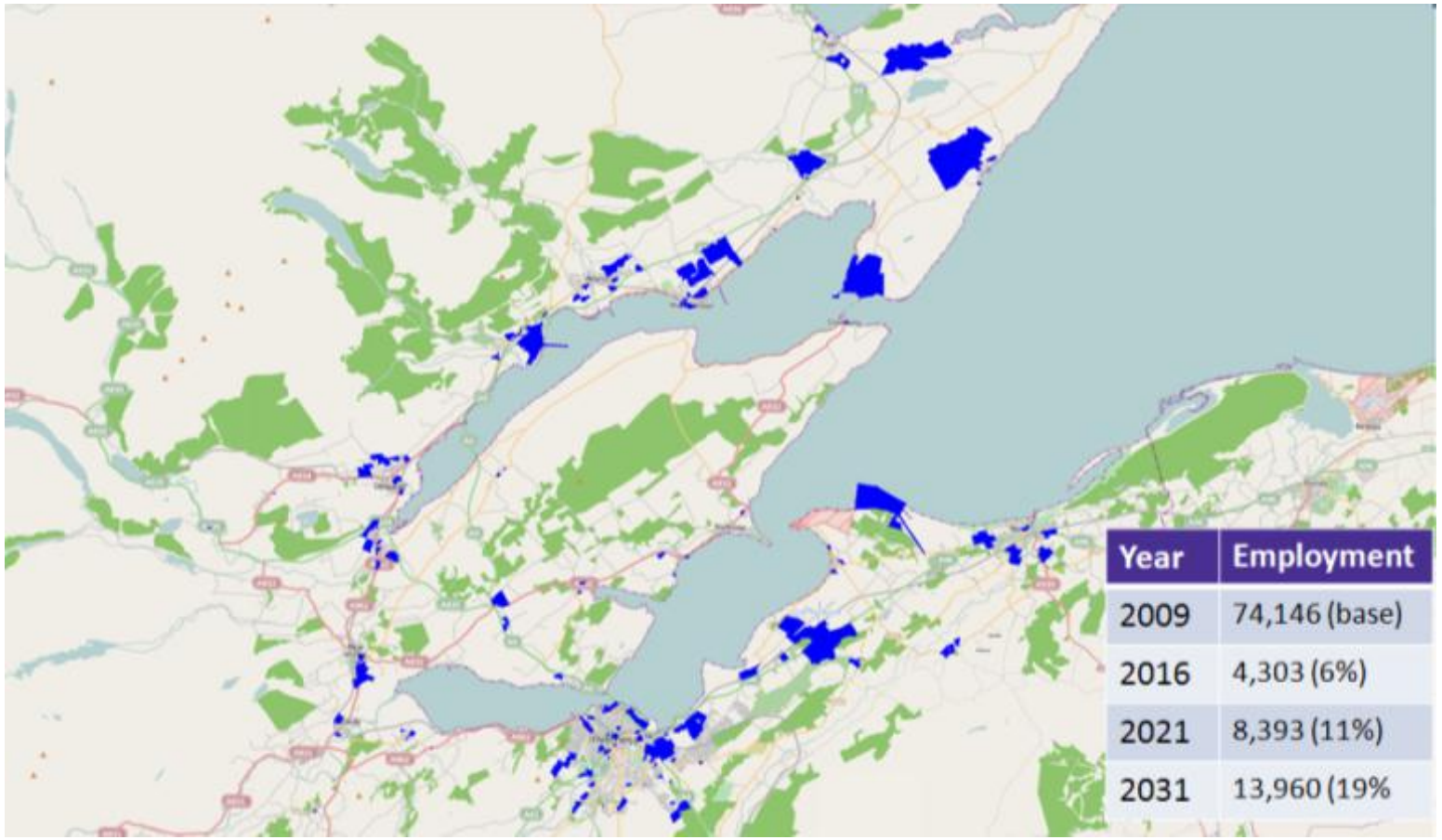
The following figures illustrate the location of the housing and employment developments supported in the IMFLDP Main Issues Report.

Figure 7 – Housing Developments



Capabilities on project:
Transportation

Figure 8 – Employment Developments



(Appendix G illustrates the development growth in greater detail)

Capabilities on project:
Transportation

As illustrated in

Figure 7, the residential developments are largely concentrated on the A96 Corridor within and between Inverness and Nairn, including a new settlement at Tornagrain, and along the Easter Ross Corridor between and within Dingwall and Tain. **Figure 8** shows business development is also concentrated in these growth corridors, with large sites including Inverness Airport Business Park, Whiteness, Highland Deephaven at Evanton and Nigg.

Table 10 highlights the increase in development by development type.

Table 10 - Committed and Proposed Development between 2009 and 2031

	All Jobs (number of Jobs)	Households (Homes)	Primary & Secondary schools (Jobs)	Higher Education (Jobs)	Adult education (Jobs)	Hotels, camp sites etc (Jobs)	Retail trade (Jobs)	Health / Medical (Jobs)	Services (business, other, postal/courier) & equipment rental (jobs)	Industry, construction and transport (Jobs)	Restaurants and bars (Jobs)	Recreation and sport (Jobs)	Agriculture and fishing (jobs)	Business (jobs)	Holiday accommodation and second residences (Homes)
2009	74146	65886	3929	763	822	3177	8703	9147	7090	17544	2797	2852	885	16437	3830
2016	78449	71253	3990	616	840	3300	9726	9470	7461	18811	2924	2916	890	17505	4195
	6%	8%	2%	-19%	2%	4%	12%	4%	5%	7%	5%	2%	1%	6%	10%
2021	82539	77337	4020	816	847	3497	10835	9690	7656	19918	3051	2966	895	18348	4550
	11%	17%	2%	7%	3%	10%	24%	6%	8%	14%	9%	4%	1%	12%	19%
2031	88106	87337	4083	1216	847	3719	11437	10140	7966	21512	3196	3055	895	20040	5098
	19%	33%	4%	59%	3%	17%	31%	11%	12%	23%	14%	7%	1%	22%	33%

The table highlights that the main increases, in terms of percentage change, are in higher education, holiday homes, houses and retail. The largest increase over the plan period is in higher education due to the construction of the Highland and Islands University.

4.3 Infrastructure and Public Transport Improvements

At present the network is known to suffer from long delays at a number of locations, including Longman Roundabout, Raigmore Roundabout, the Inshes area / Old Perth Road and several locations around the city centre. It is expected that without mitigation the conditions at these areas would gradually deteriorate as the Inner Moray Firth area develops, therefore improvements to the existing infrastructure, and the construction of new infrastructure, will be required. Moreover, public transport improvements are vital in order to provide sustainable transport.

As the Council cannot be certain about the timing of the delivery of a number of planned transport infrastructure improvements, six different scenarios shown in the **Table 11** below were tested using the VISUM model.

