N5 Westport to Turlough Road Project

Traffic Modelling Report

Final Report

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N5 Westport to Turlough Road Project

Traffic Modelling Report

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1.0 Introduction

1.1 The Project Appraisal Guidelines

The NRA Project Appraisal Guidelines (PAG) (March 2008) set out the following deliverables required as part of the appraisal process for major schemes:

- Project Review;
- Traffic Modelling Report;
- Cost Benefit Analysis;
- Project Appraisal Balance Sheet;
- Business Case; and
- Post Project Review

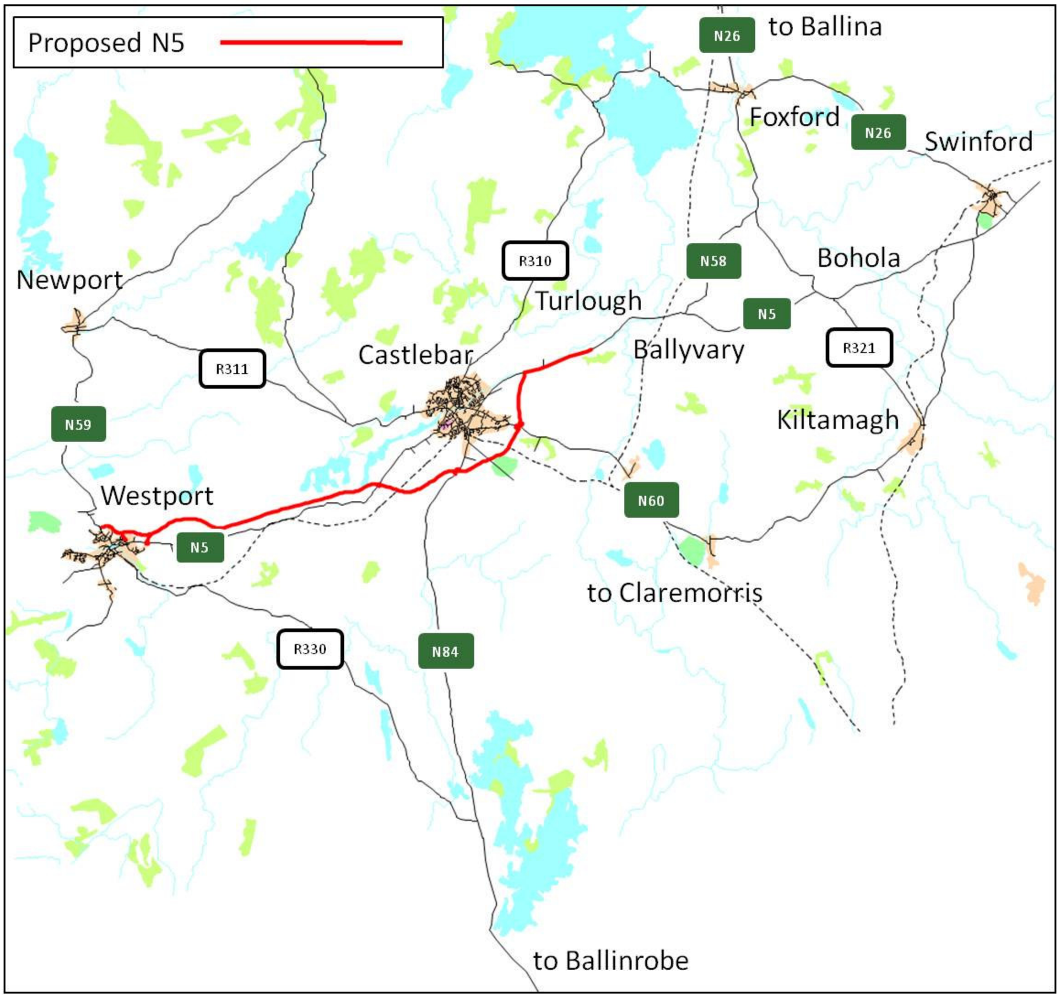
The purpose of the Traffic Modelling Report (TMR) is to describe the traffic forecasting that has been undertaken. The report outlines the development of the base year traffic model, the methodology for forecasting future year demands and the testing of scheme options.

1.2 Project Description

The route selection process for the N5 Westport to Bohola (WEBO) Road Project was dictated by the proposed N26 tie-in at Bohola. The refusal of the N26 Ballina to Bohola Stage 2 Road Scheme by an Bord Pleanála (ABP) has now lead to the curtailment of the N5 WEBO scheme which now terminates at Turlough 6km east of Castlebar.

The scheme which is now referred to as the N5 Westport to Turlough Road Project commences at the existing N59 at Deerpark East, north of Westport and extends to the N5 at Turlough. The route is approximately 27.2km in length and is designed as a Type 2 Dual Carriageway. The scheme is shown in Figure 1.1 overleaf:

Figure 1.1: N5 Westport to Turlough Project



Source: NAVTEQ Mapping

1.3 Modelling Background

As part of the appraisal process of the N5 WEBO scheme, AM and PM peak hour base year (2007) traffic models were developed. These 2007 models were calibrated and validated against NRA criteria and satisfied the requirements as set out in the NRA PAG.

In order to develop 2010 base year models for the N5 Westport to Turlough Project, the 2007 WEBO models have been updated to reflect the current traffic conditions in 2010.

2.0 Data Collection

2.1 Introduction

In order to update the 2007 WEBO models to a base year of 2010 a significant level of traffic data was required to ensure that the model could replicate existing traffic patterns and volumes. This section of the Traffic Modelling Report describes the collation of traffic data for the construction of the 2010 Base Year Traffic Models.

2.2 Traffic Surveys

Traffic surveys undertaken in the study area as part of previous road projects were made available alongside traffic survey data that was collected as part of this study. These incorporated Roadside Interviews (RSI), Automatic Traffic Counts (ATC) and Turning Count surveys.

2.2.1 Existing Survey Data

A summary of the existing survey data used in the development of the 2007 WEBO models is given in Table 2.1 below and is graphically represented in Figure 2.1.

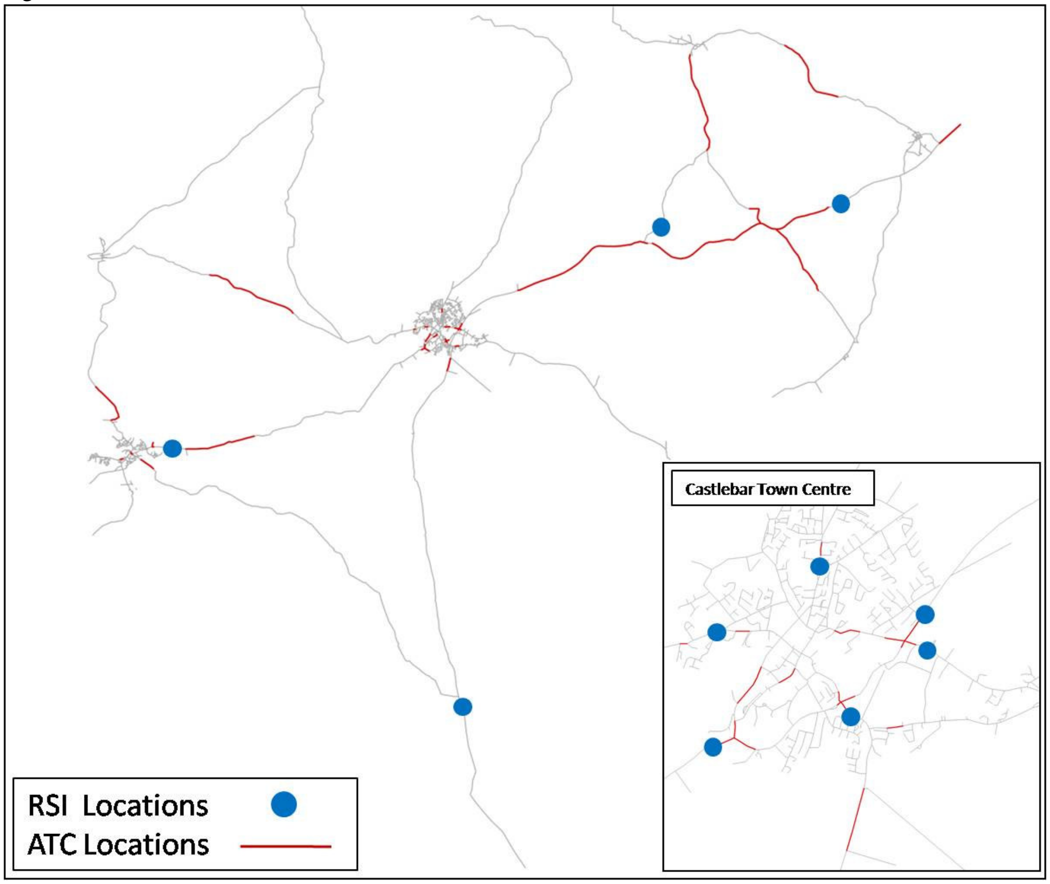
Table 2.1: Summary of Existing Traffic Survey Data

Source	Survey Location	Date of Survey	Type of Data	No. of sites	Use in N5 LAM
Castlebar Ring Road Project Traffic Report	Castlebar	May 2007	RSI	6	Matrix development
NRA National Highways Model	Various/ Network	April 2007	RSI	4	Matrix development
Westport N5/N59 Northern Relief Road SATURN Traffic Model Final Report	Westport	May 2006	Saturn Matrix	N/A	Matrix development
N5 Westport to Bohola Road Project	Various/ Network	Feb 2008	MCC	3	Calibration
Castlebar Ring Road Project Traffic Report	Castlebar	May 2007	ATC	13	Calibration
N5/N59 North Westport Relief Road: Route Selection Report	Westport	May 2006	ATC	6	Calibration
NRA National Highways Model	Various/ Network	May 2007	ATC	7	Calibration
Castlebar Ring Road Project Traffic Report	Castlebar	May 2007	Journey Times	4 Routes	Validation
N5 Westport to Bohola Road Project	Various/ Network	Feb 2008	MCC	13	Validation

The location of the RSI and ATC counts are graphically represented below in Figure 2.1.

Note that the majority of RSI sites are located around Castlebar.

