Cork County Council

Carrigaline TPREP

Local Area Model Calibration and Validation Report & Results

Issue | 19 July 2021

Job number 277833-00

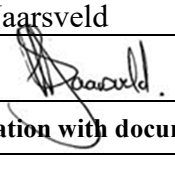
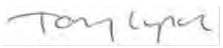
Ove Arup & Partners Ireland Ltd

Arup
50 Ringsend Road
Dublin 4
D04 T6X0
Ireland
www.arup.com

ARUP

Document verification

ARUP

Job title		Carrigaline TPREP			**Job number** 277833-00
Document title		Local Area Model Calibration and Validation Report & Results			**File reference**
Document ref					
Revision	**Date**	**Filename**	LAM Calibration and Validation Summary Report.docx		
Draft 1	8 June 2021	Description	First draft		
			Prepared by	Checked by	Approved by
		Name	Krissel Alcaraz Gerna Van Jaarsveld	Krissel Alcaraz Simon Van Jaarsveld	Tony Lynch
		Signature			
Draft 2	14 Jun 2021	Filename	LAM Calibration and Validation Summary Report Draft 2.docx		
		Description			
			Prepared by	Checked by	Approved by
		Name	Krissel Alcaraz; Gerna van Jaarsveld	Simon van Jaarsveld	Tony Lynch
		Signature			
Draft 3	8 Jul 2021	Filename	LAM Calibration and Validation Summary Report Draft 3.docx		
		Description			
			Prepared by	Checked by	Approved by
		Name	Krissel Alcaraz; Gerna van Jaarsveld	Simon van Jaarsveld	Tony Lynch
		Signature			
Issue	19 Jul 2021	Filename	LAM Calibration and Validation Summary Report1.docx		
		Description	Final Report		
			Prepared by	Checked by	Approved by
		Name	Krissel Alcaraz, Gerna van Jaarsveld	Simon van Jaarsveld	Tony Lynch
		Signature			
Issue Document verification with document					✓

Contents

Appendices

1 Introduction

1.1 Overview

The Carrigaline Transportation and Public Realm Enhancement Plan (TPREP) is an integrated transportation framework focused on addressing the transportation infrastructure and public realm enhancement required to support the sustainable development of the town.

Introducing sustainable modes of transport such as bus lanes, cycle lanes, wider footpaths and traffic restrictions has a traffic capacity impact as there are limited space available to provide additional infrastructure. Where there are space constraints, existing infrastructure had to be reconfigured to allow new infrastructure to be accommodated.

The Carrigaline TPREP developed eight high level transportation strategies. The objective of the transportation strategies was to create an environment where the dominance of vehicles is reduced within the heart of the town to make space for other modes of transport, to provide alternative routes for vehicles to take and to accommodate future development within Carrigaline in a sustainable way. These strategies were evaluated based on criteria set out in the Common Appraisal Framework for Transport Projects and Programmes published by the Department of Transport, Tourism and Sport. One of the criteria considered as part of this framework is the 'operational performance' of strategies.

A traffic model was developed to review the operational performance of the transportation strategies and helped to identify the preferred transportation strategy. The preferred strategy that emerged from the strategy evaluation was Transportation Strategy 7, which provides outer distributor roads to both east and west of the town and providing the required framework to allow for an upgrade of the streets within the centre of Carrigaline to accommodate greater access by active and sustainable travel modes. More detail can be obtained from the report 'Carrigaline TPREP Strategy Evaluation Report' on the process and outcome of the strategy evaluation that was carried out.

1.2 Purpose of the Report

This report describes the development of the Carrigaline Local Area Model (LAM), including detailed information on calibration and validation statistics. The Carrigaline LAM has been used to assess the robustness of junction designs and road network changes proposed as part of the Carrigaline Transportation and Public Realm Enhancement Plan (TPREP). This report provides an overview of the methodology used to generate forecast demand matrices for assignment in the Carrigaline LAM and also includes the results for the preferred strategy (Do Something) compared against a baseline and future Do Minimum scenario.

1.3 Report Structure

The remainder of the report is structured as follows:

- Chapter 2 – Road Network Development;
- Chapter 3 – Prior Trip Matrix Development;
- Chapter 4 - Model Calibration Process and Results;
- Chapter 5 – Validation;
- Chapter 6 – Future Year Model Development;
- Chapter 7 – Transport Model Results;
- Chapter 8 – Conclusion.

2 Transport Model Development

2.1 Introduction

The National Transport Authority's (NTA) South West Regional Model (SWRM) 2012 base year model was used for the purposes of developing the Carrigaline Local Area Model (LAM). Using this model as a base ensures that the LAM is consistent with the NTA model and robust in its assessment of transportation issues.

Traffic survey data that was collated for the area was utilised to calibrate and validate the base LAM for 2018 to ensure that it provides accurate representation of traffic flow in the study area. This was carried out in accordance with TII's Project Appraisal Guidelines, TII's Design Standards and international best team practise.

Future year Do Minimum and Do Something scenarios have been developed. This model was used for macro modelling and to provide input to detailed modelling of junctions using software such as LinSig and Junctions 9/10.

This section outlines the NTA regional modelling system and how the Carrigaline LAM was derived.

2.2 NTA Regional Modelling System

The NTA has developed a Regional Modelling System for the Republic of Ireland to assist in the appraisal for a wide range of potential future transport and land use options. The NTA Regional Modelling System comprises three main element including:

- The National Demand Forecasting Model (NDFM);
- Regional Models (including the SWRM); and
- A suite of Appraisal Modules.

The NDFM uses input attributes such as land-use data and population to estimate the total daily travel demand produced and attracted to each of the Census Small Areas in Ireland. In total there are 18,488 CSAs which are effectively operating as traffic zones in this model which can be used to produce a trip matrix.

South-West Regional Model (SWRM)

The Regional Models (RM) are focused on the travel to work areas of the major population centres of Dublin, Cork, Galway, Limerick and Waterford. There are five regional models as shown in **Figure 1**.

Source: SWRM Zone System Development Report, NTA

Figure 1: Regional Model Areas

The SWRM is a strategic multi-modal transport model representing travel by all the primary surface modes – including, walking and cycling (active modes), and travel by car, bus, rail, tram, light goods and heavy goods vehicles, and broadly covers the Munster province of Ireland including the counties of Cork and Kerry.

The SWRM includes the following key elements:

Trip End Integration: The Trip End Integration module converts the 24 hour trip ends output by the NDFM into the appropriate zone system and time period disaggregation for use in the Full Demand Model (FDM);

The Full Demand Model (FDM): The FDM processes travel demand, carries out mode and destination choice, and outputs origin-destination travel matrices to the assignment models. The FDM and assignment models run iteratively until an equilibrium between travel demand and the cost of travel is achieved; and

Assignment Models: The Road, Public Transport, and Active Modes assignment models receive the trip matrices produced by the FDM and assign them in their respective transport networks to determine route choice and the generalised cost for each origin and destination pair.

Destination and mode choice parameters within the SWRM have been calibrated using two main sources:

- Census 2011 Place of Work, School or College - Census of Anonymised Records (2011 POWSCAR), and
- The Irish National Household Travel Survey (2012 NHTS).

The NTA Regional Modelling System is a sophisticated modelling tool available for assessing complex multi modal transport movements within an urban context and provides a consistent framework for transport assessment.

The SWRM is the most appropriate tool to use as a basis for the development of a local area model and to estimate the multi-modal impact of transport schemes within the model area. In addition, it provides the platform to forecast future trip demand and distribution.

In order to generate prior matrices for the Carrigaline LAM, a cordon was extracted from a run of the SWRM.

2.3 Model Software Platform

The model software used is the SATURN (Simulation Assignment of Traffic to Urban Road Networks) suite of transportation modelling programs. SATURN is a suite of flexible network analysis programs developed at the Institute for Transport Studies, University of Leeds. Saturn can be used as a traffic assignment tool to show how traffic pattens change when new infrastructure is introduced in a network and can be used on local, regional and national level. It can also be used as a junction simulation model.

The Carrigaline LAM was developed using a cordon of the SWRM using the SATURN suite of programs (V11.4.07H).

2.4 Model Cordon Area

Carrigaline is a town with a population of approximately 16,000 people in 2016 CSO Census which covers a built-up area of around 5km^2 the town is located 8km to the south of Cork City with agricultural land segregating the two settlements. There are a number of regional routes that traverses Carrigaline from all directions. The cordon model area includes the built-up area of Carrigaline, the immediate lands to it and regional routes to it.

The cordon area of the model can be described as follows:

- the N28 to the north of the Shannonpark Roundabout as far as Carrs Hill;
- Church Road to the east up to Rheens East Industrial Estate;
- Kilmoney and Commeen to the south covering all built up area in this direction;
- To the west, the model includes Ballinrea Road, R613 Ballea Road, R611 and Forest Road.

In order to ensure that the model incorporated potential re-assignment of traffic, an initial evaluation of the impact of the schemes to be tested in this study was undertaken. This high-level test revealed areas in the model where re-assignment could take place. A sense check was undertaken to ensure that the re-assignment appeared logical and following this, the modelled area was confirmed.

A map of the model area is shown in **Figure 2** below.

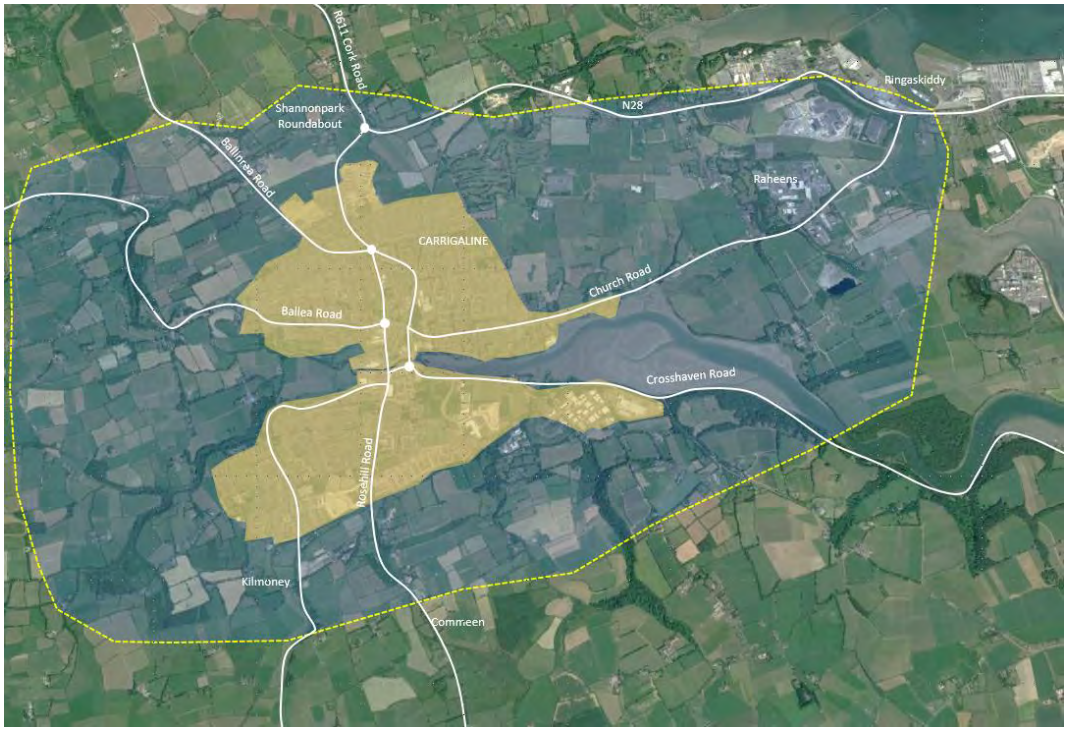


Figure 2: Carrigaline Model Area

2.5 Model Time Periods

Two time periods were considered for this peak hour model, chosen to be representative of the typical morning and evening peak travel patterns in Cork:

- AM peak hour (08:00 – 09:00);
- PM peak hour (17:00 – 18:00).

The above time-periods were used to correspond with the SWRM model.

2.6 User Classes

The 2018 trip demand matrices are consistent with the NTA SWRM which are the following:

- User Class 1 – Taxi;
- User Class 2 – Car Employer's Business;
- User Class 3 – Car Commute;
- User Class 4 – Car Education;
- User Class 5 – Car Other; User Class 6 – Light Goods Vehicles (LGV);
- User Class 7 – Other Goods Vehicle 1 (OGV1);
- User Class 8 – Other Goods Vehicle 2 (OGV2) Permit Holder; and
- User Class 9 – OGV2 Non Permit Holder.