Table 11 – Infrastructure and Public Transport Scenarios

Reference Date *	Scenario 1	Scenario 2
2011	Existing road layout (base model) Milton of Leys Link Road**	
2016	Culloden road widening between Caulfield Road North and Inshes overbridge. Longman roundabout signalisation and signalised junctions at Rose Street and Henderson Road (completed 2013) Conon Rail Halt (completed 2013)	As scenario 1 plus:- A96 dualling west of Smithton Inshes Network Upgrades Dingwall Kinnairdie Link Road and Country Junction improvements Widening of Barn Church Road and improvements to BCR/Tower Road junction. Smithton Park and Ride (A96) Signalisation of Raigmore roundabout
2021	As 2016 scenario 2.	As scenario 1 plus:- Inverness West Link Road Dalcross Rail Halt Campus Pedestrian Bridges over the A9 and Public Transport Bridge over the Railway have not been modelled
2031	As 2021 scenario 2.	As scenario 2 plus:- Inverness East Link Road Dualling of A96 between Inverness and Nairn Nairn and Tornagrain bypasses

**Reference dates are indicative only in order to define a quantum of development and associated infrastructure. In practise build out rates of both development and infrastructure will be subject to prevailing economic circumstances.*
***The Milton of Leys Link Road has already been built and has been modelled in a Do Nothing 2011 scenario. The 2011 model was developed as a check on expected traffic volumes on this link road to validate the modelling parameters.*

Infrastructure and public transport improvements will either be delivered by developers, the Council and/or Transport Scotland. The majority of improvements are located on the arterial roads, such as the A9, A96, Culloden Road / Old Perth Road and A82, however there are plans for improvements within Dingwall with the introduction of the Kinnairdie Link Road which will allow further development to proceed.

The main improvements set out by the Council are the West Link, which is expected to reduce traffic volume in the city centre and open Inverness South for development, and Inshes Network Upgrade which is an area subject to delay and congestion.

Transport Scotland's proposed infrastructure improvements are focused mainly to the east of Inverness along the A96; however improvements to the Longman Roundabout have also been highlighted.

With regards to public transport, three improvements have been committed/proposed; Conon Rail Halt which opened in February 2013; the Smithton Park and Ride which is expected to bring relief to Raigmore junction, and Dalcross Rail Halt which will serve Inverness Airport, and the planned new town at Tornagrain and Inverness Airport Business Park. The section 4.4 discusses the public transport interventions in greater detail.

4.4 Public Transport Interventions

It is important that the assessment of the impact of the level of development supported in the IMFLDP is not limited to the growth of private vehicles; it must also take into account public transport provision and walking and cycling. The MFTM model is capable of assessing both improvements / additions to the road network, and better public transport connectivity and facilities. The following section focuses on the committed and proposed public transport improvements.

As highlighted previously the following public transport improvements have been modelled:

1. Conon Rail Halt (introduced in 2016 Scenario 1);
2. Smithton Park and Ride (introduced in 2016 Scenario 2);
3. Dalcross Rail Halt (introduced in 2021 Scenario 2); and

The bridges across the A9 and the Railway, which will carry pedestrians and cyclists, were unable to be modelled due to the modes of transport it was facilitating, walking and cycling. The MFTM was never developed to assess these modes due to limited information on walking and cycling origin / destination demands.

4.4.1 The Conon Rail Halt

The Conon Rail Halt opened in February 2013, it therefore has been incorporated into 2016 models. To model this station a number of alterations were carried out on the model. Firstly, the two services which passed through Conon Bridge were coded to service the station; these trains travel to and from the north and west Highlands and also serve Inverness. Secondly, the zones surrounding the Conon Bridge area were all connected to the station via pedestrian links.

4.4.2 Smithton Park and Ride

The difficulties in travelling along the A96 especially through Raigmore junction will be highlighted within this chapter 5. Therefore, a park and ride site prior to a congested area such as Raigmore junction is considered to be an appropriate alternative means of providing access to the city centre. The park and ride site has been modelled to capture certain drivers e.g. westbound trips into Inverness and each driver now considers the merits, in terms of cost savings, between their car journey and using the park and ride service. The cost of travelling by private vehicle will gradually increase in the future resulting in a potential transfer to public transport use. Furthermore, zones close by the park and ride site were given walking links in order for locals to access the site as a bus service. In terms of bus services, a 15 minute service was modelled which had a number of stops on the route into and out Inverness.

4.4.3 Dalcross Rail Halt

The proposed Dalcross Rail Halt will serve Inverness Airport, and the planned new town at Tornagrain and Inverness Airport Business Park. It must be noted that the timing of Transport Scotland / developers led improvements are out with the control of

The Highland Council. Little information is currently available on this station, other than its proposed location, therefore the following assumptions were made.

- A 30 minute service was modelled which connected Inverness with Nairn via Dalcross Rail Halt;
- All nearby zones were connected to the station to create walking links; and
- Connections to bus stops from Dalcross Rail Halt were added.

The location of this Rail Halt is paramount to its expected success. Being located close to two major development areas has clear benefits.

4.5 Summary

In summary, development of the 'preferred' development sites from the Main Issues Report phased to deliver the housing land requirement within the plan period would see a significant increase in employment and housing in the Inner Moray Firth Area over the next 2 decades and beyond. Therefore infrastructure and public transport interventions are required to mitigate against future demand pressures.

5 Model Results

5.1 Introduction

The following chapter discusses the results from the modelling exercise. The exercise utilised the MFTM to assess each of the six transport infrastructure delivery scenarios against the specified scale and location of development supported in the Main Issues Report. In order to assess whether the development had caused detriment to the network or whether the interventions had mitigated against additional development pressures, a number of performance indicators were examined:

- Level Of Service;
- End of Period Queuing;
- Volume vs Capacity; and
- Change in Traffic Volumes between scenarios

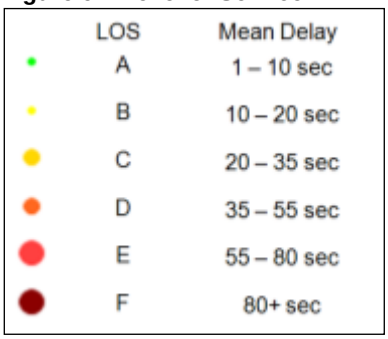
With regards to the committed public transport interventions listed in paragraph 4.3, an analysis was carried out to assess the extent to which public transport could reduce pressure on the road network.

5.2 Performance Indicators

5.2.1 Level of Service

Level of Service (LOS) simply refers to the “mean delay” experienced when traversing through a junction. The “mean delay” is categorised by the following letters:

Figure 9 – Level of Service



Note: The associated coloured circles highlight the LOS within the VISUM outputs (all LOS diagrams for each scenario are held within Appendix B for Inverness and Appendix D for Nairn/Dingwall).

LOS provides a good indication of whether a junction requires either additional capacity or modification to signal timings. A LOS value in the E or F category would indicate that the junction requires further examination by a more detailed assessment tool such as micro-simulation. AECOM has highlighted any junctions which display a LOS category E or F, however depending on a driver’s perception of “acceptable delay”; critical junctions may be limited to any junctions displaying a LOS category F.

5.2.2 End of Period Queuing Results

VISUM is able to calculate average and maximum queue lengths; however this can only be extracted at a junction level and is unable to be presented on the entire network. In order to display the main queuing issues, and therefore indicate those junctions which are causing the most concern, AECOM has concentrated on the “End of Period” queues. “End of Period” queues basically

form once demand exceeds capacity, in other words, when vehicles are unable to pass a certain point on the network, due to junctions or roads being over saturated.

“End of Period” queues are a good indication that a junction or road requires upgrading (see Appendix F).

5.2.3 Volume vs Capacity (V/C) Results

Generally LOS and “End of Period” queuing refers to failures at a node (a junction), however a network can also fail on a link (a road), when capacity is breached by traffic volume. As traffic volume approaches 90% of the link capacity, traffic flow begins to slow down as drivers weave into smaller gaps, thus causing upstream vehicles to brake. Once the traffic volume goes beyond 90% of the link capacity, shockwaves occur resulting in waves of vehicles reducing their speeds. Finally once the capacity has been breached, queues will start to form as drivers are unable to move along the link.