Figure 2.1: Location of RSI and ATC counts



2.2.2 2010 Survey Data

In order to establish an understanding of traffic patterns and volumes in the study area in 2010 a number of additional traffic surveys were carried out. The surveys which were undertaken are summarised in Table 2.2 below and graphically represented in Figures 2.2 to 2.5

Table 2.2: Summary of Traffic Survey Data

Source	Survey Location	Date of Survey	Type of Data	No. of sites
N5 Westport to Turlough	Various	June 2010	MCC	14
N5/N26 Strategic Route Ass.	N26/N17/N60	June 2010	RSI	1

Figure 2.2: Location of MCC Counts (Sites 1 – 3)

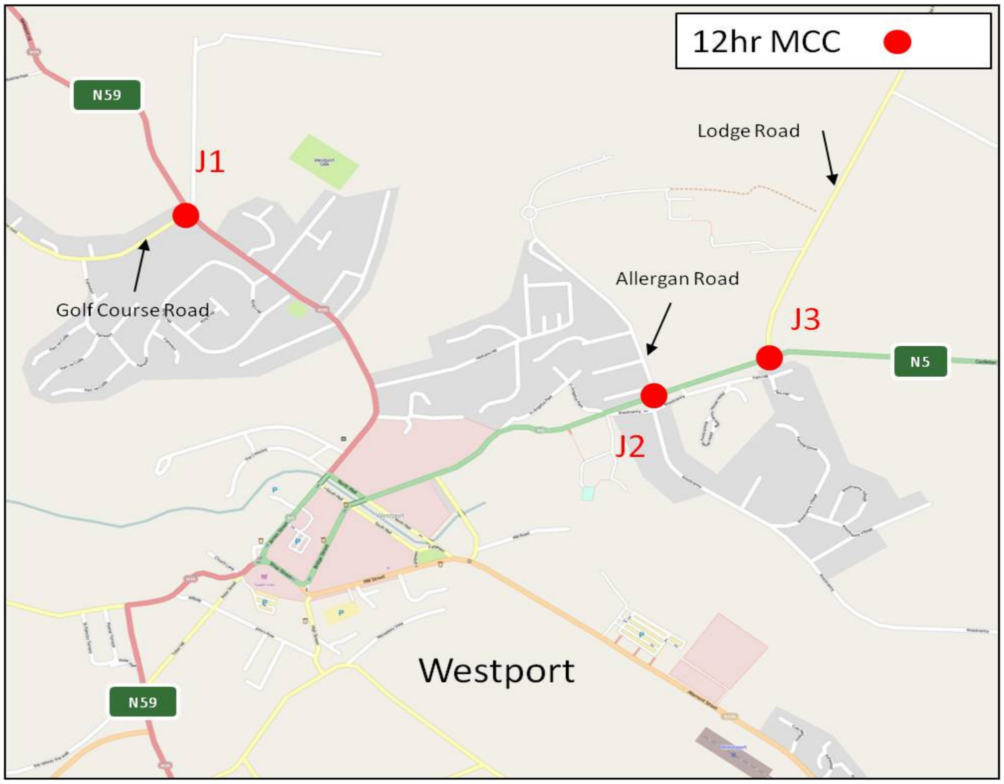


Figure 2.3: Location of MCC Counts (Sites 4 – 5)

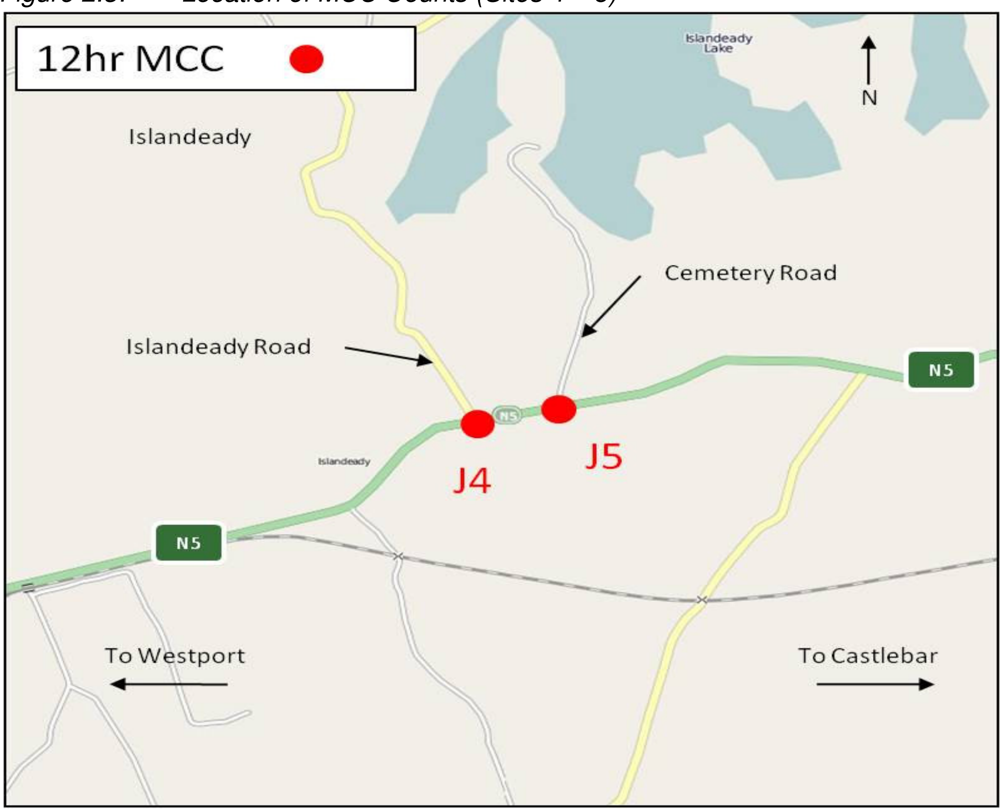


Figure 2.4: Location of MCC Counts (Sites 6 – 11)

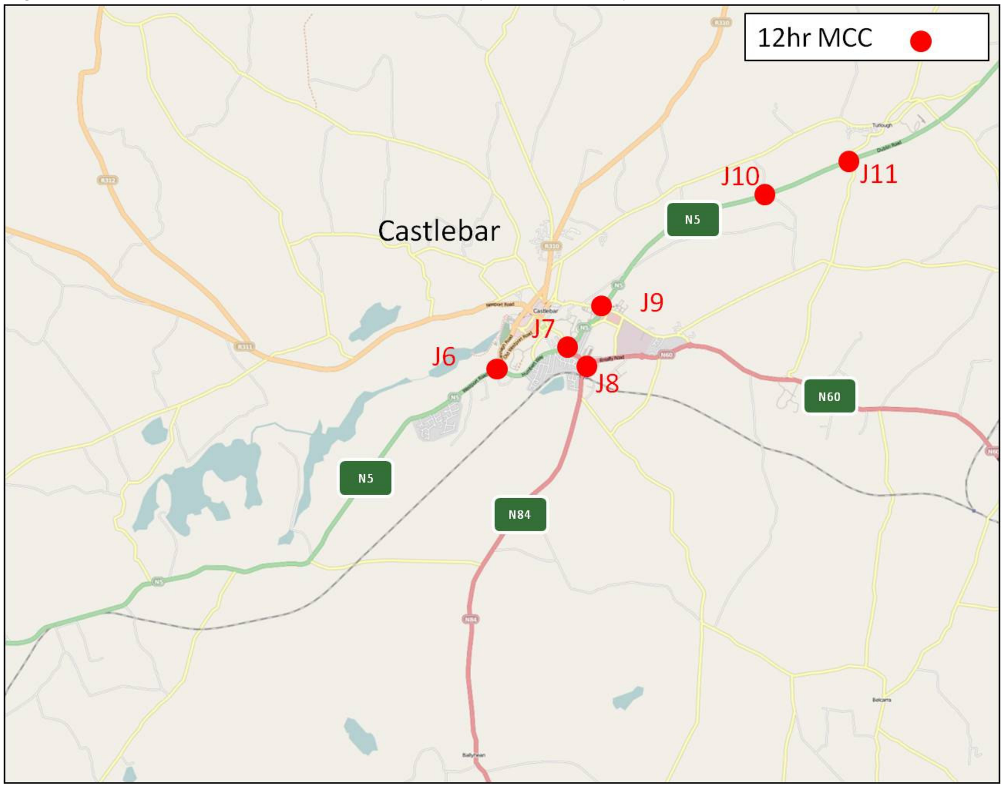
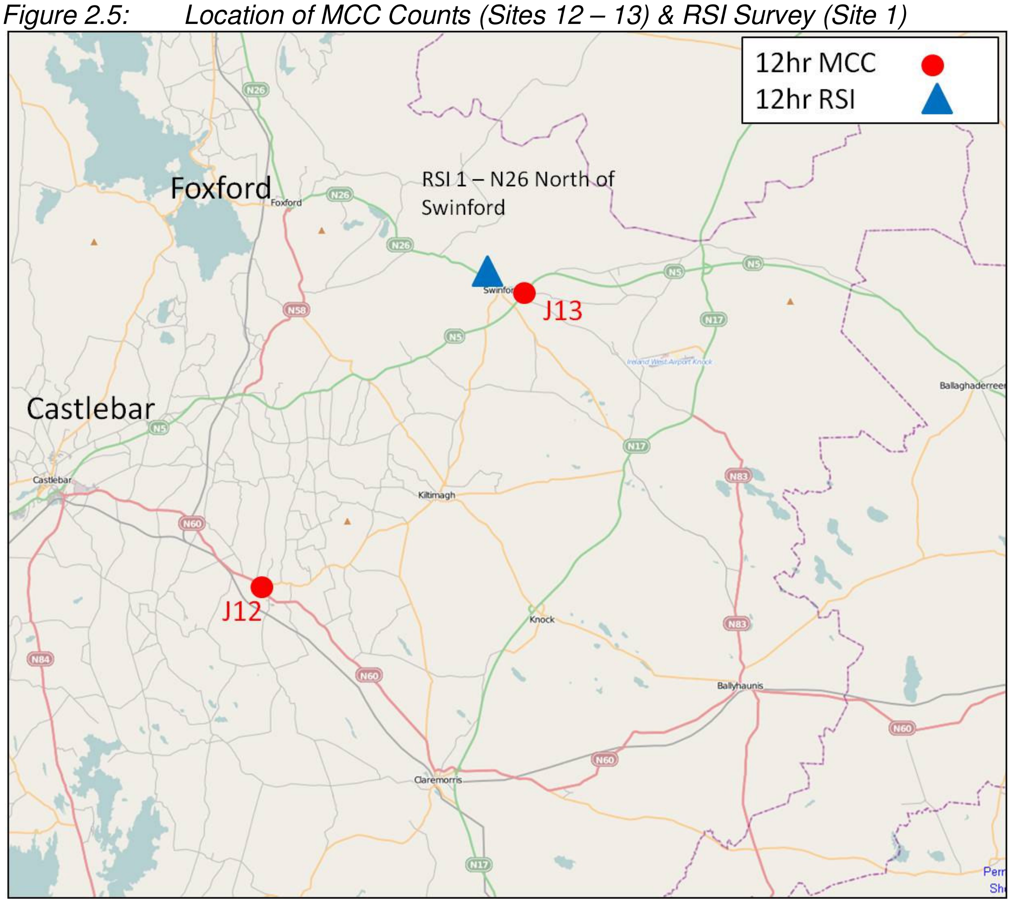


Figure 2.5: Location of MCC Counts (Sites 12 – 13) & RSI Survey (Site 1)



2.2.3 Manual Classified Count (MCC) Surveys

MCC surveys were undertaken by video for the period 07:00 – 19:00 (12hrs) at a number of important junctions in order to establish current volumes of flow on key links and turning movements. The flows were broken down into 15 minute intervals and were classified by vehicle type into the following classifications:

- Cyclists;
- Motorcyclists;
- Car;
- Lights Goods Vehicles – (2 axle, single tyre);
- Other Goods Vehicles 1 – (2 axle, twin tyres, 3 axle rigid);
- Other Goods Vehicles 2 – (4 axle or more rigid or articulated); and
- Buses.

The MCC surveys were undertaken at 13 junctions within the study area, as follows;

- Junction 1 – N59/Golf Links Road;
- Junction 2 – N5/Allergen Road;
- Junction 3 – N5/Lodge Road;
- Junction 4 – N5/Islandeady;
- Junction 5 – N5/Cemetery Road;
- Junction 6 – N5/R310 (Castlebar West);
- Junction 7 – N5/N84 (Castlebar);
- Junction 8 – N84/N60 (Station Road);
- Junction 9 – N5/R373 (Castlebar East);
- Junction 10 – N5/L5785;
- Junction 11 – N5/L5784 (Abbeybreaffy Road);
- Junction 12 – N60/R324 at Balla; and
- Junction 13 – N5/N26 at Swinford;

The MCC data was used to calibrate and validated the base year models to ensure a reliable representation of the existing patterns and demand in the study area.