2.7 Network Development

The existing SWRM has been used as the starting network for the Carrigaline LAM which incorporates the major road links within the town centre. The SWRM has been thoroughly checked to avoid missing any relevant road links within the model area.

Updates were made to the cordoned SWRM by disaggregating zones in Carrigaline. Connectors were used to connect centroids to the network and existing links were split to accommodate additional connectors.

A number of existing strategic links were added to the network in the study area that were not in the cordoned SWRM to provide a better representation of the traffic distribution in the model area:

- Ballea Hill between Ballea Road to Forest Road;
- Captain's Boreen between Ballea Hill and Kilmoney Road Lower;
- Ferney Road between Church Hill and Kilnagleary;
- Kilnaglery between R612 and Ferney Road;
- Fuschia Avenue between Rose Hill and Ferney Road; and
- The Green / Cedarwood Road / Laurelmount Drive between Waterpark and Fernhill Road.

Once the network and zoning system were refined, the Carrigaline LAM was calibrated initially to update the network attributes based on the observed traffic data illustrated in **Figure 4**, which is discussed in the next section.

3 Prior Matrix Development

3.1 Zone System Development

As the SWRM is primarily used for the purposes of regional scale strategic modelling, the cordoned model of SWRM was further refined to better reflect the local area of Carrigaline. The number of zones in the cordoned SWRM was 52, which was considered low for the purposes of the Carrigaline LAM. To develop a more representative zonal system that reflects land uses in refined detail, zones were disaggregated. The disaggregation process is discussed in this section.

Zones were generally disaggregated by matching traffic zone boundaries with CSO Population and Workplace Zone data.

Additionally, zones were further disaggregated to reflect singular land uses. For example, one zone covered a large expanse incorporating a hotel (Carrigaline Court Hotel) and a supermarket (Supervalu) with multiple car parking locations. This zone was disaggregated based on the car parks to ensure a more realistic spread of land use and associated traffic. Similarly, another zone covered Kilnaglery and Carrigaline Industrial Park and was disaggregated based on the car parks and accesses available to the car parks.

The disaggregation process outlined above resulted in the number of traffic zones to increase from 52 zones to 110, representing more refined traffic patterns associated with car parks and land uses.

Following the disaggregation process the trip matrix was updated. Traffic zones were numbered chronologically and internal and external zones were defined. Trip distribution patterns were assigned to new traffic zones created by identifying traffic zones with similar characteristics and applying the same parameters to it. Trip patterns were also verified and updated based on actual access locations onto the road network.

4 Model Calibration Process and Results

4.1 Introduction

The LAM network undertook a calibration process to ensure that the network and demand provide a robust assignment when compared with the observed traffic data. Adjustments in the network may involve updates of junction and links based on information available (such as aerial imagery, junction staging plans and local knowledge).

In terms of demand adjustments, trip distribution and trip generation/attraction may be adjusted which typically involves matrix estimation.

The Carrigaline LAM was calibrated and validated in accordance with Transport Infrastructure Ireland's (TII) Project Appraisal Guidelines (PAG) for National Roads Unit 5.1 – Construction of Transport Models (October 2016) and NTA's Regional Model Spec2 Model Specification Report version 2.0.17. Additionally, the LAM development has followed guidance from the UK's Department for Transport's (DfT) Transport Analysis Guidance (TAG) unit M3-1.

4.2 Traffic Survey Data

Due to the COVID-19 pandemic, new traffic counts and journey time surveys were unavailable for the purposes of calibrating and validating the Carrigaline LAM. Therefore, available historic traffic survey data was used for this purpose.

4.2.1 Manual Classified Turning Counts (MCC)

Historical Manual Classified Turning Count (MCC) were available at 12 sites in Carrigaline and are shown in **Figure 3** below. The counts were recorded on various dates including 1st April 2014, 14th Sept 2017 and 1st May 2018. These counts are a collection of data that was used for previous projects carried out within Carrigaline by Arup and Cork County Council including:

- Carrigaline Western Relief Road;
- Shannonpark Roundabout Upgrade;
- Janesville Residential Development;
- Bothar Guidel Upgrade Project.

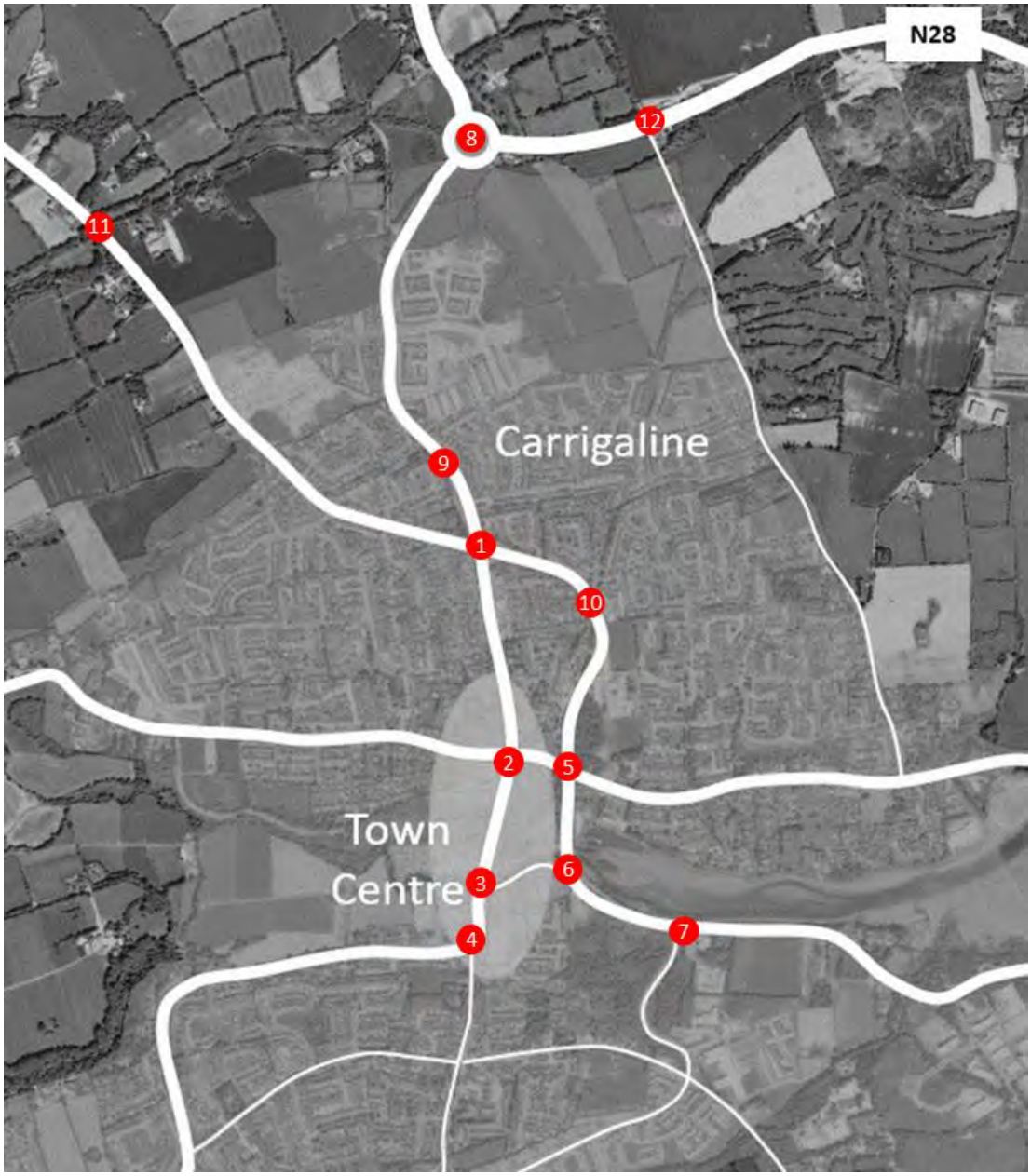


Figure 3: MCC Locations

Details of the survey locations for the purposes of Carrigaline LAM calibration are summarised in **Table 1** below.

Table 1: Traffic survey data locations

Site No.	Junction
1	Cork Road / Ashgrove Drive / Ballinrea Road
2	Main Street / Church Hill / Ballea Road
3	Main Street / R612 Crosshaven
4	Main Street / Kilmoney Road Lower / Church Hill
5	Cork Road / Bothar Guidel / Church Hill
6	Cork Road / R612 Crosshaven

7	R612 Crosshaven / Kilnagleary (to Ferney Road)
8	N28 Shannonpark Roundabout
9	Cork Road / Heron's Wood
10	Cork Road / Bridgemount
11	Ballinrea Cross
12	N28 / Fernhill Road

4.2.2 Journey Time Surveys

Best practice would require the surveying of journey times at the same time as traffic count surveys. Historic traffic count survey data for 2014, 2017 and 2018 were used, due to the impact of the pandemic on traffic patterns. In order to match these, various sources of journey time survey data, including historic data, had to be interrogated for the development of the model. These included the following:

- Tom Tom Journey Time data (2018);
- Google Maps Journey Time data (2021);
- Observed Journey Time Survey data (2006).

In order to match the inferred 2018 historical demand with equivalent journey time information, data for 2018 was obtained from TomTom. It should be noted that the data provided by Tom Tom only covers about 5% to 10% of all road users and also does not cover the exact time period of the traffic count survey data. The data were provided by Tom Tom for an average working day during the months September to November 2018.

In order to validate the use of this limited data set, the Tom Tom data set was then compared to journey time data extracted from Google Maps. The estimated minimum and maximum ranges of journey times were extracted from Google Maps for both the AM and PM peak hour for a Wednesday in 2021.

When compared, it was found that the Tom Tom data set was between 16% and 51% slower than the maximum journey time range estimated by Google Maps in the AM peak hour. For the PM peak hour, the Tom Tom data set was not consistently faster or slower than the journey time ranges estimated by Google Maps, but in most cases, did not fall within the range estimated by Google Maps.

These discrepancies raised concerns over the accuracy of the Tom Tom data set.

As an additional check, a 2006 observed journey time survey data set that was used in the development of a 2007 model for Carrigaline, was interrogated. The 2021 Google Maps data set was compared to this 2006 observed data set. It was found that in all of the cases the 2006 observed data set were much faster than the minimum limit of the estimated Google Maps journey time range.

In conclusion it was found that the 2018 Tom Tom data set was slower than the 2021 Google Maps data set in the AM peak hour and the 2006 observed data set was faster than the 2021 Google Maps data set in both the AM and PM peak hour.

Given this comparison, and the challenges posed, the model validation process was proceeded based on the 2021 Google Maps data set, which provides an estimated minimum and maximum range of journey times.

4.3 Network Calibration Steps

Steps were undertaken to calibrate the 2018 base year model to ensure they were generally in line with survey information and are the following:

- Updated basic network information such as posted speed, link length and junction configuration;
- Checking routes within the network through screen line cordons that surround the town centre; and
- Undertaking matrix estimation to refine the prior matrix to best fit the observed traffic survey flows.

As the Carrigaline LAM was coded based on best practice approaches developed during the NTA Regional Model Scoping Process, the model provided an accurate and up-to date representation of the existing road network. If required however, the following network model parameters were adjusted if there was clear reason for doing so, such as:

- Junction type and layout;
- Link lengths;
- Signal staging and timings;
- Link posted / free flow speed;
- Junction and link saturation flows;
- Banned turns; and
- Zone loading.

It should be noted that the observed traffic flows used in the calibration process were kept independent of observed link flows reserved for validation purposes.

4.4 Trip Demand Adjustment (Matrix Estimation)

Due to the prior matrix being extracted from the 2012 SWRM cordon, adjustments were made in order to extrapolate the existing matrix for the purposes of calibrating the 2018 Carrigaline LAM. As shown in **Figure 3**, the historic traffic count data form a cordon of the town and therefore, it was possible to use this data to uplift the 2012 prior matrix to best match the counts. The initial matrix estimation process was undertaken through the use of scaling the select link matrices to significantly improve the match between observed and modelled flows, and not introduce more trips into a zone than could realistically be expected.