The V/Cs for each link is highlighted in Appendix C for Inverness and Appendix D for Nairn/Dingwall.

5.2.4 Changes in Traffic Flow

Between each scenario, changes in traffic volumes, and hence travel patterns, will occur. The use of the demand model assignment results in trip shortening due to drivers either moving home or employment to minimise travel delay. These changes in traffic movements can highlight areas where the Council should focus their infrastructure improvements (Appendix E illustrates the changes in traffic flow between scenarios).

Capabilities on project:
Transportation

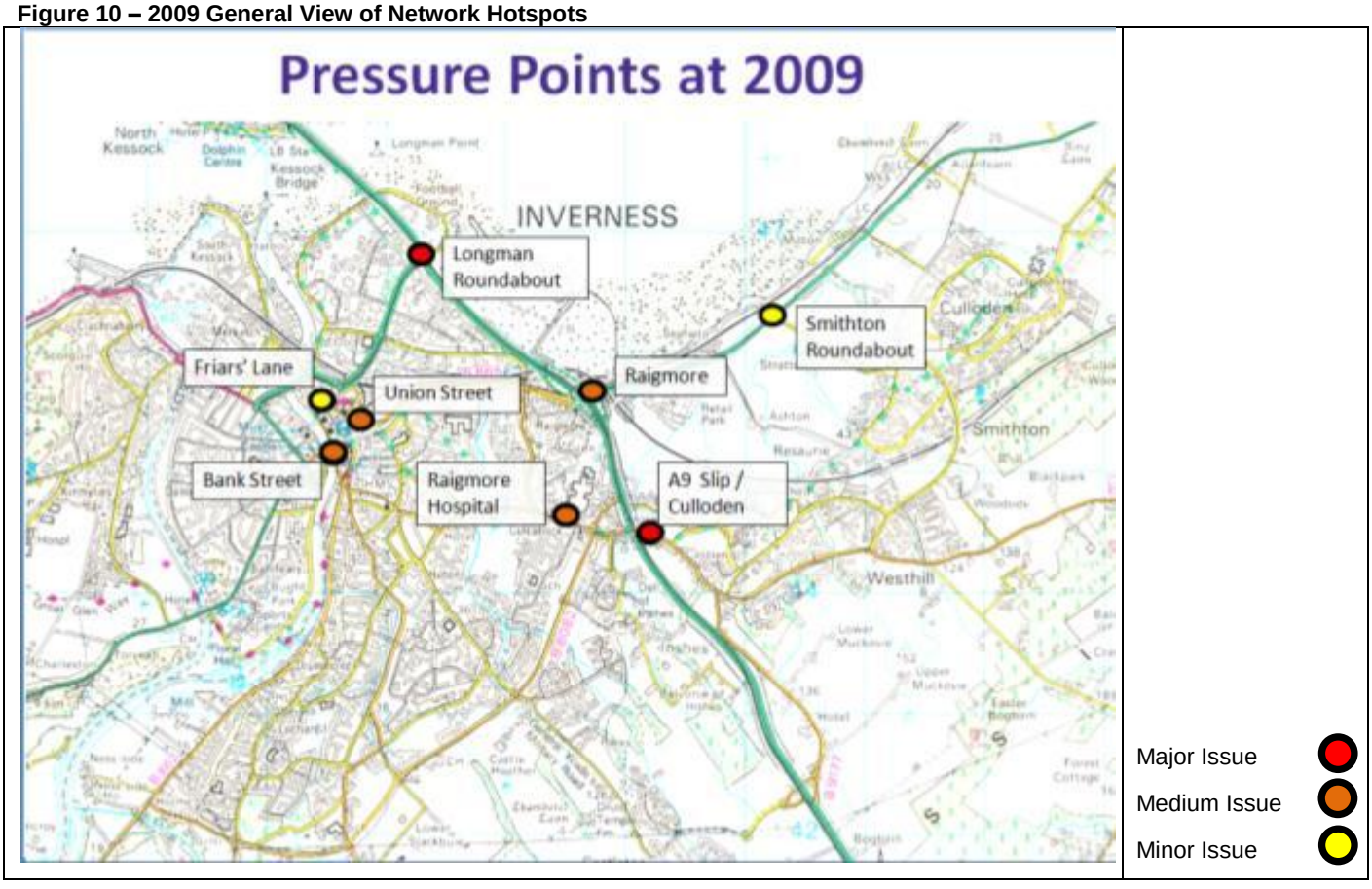
5.3 Results

The following section describes each scenario test, highlighting the network issues during the AM and PM peaks. At the end of each scenario description a number of interventions are proposed which may eliminate the issues being highlighted. Although the proposed interventions focus on providing greater road capacity to the network, it should be noted that Public Transport schemes such as improved bus reliability, increased service rates, cycles lanes etc combined with parking strategies could provide a sufficient modal shift which could in turn partly mitigate against the proposed highway improvements, however this is beyond the scope of the commission that was undertaken.

5.3.1 2009 Base Year

It must be noted at the outset that not all issues which are currently experienced on the Inner Moray Firth network have been captured within the base model. Due to the size and complexity of the model, certain areas have either limited survey information available or due to the nature of the strategic models, detailed driver behaviour was difficult to replicate. Due to this being a 2009 model, it does not include the Henderson Road Improvements, Milton of Leys and signal timings in Nairn are as per the timings in 2009. The main hotspot areas are highlighted below in **Figure 10.**

Figure 10 – 2009 General View of Network Hotspots



AM Peak

During the AM peak period, Longman Roundabout and the A9 slip road to Culloden Road display issues which result in a LOS category F. With regards to Longman Roundabout, delays are experienced from the Kessock Bridge due to heavy southbound demand and a high cutting movement from Longman Road. The Stadium Road approach also suffers due to the cutting movements from Kessock Bridge and Longman Road. The A9 slip road at Culloden Road is restricted due to green time allocation resulting from the heavy demand from Culloden Road westbound.

The A96 west of Smithton Junction is highlighting a link V/C of between 90 and 100% which means shockwaves and sporadic queuing may occur during the peak hour.

Although the network suffers issues during the peak, all queues disperse prior to the end of the peak period. Whilst the model indicates that the majority of transport issues occur in or on the road network around Inverness, it should be noted that the model assumed a basic level of access had been provided at each new development site. Due to the strategic nature of the model it is not possible to identify each and every infrastructure item required. It is understood that the Council will be providing further details on likely transport infrastructure requirements for new development through the Local Development Plan and individual pre-application and planning application processes.

PM Peak

Two junctions have been highlighted as having traffic issues - the Bridge Street / Young Street junction and the Culloden Road / A9 slip junction. The Bridge Street / Young Street junction is shown to experience most delays on the Young Street approach due to limited capacity to deal with the eastbound demand. The Culloden Road / A9 slip junction is shown to experience delays on the A9 slip right turn and the Culloden Road eastbound movements due to limited capacity / high demand.

Queues at the end of the period are located on the A96 approach to Raigmore junction and on the Young Street approach to the Bridge Street / Young Street junction.

In terms of link V/C, only the A96 west of Smithton junction is of concern, due to high eastbound flows on the single carriageway.

Similar to the AM peak, there are no issues outside Inverness; however it has been acknowledged that the model is possibly underestimating the delays at the County Junction within Dingwall which, through detailed work in the area, has been observed as having long delays on the northbound approach. The model currently indicates a LOS C at the County Junction during the PM peak, the delay witnessed on site would merit a LOS E or F, therefore future predictions may be underestimated.