2.3 Journey Time Surveys

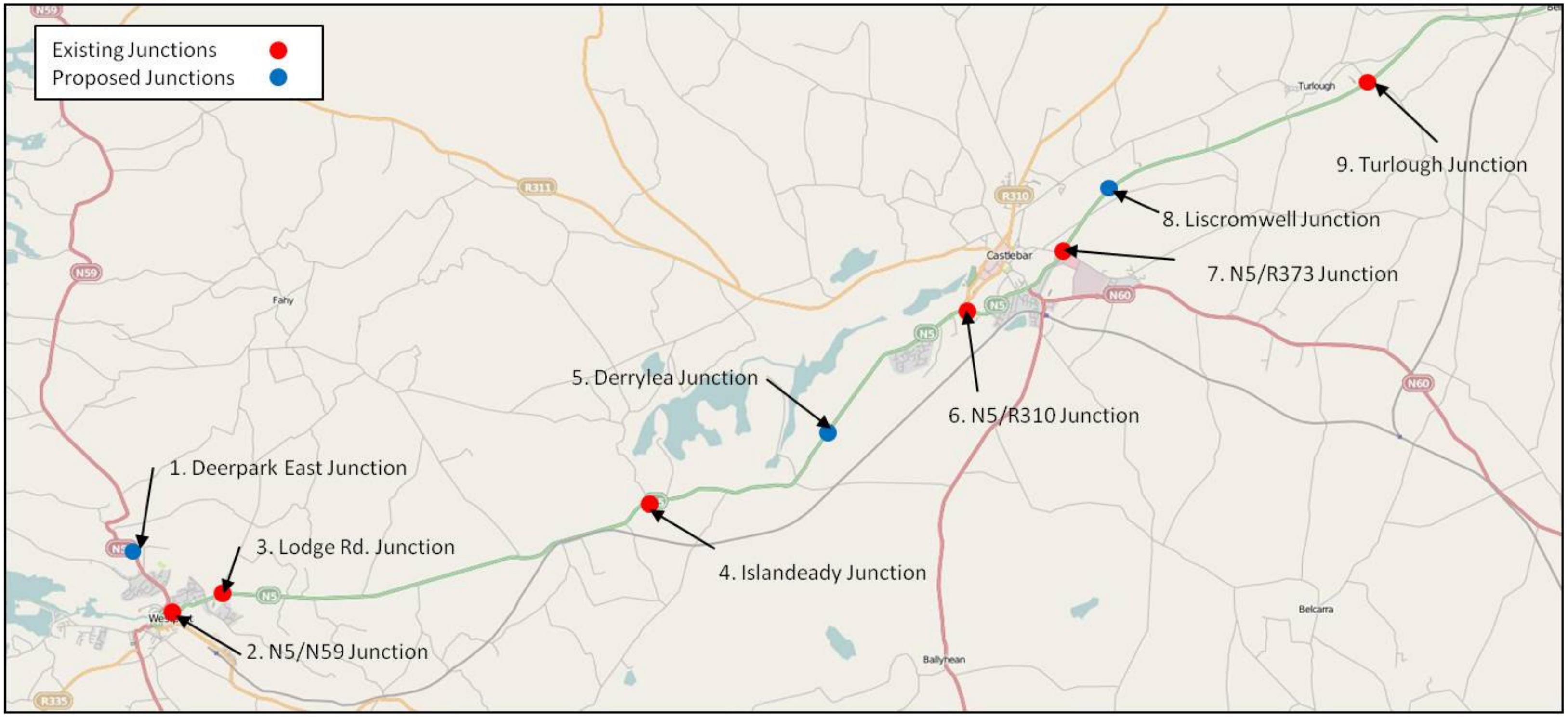
Journey time information is required in order to ensure that the travel time on existing roads is properly reflected within the base models, thereby ensuring that a robust assignment can be undertaken.

Journey time surveys were undertaken on the N59 and N5 between Westport and Turlough in both directions during the AM and PM peak periods. Table 2.3 summaries the journey time routes, which are also illustrated in Figure 2.6

Table 2.3: Journey Time Route Description

Route Section	Route Start Point	Route End Point
1 – 2	N59 Deerpark East	N5/N59 Junction
2 – 3	N5/N59 Junction	N5 Lodge Road Junction
3 – 4	N5 Lodge Road Junction	N5 Islandeady Junction
4 – 5	N5 Islandeady Junction	N5 Derrylea Junction
5 – 6	N5 Derrylea Junction	N5/R310 Junction
6 – 7	N5/R310 Junction	N5/R373 Junction
7 – 8	N5/R373 Junction	N5 Liscromwell Junction
8 – 9	N5 Liscromwell Junction	N5 Turlough Junction

Figure 2.6: Journey Time Survey Points



3.0 Model Development

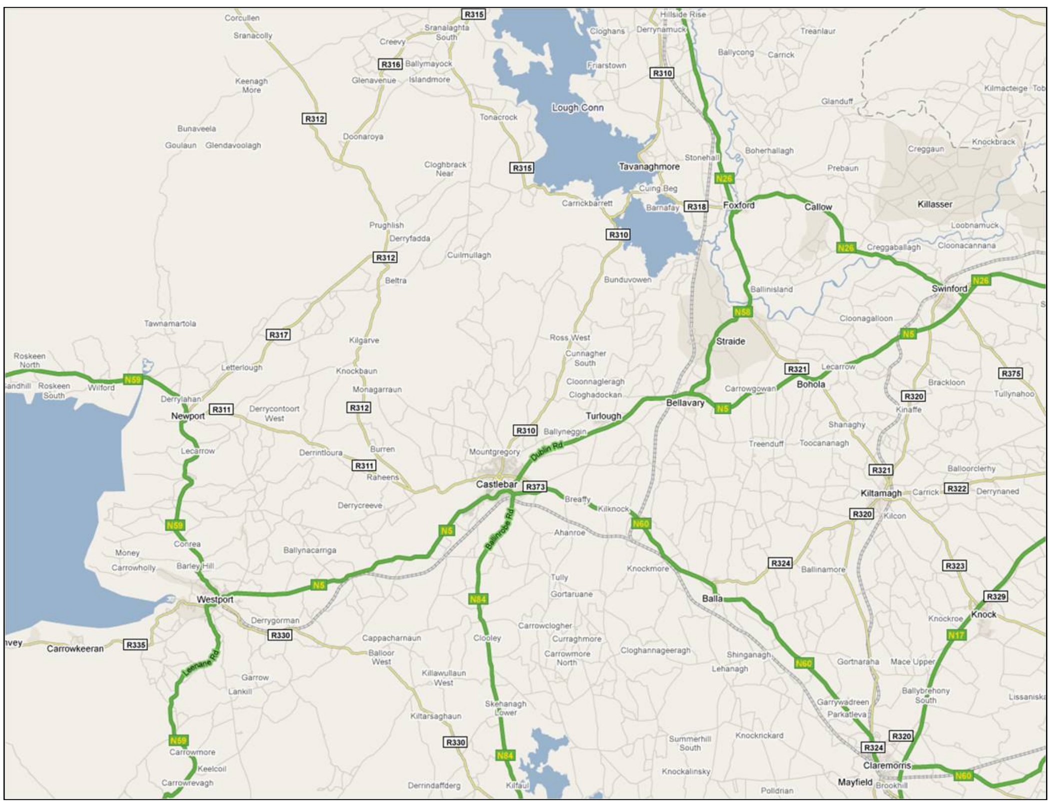
3.1 Overview

In order to develop forecast traffic levels it is first necessary to develop a robust representation of the current traffic patterns. This section of the report describes the development, calibration and validation of the 2010 N5 Base Year Local Area Model (LAM).

3.2 Network Development

As a starting point for the development of the N5 LAM, the 2006 NRA National Traffic Model (NTM) was used as a base from which a suitable section was cordoned out. An amalgamation of site investigation and aerial photography was used to enhance this cordon to construct a VISUM network for the N5 LAM. The area of interest is illustrated in Figure 3.1

Figure 3.1: Model Area of Interest



The study area for the N5 LAM incorporates all the previous individual projects which were undertaken in the study area as follows:

- N5/N59 North – Western Relief Road;
- N5 Westport to Castlebar;
- Castlebar Ring Road Project;
- N5 Ballyavary – Bohola Road Project; and

- N5 Westport to Bohola Road Project

This data informed the cordoning of the NTM VISUM model to produce the N5 LAM, as illustrated in Fig 3.2

Figure 3.2: Cordoned N5 LAM

3.2.1 Refinement of LAM Zoning System

In order to obtain suitable detail within the N5 LAM, a more detailed zoning system than used in the NTM was adopted. The zoning system in the NTM is based on the aggregation of Electoral Division's (ED's), which were suitable for most zones in the LAM apart from those which represent Westport and Castlebar town centres, which were further disaggregated into four and thirteen zones respectively. Additionally the ED surrounding Castlebar town centre was split into five smaller zones, and the zone surrounding Westport town centre split into two smaller zones.

This additional detail allowed more precise movements in and out of these town centres to be mapped within the model. The entire study area was covered by 64 zones. Movements to and from the study area were accounted for with twelve external zones corresponding to the main routes into and out of the study area. The N5 LAM, therefore, has 76 zones in total. The final N5 LAM zone plan is illustrated in Appendix A.

3.3 Links Travel Times

The total travel time of a trip from origin to destination is a function of both link travel time and junction delay. Link travel times in the network are determined by a predefined volume-delay function (VDF) in VISUM, which describes the relationship between current traffic volumes (q) and the capacity of the link (qmax).

The VDF used in this model is based on the Bureau of Public Roads (BPR) function:

$$tCur = t0^* (1 + a * sat^b)$$

where:
t0 = free flow travel time (based on link length (km) and free flow speed (v0))
sat = q/(qmax * c)
a = 0.1
b = 2
c = 1

The VDF function is globally applied to all links in the network as the capacity (q) and free flow speed (v0) of each link (input during network development) feed directly into the VDF.

3.4 Junction Delay

The impedance of each main junction in the network was modelled using the Intersection Capacity Analysis (ICA) method.

The ICA calculation precisely considers the geometry and signal control of the junction and calculates the capacity of the junction and the turning time (tCur) of each turn according to the Highway Capacity Manual (HCM). The method takes into account the impact of conflicting turns upon junction capacity and therefore provides more realistic results of junction capacity and delay.

The impedance of all minor junctions is calculated using the Turns VD method, which considers the free-flow turning travel time (t0) of each turn.

3.5 Matrix Development

The calibrated and validated 2007 AM and PM peak hour matrices were updated to 2010 using matrix estimation in VISUM. The 2010 traffic flows were entered in the model and the matrices were adjusted using the matrix estimation tool 'TFlowFuzzy' in VISUM.

The matrices were reviewed and where necessary further adjustments were made based on the RSI data available in the study area.

3.6 Assignment Model

The assignment model applies the demand for travel, represented by the trip matrices, to the supply, in the form of the road network. The 'generalised cost' of the journey, represented by a combination of time and distance, is compared in a route choice algorithm, and a stable output produced, where, ideally, all possible routes between an origin and destination have the same 'cost'.