Finally, once the initial scaling of the prior matrix was exhausted, Matrix Estimation (ME) in SATURN was used to develop the base year model matrices by making minor adjustments to the demand based on observed traffic flows. The ME process iteratively computes a best fit matrix based on the prior matrix and the selection of observed traffic flows inputted.

The matrix estimation process was constrained using the SATURN parameter XAMAX, limiting the permitted amount of change to link flow on each O-D pair. The XAMAX set for cars, LGVs and HGVs in both AM and PM peaks were set to 2.

4.5 Traffic Flow Calibration Results (Prior ME Calibration)

Figure 4 below shows the calibration and validation locations for both links and screen lines that was used in the Carrigaline LAM.

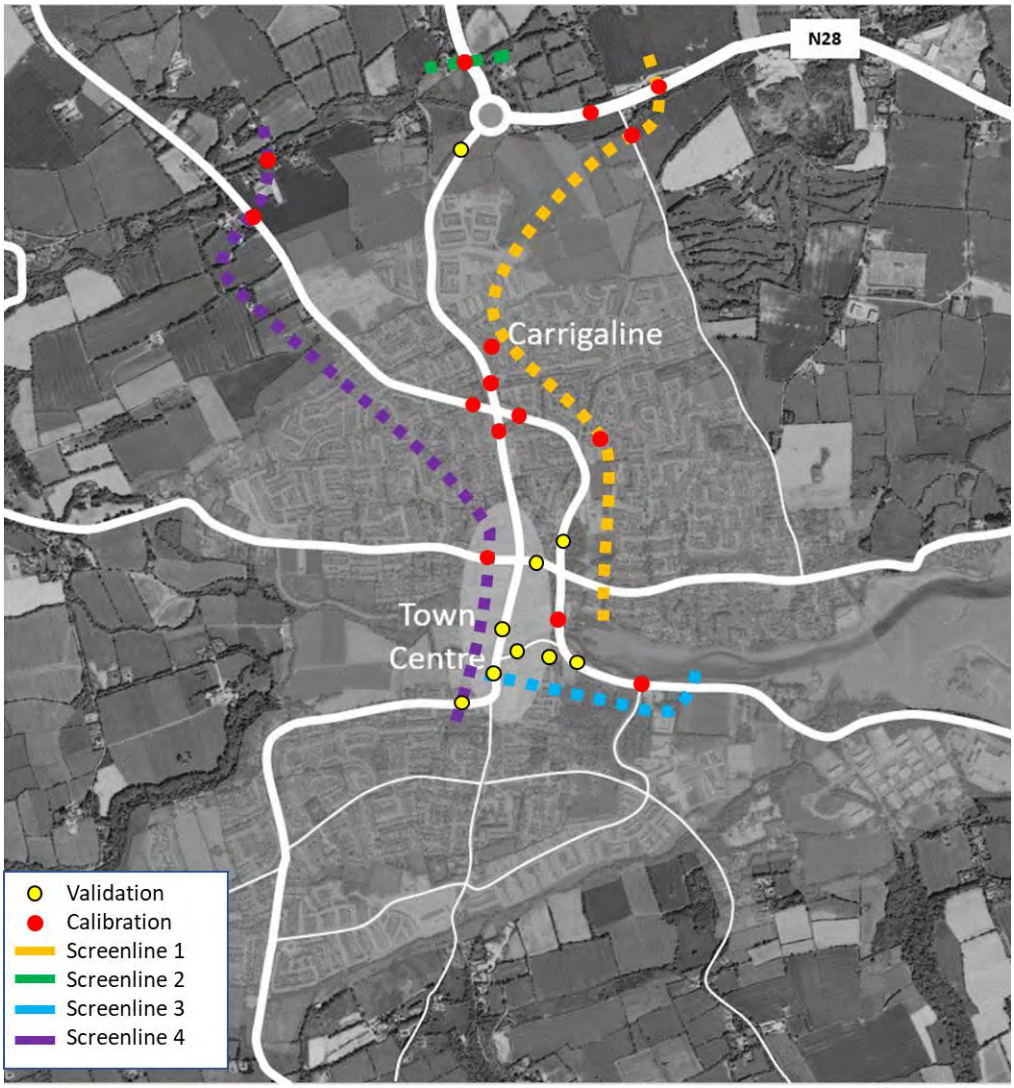


Figure 4: Carrigaline LAM calibration and validation link and screen line locations

Table 2 to **Table 9** summarises the performance of the model with the prior matrices in comparison with the observed individual link flows. The results show that the prior matrices for cars do not satisfy the criteria and therefore requires matrix estimation in order to have a better representation of observed traffic data. The prior matrices for both LGV and HGV in both peaks appear to perform better and generally meet the calibration criteria.

Table 2: Individual Link Flow - Prior ME Summary – Car – AM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	28	17	61%	Fail
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	6	2	33%	Fail
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	34	16	47%	Fail

Table 3: Individual Link Flow - Prior ME Summary – LGV - AM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	34	34	100%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	0	0	0%	N/A
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	34	34	100%	Pass

Table 4: Individual Link Flow - Prior ME Summary – HGV - AM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	34	34	100%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	0	0	0%	N/A
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A

GEH <5 for individual flows	> 85% of cases	34	34	100%	Pass

Table 5: Individual Link Flow - Prior ME Summary – All Vehicles – AM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	27	11	63%	Fail
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	7	2	29%	Fail
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	34	16	47%	Fail

Table 6: Individual Link Flow - Prior ME Summary – Car – PM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	28	11	39%	Fail
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	6	0	0%	Fail
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	34	8	24%	Fail

Table 7: Individual Link Flow - Prior ME Summary – LGV - PM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	34	33	97%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	0	0	0%	N/A
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	34	33	97%	Pass

Table 8: Individual Link Flow - Prior ME Summary – HGV - PM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	34	34	100%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	0	0	0%	N/A
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	34	34	100%	Pass

Table 9: Individual Link Flow - Prior ME Summary – All Vehicles – PM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	27	11	41%	Fail
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	7	1	14%	Fail
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	34	9	26%	Fail

Table 10 and **Table 11** summarises the screen line flow calibration in both AM and PM peaks for the combined vehicle classes. Both show the majority do not satisfy both the flow and GEH criteria, with the exception of screen lines 2 (northbound), 3 (northbound) and 4 (westbound) in the AM peak, which meet the criteria. The results show that the screen lines do not perform well in the PM peak, with all screen lines being above the flow criteria of +/-5% and the majority being above GEH of 5.

Table 10: Screen line Results - Prior ME - Total Vehicles - AM Peak

Screen line	Direction	Observed (veh)	Modelled (veh)	Difference (Observed-Modelled)	Diff %	GEH	Flow Pass	GEH Pass
1	EB	2132	1646	486	23%	11.5	Fail	Fail
	WB	1471	1017	454	31%	13.2	Fail	Fail
2	NB	1,042	1,035	7	1%	0.2	Pass	Pass
	SB	1,358	1,127	231	17%	6.8	Fail	Fail
3	NB	917	898	19	2%	0.6	Pass	Pass

	SB	852	627	225	26%	8.5	Fail	Fail
4	EB	1386	981	405	29%	12.0	Fail	Fail
	WB	1131	1132	-1	0%	0.0	Pass	Pass

Table 11: Screen line Results - Prior ME - Total Vehicles - PM Peak

Screen line	Direction	Observed (veh)	Modelled (veh)	Difference (Observed-Modelled)	Diff %	GEH	Flow Pass	GEH Pass
1	EB	1325	699	626	47%	20.2	Fail	Fail
	WB	1931	1183	748	39%	19.4	Fail	Fail
2	NB	1,252	930	322	26%	10.0	Fail	Fail
	SB	1,409	1,280	129	9%	3.6	Fail	Pass
3	NB	901	559	342	38%	13.1	Fail	Fail
	SB	1239	911	328	26%	10.2	Fail	Fail
4	EB	1511	894	618	41%	18.2	Fail	Fail
	WB	1276	962	314	25%	9.6	Fail	Fail

4.6 Traffic Flow Calibration Results (Post ME Calibration)

Table 12 to **Table 19** summarises the individual link flow calibration (post ME) in both AM and PM peaks for car, LGV and HGV. The results show that once ME was undertaken, the model in both AM and PM peaks are well within the TAG criteria.

Table 12: Individual Link Flow - Post ME Summary – Car – AM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	28	27	96%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	6	4	67%	Fail
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	34	31	91%	Pass

Table 13: Individual Link Flow - Post ME Summary – LGV - AM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	34	34	100%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	0	0	0%	N/A
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	34	34	100%	Pass

Table 14: Individual Link Flow - Post ME Summary – HGV - AM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	34	33	97%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	0	0	0%	N/A
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	34	34	100%	Pass

Table 15: Individual Link Flow - Post ME Summary – All Vehicles - AM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	27	36	96%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	7	5	71%	Fail
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	34	30	88%	Pass

Table 16: Individual Link Flow - Post ME Summary – Car – PM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	28	28	100%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	6	6	100%	Pass
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	34	33	97%	Pass

Table 17: Individual Link Flow - Post ME Summary – LGV - PM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	34	34	100%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	0	0	0%	N/A
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	34	34	100%	Pass

Table 18: Individual Link Flow - Post ME Summary – HGV - PM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	34	34	100%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	0	0	0%	N/A
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	34	34	100%	Pass

Table 19: Individual Link Flow - Post ME Summary – All Vehicles - PM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	27	27	100%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	7	7	100%	Pass
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	34	33	97%	Pass

Table 20 and **Table 21** summarises the screen line flow calibration in both AM and PM peaks for the combined vehicle classes. Both show that almost all of the screen lines satisfied both the flow and GEH criteria, with the exception of screen lines 1 (westbound) and 4 (westbound) in the AM peak. However, this was deemed acceptable since they are both well within the GEH criteria, albeit just above the flow criteria of +/-5%.

Table 20: Screen line Results - Post ME - Total Vehicles - AM Peak

Screen line	Direction	Observed (veh)	Modelled (veh)	Difference (Observed-Modelled)	Diff %	GEH	Flow Pass	GEH Pass
1	EB	2,132	2076	56	3%	1.2	Pass	Pass
	WB	1,471	1,581	-110	-7%	2.9	Fail	Pass
2	NB	1,042	1,086	-44	-4%	1.4	Pass	Pass
	SB	1,358	1,407	-49	-4%	1.3	Pass	Pass
3	NB	917	938	-21	-2%	0.7	Pass	Pass
	SB	852	834	18	2%	0.6	Pass	Pass
4	EB	1386	1416	-30	-2%	0.8	Pass	Pass
	WB	1131	1193	-62	-6%	1.9	Fail	Pass

Table 21: Screen line Results - Post ME - Total Vehicles - PM Peak

Screen line	Direction	Observed (veh)	Modelled (veh)	Difference (Observed-Modelled)	Diff %	GEH	Flow Pass	GEH Pass
1	EB	1325	1353	-28	-2%	0.8	Pass	Pass
	WB	1931	1869	62	3%	1.5	Pass	Pass
2	NB	1,252	1,260	-8	-1%	0.2	Pass	Pass
	SB	1,409	1,449	-40	-3%	1.1	Pass	Pass
3	NB	901	919	-18	-2%	0.6	Pass	Pass

	SB	1239	1226	13	1%	0.4	Pass	Pass
4	EB	1511	1557	-46	-3%	1.2	Pass	Pass
	WB	1276	1344	-68	-5%	1.9	Pass	Pass

4.7 Analysis of Trip Matrix Changes

Matrix Estimation (ME) was undertaken to adjust the prior matrix to best fit the observed traffic flows. Therefore, it is important to analyse the impact of the matrix estimation between the prior and post ME matrices to understand if there are any anomalies with trip patterns.

Table 7.1 of the Regional Model Specification Report states the matrix estimation change criteria, which is specified from TAG Unit M3-1. This is shown in Table 22 below.

Table 22: Matrix Estimation Criteria

Measure	Significance Criteria
Matrix zonal cell values	Slope within 0.98 and 1.02; Intercept near zero; R^2 in excess of 0.95.
Matrix zonal trip ends	Slope within 0.99 and 1.01; Intercept near zero; R^2 in excess of 0.98.