The following improvements could assist in easing the issues above:

- Signalisation or grade separation of the Longman Roundabout;
- Increase capacity at the A9 slip / UHI junctions, however this would be limited due to the single lane capacity over the A9;
- Increase road capacity west of Smithton junction, i.e. increase from single lane to dual carriageway;
- Review Bridge Street / Young Street phasing and restrict movements in order to increase capacity. Furthermore, reduce capacity restraints on Bridge Street eastbound by coordinating pedestrian phases with the signals at the junction; and
- Improve approach capacity from the A96 to Raigmore junction e.g. increase to three lanes or consider signalisation.

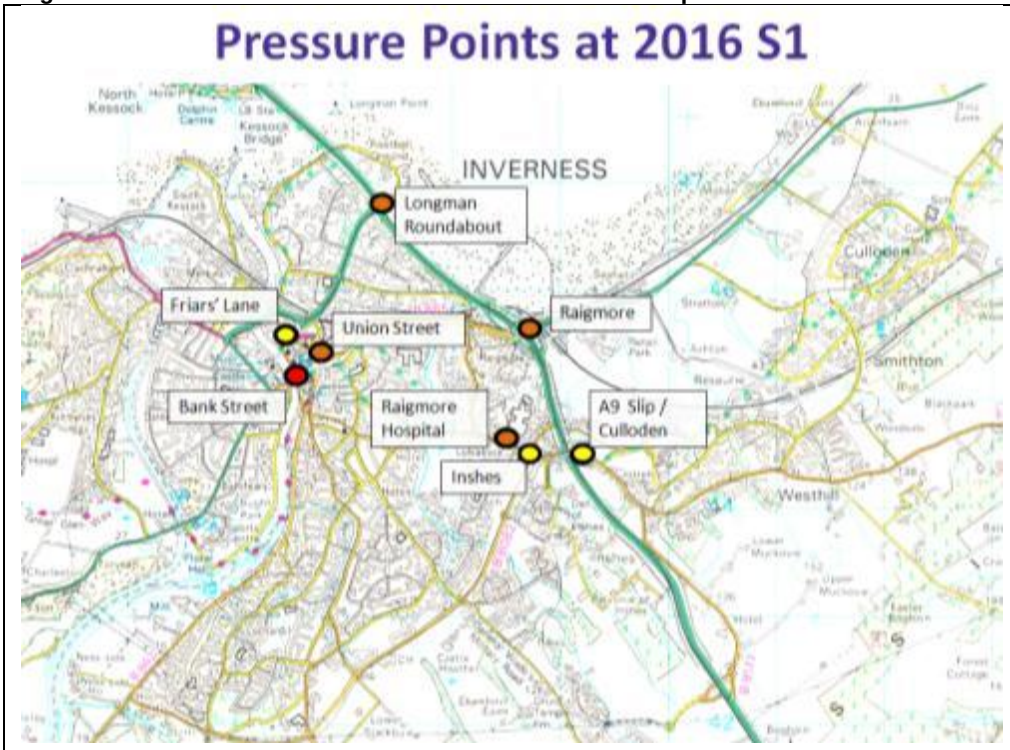
2016 Scenario 1

The 2016 scenario 1 sees an increase in dwellings of 8% on the base and a 6% rise in employment. This scenario also has the following infrastructure and public transport improvements:

- Milton of Leys Link Road (Council)*;
- Culloden road widening between Caulfield Road North and Inshes overbridge.
- Longman roundabout signalisation and signalised junctions at Rose Street and Henderson Road
- Conon Rail Halt

The main hotspot areas are highlighted below in **Figure 11**.

Figure 11 – 2016 Scenario 1 General View of Network Hotspots



AM Peak

The introduction of signals at Longman Roundabout improves performance, with LOS improving from a category F to a category B. A marginal improvement is also experienced at the Culloden Road / A9 junction however the junction still remains a LOS category D.

Queues build back from Raigmore junction on the A96 as well as Smithton Roundabout due to lane capacity. Within the city centre no major queuing was observed.

Sir Walter Scott Drive north of Inshes, A96 west of Smithton junction and the Longman Roundabout itself all display a link V/C in excess of 90%. Other areas such as Bridge Street and the circulating carriageway on Raigmore junction indicate potential issues due to limited link capacity.

Outside Inverness the model indicates no issues on the strategic network.

PM Peak

As more developments come on-line the junction at Union Street / Academy Street begins to deteriorate. The majority of delays suffered at Union Street / Academy Street junction are from the southbound approach on Academy Street again due to limited capacity and high demand.

In terms of "End of Period" queues, these further increase on the A96 approach to Raigmore and on Young Street. Young Street queues extend onto Kenneth Street and Glenurquhart Road.

Link V/C continues to be an issue on the A96 to the west of Smithton junction due to limited road capacity and high demands. Other areas including Longman Roundabout is also approaching a point of concern.

Although there are a few minor changes in link V/C there remains no issues outside Inverness.

The following improvements could assist in easing the issues above:

- Consider re-configuration of the circulating lanes on Longman Roundabout or increase capacity;
- Review Bridge Street / Young Street phasing and banned movements in order to increase capacity, furthermore reduce capacity restraints on Bridge Street eastbound by coordinating pedestrian phases; and
- Increase road capacity west of Smithton junction, i.e. increase from single lane to dual carriageway.

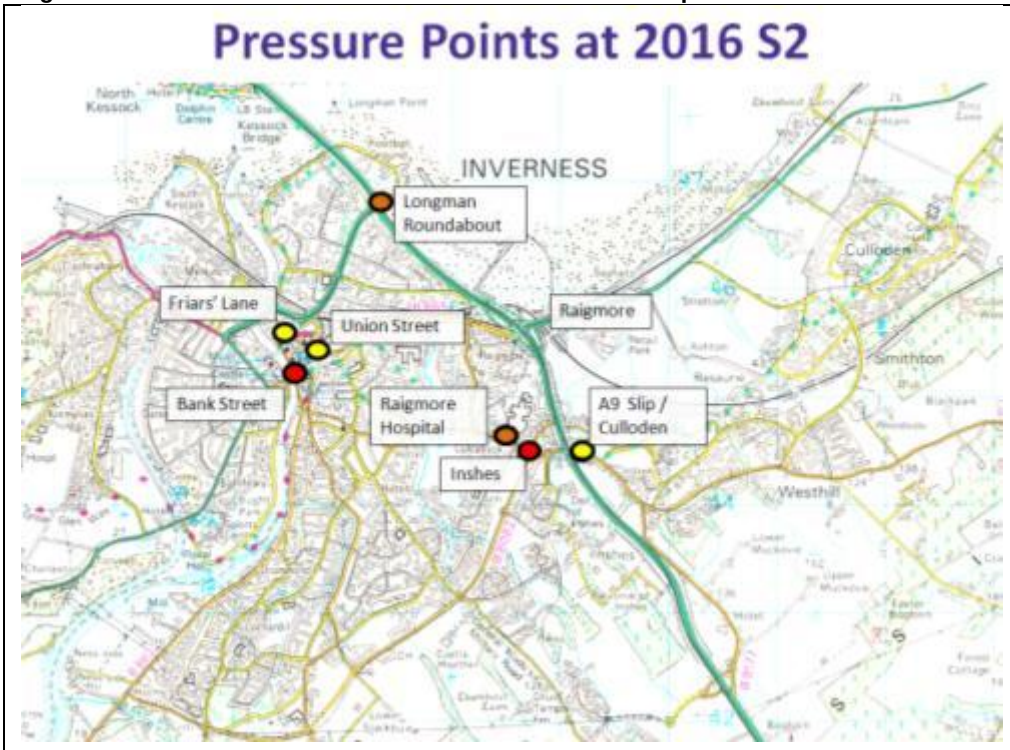
2016 Scenario 2

The 2016 scenario 2 has the same increase in dwellings of 8% on the base and a 6% rise in employment as in scenario 1. However, this scenario sees the following additional infrastructure and public transport improvements:

- Widening of Barn Church Road (Developer);
- Inshes / Old Perth Road improvements (Council);
- A96 dualling west of Smithton (Developer);
- The Dingwall Kinnairdie Link Road and County junction improvements (Council);
- Smithton Park & Ride (Developer); and
- Raigmore Signalisation (Developer).