The 'generalised cost' is calculated using the same parameters as the National Traffic Model:

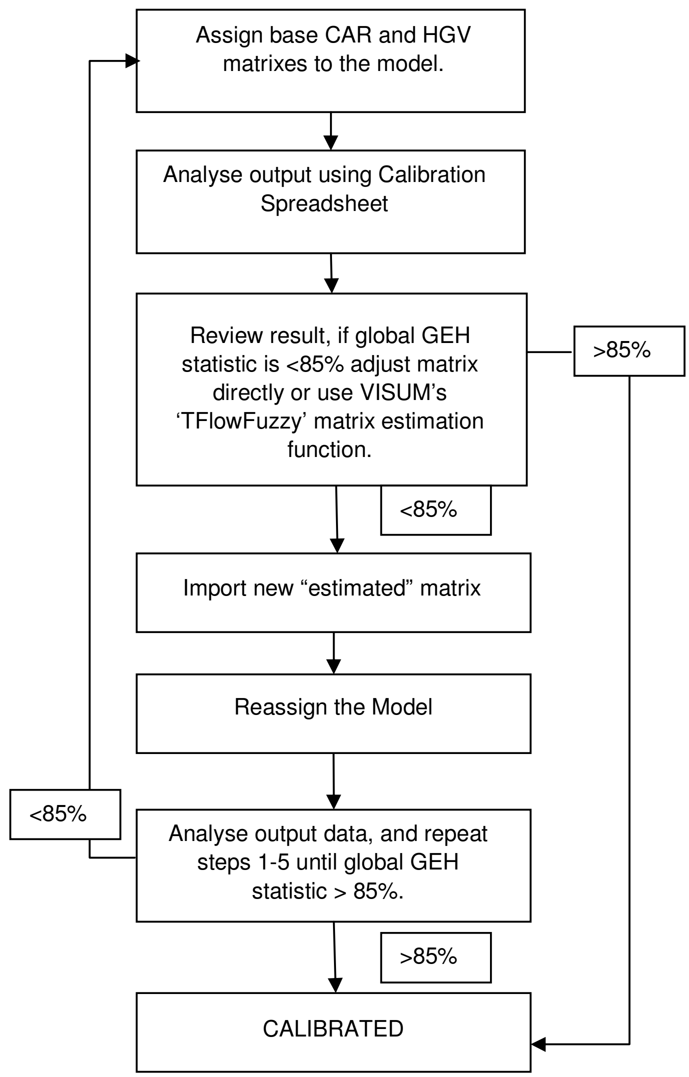
- Car Generalised Cost = 0.869*time (seconds) + 0.0073* length (metres); and
- HGV Generalised Cost = 1 * time (seconds)

The Route Choice Algorithm selected is the same as that used in the National Traffic Model: Equilibrium Lohse. This starts with an 'all or nothing' assignment, and assigns in an iterative fashion, with drivers consecutively including information gained during their last journey for the next route choice. The assignment terminates when a stable solution is calculated.

3.7 Model Calibration

The purpose of model calibration is to ensure that the model assignments reflect the existing travel situation. Calibration is an iterative process, whereby the model is continually revised to ensure that the most accurate replications of the base year conditions are represented. The model calibration process is outlines in Figure 3.3 below.

Figure 3.3 : Model Calibration Process



3.7.1 Calibration Criteria

The NRA Project Appraisal Guidelines (PAG) specifies the acceptable values for modelled and observed flow comparisons and suggests how calibration should relate to the magnitude of the values being compared. A summary of these targets is shown in Table 3.1.

Table 3.1: Model Calibration Criteria: Link Flows

Criteria and Measure	Guideline
Assigned Hourly Flows (e.g. links or turning movements) vs. Observed Flows:	
Individual flows within 15% for flows 700 – 2700 vph	
Individual flows within 100 vph for flows <700 vph	> 85% of cases
Individual flows within 400 vph for flows > 2700	
Total screenline flows (normally >5 links to be within 5%)	

The standard method used to compare modelled values against observations on a link involves the calculation of the Geoff Havers (GEH) statistic (Chi-squared statistic), incorporating both relative and absolute errors.

The GEH statistic 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 statistic is calculated as follows:

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

Where:
M is the modelled flow
C is the observed flow

Guidance in the Project Appraisal Guidelines sets out the following criteria:

Table 3.2: Model Calibration Criteria: GEH Values

Criteria and Measures		Requirement
GEH statistic	Individual flows: GEH < 5	> 85% of cases
GEH statistic	Screenline totals: GEH < 4	All (or nearly all) screenlines

3.7.2 Calibration Results

The results of the calibration exercise are outlined below in Table 3.3 and 3.4 below. The detailed summary tables are included in Appendix B.

Table 3.3: Calibration Results: Individual Flows

Time Periods	**% of Calibration Sites Meeting the flow criteria that: Individual Flows within 15% for flows 700 – 2700 vph Individual flows within 100 vph for flows < 700 vph Individual flows within 400 vph for flows > 2700 vph**	
	Total Traffic	**Required**
AM Peak	100%	>85%
PM Peak	90%	>85%

Table 3.4: Calibration Results: GEH Values

Time Periods	% of Calibration Sites with GEH < 5	
	Total Traffic	**Required**
AM Peak	100%	>85%
PM Peak	96%	>85%

The comparison of modelled and observed flows has identified that the AM and PM Peak period models match the PAG flow criteria. Likewise, the GEH results show that the AM, and PM Peak periods models also match the PAG criteria. The results therefore confirm that the models have been calibrated to a standard compliant with the PAG criteria for all time periods.

3.8 Model Validation

Model validation comprises the comparison of calibrated flows against an independent data set which was not used as part of the calibration process. Validation checks included:

- Matrix validation checks;
- Link flow validation and statistical criteria; and
- Overall model validation (e.g. journey times)

3.8.1 Validation of Traffic Flows

The observed and modelled flows were compared at each of the validation sites in accordance with the criteria above. The permissible difference was calculated for each value and compared with that which had been modelled. Validation results are included in Appendix C and are summarised in Tables 3.5 and 3.6 below:

Table 3.5: Validation Results: Individual Flows

Time Periods	% of Validation Sites Meeting the flow criteria that: Individual Flows within 15% for flows 700 – 2700 vph Individual flows within 100 vph for flows < 700 vph Individual flows within 400 vph for flows > 2700 vph	
	Total Traffic	**Required**
AM Peak	94%	>85%
PM Peak	100%	>85%

Table 3.6: Validation Results: GEH Values

Time Periods	% of Validation Sites with GEH < 5	
	Total Traffic	**Required**
AM Peak	94%	>85%
PM Peak	100%	>85%

The comparison against the validation counts shows that the AM and PM Peak period models clearly satisfies the PAG requirements for traffic flow on links and the GEH criteria of 85%. The results therefore demonstrate that the validation criteria are successfully met.

3.8.2 Journey Time Validation

The journey time validation was carried out in accordance to the guidelines set out in the PAG. The validation was carried out for the Base AM and PM models. Summarised below are the journey time validation results for the Base AM and PM models.

Table 3.6: Validation Results: AM Peak

Route Section	Direction	Surveyed Journey Time (s)	Modelled Journey Time (s)	Validated (Diff < 15% Surveyed)		
				Diff	15%	Valid
1-2	East	120	130	10	8%	✓
	West	152	130	-22	-14%	✓
2-3	East	123	122	1	-1%	✓
	West	553	270	-263	-51%	✗
3-4	East	352	356	4	1%	✓
	West	327	344	17	5%	✓
4-5	East	178	158	-20	-11%	✓
	West	160	151	-9	-6%	✓
5-6	East	192	166	26	-14%	✓
	West	180	159	21	-12%	✓
6-7	East	158	191	33	21%	✗
	West	180	189	9	5%	✓
7-8	East	107	122	15	14%	✓
	West	140	136	-4	-3%	✓
8-9	East	155	151	-4	-3%	✓
	West	175	163	-12	-7%	✓

Table 3.7: Validation Results: PM Peak

Route Section	Direction	Surveyed Journey Time (s)	Modelled Journey Time (s)	Validated (Diff < 15% Surveyed)		
				Diff	15%	Valid
1-2	East	145	125	-20	-14%	✓
	West	153	130	-23	-15%	✓
2-3	East	193	170	23	-11%	✓
	West	336	164	-172	-51%	✗
3-4	East	354	356	2	1%	✓
	West	336	359	23	7%	✓
4-5	East	199	170	-29	-15%	✓

	West	170	162	-8	-5%	✓
5-6	East	216	187	29	-13%	✓
	West	191	195	4	-2%	✓
6-7	East	184	186	2	1%	✓
	West	241	225	16	-7%	✓
7-8	East	99	105	6	6%	✓
	West	126	124	-2	-1%	✓
8-9	East	178	169	-9	-5%	✓
	West	217	201	-16	-7%	✓

The results show that differences between modelled and observed journey times, are within 15% for more than 85% of cases during both the AM and PM Peak Hours. As such the base year models are validated to the requirements of the PAG.

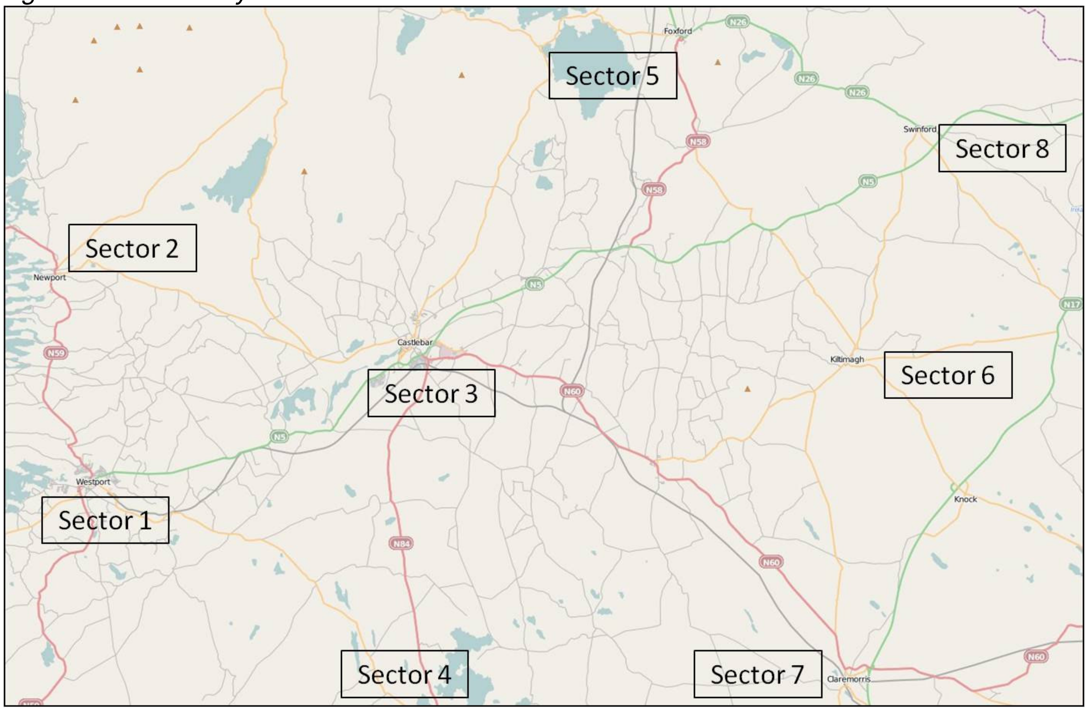
3.9 Existing Travel Patterns

A good understand of existing travel patterns through the study area can be derived through an analysis of the key desire line from the traffic models. This analysis of desire lines is achieved through the definition of 'sectors' which represent areas of the traffic model as follows:

- Sector 1 – Westport area;
- Sector 2 – Newport area;
- Sector 3 – Castlebar area;
- Sector 4 - Ballinrobe area;
- Sector 5 – Foxford/Ballina area;
- Sector 6 – Kiltimagh area
- Sector 7 – Claremorris/Tuam; and
- Sector 8 – Swinford area.

These sectors are illustrated in Figure 3.4

Figure 3.4: Study Area Sectors



The desire lines for the 2010 AM and PM peak hours are illustrated in Figure 3.5 and 3.6, respectively. Travel demand between sectors is indicated by colour and bandwidth thickness. It is to be noted that travel to a sector at the edge of the model will include travel to areas beyond that sector (e.g. travel from Sector 3 - Castlebar to Sector 8 - Swinford, includes onward travel to Dublin via the N5).