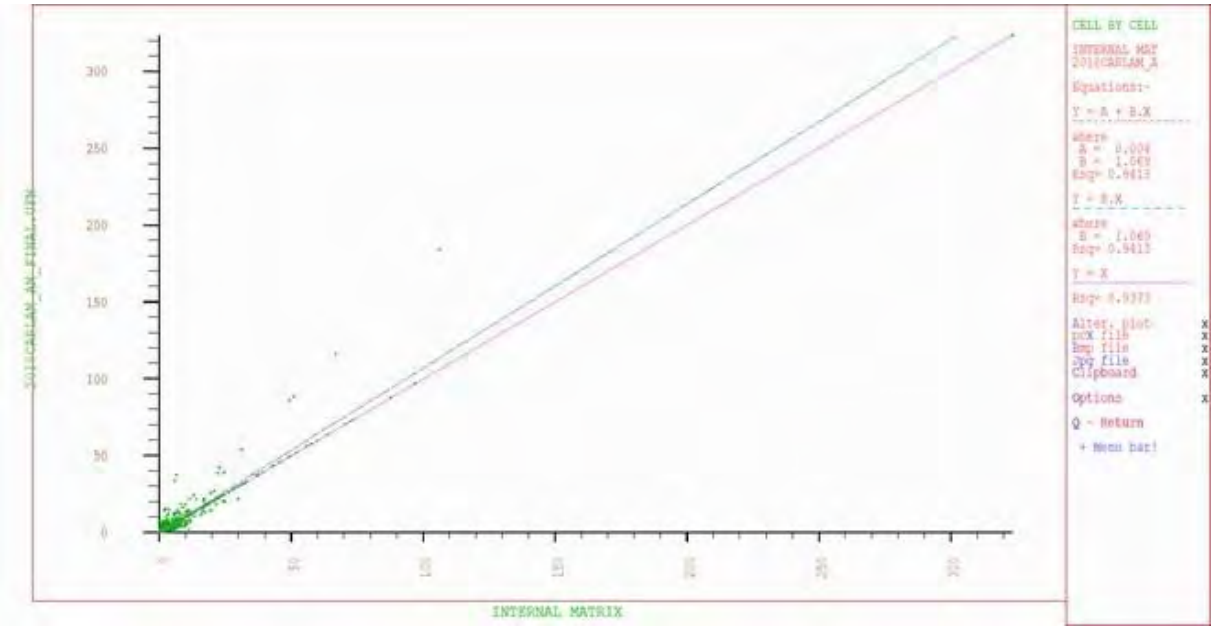


Figure 5: Regression Analysis of Zonal Cell Values – AM Peak Hour

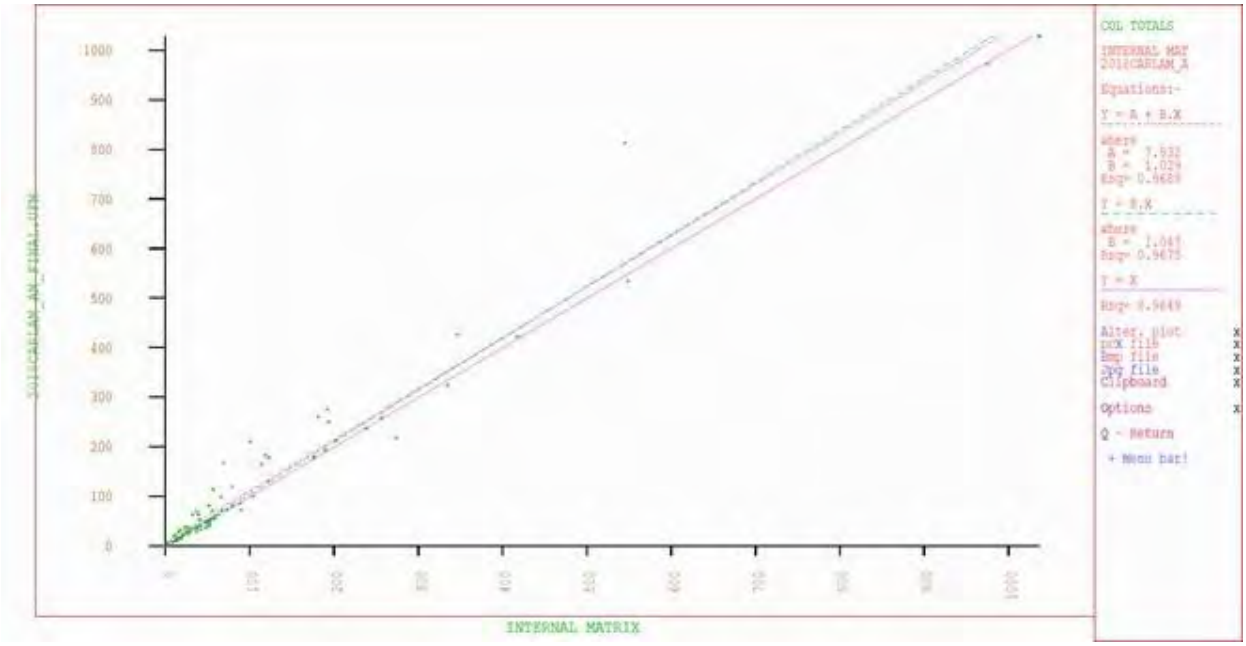


Figure 6: Regression Analyses of Zonal Trip Ends (Attractions) – AM Peak Hour

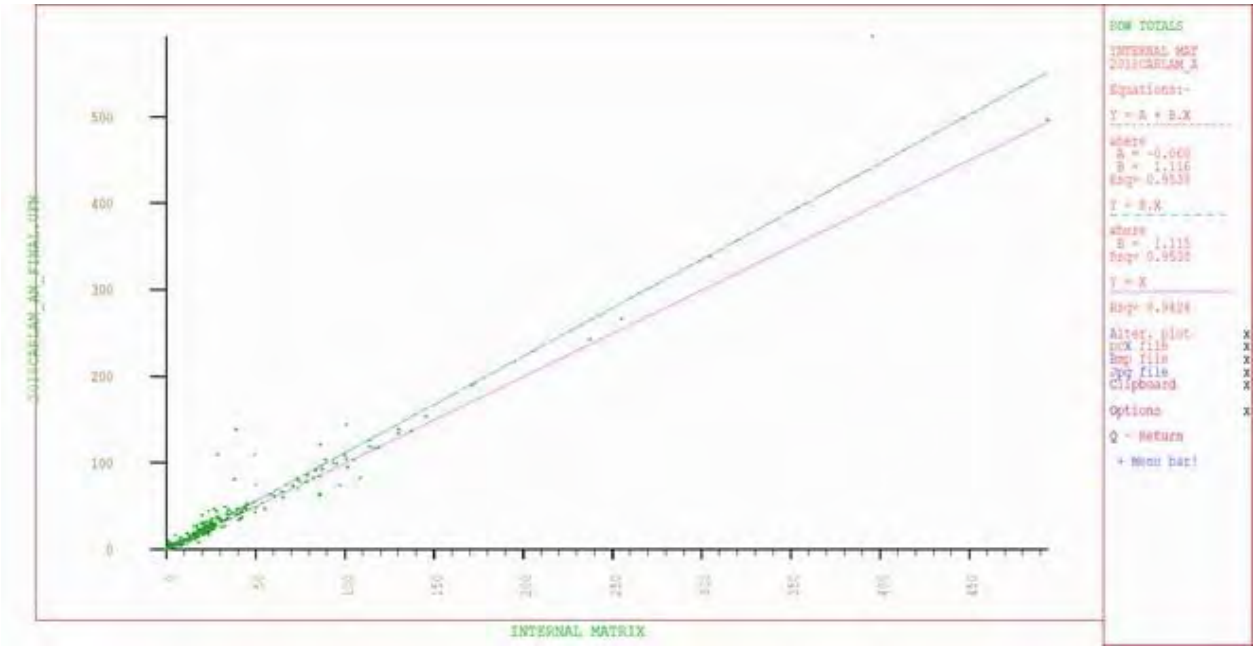


Figure 7: Regression Analyses of Zonal Trip Ends (Productions) – AM Peak Hour

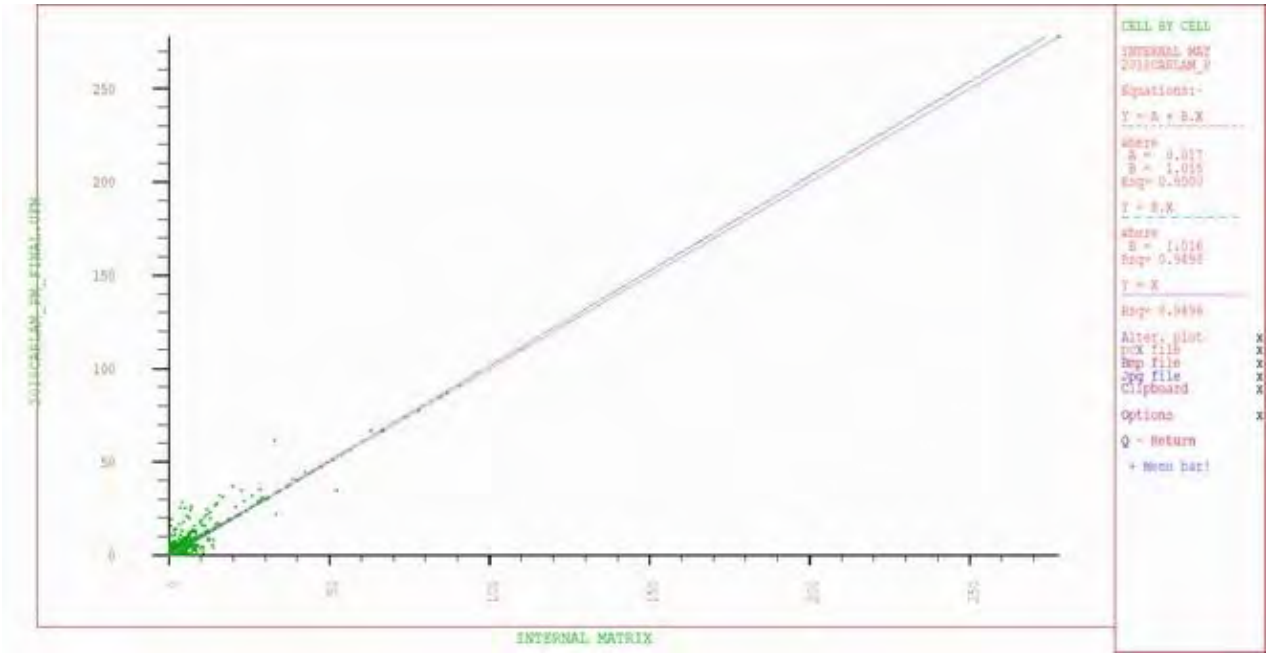


Figure 8: Regression Analysis of Zonal Cell Values – PM Peak Hour

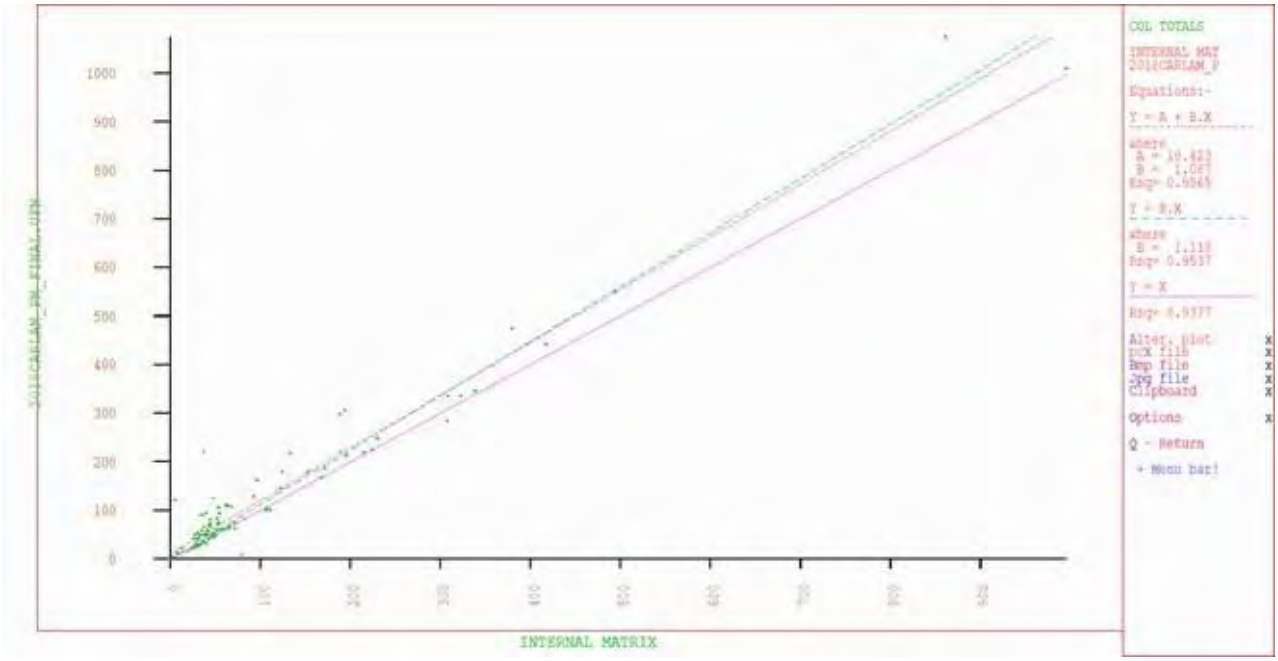


Figure 9: Regression Analyses of Zonal Trip Ends (Attractions) – PM Peak Hour

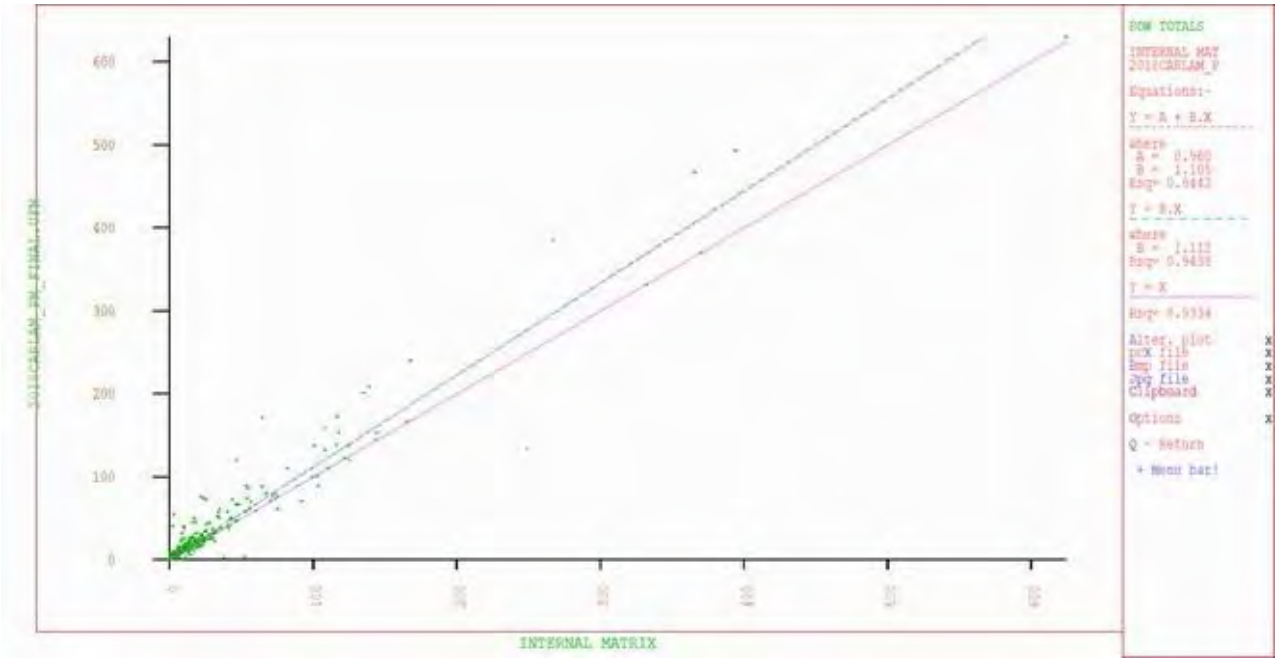


Figure 10: Regression Analyses of Zonal Trip Ends (Productions) – PM Peak Hour

Table 23: AM Peak Hour Matrix Changes Summary

AM	Intercept (A)	Pass	Slope (B)	Pass	RSQ	Pass
Cells	0.04	Y	1.069	Y	0.9413	N
Rows	-0.06	Y	1.116	N	0.9538	N
Columns	7.932	Y	1.029	N	0.9688	N

Table 24: PM Peak Hour Matrix Changes Summary

PM	Intercept (A)	Pass	Slope (B)	Pass	RSQ	Pass
Cells	0.017	Y	1.015	Y	0.95	Y
Rows	0.96	Y	1.105	N	0.9442	N
Columns	10.423	Y	1.087	Y	0.9565	N

The above analysis as per Figure 5 to Figure 10 and Table 23 and Table 24 shows that changes were made to the 2012 prior matrices to match 2018 observed traffic flow data. The initial assignment of the 2012 prior matrices did not match the observed 2018 traffic flow data. The calibration process required a number of changes to be made to take account of longer distance trips specifically.

4.8 Trip Length Distribution Analysis

Trip length distribution analysis is recommended by the TII guidance to understand the difference between the trip length distribution between prior and post ME matrices. This comparison can be undertaken using the coincidence ratio, which is defined in the TII guidance as:

$$CR = \frac{\sum\{\text{Min}(TLDs, TLDf)\}}{\sum\{\text{Max}(TLDs, TLDf)\}}$$

Where TLDs is the source trip length frequency and TLDf is the final trip length frequency. A desirable range for the coincidence ratio is between 0.7 and 1.0 where a ratio of 1.0 suggests an identical distribution.

The coincidence factor found for the AM peak hour is 0.89 and for the PM peak hour is 0.84, and this therefore indicates that no dramatic changes were introduced to the assumed trip length frequencies.

Figure 11 and Figure 12 below show a comparison between the trips from the 2012 prior matrices (in red) and the trips from the 2018 calibrated matrix (in green outline) in 1 kilometre bins (on the x axis).

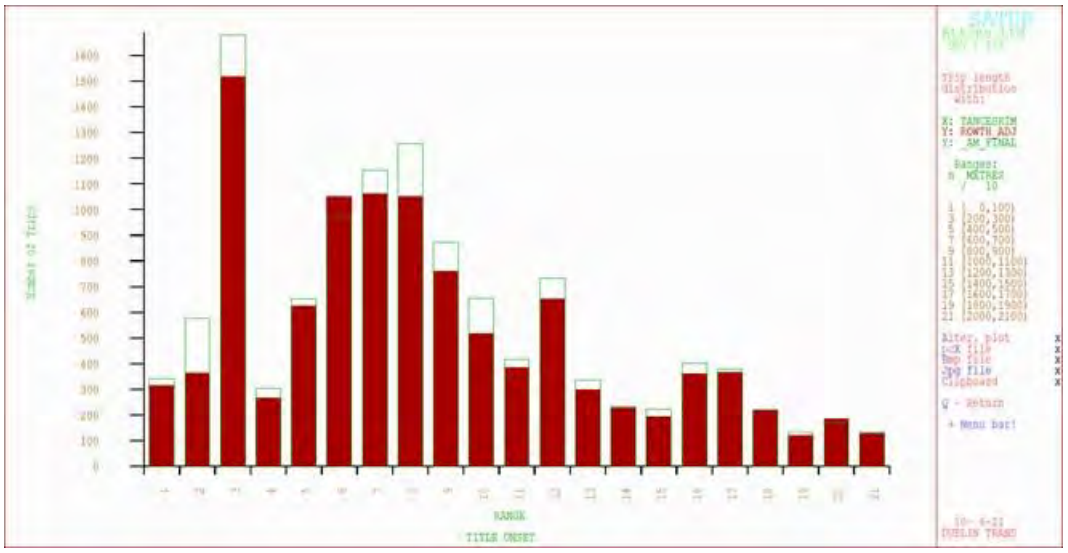