The main hotspot areas are highlighted below in **Figure 12.**

Figure 12 – 2016 Scenario 2 General View of Network Hotspots



AM Peak

Improvements to the Inshes area helps to minimise delays, however the A9 slip / Culloden Road junction remains a problem showing a LOS of E, due to increased demand with the opening of the University of Highland and Islands.

No major queues are present in this scenario with the exception of Longman Roundabout.

Increasing the capacity on the A96 west of Smithton has resulted in the link V/C reducing. However Sir Walter Scott Drive north of Inshes continues to cause concerns with regards to link capacity. The circulating carriageway at Raigmore is approaching a significant level of V/C (80%+), however Bridge Street improved due to rerouting due to congestion. The only example of V/C above 90% remains at Longman roundabout.

The introduction of the Kinnairdie Link in Dingwall results in a shift in traffic from Bridgend Avenue to the new link road. All other locations outside Inverness display no issues.

PM Peak

Although improvements to the Inshes area have been introduced, the LOS remains poor with an LOS category F at Raigmore Hospital junction. Raigmore Hospital increases in size between 2009 and 2016 placing more pressure on the Old Perth Road / Raigmore Hospital junction, even with the increase in capacity the delays persist, especially for the right turning traffic into the hospital. The other city centre junctions remain similar to that of 2016 Scenario 1, since no improvements have been introduced.

The introduction of signals at Raigmore junction removes the queues on the A96. However queues remain on Young Street, again due to no interventions. Queues also form southbound at Raigmore Hospital junction.

Improvements to the A96 alleviated the link capacity problem. Longman Roundabout has a link V/C of over 90% which is expected to cause circulatory problems. Within the city centre, only Bridge Street is of concern with a link V/C between 80 and 90%.

Similar to the AM peak, the introduction of the Kinnairdie Link has shifted traffic from Bridgend Avenue onto the new link road. No other issue to report within the surrounding area.

The following improvements may assist in easing the issues above:

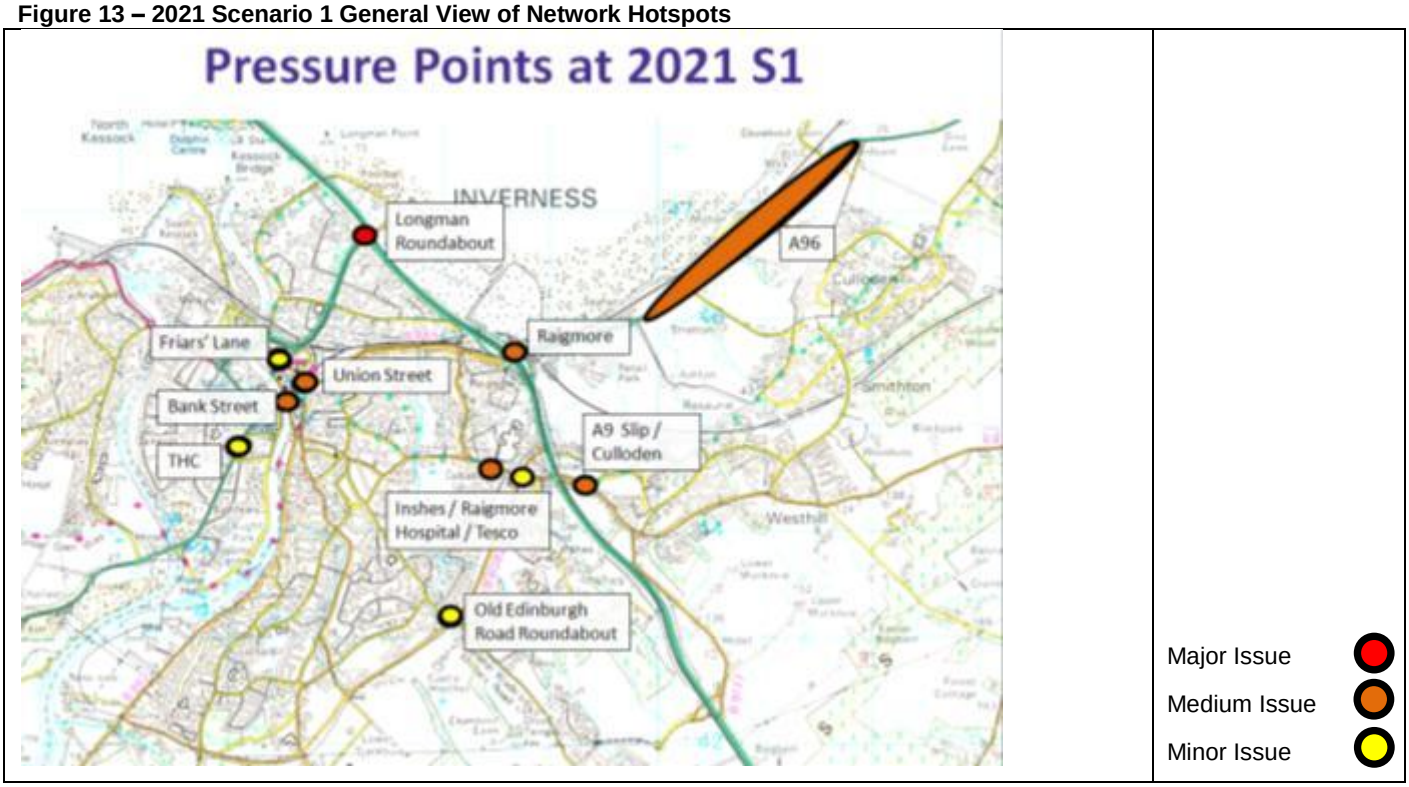
- Review signals timings at the A9 Slip / UHI.
- Review signals at Raigmore and possible widening to a three lane approach due to issues highlighted in the AM peak;
- Review Bridge Street / Young Street phasing and banned movements in order to increase capacity, furthermore reduce capacity restraints on Bridge Street eastbound by coordinating pedestrian phases;
- Review signal timings in the Raigmore Hospital area to improve capacity;
- Consider re-configuration of the circulating lanes on Longman Roundabout or increase capacity.

5.3.2 2021 Scenario 1

The 2021 scenario 1 sees an increase in dwellings of 17% on the base and an 11% rise in employment. The 2021 Scenario 1 sees no further infrastructure improvements and therefore remains the same as 2016 Scenario 2.

The main hotspot areas are highlighted below in **Figure 13.**

Figure 13 – 2021 Scenario 1 General View of Network Hotspots



AM Peak

The A96 approach to Raigmore junction has an LOS of category F due to the heavy demand on the A96 and limited capacity. The A9 slip / Culloden Road junction indicates a LOS category E, again this is due to limited capacity and also limited green time for both westbound traffic on Culloden Road and the left turn from the A9 slip road. Within the town, King Brude Road junction at Muirtown also displays a LOS category E.

In terms of queuing, Longman Roundabout now extends almost to Kessock Bridge.