Figure 3.5: 2010 AM Desire Lines

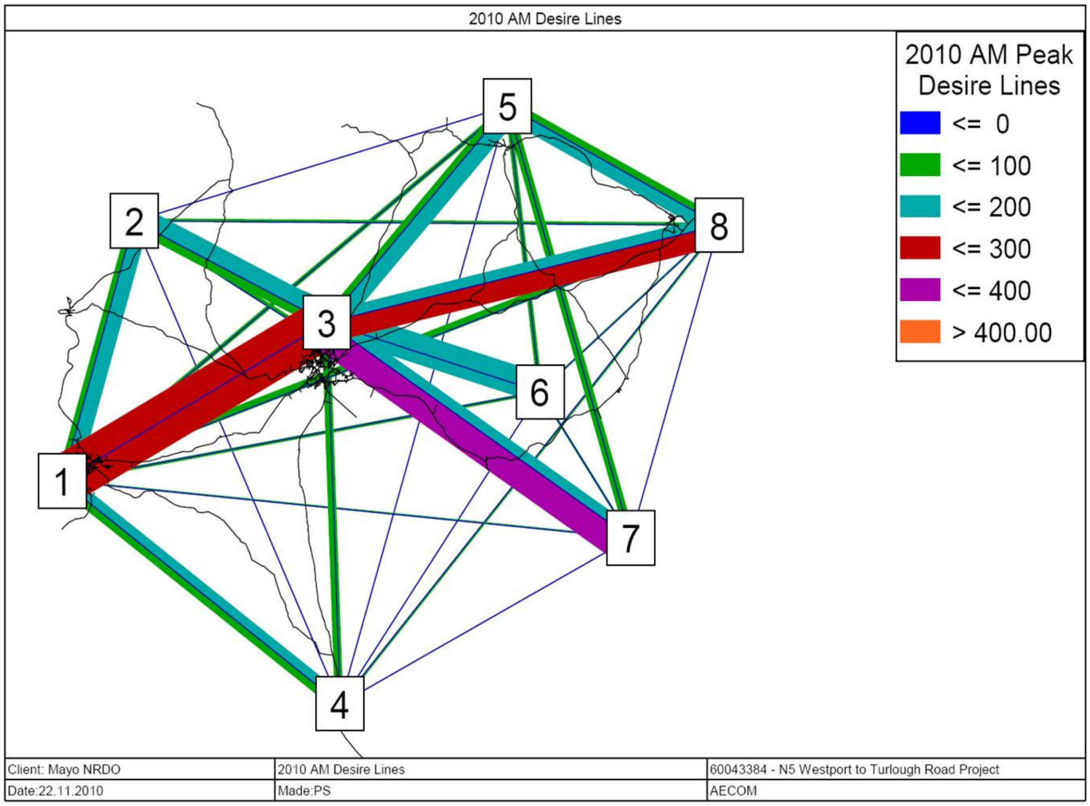
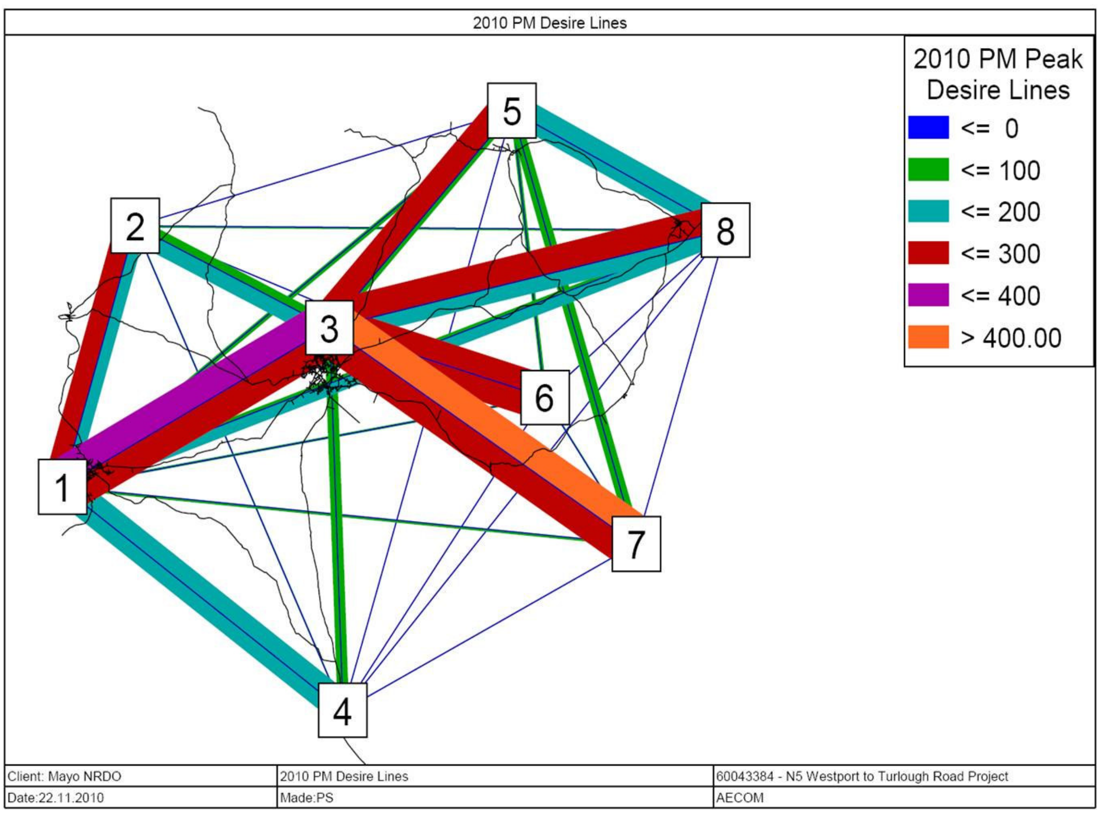


Figure 3.6: 2010 PM Desire Lines



The diagrams highlight the dominance of the demand into the Westport and Castlebar area, with key demands arising from the Claremorris, Foxford/Ballina and the Kiltimagh area. Other key demands include the Foxford/Ballina to Swinford and the Castlebar/Westport to Swinford/Dublin.

4.0 Future Year Model Development

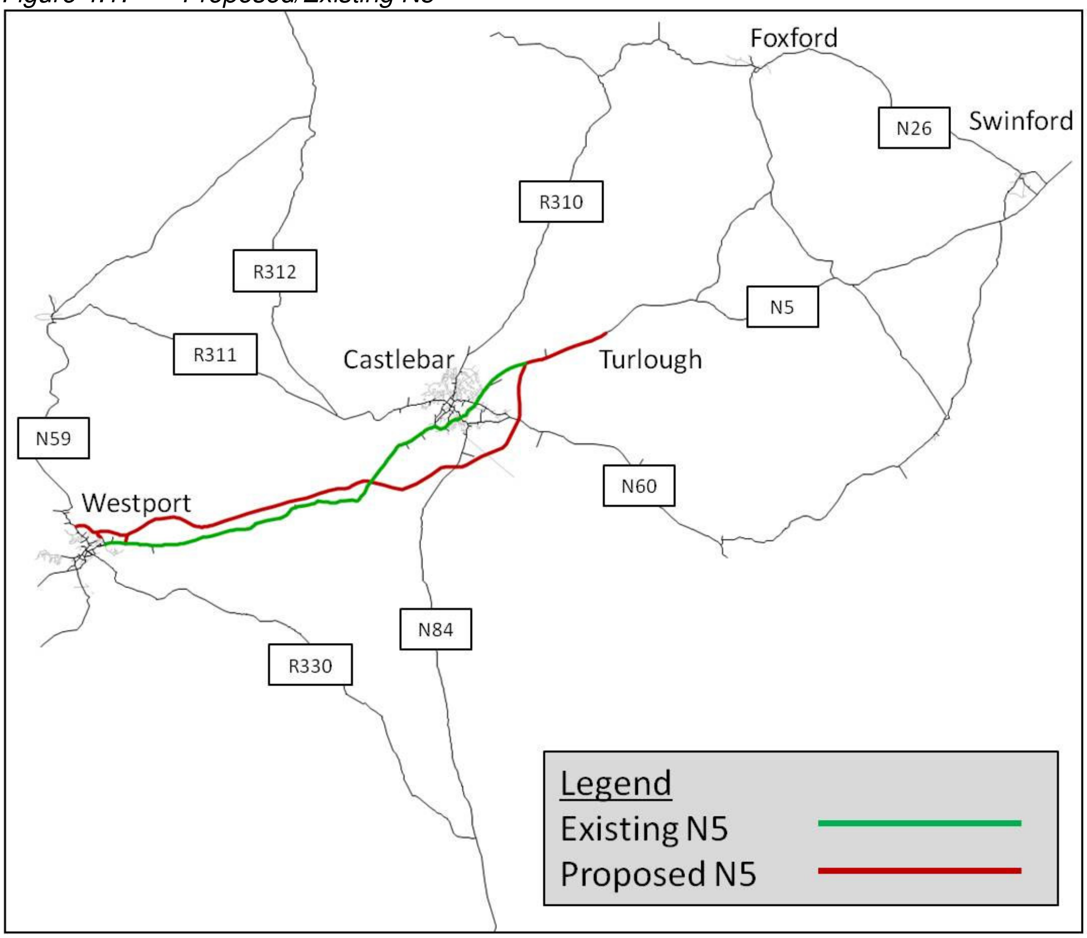
4.1 Introduction

This section of the report sets out the development of the future year LAM for the scheme opening year (2015) and design year (2030).

4.2 Future Year Network Development

The future year "Do-Minimum" network includes the 2010 existing road network with no further infrastructure improvements, whilst the future year "Do-Something" network includes all the assumptions of the "Do-Minimum" network plus the proposed N5 Westport to Turlough Road Project. The "Do-Something" road network and existing N5 are shown in Figure 4.1 below:

Figure 4.1: Proposed/Existing N5

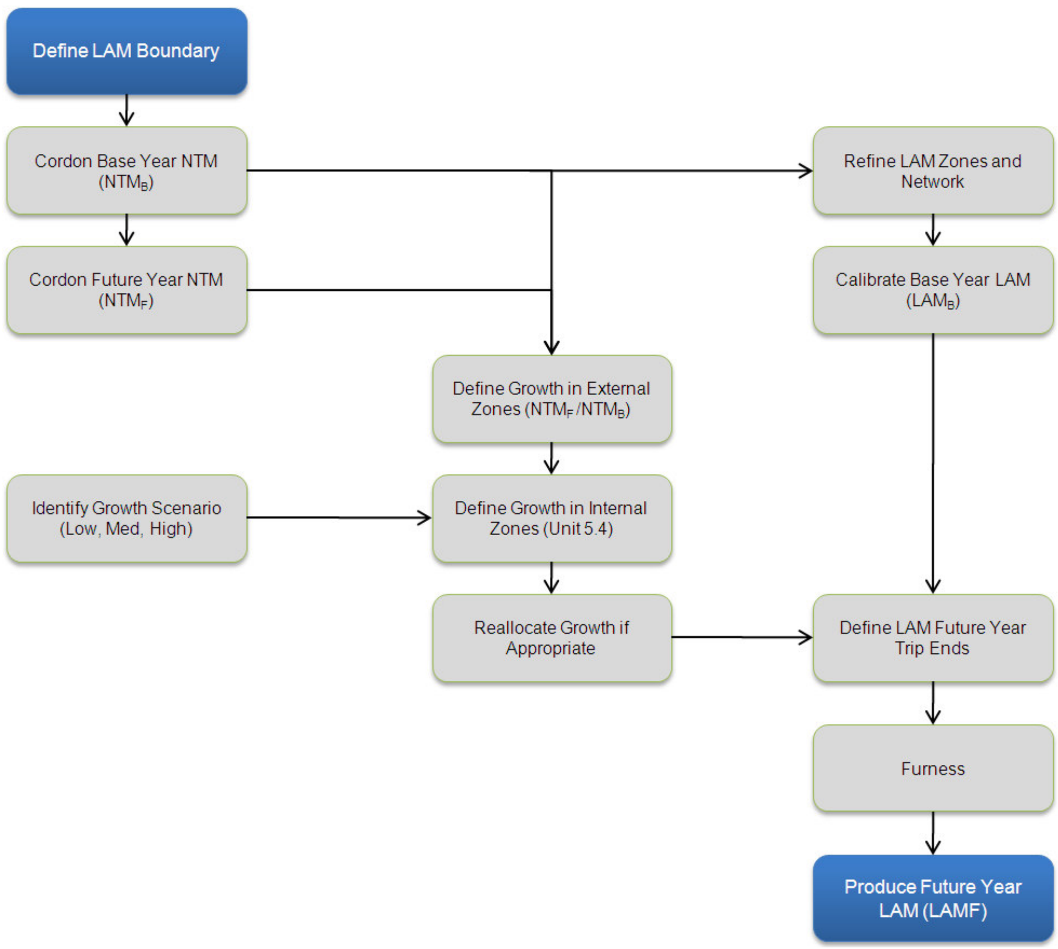


4.3 Future Year Matrix Development

The development of traffic growth forecasts for the future year LAM is based on the methodology set out in *Unit 5.3 Traffic Forecasting* of the NRA PAG.