Figure 11: Trip length frequency comparison – AM Peak Hour

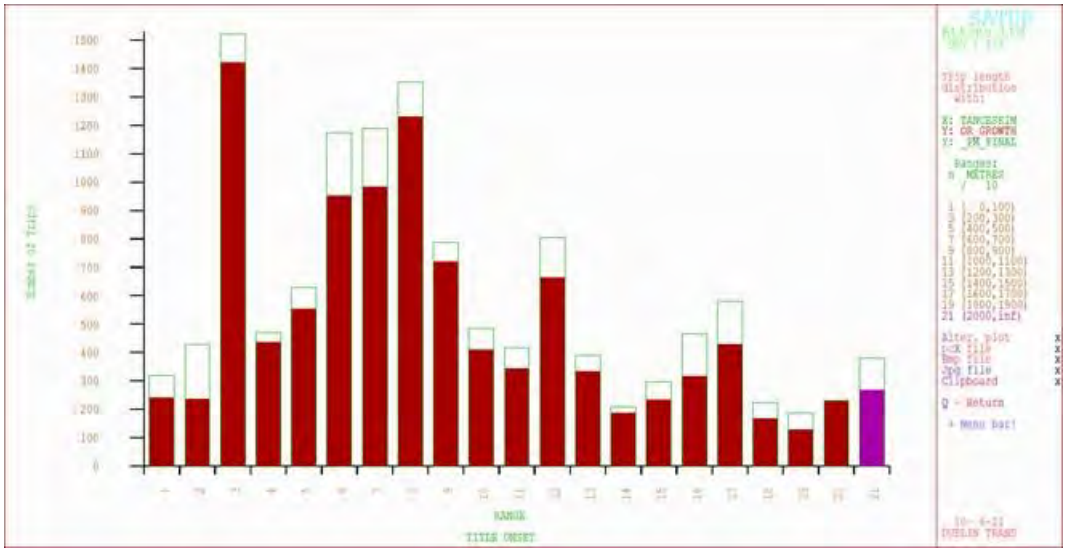


Figure 12: Trip length frequency comparison – PM Peak Hour

4.9 Calibration Summary

In order for the Carrigaline LAM to better reflect the traffic survey data, calibration of the network and prior matrices were undertaken. The results are summarised below:

- Network edits were initially undertaken to better reflect the existing situation in Carrigaline, as well as to better reflect the traffic survey data;
- Once all network edits were exhausted, the matrices were adjusted through scaling and using SATURN's ME application to best match the traffic survey data;
- The results show that the model calibrates within the TII and TAG criteria in terms of individual link flows and GEH;
- The screen line results show that the model calibrates well within the TII and TAG criteria and therefore provides a robust representation of traffic travelling in and out of the Carrigaline LAM area;
- The analysis of trip matrix changes shows that a number of changes had to be made to the 2012 cordon matrix (prior) to achieve an acceptable 2018 calibrated cordon matrix that is representative of observed traffic flows and journey times on the network;
- The trip length frequency distribution analysis shows that no dramatic changes were introduced to the assumed trip length frequencies as a result of the calibration and matrix estimation process.

5 Validation

5.1 Introduction

For the purposes of validating the Carrigaline LAM, the individual observed link flows were compared against modelled flows to ensure that the distribution of traffic in the model is robust. Additionally, journey time routes were also validated against Project Assessment Guidelines (PAG), where more than 85% of routes should have modelled times "within 15% of surveyed times (or 1 minute, if higher than 15%)".

5.2 Link Flow Validation

It should be noted that the model was validated against link flows as the individual link flows that were used for screen lines were used for the purposes of calibrating the model. As discussed in Section 4.4, the historic traffic count data form a cordon of the town and therefore, it was possible to use this data to uplift the 2012 prior matrix to best match the counts.

Table 25 to Table 32 summarises the individual link flow validation in both AM and PM peaks for car, LGV, HGV and all vehicles. The results show that the model generally meets the TAG guidelines in both AM and PM peaks.