In terms of link V/C that are approaching capacity, Longman Roundabout is in excess of 90% which is expected to result in a breakdown of traffic flows and sporadic queuing. The A9 slip at Culloden Road and Raigmore junction are between 70% and 80% V/C which could lead to significant congestion issues.

With regards to the towns surrounding Inverness, there is little difference between 2021 and 2016.

PM Peak

The city centre continues to display issues along Academy Street, Young Street / Bridge Street, as well as Young Street and Friars Lane junctions due to demand and restricted capacity. The Inshes area remains a problem with delays experienced at Raigmore Hospital junction, which could benefit from improved signal time optimisation. Additionally, the junction at Tomnahurich/Bruce Gardens has an LOS of E.

New ”End of Period” queues form on the southern approach to Longman Roundabout. The queues highlighted in 2016 at Raigmore Hospital and Young Street increase with the increase in demand.

In terms of link V/C, the stretch between Newton of Petty and Smithton Roundabout on the A96 has deteriorated with a link V/C now over 80%. Longman indicates a 90% V/C. Within the city centre only Bridge Street needs to be highlighted, having a link capacity with a V/C of 75%.

With regards to the surrounding area, the PM peak indicates a similar picture to that of the AM peak.

Possible Improvements:

- Review signals timings at the A9 Slip / UHI Review signals at Raigmore and possible widening to a three lane approach due to issues highlighted in the AM peak;
- Increase link capacity west of Smithton junction and dual the Carriageway sections between Newton of Petty and Smithton Roundabout;
- Review Bridge Street / Young Street movements and see if right turn into Castle Road can be facilitated;
- Review signal timings in the Raigmore Hospital area to improve capacity;
- Consider re-configuration of the circulating lanes on Longman Roundabout or increase capacity; and
- Review of signals and junction configuration at King Brude Road (within the Muirtown Area).

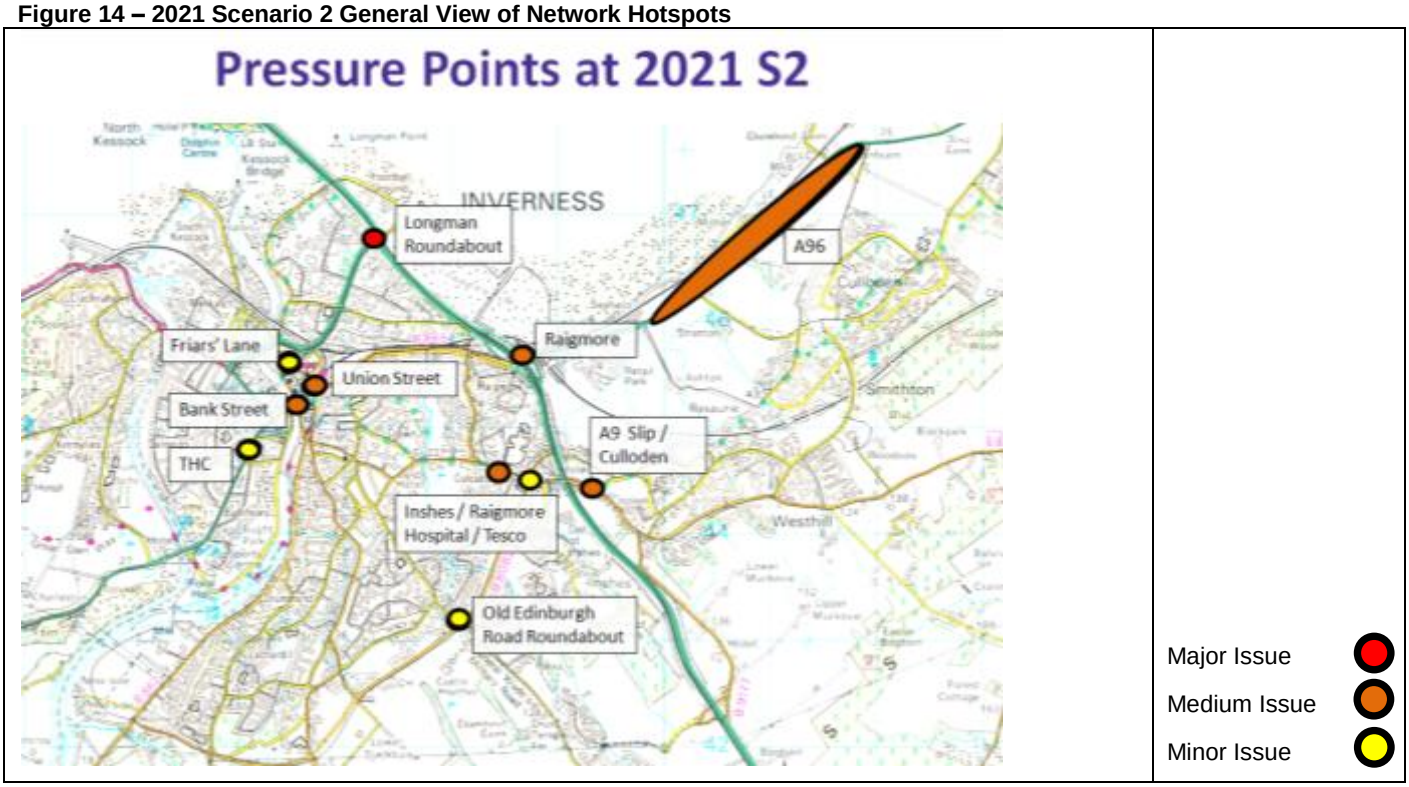
2021 Scenario 2

The 2021 scenario 2 also sees the same increase in dwellings of 17% on the base and an 11% rise in employment as scenario 1. This scenario has the following additional infrastructure and public transport improvements:

- West Link (Council); and
- Dalcross Rail Halt (Network Rail).

The main hotspot areas are highlighted below in **Figure 14.**

Figure 14 – 2021 Scenario 2 General View of Network Hotspots



AM Peak

The introduction of the West Link has a positive impact in many areas. Firstly the King Brude Road junction indicates a drop in delay with the LOS reducing to a category D. At the outskirts of the city the impact is less with the LOS category remaining poor on the A9 slip and A96.

Longman Roundabout indicates a slight improvement in terms of “End of Period” queuing however this is marginal and has little reduction in delay into the city.

Similar to queuing, there is no significant change in V/C.

The surrounding area still indicates no major problems, all links and junctions are well within capacity.

PM Peak

The delays at the main junctions within the city centre have reduced. However, in most cases the LOS category remains the same since category F represents any delays from 80 seconds upward (depending on junction type). The greatest reduction in delay is seen at the Bank Street / Young Street / Bridge Street junctions, where the LOS has improved to level E.

With the introduction of the West Link, queues at the "End of Period" were eliminated from the city centre. Queuing at Longman Roundabout and Raigmore Hospital remain the same.

The introduction of the West Link also had a positive impact on link V/C within the city centre. The West Link carries around 40 – 50 % of its link capacity which allows for future development. Further afield there is little improvement with issues remaining at Longman Roundabout.

Again similar to the AM peak there are no issues being highlighted from any towns within the Inner Moray Firth area.