The PAG sets out the criteria for using the Zonal Growth Rates forecasting methodology which is used for forecasting traffic growth when using Assignment Models. The forecasting process is summarised in Figure 4.2 below

Figure 4.2: Zonal Growth Rates Methodology



4.3.1 Growth Scenario

The medium growth scenario was used as part of the forecasting process for the proposed scheme.

4.3.2 Internal Zone Trip End Growth

The relationship between the N5 LAM zones and the NTM zones was established, then annualised origin and destination Trip End Growth (TEG) factors for the zones in the N5 LAM were extracted from *Unit 5.4 of the PAG* for both the AM and PM Peak Period.

The TEG factors were then applied to the base year origin and destination trip ends for all internal zones in the LAM

4.3.3 External Zone Trip End Growth

The LAM boundary was cordoned from the Future Year (2025) NTM and compared against the Base Year (2006) NTM which was cordoned as part of the development of the 2010 Base Year N5 LAM. The resulting growth factor for each external zone trip end was indentified and annualised.

The resulting TEG factors were then applied to the base external origin and destinations trip ends in the LAM for both the scheme Opening and Design Year.

4.3.4 Future Year Trip Distribution

Future year trip distribution was based on the "Furness" growth factor method. In order to carry out the trip distribution process it was first necessary to 'seed' the cells with no trips in the base year matrices with very small numbers to allow for future year trips between those specific cells. Otherwise any cell with a zero will remain zero irrespective of the factor applied. As part of the trip distribution process the matrix totals were doubly constrained to the mean of the forecast trip ends totals.

4.3.5 Matrix Totals

A comparison of the trip matrix totals and their growth between 2010 - 2015 and 2010 - 2030 are outlined in Table 4.1 and 4.2, respectively.

Table 4.1: Trip Matrix Total Comparison (2010 Base – 2015 Opening Year)

Matrix (All Vehicles)	2010 Matrix Total	2015 Matrix Total	Overall Growth	% Growth (2010 - 2015)
AM Peak	8551	9100	549	6.4%
PM Peak	10282	10952	670	6.5%

Table 4.2: Trip Matrix Total Comparison (2010 Base – 2030 Design Year)

Matrix (All Vehicles)	2010 Matrix Total	2030 Matrix Total	Overall Growth	% Growth (2010 - 2030)
AM Peak	8551	11068	2517	29.4%
PM Peak	10282	13240	2958	28.8%

4.4 Future Year Matrix Analysis

The PAG require a quantitative assessment of the impact of the traffic forecasting procedure to be undertaken upon the following criteria:

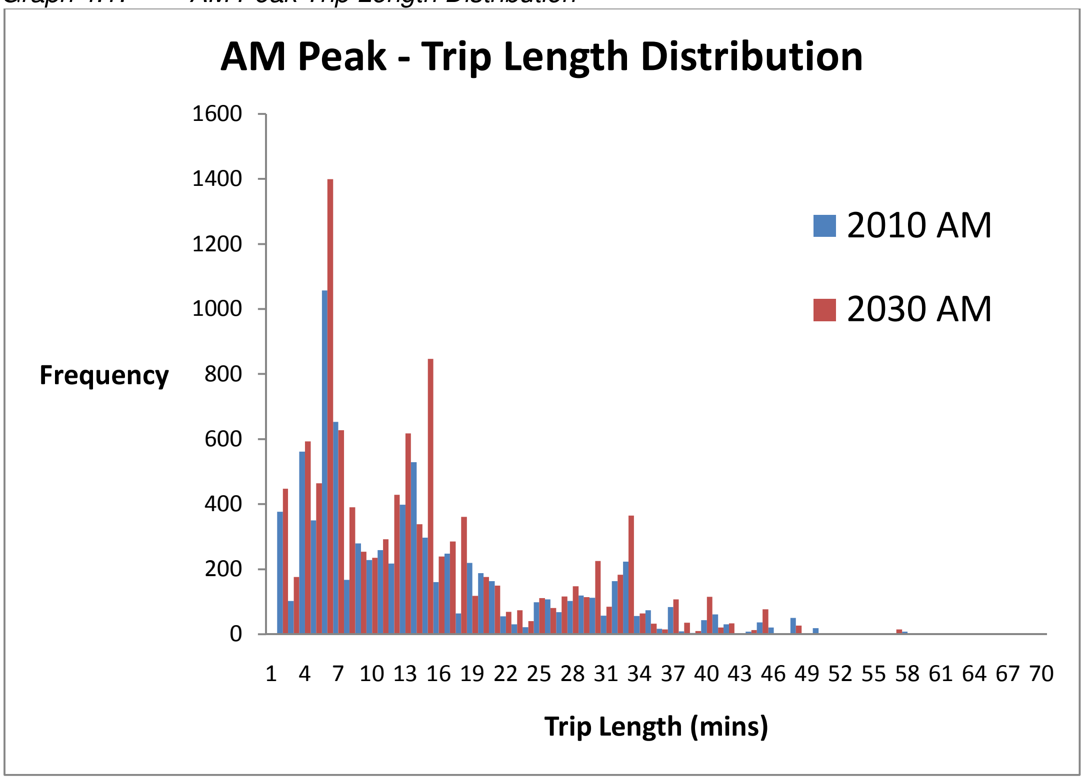
- Trip Length Distribution;
- Trip End Growth; and
- Zone to Zone Growth.

4.4.1 Trip Length Distribution

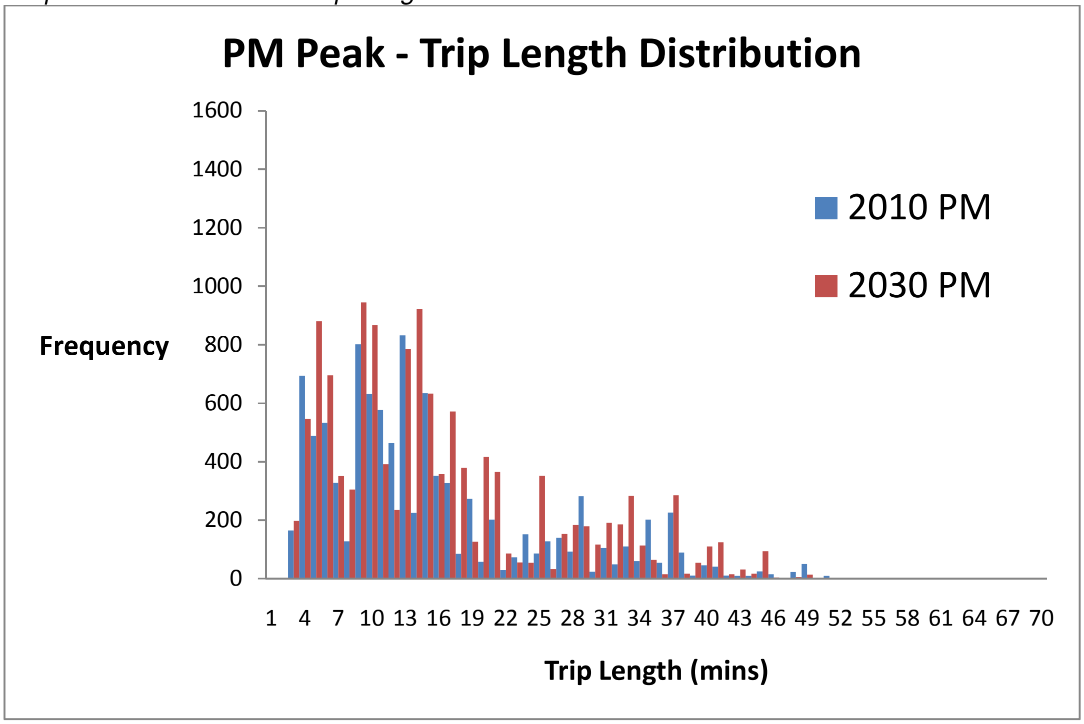
Trip Length Distribution (TLD) graphs for both the AM and PM Peaks are illustrated below. The graphs compare the TLD in the Base Year model and Design Year model.

Overall the TLD remains constant between the Base and Design Year models in both the AM and PM Peak with some minor variations in distribution as a result of the trip distribution process.

Graph 4.1: AM Peak Trip Length Distribution



Graph 4.2: PM Peak Trip Length Distribution



4.4.2 Trip End Growth

An assessment of the Trip End Growth (TEG) between the Base and Design Year demand in the AM and PM Peak was undertaken to assess if there were any significant changes in demand at zonal level compared to the overall growth between the Base and Design Year demand.

The assessment indicated that the percentage increase between several trip ends in the Base and Design Year demand was significant but that the actual increase in the number of trips was only minor.

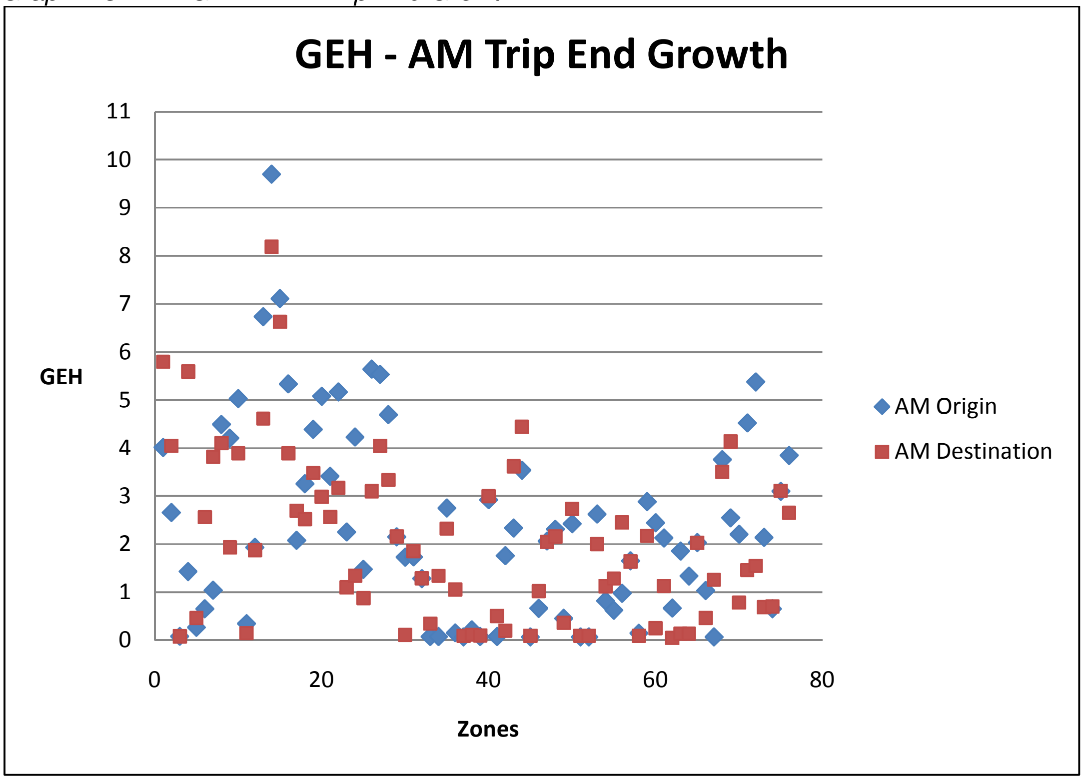
In order to assess the true magnitude of TEG, the GEH statistic was applied to the Base and Design Year trip ends in order to take account of not only the difference between the Base and Design Year demand, but also the magnitude of the difference.