Table 25: Individual Link Flow Validation – Car – AM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	17	16	94%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	1	1	100%	Pass
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	18	17	94%	Pass

Table 26: Individual Link Flow Validation – LGV - AM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	18	18	100%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	0	0	0%	N/A

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	18	18	100%	Pass

Table 27: Individual Link Flow Validation – HGV - AM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	18	18	100%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	0	0	0%	N/A
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	18	18	100%	Pass

Table 28: Individual Link Flow Validation – All Vehicles - AM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	15	14	93%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	3	3	100%	Pass
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	18	16	89%	Pass

Table 29: Individual Link Flow Validation – Car – PM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	15	13	87%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	3	3	100%	Pass

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	18	16	89%	Pass

Table 30: Individual Link Flow Validation – LGV - PM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	18	18	100%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	0	0	0%	N/A
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	18	18	100%	Pass

Table 31: Individual Link Flow Validation – HGV - PM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	18	18	100%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	0	0	0%	N/A
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	18	18	100%	Pass

Table 32: Individual Link Flow Validation – All Vehicles - PM Peak

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 100 veh/h of counts for flows less than 700 veh/h	> 85% of cases	14	12	86%	Pass
Individual flows within 15% of counts for flows from 700 to 2,700 veh/h	> 85% of cases	4	4	100%	Pass

Criteria	Acceptable Guideline	No. of sites	Passed	%	Pass/Fail
Individual flows within 400 veh/h of counts for flows more than 2,700 veh/h	> 85% of cases	0	0	0%	N/A
GEH <5 for individual flows	> 85% of cases	18	16	89%	Pass

5.3 Journey Time Validation

The journey time data was compared to modelled journey times. The assessment is based on the criteria as stipulated by TII that modelled journey times should be within 15% of observed journey times, or 1 minute if higher than 15%.

Table 33: Journey Time Validation Summary – AM peak hour

Route	Description	Direction	Google Maps	Modelled Times	Difference	% Difference	Pass (Google Maps)
1	Cork Road	SB	300 - 480	371	-354	-49%	Y
1	Cork Road	NB	300 - 480	373	-348	-48%	Y
2	R613	SB	480 - 600	623	-205	-25%	Y
2	R613	NB	480 - 600	538	-182	-25%	Y
3	Ballinrea Road, Cork Road, R612	SB	360 - 600	550	7	1%	Y
3	Ballinrea Road, Cork Road, R612	NB	360 - 540	559	105	23%	Y
4	Ballinrea Road, R611, N28	EB	480 - 840	668	-70	-10%	Y
4	Ballinrea Road, R611, N28	WB	420 - 540	362	-264	-42%	Y

Table 34: Journey Time Validation Summary – PM peak hour

Route	Description	Direction	Google Maps	Modelled Times	Difference	% Difference	Pass (Google Maps)
1	Cork Road	SB	420 - 720	459	-146	-24%	Y
1	Cork Road	NB	360 - 600	401	-65	-14%	Y
2	R613	SB	480 - 600	533	-189	-26%	Y
2	R613	NB	480 - 720	600	-257	-30%	Y
3	Ballinrea Road, Cork Road, R612	SB	420 - 720	556	269	93%	Y
3	Ballinrea Road, Cork Road, R612	NB	420 - 720	570	377	195%	Y
4	Ballinrea Road, R611, N28	EB	480 - 600	469	-128	-21%	Y
4	Ballinrea Road, R611, N28	WB	420 - 720	492	-15	-3%	Y

It was found that the modelled times fell within the range indicated by the Google Maps journey time data, or within 1 minute of the upper or lower limit indicated by the Google Maps journey time data.

5.4 Calibration and Validation Summary

To summarise, the Carrigaline LAM used a cordon of NTA's South West Regional Model and the network and zonal system were refined to better reflect the local traffic. Due to the COVID-19 pandemic, the latest traffic survey data including commissioned traffic counts were unable to be collated for the purposes of calibrating and validating the LAM. Therefore, available historic traffic survey data were used for the purposes of calibration and validation of the Carrigaline LAM.

The Carrigaline LAM was calibrated and validated in accordance with Transport Infrastructure Ireland's (TII) Project Appraisal Guidelines (PAG) for National Roads Unit 5.1 – Construction of Transport Models (October 2016) and NTA's Regional Model Spec2 Model Specification Report version 2.0.17. Additionally, the LAM development has followed guidance from the UK's Department for Transport's (DfT) Transport Analysis Guidance (TAG) unit M3-1.

The calibration and validation results indicate that the model is robust and therefore can be used for the purposes of forecast transport scheme improvements and/or developments.

6 Forecast Model Development

6.1 Literature Review

The most recent relevant strategic planning and modelling for the Carrigaline Study area was done as part of the CMATS project. The principle of the forecast modelling was therefore based on utilising the demand and supply assumptions from the CMATS project.

The following reports were reviewed:

- National Demand Forecasting Model (NDFM) Development Report, NTA, July 2015;
- South West Regional Model (SWRM) Full Demand Model Calibration Report, NTA, 2015/2016;
- South West Regional Model Zone System Development Report, NTA, 2015/2016;
- South West Regional Model Road Model Development Report, NTA, April 2016;
- South West Regional Model Public Transport Assignment Model Development Report, NTA, April 2016;
- Cork Planning Datasheet 2036 Baseline - Tech Note v4.1, NTA, June 2017
- Cork Metropolitan Area Transport Strategy (CMATS) Demand Analysis Report, NTA, September 2017;
- Cork Metropolitan Area Transport Strategy Transport Modelling Assessment Report, NTA, September 2018.

6.2 Demand assumptions

For the CMATS project Cork County Council worked with the NTA to update the standard forecast base from a 2011 base to a 2016 base. As part of the CMATS project, the standard forecast for the CMATS model was updated from a 2035 forecast to a 2040 forecast and took into account the National Planning Framework 2040.

This latest forecast planning sheet is available from the NTA on a national level for each of the 18 488 Census Small Areas (CSA). The fields in the planning sheet relate to demographic information for population, employment, education and age. The forecast planning sheet is used in the NTA's NDFM component of the NTA's strategic modelling suite.

The proposed strategic services and infrastructure as per CMATS will reduce road based demand in the larger SWRM area by 3% - 5% and between 4% and 7% in the Carrigaline study area, as shown in the table below.

Table 35: Road Based Demand / Mode Choice Impact of CMATS

Peak Hour	**2012 SWRM Matrix (792 Zones)**	**2040 SWRM Matrix (792 Zones)**		**Reduction in road based demand**
		CMATS Do Minimum	CMATS Do Something with Supporting Infrastructure	
AM Peak Hour	130 705	176 796	171 532	3%
PM Peak Hour	113 887	158 888	151 359	5%
Peak Hour	**2012 Cordon Matrix (52 Zones)**	**2040 Cordon Matrix (59 Zones)**		**Reduction in road based demand**
		CMATS Do Minimum	CMATS Do Something with Supporting Infrastructure	
AM Peak Hour	10 453	13 260	12 715	4%
PM Peak Hour	10 183	13 812	12 796	7%

6.3 Strategic services and infrastructure assumptions

Based on the CMATS Modelling Assessment Report, NTA, September 2018 three forecast scenarios were developed for the CMATS project:

- Do Minimum;
- Do Strategy; and
- Do Strategy with supporting measures.

The NTA confirmed that the Do Strategy with Supporting Measures was the agreed planning scenario going forward.

In terms of Carrigaline this mainly includes:

- Primary and secondary cycle network proposals;
- M28 Cork to Ringaskiddy; and
- BusConnects Carrigaline to Cork City Centre.

6.4 Local Area Model Forecast Development

The CMATS Do Strategy with Supporting Measures scenario and the latest 2040 planning sheet data was utilised to produce an updated SWRM road based demand output. From this strategic model a cordoned demand matrix was extracted for the Carrigaline study area – referred to as the 2040 cordon matrix (prior). This matrix represents the final road-based traffic assignment, taking into account any travel behaviour choice effects (mode, route, destination, time of day effects as a result of the CMATS interventions.

The 2040 cordon matrix (prior) consists of 59 zones compared to the 2018 calibrated cordon matrix of the same area, which consists of only 52 zones.

This is mainly due to the introduction of the new M28 road and supporting road links. The additional 7 zones were therefore added to the 2018 calibrated cordon matrix.

The relative calibration effects that were introduced when the 2012 cordon matrix (prior) was used to develop the 2018 calibrated cordon matrix, had to be incorporated into the forecast matrix development.

The first step was to factorise the 2040 cordon matrix (prior) with the growth factors derived from the comparison of the 2018 calibrated cordon matrix vs the 2012 cordon matrix (prior). This resulted in an initial forecast matrix referred to as the 2040 calibrated cordon matrix.

As a second step, the 2040 calibrated cordon matrix was then further enhanced by making the following adjustments:

- A check was introduced to ensure residential zones within Carrigaline were capped to 2018 levels to restrict growth to/from these zones in the future.
- The Fernhill Extension area was incorporated assuming Scenario 2 from the following information:

Table 36: Fernhill Extension Area Vehicle Trip Generation of External Trips

Land Use	**AM Peak**		**PM Peak**	
	In	Out	In	Out
Scenario 1	173	533	426	192
Scenario 2	250	330	268	228

Figure 13: Fernhill Extension Area Trip Distribution

Thirdly, as a final check, some minor adjustments were made to intra-zonal trips to ensure the matrix totals matched those of the original 2040 calibrated cordon matrix. This ensured no unwanted increases or decreases in car mode share had been introduced through the process.

Table 39 presents the projected matrix totals comparing the Cordon Matrix obtained from the Southwestern Regional Road including the strategy measures as noted in the Cork Metropolitan Area Strategy to those included for within the calibrated cordon matrix representing the local area model.

Table 37: Forecast Matric Development - Matrix Totals

Total PCUs	**2012 Cordon Matrix (Prior) (52 Zones)**	**2040 Cordon Matrix (Prior) (59 Zones)**	**Growth per year**
AM Peak Hour	10 453	12 715	0.7%
PM Peak Hour	10 183	12 796	0.82%
Total PCUs	**2018 Calibrated Cordon Matrix (117 Zones)**	**2040 Calibrated Cordon Matrix (117 Zones)**	**Growth per year**
AM Peak Hour	11 946	14 047	0.74%
PM Peak Hour	12 536	15 247	0.89%

The above table has identified an approximate 20% increase in vehicular movements within the Carrigaline area up to the 2040 Forecast Matrix. This coupled with a 16% percent increase in active and sustainable travel trips within the town will cater for an increased population in the range of 26,000 persons with between 3,500 -4,000 persons catered for within the Fernhill Expansion area identified to the north east of Carrigaline.

For the Do Something scenario, it was assumed that car mode share in Carrigaline town would reduce by 15%. This calculation was based on using the old jurisdiction of Cork City's mode share from Census data as the target for Carrigaline, with the adjustment in car mode share primarily focused on school trips rather than work trips. Therefore, this has been incorporated in the matrices used in the LAM for the 2040 Do Something TS7 scenario. It should be noted that the 15% reduction in car trips was only applied in internal trips within Carrigaline, as shown in **Figure 14** below.

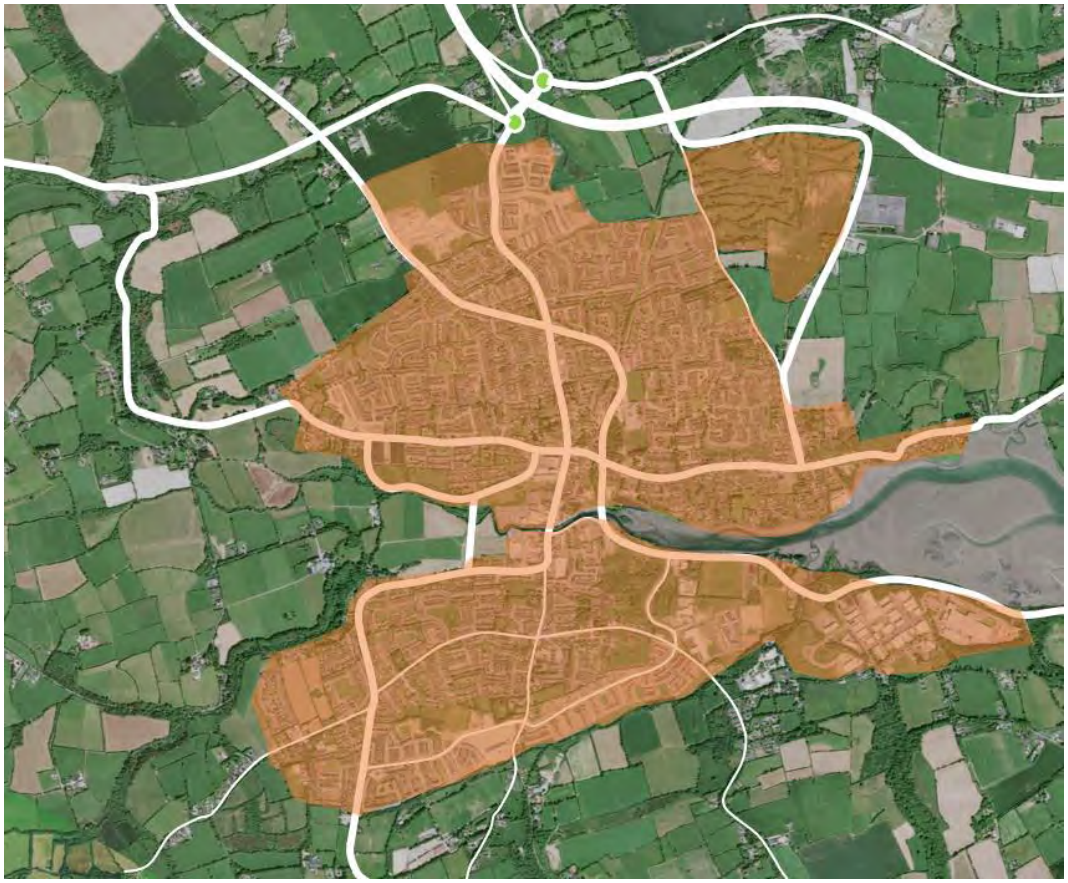


Figure 14: Carrigaline and SLR where 15% reduction in car mode share was applied

7 Modelling Results

7.1 Introduction

This section outlines the output of the Carrigaline LAM which was used to review the impact of the preferred transportation strategy. The traffic model was also used as part of the multi criteria analysis to review the eight transportation strategies considered; however, the results of this evaluation in provided within the Transportation Strategy Evaluation Report.