Possible Improvements:

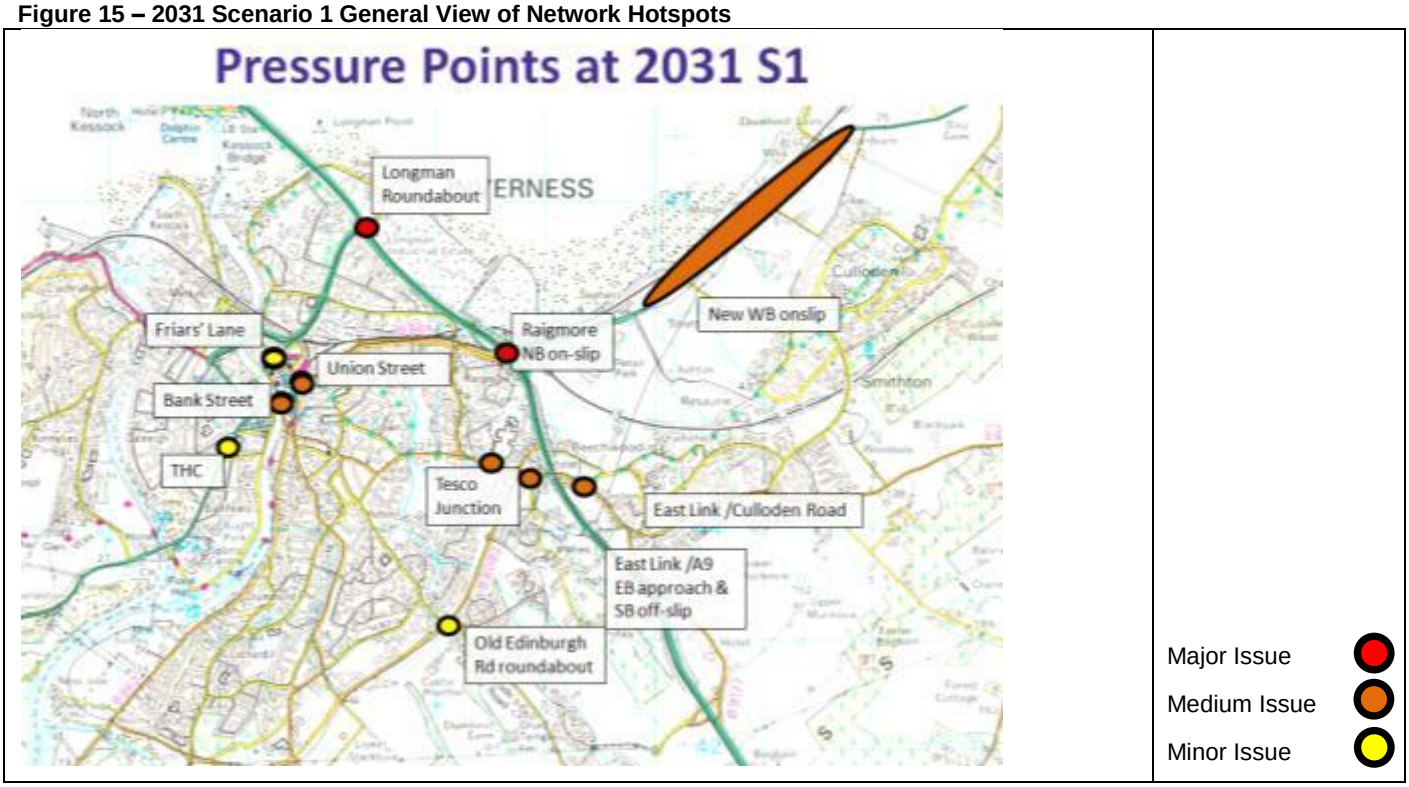
- Review signals timings at the A9 Slip / UHI. Review signals at Raigmore and possible widening to a three lane approach due to issues highlighted in the AM peak;
- Increase link capacity west of Smithton junction by dualling the section of carriageway between Newton of Petty and Smithton Roundabout;
- Review Bridge Street / Young Street movements and see whether the right turner into Castle Road can be facilitated;
- Review signal timings in the Raigmore Hospital area to improve capacity;
- Consider re-configuration of the circulating lanes on Longman Roundabout or increase capacity.

5.3.3 2031 Scenario 1

The 2031 scenario 1 sees an increase in dwellings of 33% on the base and a 19% rise in employment. The 2031 Scenario 1 sees no further infrastructure improvements and therefore remains the same as 2021 Scenario 2.

The main hotspot areas are highlighted below in **Figure 15.**

Figure 15 – 2031 Scenario 1 General View of Network Hotspots



AM Peak

The city centre traffic conditions remain similar to that of the 2021 Scenario 2 with no junctions displaying a LOS above category D. King Brude Road and A9 Slip remain at LOS level E and the Raigmore junction remains at LOS level F.

"End of Period" queues significantly increased on Longman Roundabout, with queues stretching onto Kessock Bridge and extending along the Longman Road towards Seafield Road. Raigmore Roundabout also has a queue forming along the A96.

The link V/C remains a problem at Longman Roundabout and there is a notable deterioration on the A96, especially to the east of Smithton.

The A96 west of Nairn now indicates a link V/C of between 50% to 60%, however the junctions within Nairn remain well within capacity.

PM Peak

The LOS remains similar to 2021 Scenario 2 with the exception of the A96 approach to Raigmore junction which now has a LOS category E and Raigmore Hospital which has improved to LOS level E. The main junction issues within the city centre remain

the Bank Street / Young Street / Bridge Street junction, Union Street / Academy Street and Raigmore Hospital, all indicating LOS category of either E or F.

Queuing increases at Longman Roundabout due to the increase in demand compared to 2021. Within the Inshes area, queues remain at the hospital after the model period similar to the 2021 Scenario 2.

In general, it is a similar picture in term of link V/C. However the A96 east of Smithton has greatly deteriorated and has now reached a V/C greater than 90%

With regards to the towns within the Inner Moray Firth area the model indicates problems in Dingwall. It shows that High Street has a link V/C of between 60% and 70%, however the majority of the Dingwall network is operating below 50% capacity.

Possible Improvements:

- Review signals timings at the A9 Slip / UHI. Possible use of MOVA to minimize delays;
- Review signals at Raigmore and possible widening to a three lane approach due to issues highlighted in the AM peak;
- Increase link capacity east of Smithton junction and dual the carriageway sections between Newton of Petty and Smithton Roundabout;
- Review Bridge Street / Young Street movements and see if right turn into Castle Road can be facilitated;
- Review signal timings in the Raigmore Hospital area to improve capacity;
- Consider re-configuration of the circulating lanes on Longman Roundabout or increase capacity; and
- Review of signal timings on the Millburn approach to Raigmore.