The graphs below show the GEH between the Base and Design Year demand both in the AM and PM Peak. The PAG guidance on the GEH statistic indicates that any a GEH statistic above 10 warrants further investigation. There is only 1 zone (Destination Zone 66) with GEH stats above 10 in the PM, with no GEH stats above 10 in the AM Peak.

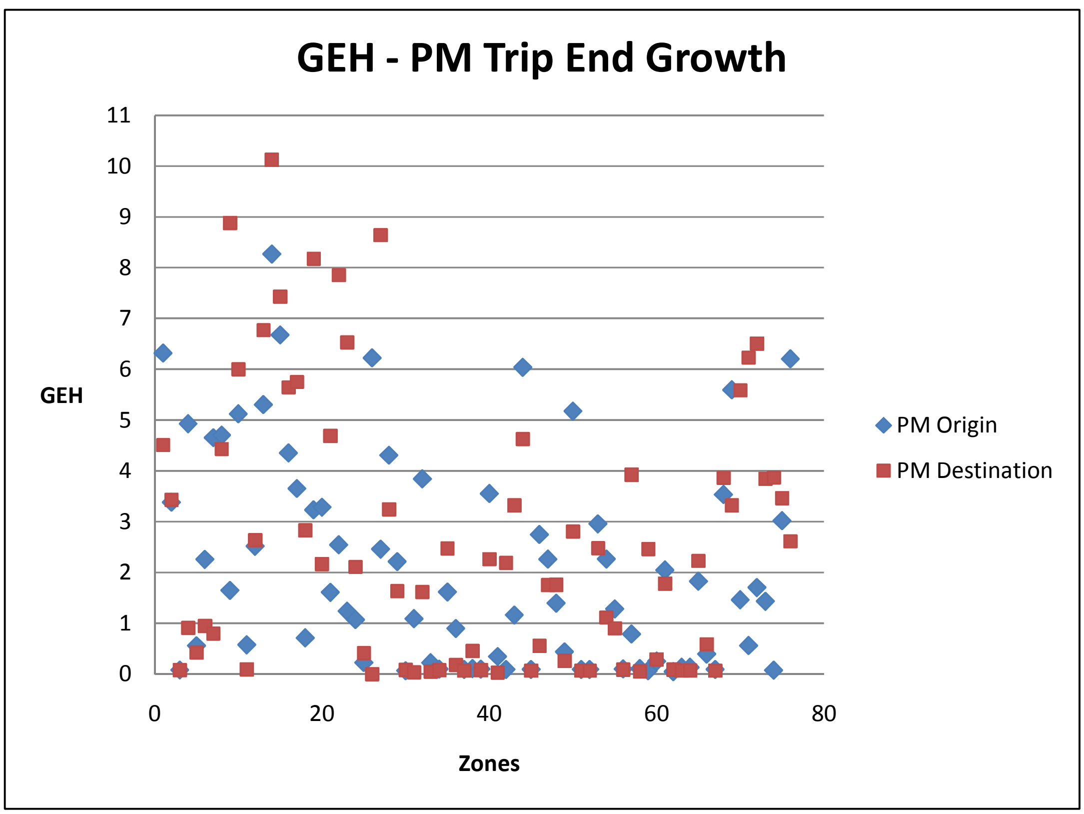
Zone 66 represents one of the largest zones in Westport, the zone grows by 32% in the PM Peak which is slightly above the average growth for the study area, with the total number of destination trips increasing from 1104 to 1466.

The NTM sector in which zone 66 is represented is forecast to growth by 32% over the period 2010 to 2030, so it is assumed that the forecast procedures have not altered the trip end growth for Zone 66.

Graph 4.3: GEH – AM Trip End Growth



Graph 4.4: GEH – PM Trip End Growth

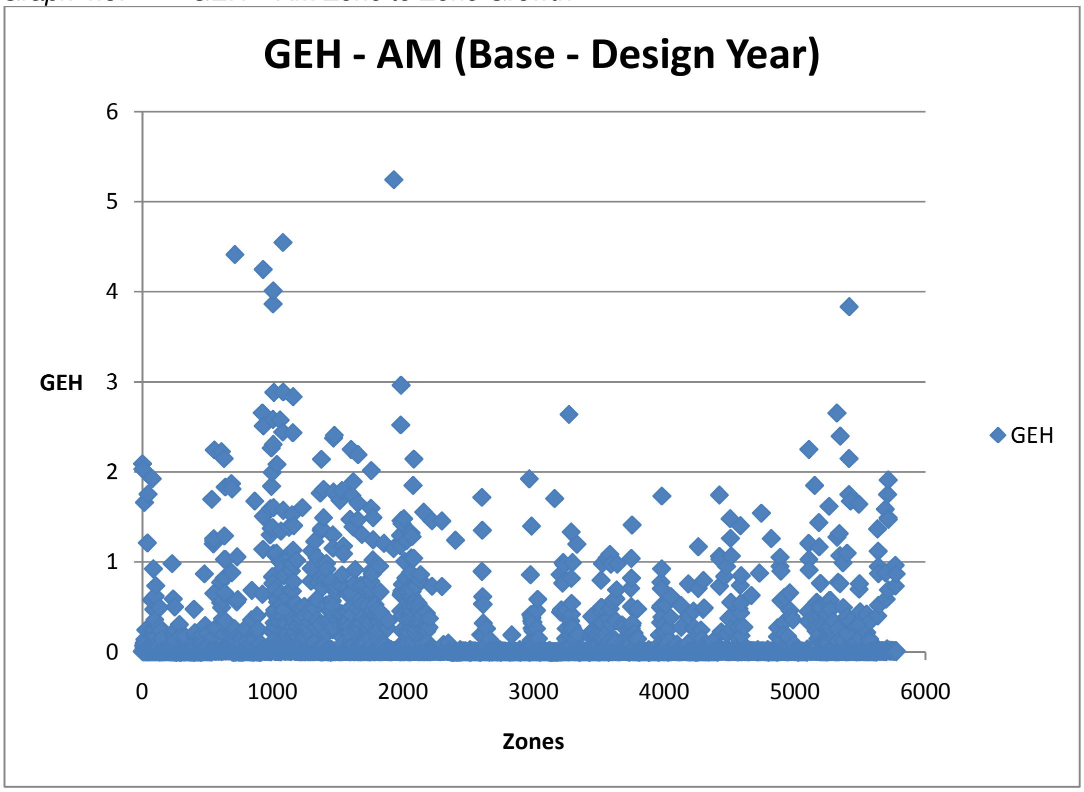


4.4.3 Zone to Zone Growth

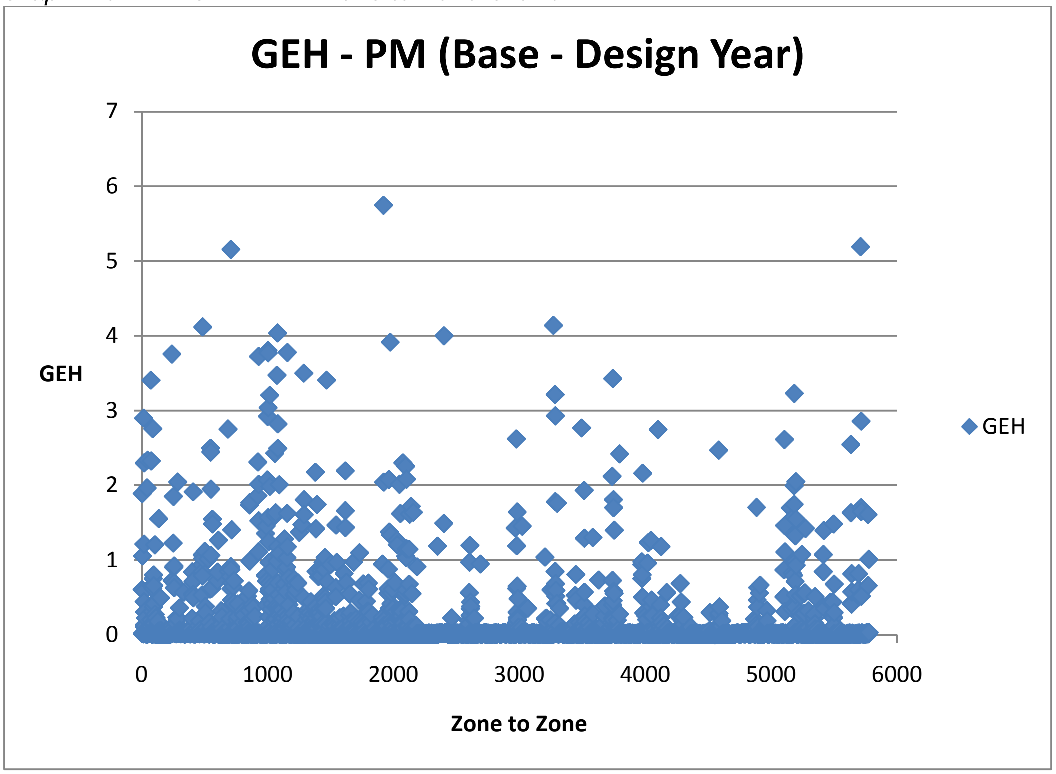
The same procedure for TEG was also undertaken for zone to zone growth. The GEH statistic for each origin-destination pair was assessed to show any significant outliers or issues in the AM and PM Peak demand.

Graphs 4.5 and 4.6 show the GEH statistic on a zone to zone basis for the AM and PM demand, respectively. Both graphs show that there is no GEH statistic over 10, with only a minor number over 5 both in the AM and PM.

Graph 4.5: GEH – AM Zone to Zone Growth



Graph 4.6: GEH – PM Zone to Zone Growth



4.5 Network Performance Indicators

The network performance indicators for the opening and design year scenarios are outlined in Tables 4.3 and 4.4 for the AM and PM Peak, respectively.

The statistics show that there is a reduction in total network travel time and total network delay and a subsequent increase in average vehicle speed between the Do-Something and Do-Minimum scenarios in both the opening year and design year.

Table 4.3: Network Performance Indicators (AM Peak)

Scenario	Total Vehicle km	Total Network Travel Time (hrs)	Total Network Delay (hrs)	Average Vehicle Speed (km/hr)	Average Trip Length (km)
2010 Base	121200	1921	102	63.09	14.17
2015 Do-Min	129279	2129	209	60.72	14.21
2015 Do-Some	129991	1993	92	65.22	14.28
2030 Do-Min	157069	2590	254	60.64	14.19
2030 Do-Some	158311	2491	169	63.55	14.30

Table 4.4: Network Performance Indicators (PM Peak)

Scenario	Total Vehicle km	Total Network Travel Time (hrs)	Total Network Delay (hrs)	Average Vehicle Speed (km/hr)	Average Trip Length (km)
2010 Base	152524	2644	387	57.69	14.83
2015 Do-Min	164361	3247	778	50.62	15.01
2015 Do-Some	163953	2915	517	56.24	14.97
2030 Do-Min	200041	4129	1124	48.45	15.11
2030 Do-Some	201602	3801	842	53.04	15.23

4.6 Estimation of Annual Average Daily Traffic (AADT)

To estimate the annual average daily traffic (AADT), conversion rates were developed which allowed extrapolation of AM and PM peak hour traffic flows to AADT. A relationship was developed based on regression analysis of 3 permanent NRA counters and a number of long term ATC counters in the study area which were used as part of the development of the National Traffic Model.