The results in this report is only relating to the preferred transportation strategy which were identified as Transportation Strategy 7.

Three traffic scenarios were considered and compared to one another including:

- 2018 Base Year;
- 2040 Do Minimum; and
- 2040 Preferred / Transportation Strategy 7.

Traffic model output was obtained for both the AM and PM peak hour periods.

7.2 2040 Do Minimum Scenario

The Do Minimum Scenario is based on the CMATS transportation infrastructure proposals with supporting measures. For Carrigaline, the most relevant measures from an infrastructure point of view include the following:

- Proposed primary and secondary cycle network proposals are in place;
- The M28 Cork to Ringaskiddy motorway is operational; and
- The BusConnects Carrigaline to Cork City Centre is operational.

7.3 2040 Do Something Scenario

The Do Something Scenario includes the assumptions of the 2040 Do Minimum Scenario but also includes the transportation infrastructure as outlined in Transportation Strategy 7. The main components of this study include the following:

- Bus lanes on Cork Street between the Shannonpark Roundabout and Ballinrea Road Junction;
- Northbound bus lane on Main Street between Ballinrea Road Junction and entrance to Maxol filling station;
- Provision of the proposed active mode network including the strategic cycle route network, the primary, secondary and feeder network;

- Traffic restrictions including the bus only in the southbound direction on Main Street between Ballea Road junction and Crosshaven Road Junction, one way northbound on Main Street for vehicles, one way westbound traffic on Crosshaven Road from library access to Main Street and one way southbound traffic lane on Church Hill Road.
- New traffic signal-controlled junctions with enhanced facilities for pedestrians;
- The introduction of an Active Travel Priority Zone including a new 30kph speed limit for the core of the town centre and its approaches;
- Provision of a Western and Eastern Outer Distributor Road as alternative routes for longer distance traffic to bypass the town centre;
- Supporting measures including enhanced public realm, improved permeability and wayfinding, provision of a local mobility hub and park and ride, heavy goods vehicle management, parking management, smart mobility measures and school travel plans.

8 Traffic Flows

8.1 Introduction

Appendix A includes tables and figures showing the traffic flow on the road network. The three scenarios outlined above, including 2018 base year, 2040 Do Minimum and 2040 Do Something is compared with one another.

The traffic flows were divided into three sets of information, including the Central Corridor, the Western Corridor and the Eastern Corridor.

8.2 The Central Corridor

Appendix A1 shows a table with traffic flows in PCU of the Central Corridor which includes Cork Street / Main Street / Church Hill and Rose Hill. The traffic flows include both AM and PM peak periods for the three scenarios. Both north and southbound flows are shown. The flows for each peak period have been added together to provide the total flow for each corridor.

For the AM peak in the 2018 base year, the total flow was 6,761 PCU and 8,517 PCU for the PM peak. For the 2040 Do Minimum Scenario the total flow is expected to increase to 8,543 PCU during the AM peak and 9,207 PCU during the PM. In the Do Something Scenario the total PCU in the AM peak is expected to be 3,821 while 4,438 PCU for the PM peak.

Therefore, the results show that in the Do Minimum Scenario it can be expected that the traffic within the Carrigaline town centre will increase by 26% in the AM peak and 8% in the PM peak as shown in **Table 38**. Significant increases in traffic is expected on Church Hill and Rose Hill without any intervention.

Table 38 however also shows that the Do Something Scenario (TS7) is expected to result in a significant decrease in traffic of more than 40% in each peak hour period.

Table 38: Central Corridor Traffic Flow Scenario Comparison

2018 Baseline to 2040 Do Minimum Difference		**2018 Baseline to 2040 Do Something Difference**	
26%	8%	-43%	-48%

The results above show that the preferred strategy achieves the goal of reducing traffic volumes within the town centre to make space for active modes of transport bus priority and public realm interventions to be implemented.

8.3 Western Corridor

Appendix A2 shows a table with traffic flows in PCU of the Western Corridor which includes roads on the western outskirts of the town including Ballinrea Road, Ballea Road, Kilmoney Road, and the Inner Link Road. While the strategy objective is to reduce traffic flows within the central corridor, the success of the modelling results is showing vehicles using this route as an alternative route.

The traffic flows include both AM and PM peak periods for the three scenarios. Both north and southbound flows are shown. The flows for each peak period have been added together to provide the total flow for each corridor.

For the AM peak in the 2018 base year, the total flow was 6,383 PCU and 6,360 PCU for the PM peak. For the 2040 Do Minimum Scenario the total flow is expected to increase to 6,881 PCU during the AM peak and 8,214 PCU during the PM. In the Do Something Scenario the total PCU in the AM peak is expected to increase to 8,214 and to 8,915 PCU for the PM peak.

Table 39 shows that in the comparison of the 2018 base line scenario to both the 2040 scenarios, there is expected to be a general increase on the western corridor traffic flows. The increase in the Do Something Scenario is however substantially more compared to the Do Minimum scenario.

Table 39: Western Corridor Traffic Flow Scenario Comparison

2018 Baseline to 2040 Do Minimum Difference		**2018 Baseline to 2040 Do Something Difference**	
8%	8%	29%	40%

The results outlined above show that Transportation Strategy 7 achieves the goal of providing an alternative route for vehicles which have destinations elsewhere than Carrigaline town centre. This route seems to be attractive enough for drivers to decide to avoid the town centre and rather to use the bypass corridor, even if this route is longer. Although this route might be longer, for some drivers this route will imply a time saving and therefore is considered to be more attractive.

8.4 Eastern Corridor

Appendix A3 shows a table with traffic flows in PCU of the Eastern Corridor which includes roads on the eastern outskirts of the town including Church Road, Waterpark, Fernhill Road, N28, M28 and the new eastern outer relief road. Similar to the Western Corridor, this route is also expected to become an alternative route to the town centre routes.

The traffic flows include both AM and PM peak periods for the three scenarios. Both north and southbound flows are shown. The flows for each peak period have been added together to provide the total flow for each corridor.

For the AM peak in the 2018 base year, the total flow was 13,676 PCU and 14,196 PCU for the PM peak. For the 2040 Do Minimum Scenario the total flow is expected to increase to 16,744 PCU during the AM peak and 18,670 PCU during the PM. In the Do Something Scenario the total PCU in the AM peak is expected to increase to 18,189 and to 20,083 PCU for the PM peak.

Table 40 shows that in the comparison of the 2018 base line scenario to both the 2040 scenarios, similar to the western corridor there is expected to be a general increase on the western corridor traffic flows. The increase in the Do Something Scenario is however substantially more compared to the Do Minimum scenario.

Table 40: Eastern Corridor Traffic Flow Scenario Comparison

2018 Baseline to 2040 Do Minimum Difference		**2018 Baseline to 2040 Do Something Difference**	
22%	32%	33%	41%

This route which is also part of Transportation Strategy 7 therefore also achieves its goal as an attractive route for drivers who would rather avoid the town centre, by saving time using this route.

9 Junction Analysis

9.1 Introduction

The performance of a number of key junctions of the Carrigaline road network was carried out using ARCADY for roundabouts and LinSig for signalised junctions. Both software programs are the industry standard for assessing junctions. The junction analysis results are expressed in Ratio of Flow to Capacity (RFC) for roundabouts and Degree of Saturation (DoS) for signalised junctions. Queues (in PCUs) and delays (in seconds) were also extracted from each junction for additional information.

Junction analysis were carried out for the 2040 Do Minimum and the 2040 Do Something scenarios.

The location of the junctions that were assessed are shown in **Figure 15**.

Figure 15: Location of junctions assessed

9.2 Bothar Guidel / Church Road / Cork Road

Table 41 below shows the junction analysis results for Bothar Guidel / Church Road / Cork Road in both 2040 Do Min and Do Something (TS7) scenarios.

Table 41: Junction Analysis Results - Bothar Guidel / Church Road / Cork Road

Scenario	2040 Do Minimum		2040 Do Something (TS7)	
Time Period	**AM**	**PM**	**AM**	**PM**
Queue (PCU)	14.8	13.5	36.7	28.7
Delay (s)	77.2	68.8	232.7	110.9
DOS	79.3%	76.2%	106.5%	86.8%

This junction is expected to operate below capacity in the 2040 Do Minimum scenario for both the AM and PM peaks with Degree of Saturation (DoS) of 79.3% and 76.2%, respectively.

In the 2040 Do Something Scenario, this junction will operate above capacity in the AM peak, with a DoS of 106.5%. It will operate below capacity in the PM peak, with a DoS of 86.8%. This result can be expected since traffic restrictions on Main Street is expected to increase traffic on Bothar Guidel which runs parallel to Main Street and is seen as an alternative.

9.3 Kilmoney Road Lower / Church Hill

Table 42 below shows the junction analysis results for Kilmoney Road Lower / Church Hill in both 2040 Do Min and Do Something (TS7) scenarios.

Table 42: Junction Analysis Results – Kilmoney Road Lower / Church Hill

Scenario	2040 Do Minimum		2040 Do Something (TS7)	
Time Period	**AM**	**PM**	**AM**	**PM**
Queue (PCU)	60.8	43.4	1.6	2.9
Delay (s)	444.68	324.44	28.8	30.3
RFC / DOS	1.22	1.17	14.7%	25.6%

This junction operates well over capacity in 2040 Do Minimum, with RFC of 1.22 and 1.17 in both AM and PM peak, respectively.

In the Do Something TS7 scenario, the junction is expected to operate at a much-reduced DoS during both peak hour periods, with 14.7% and 25.6% in both AM and PM peak, respectively. This is due to the reconfiguration of this junction which includes reduced traffic from on the Church Hill south bound approach due to the introduction of a bus lane on Main Street which reduces overall traffic flow and the introduction of a 30kph speed limit.

9.4 Main Street / Crosshaven Road

Table 43 below shows the junction analysis results for Main Street / Crosshaven Road in both 2040 Do Min and Do Something (TS7) scenarios.

Table 43: Junction Analysis Results – Main Street / Crosshaven Road

Scenario	2040 Do Minimum		2040 Do Something (TS7)	
Time Period	AM	PM	AM	PM
Queue (PCU)	10.2	8.8	0.4	0.7
Delay (s)	39.4	45.5	8.36	9.29
RFC / DOS	62.7%	58.4%	0.26	0.39

This junction operates well within capacity in 2040 Do Minimum, with DoS of 62.7% and 58.4% in both AM and PM peak, respectively.

In the 2040 Do Minimum Scenario this junction is expected to improve in the 2040 Do Something TS7 Scenario, with RFCs of 0.26 and 0.39 in both AM and PM peak, respectively. In this scenario the traffic flow on Main Street is expected to drop significantly sue to traffic restrictions and there will only be one-way traffic feeding the junction from the Crosshaven approach.

9.5 Bothar Guidel / Crosshaven Road

Table 44 below shows the junction analysis results for Bothar Guidel / Crosshaven Road in both 2040 Do Min and Do Something (TS7) scenarios.