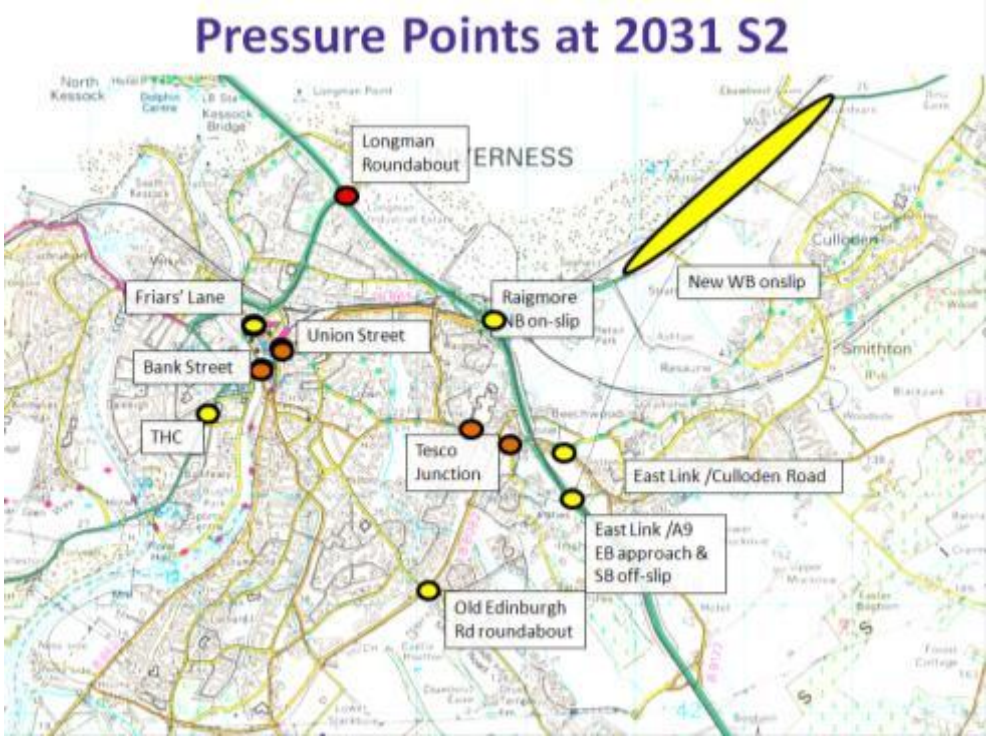
2031 Scenario 2

The 2031 scenario 2 sees the same increase in dwellings of 33% on the base and a 19% rise in employment as in scenario 1. This scenario sees the following infrastructure and public transport improvements:

- A96 dualling between Raigmore and Nairn (Transport Scotland);
- Nairn and Tornagrain Bypass (Transport Scotland); and
- East Link Road (Transport Scotland).

The main hotspot areas are highlighted below in **Figure 16.**

Figure 16 – 2031 Scenario 2 General View of Network Hotspots



AM Peak

The introduction of the East Link has a significant impact on the network with no LOS above category D being displayed within Inverness.

Residual queuing is apparent in a number of locations, including Longman Roundabout and Raigmore junction.

As expected the improved A96 capacity results in a lower V/C as a whole, therefore capacity is adequate for the demand. However there is some potential for congestion at the new A96 junction at Smithton where the V/C is over 90%. Longman Roundabout remains an issue with not enough capacity to facilitate the traffic flows.

The introduction of the Nairn bypass has a major impact on traffic flows through Nairn. Previously the link V/C on the A96 west of Nairn was between 50% and 60%, however with the introduction of the Nairn bypass this has fallen to between 30% and 40%. The Nairn bypass has a flow of approximately 800 vehicles (two way flow) during the AM peak. With no network alterations within Dingwall, the traffic conditions remain similar to 2031 S1.

PM Peak

The city centre remains an issue with LOS remaining high at a number of junctions including Bank Street / Young Street / Bridge Street junction and Union Street / Academy Street. Improvements can be seen at the Raigmore junction from the A96.

Residual queuing from the eastbound approach to the new A9 grade separated junction extends back along the new road that connects to Culloden Road. Queues around Longman roundabout improve westbound along the A9 but worsen on Longman Road northbound.

Full dualling of the A96 greatly improves congestion, bringing the link V/C down between 50 and 60%. However Longman Roundabout remains a problem with a V/C of over 90%

Similar to the AM peak, the introduction of the Nairn bypass reduces flows through Nairn. During the PM peak the Nairn bypass carries approximately 900 vehicles (two way flow). Conditions within Dingwall improve slightly compared to 2031 S1, most notably on Tulloch Street

Possible Improvements:

- Review Bridge Street / Young Street movements and see if right turn into Castle Road can be facilitated;
- Consider re-configuration of the circulating lanes on Longman Roundabout or increase capacity;
- Review the new A9 grade separated junction in order increase capacity;

Summary and Conclusions

6.1 Summary

The MFTM has been updated to reflect the proposed changes which have been recommended by The Highland Council and all parties which are currently utilising the model. The resulting changes, in terms of network performance, have been cross referenced to the original survey data to establish that the model retained its integrity in terms of the DMRB criteria. The base model outputs illustrated that the model still retains a high level of correlation with the survey data and therefore is acceptable to test future scenarios.

The Highland Council presented a Local Development Plan strategy for 2016, 2021, 2031 and post 2031. It must be noted that a single development plan for each forecast year was proposed. Accompanying their Local Development Plan is an infrastructure programme which has been planned to alleviate any congestion which may arise from the introduction of the developments. Further to the proposed infrastructure, public transport interventions have also been introduced to maintain or possibly increase the modal share in favour of bus and train modes.

Each development projection, with the associated infrastructure scenario, was combined within the VISUM model to analyse the possible impact on the network. The modelling exercise has highlighted a number of future issues, in term of current and proposed infrastructure. The proposed infrastructure remains insufficient for the expected demands on the network. The development pressures place strain on the main arterial route into Inverness, most notably, the A96, the A9 southbound approach to Longman and the A82 / Young Street into Inverness City Centre. Although it is clear that the proposed infrastructure has a positive effect on the network, most notably the East and West Link road and the dualling of the A96, the majority of the schemes have a short life span. Of most note is the Inshes area, which continues to highlight delays due to the increase in traffic being generated from the east and south Inverness developments.

6.2 Conclusions

The results indicate that further consideration must be given to several parts of the network within the Inner Moray Firth area. The models highlight that the improvements under consideration are at the outskirts of the Inverness, which make it easier for drivers to access Inverness. However, little consideration has been given to Inverness City Centre. As a result, congestion continues to build around the main junctions. With the exception of the West Link, there are no proposals to improve / reduce the flow through the city centre.

The inclusion of the East Link brings relief to Raigmore junction and Inshes area, however the model indicates that the proposed A9 grade separated junction will suffer long delays at the day of opening. It is therefore suggested that this should be reviewed in more detail via micro simulation and presented to Transport Scotland for consideration.

Finally, the signalisation of Longman Roundabout highlights issues from the day of opening due to limited capacity on the circulating carriageway. Further analysis is required, again via Micro simulation in order to test alternative designs.

The modelling outcomes indicate that further mitigation measures are required if the network is to cope with the future development pressures as set out in the Development Plan. Major schemes have been incorporated into the network, such as the West and East Link Road, dualling of the A96 and the bypasses for Tornagrain and Nairn, much of which improves the operation, however there remains several congestion hotspots which cannot rely on increasing road capacity. Therefore our conclusions point towards a focus on promoting sustainable transport, via:

- Incorporating bus and cycle lanes into the network;
- Locating park and ride facilities on strategic routes into Inverness;
- Improved bus information via technology;

- Parking strategies

Although road construction is vital to the development of the Inner Moray Firth area it is not wholly sustainable, other alternative methods are also required in order to maintain the road capacity for longer. It may also be possible that a combination of public transport and walking and cycling improvements could mitigate these impacts. The Council will be discussing the findings of this report with a number of stakeholders to look at how best to mitigate the transport impacts identified.

Appendix A

Journey Time Graphs

Capabilities on project:
Transportation

Journey Time Graphs

Appendix B

Level of Service

Capabilities on project:
Transportation

Level of Service

Appendix C

Volume over Capacity (Links)

Capabilities on project:
Transportation

Volume over Capacity (Links)

Appendix D

Dingwall and Nairn LOS and V/C

Capabilities on project:
Transportation

Dingwall and Nairn LOS and V/C

Appendix E

Changes in Traffic Flow

Capabilities on project:
Transportation

Changes in Traffic Flow

Appendix F

End of Period Queues

Capabilities on project:
Transportation

End of Period Queues

Appendix G

Development Growth Diagrams

Capabilities on project:
Transportation

Development Growth Diagrams