The AM and PM Peak Hour flows were converted to AADT flows using the following formula:

$$AADT = (7.337 * x) + (5.773 * y)$$

Where,

x = AM Peak Period Demand

y = PM Peak Period Demand

In order to assess the accuracy of the AM and PM Peak hour expansion factors to AADT a comparison of observed and modelled 2010 base year AADT has been undertaken in Table 4.5 below.

Only 12hr (07:00 – 19:00) observed data is available for 2010, therefore to establish 2010 AADT a conversion factor of 1.23 has been applied to the 12hr counts. This conversion factor is based on the relationship between 12hr weekday flow (07:00 – 19:00) and AADT flow taken from the NRA permanent counter located on the N60 at Balla in 2010.

Table 4.5: Accuracy of AM & PM Expansion Factors to AADT

Location	Observed 12hr Flow (7am – 7pm)	Observed AADT	Modelled AADT	Accuracy
N5 East of Westport	9833	12095	11400	-6%
N5 West of Castlebar	11238	13823	14300	4%
N5 Lawn Road	14303	17593	16400	-7%
N84 Station Road	14540	17884	15500	-13%
N60 Breaffy Road	8855	10892	11000	1%
R373 Moneen Road	13037	16036	15700	-2%
N5 East of Castlebar	11028	13564	14200	5%
N5 West of Turlough	10571	13002	13500	4%
N5 East of Swinford	6271	7713	8000	4%

The table above shows that the conversion factors used to estimate AADT from AM and PM peak hour models leads to modelled forecast AADT flows for the majority of cases.

4.6.1 Forecast AADT

The forecast AADT flows on the road network in the study area extracted from the models are outlined in Tables 4.6 for the following scenarios:

- 2010 Base Year;
- 2015 Do-Minimum;
- 2015 Opening Year Do-Something;
- 2030 Do-Minimum; and
- 2030 Design Year Do-Something

Figure 4.3 overleaf highlights the road network and locations where the AADT traffic flows were taken in the model. Tables 4.7 and 4.8 outline the forecast AADT in the NRA Low and High demographic growth scenarios, respectively.

Appendix C of this report provides a diagrammatic presentation of AADT flows for the medium growth scenario.

Figure 4.3: AADT Locations

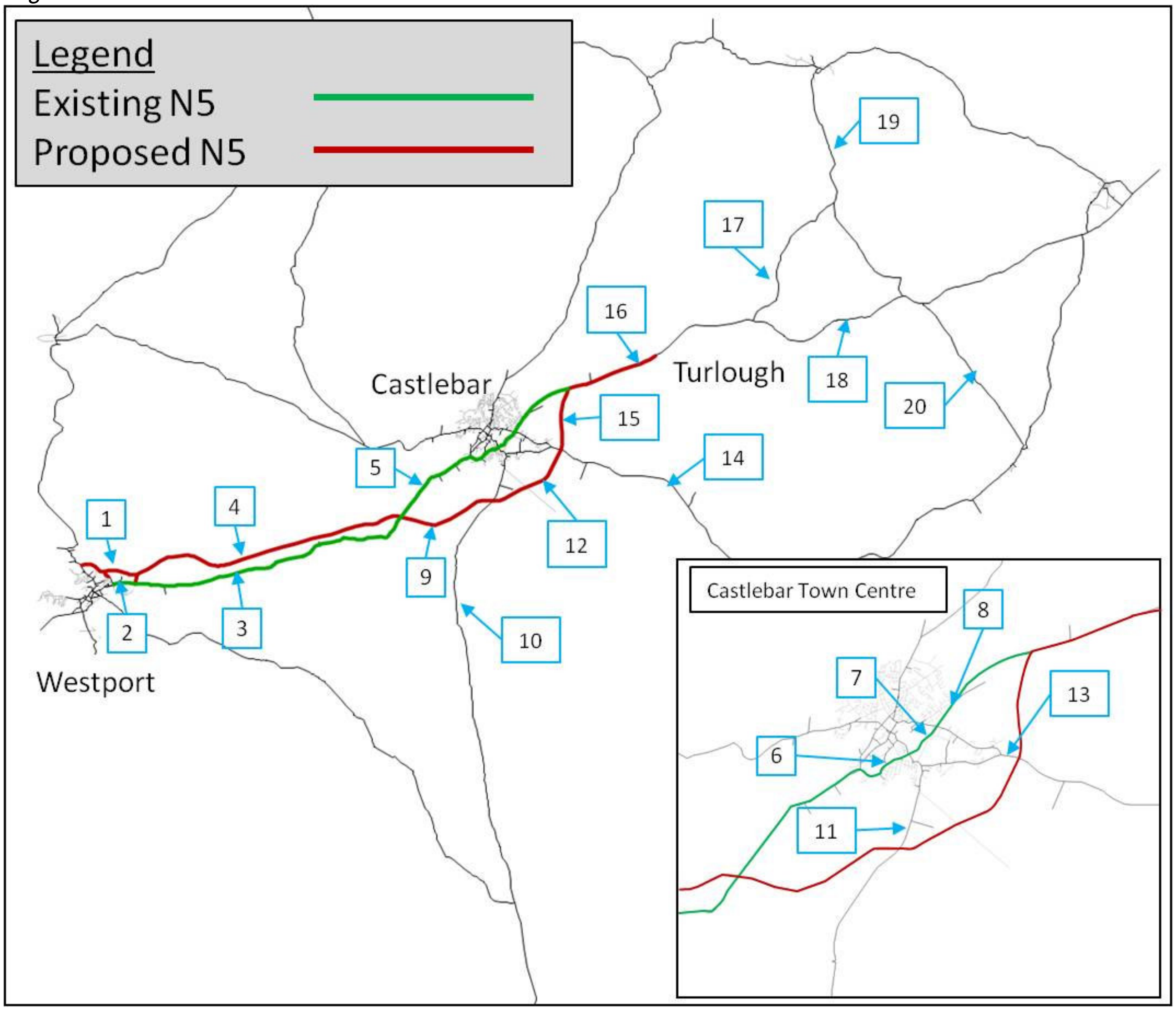


Table 4.6: Forecast AADT – NRA Medium Growth Scenario

No	Name	2010 Base	2015 Do-Min	2015 Do-Some	2030 Do-Min	2030 Do-Some
1	**Westport Link Road**	**-**	**-**	**3200**	**-**	**5700**
2	N5 East of Westport	11400	12100	9100	14100	10100
3	N5 Westport Road (Existing)	11400	12100	1500	14100	1800
4	**N5 Westport Road (Proposed)**	**-**	**-**	**10800**	**-**	**14000**
5	N5 Westport Road	11100	11700	5500	13700	7300
6	N5 Humbert Way	15400	16000	10700	18000	12600
7	N5 Lawn Road	16400	16600	11500	17700	12600
8	N5 Dublin Road	14200	14900	9100	16500	10400
9	**Proposed N5 (N5 to N84)**	**-**	**-**	**6600**	**-**	**9300**
10	N84 South of Proposed N5	4600	4900	4900	6100	6400
11	N84 North of Proposed N5	4600	4900	4700	6100	6000
12	**Proposed N5 (N84 to N60)**	**-**	**-**	**7400**	**-**	**10100**
13	N60 North of Proposed N5	11000	11600	15800	14400	18300
14	N60 South of Proposed N5	11000	11600	13800	14400	15300
15	**Proposed N5 (N60 to N5)**	**-**	**-**	**8600**	**-**	**10200**
16	N5 West of Turlough	13500	14200	16500	16000	18800
17	N58 South of Straide	4200	4300	6500	4800	6800
18	N5 West of Bohola	8000	8500	8500	9500	10300
19	N58 South of Foxford	6100	6400	6500	7400	7700
20	R321 South of Kiltimagh	3600	3900	1700	4500	3200

Table 4.7: Forecast AADT – NRA Low Growth Scenario

No	Name	2010 Base	2015 Do-Min	2015 Do-Some	2030 Do-Min	2030 Do-Some
1	**Westport Link Road**	**-**	**-**	**3000**	**-**	**5200**
2	N5 East of Westport	11400	11900	9100	13900	9700
3	N5 Westport Road (Existing)	11400	11900	1500	13900	1700
4	**N5 Westport Road (Proposed)**	**-**	**-**	**10700**	**-**	**13200**
5	N5 Westport Road	11100	11600	5500	13500	7200
6	N5 Humbert Way	15400	15600	10700	17700	12000
7	N5 Lawn Road	16400	16500	11500	17100	12600
8	N5 Dublin Road	14200	14800	9100	15800	10100
9	**Proposed N5 (N5 to N84)**	**-**	**-**	**6500**	**-**	**8600**
10	N84 South of Proposed N5	4600	4800	4900	5600	5700
11	N84 North of Proposed N5	4600	4800	4700	5600	5200
12	**Proposed N5 (N84 to N60)**	**-**	**-**	**7000**	**-**	**9200**
13	N60 North of Proposed N5	11000	11400	15300	13200	17200
14	N60 South of Proposed N5	11000	11400	13600	13200	14800
15	**Proposed N5 (N60 to N5)**	**-**	**-**	**8400**	**-**	**9800**
16	N5 West of Turlough	13500	14000	16200	15600	18000
17	N58 South of Straide	4200	4300	6400	4300	6800
18	N5 West of Bohola	8000	8400	8400	9500	10000
19	N58 South of Foxford	6100	6300	6300	6600	7200
20	R321 South of Kiltimagh	3600	3800	1700	4500	2600

Table 4.8: Forecast AADT – NRA High Growth Scenario

No	Name	2010 Base	2015 Do-Min	2015 Do-Some	2030 Do-Min	2030 Do-Some
1	**Westport Link Road**	**-**	**-**	**3700**	**-**	**8000**
2	N5 East of Westport	11400	12500	9200	14800	12000
3	N5 Westport Road (Existing)	11400	12500	1600	14800	2200
4	**N5 Westport Road (Proposed)**	**-**	**-**	**11400**	**-**	**17800**
5	N5 Westport Road	11100	12200	6000	14200	9500
6	N5 Humbert Way	15400	16300	11400	19500	14700
7	N5 Lawn Road	16400	16700	12000	17700	13800
8	N5 Dublin Road	14200	15500	9500	16500	12500
9	**Proposed N5 (N5 to N84)**	**-**	**-**	**7100**	**-**	**13800**
10	N84 South of Proposed N5	4600	5200	5200	7900	8400
11	N84 North of Proposed N5	4600	5200	4700	7900	7700
12	**Proposed N5 (N84 to N60)**	**-**	**-**	**7900**	**-**	**13900**
13	N60 North of Proposed N5	11000	12300	16600	15600	20600
14	N60 South of Proposed N5	11000	12300	14400	15600	17100
15	**Proposed N5 (N60 to N5)**	**-**	**-**	**8900**	**-**	**13900**
16	N5 West of Turlough	13500	14600	17100	17100	21100
17	N58 South of Straide	4200	4400	6700	4000	6400
18	N5 West of Bohola	8000	8800	8900	11100	12500
19	N58 South of Foxford	6100	6500	6600	8000	8300
20	R321 South of Kiltimagh	3600	4000	1800	6200	4500

Appendix A
Zone Plans

Appendix B
Model Calibration/Validation

Appendix C
AADT Diagram