Table 44: Junction Analysis Results – Bothar Guidel / Crosshaven Road

Scenario	2040 Do Minimum		2040 Do Something (TS7)	
Time Period	AM	PM	AM	PM
Queue (PCU)	3	20.2	21.5	28
Delay (s)	13.39	72.42	25.2	30.8
RFC / DOS	0.76	0.99	82%	86.5%

This junction is expected to operate within capacity in the 2040 Do Minimum Scenario AM peak, but almost at capacity in the PM peak. In the Do Something TS7 Scenario, this junction is expected to operate within capacity during both AM and PM peaks with DoS of 82% and 86.5%, respectively. This junction is currently a roundabout but will be upgraded to a signal-controlled junction which was assumed for both future year scenarios as this proposal is independent from the Carrigaline TPREP Strategy.

9.6 Ballea Road / Cork Road

Table 45 below shows the junction analysis results for Ballea Road / Cork Road in both 2040 Do Min and Do Something (TS7) scenarios.

Table 45: Junction Analysis Results – Ballea Road / Cork Road

Scenario	2040 Do Minimum		2040 Do Something (TS7)	
Time Period	**AM**	**PM**	**AM**	**PM**
Queue (PCU)	1.6	1.4	12.1	11.4
Delay (s)	12.43	10.41	67.9	88.3
RFC / DOS	0.62	0.58	72.8%	77.3%

This junction is expected to operate within capacity in the 2040 Do Minimum Scenario, with RFCs of 0.62 and 0.58 in AM and PM peak, respectively.

In the 2040 Do Something TS7 Scenario, the junction will continue to operate within capacity, with AM and PM peak DoS of 72.8% and 77.3%, respectively.

This junction is currently a roundabout but will be upgraded to a signal-controlled junction in the Do Something Scenario. Traffic volumes at this junction is expected to reduce in the Do Something Scenario due to traffic restrictions on the northern and southern approaches.

9.7 Ballinrea Road / Cork Road

Table 46 below shows the junction analysis results for Ballinrea Road / Cork Road in both 2040 Do Min and Do Something (TS7) scenarios.

Table 46: Junction Analysis Results – Ballinrea Road / Cork Road

Scenario	2040 Do Minimum		2040 Do Something (TS7)	
Time Period	**AM**	**PM**	**AM**	**PM**
Queue (PCU)	11.5	8.1	23.7	25.3
Delay (s)	39.69	25.67	19.5	29.3
RFC / DOS	0.94	0.90	76.1%	83.8%

This junction is expected to operate just within capacity in the 2040 Do Minimum Scenario, with RFCs of just below 1.00 in AM and PM peak.

In the 2040 Do Something Scenario, all approaches at this junction is expected to operate within capacity. The DoS in both AM and PM peaks are 76.1% and 83.8%, respectively.

Within the 2040 Do Minimum Scenario, this junction will be upgraded to a signal-controlled junction which will balance green time better among the approaches to this junction.

9.8 Inner Relief Road (south) / Kilmoney Road Lower

Table 47 below shows the junction analysis results for Inner Relief Road (south) / Kilmoney Road Lower in both 2040 Do Min and Do Something (TS7) scenarios.

Table 47: Junction Analysis Results – Inner Relief Road (south) / Kilmoney Road Lower

Scenario	2040 Do Minimum		2040 Do Something (TS7)	
Time Period	**AM**	**PM**	**AM**	**PM**
Queue (PCU)	2.7	4.3	3.9	4.2
Delay (s)	41.7	43.9	25.6	27.1
RFC / DOS	27.4%	50.9%	34.1%	36.4%

This junction will operate as a signal-controlled junction and is expected to operate well within capacity in both the 2040 Do Minimum and the 2040 Do Something Scenarios.

9.9 Inner Relief Road / Pottery site access / New Link Road

Table 48 below shows the junction analysis results for Inner Relief Road / Pottery site access / New Link Road in both 2040 Do Min and Do Something (TS7) scenarios.

Table 48: Junction Analysis Results – Inner Relief Road / Pottery site access / New Link Road

Scenario	2040 Do Minimum		2040 Do Something (TS7)	
Time Period	**AM**	**PM**	**AM**	**PM**
Queue (PCU)	5.8	7.6	8.8	9.7
Delay (s)	50.8	52.7	50.8	50.7
RFC / DOS	46.0%	56.8%	62.7%	67.5%

This junction will operate as a signal-controlled junction and is expected to operate well within capacity in both the 2040 Do Minimum and the 2040 Do Something Scenarios.

9.10 Inner Relief Road / Ballea Road

Table 49 below shows the junction analysis results for Inner Relief Road / Ballea Road in both 2040 Do Min and Do Something (TS7) scenarios.

Table 49: Junction Analysis Results – Inner Relief Road / Ballea Road

Scenario	2040 Do Minimum		2040 Do Something (TS7)	
Time Period	**AM**	**PM**	**AM**	**PM**
Queue (PCU)	10.1	10.8	9.9	11.7
Delay (s)	49.2	49.5	49.3	54.0
RFC / DOS	55.7%	64.4%	61.0%	69.9%

This junction will operate as a signal-controlled junction and is expected to operate within capacity in both the 2040 Do Minimum and the 2040 Do Something Scenarios.

10 Journey Time

10.1 Introduction

The Carrigaline LAM was also used to extract journey times for three routes through Carrigaline. These routes included the following:

- Ballinrea Road to Rose Hill;
- Shannonpark Roundabout to Crosshaven; and
- Kilmoney to Coolmore Cross (Church Road).

Journey times were extracted for both directions (i.e. north to south /south to north or east to west / west to east) and this analysis was carried out for the 2018 Base Year, 2040 Do Minimum and 2040 Do Something Scenarios.

The results of the above analysis are included in Appendix C of this report and is discussed in the section below.

10.2 Ballinrea Road to Church Hill

The journey times for this route is summarised in **Table 50** below. The results show that the journey times during the AM peak for the 2040 Do Minimum Scenario is expected to increase slightly compared to the 2018 Base Year Scenario, while the journey times during the PM peak is expected to slightly decrease. Overall, the journey times will remain more or less the same. There is little change to the road network for the 2040 Do Minimum Scenario and a modest increase in traffic volumes and therefore the results as shown is as expected.

Comparing the 2040 Do Something Scenario to the 2018 Base Year Scenario shows that the journey time along this route increased substantially in both the AM and the PM peak hour periods. This increase in journey times along this route is also expected, since Main Street has been reconfigured in the 2040 Do Something Scenario to discourage traffic using this route by introducing traffic restrictions.

Table 50: Journey Times for Ballinrea Road to Rose Hill

Scenario	Northbound		Southbound	
	AM Peak	*PM peak*	*AM Peak*	*PM Peak*
2018 Base Year	5 min 59	6 min 28 sec	5 min 53 sec	6 min 08 sec
2040 Do Minimum	6 min 6 sec	6 min 9 sec	5 min 56 sec	6 min 00 sec
2040 Do Something (TS7)	8 min 35 sec	8 min 39 sec	8 min 10 sec	8 min 17 sec

10.3 Shannonpark to Crosshaven

The journey times for this route is summarised in **Table 51** below. The results show that the journey times for the 2040 Do Minimum Scenario is expected to increase in both directions compared to the 2018 Base Year Scenario. This is due to expected traffic growth from 2018 to 2040 and no changes to the road network to accommodate the increase in demand.

Comparing the 2040 Do Something Scenario to the 2018 Base Year Scenario shows that the journey time in the North / Westbound direction will also increase, but that this increase is quite similar to the 2040 Do Minimum Scenario. In the south / eastbound direction the journey time is expected to increase by almost a minute in both the AM and PM peak periods. This increase is possibly due to the provision of bus priority and additional pedestrian crossings along this route.

Table 51: Journey Times for Shannonpark to Crosshaven

Scenario	North / Westbound		South / Eastbound	
	AM Peak	*PM peak*	*AM Peak*	*PM Peak*
2018 Base Year	9 min 26 sec	9 min 36 sec	8 min 59 sec	10 min 10 sec
2040 Do Minimum	10 min 51 sec	10 min 14 sec	9 min 12 sec	9 min 54 sec
2040 Do Something (TS7)	10 min 14 sec	10 min 16 sec	10 min 8 sec	10 min 39 sec

10.4 Kilmoney to Coolmore Cross

The journey times for this route is summarised in **Table 52** below. The results show that the journey times for the 2040 Do Minimum Scenario is expected to increase in both directions compared to the 2018 Base Year Scenario. This is due to expected traffic growth from 2018 to 2040 and no changes to the road network to accommodate the increase in demand.

Comparing the 2040 Do Something Scenario to the 2018 Base Year Scenario in the majority of cases the journey time is expected to increase. This increase is expected since this route follows through the town centre where traffic restrictions will be implemented to accommodate active travel modes and providing priority to public transport.

Table 52: Journey Times for Kilmoney to Coolmore Cross

Scenario	North / Westbound		South / Eastbound	
	AM Peak	*PM peak*	*AM Peak*	*PM Peak*
2018 Base Year	9 min 21 sec	8 min 58 sec	8 min 41 sec	9 min 33 sec
2040 Do Minimum	10 min 50 sec	9 mins	8 min 56 sec	9 min 37 sec
2040 Do Something (TS7)	10 min 33 sec	10 min 36 sec	10 min 7 sec	13 min 3 sec

11 Conclusion

This report describes the development of the Carrigaline Local Area Model (LAM), including detailed information on calibration and validation statistics. The Carrigaline LAM has been used to assess the robustness of junction designs and road network changes proposed as part of the Carrigaline Transportation and Public Realm Enhancement Plan (TPREP). This report provides an overview of the methodology used to generate forecast demand matrices for assignment in the Carrigaline LAM and also includes the results for the preferred strategy (Do Something) compared against a baseline and future Do Minimum scenario.

The report provides an overview of the NTA regional modelling system and outlines how the Carrigaline LAM was developed from the South West Regional Model. This is followed by a summary of the model specifications including the type of modelling software used, the model cordon area, user classes, network development and the peak times modelled.

The prior matrix development process is outlined followed by the model calibration process and results. In this section an overview of the traffic counts and journey time surveys is given that was used for the calibration process and the steps of this process is outlined and an overview is given of the trip demand adjustment that was carried out through matrix estimation.

Following was a review of the prior and post calibration results in the form of flow comparison between model output and observed flows along screen lines. The prior matrix results show a failure rate for the model. After matrix estimation the post calibration results show a remarkable improvement in the calibration results with the greater majority of cases passing. The results show that the model calibrates within the TII and TAG criteria in terms of individual link flows and GEH.

The screen line results show that the model calibrates well within the TII and TAG criteria and therefore provides a robust representation of traffic travelling in and out of the Carrigaline LAM area.

Following the calibration results an overview of the model validation was provided including link flow validation for various vehicle classes during the AM and PM peak hour periods. The model passed all of the validation criteria for the different vehicle classes. This was followed by journey time validation.

The Carrigaline LAM was calibrated and validated in accordance with Transport Infrastructure Ireland's (TII) Project Appraisal Guidelines (PAG) for National Roads Unit 5.1 – Construction of Transport Models (October 2016) and NTA's Regional Model Spec2 Model Specification Report version 2.0.17. Additionally, the LAM development has followed guidance from the UK's Department for Transport's (DfT) Transport Analysis Guidance (TAG) unit M3-1.

The calibration and validation results indicate that the model is robust and therefore can be used for the purposes of forecast transport scheme improvements and/or developments.

This report also includes modelling results of the Carrigaline LAM by comparing the 2018 base model to the 2040 Do Minimum and 2040 Do Something Scenarios. This analysis included a comparison of traffic flows, capacity analysis and journey time surveys for the traffic scenarios to demonstrate that the preferred strategy achieves the objectives set out for Carrigaline which is to reduce traffic flows within the town centre to provide space for other modes of transport.

The review of traffic flows shows that the traffic volumes using the central corridor through Carrigaline (Main Street) is expected to reduce in the 2040 Do Something Scenario. The traffic restriction measures put in place seems to be sufficient to push traffic out to the periphery of the town, onto the proposed eastern and western outer ring roads that is designed to accommodate longer distance commuter and through traffic within the vicinity of Carrigaline.

Junction analysis was carried out at nine critical junctions for each of the three traffic scenarios. In all of the cases, the junctions are expected to operate within capacity during the 2040 Do Something scenario, while some junctions are expected to operate over capacity in the Do Minimum Scenario. However, some junctions such as Kilmoney Road Lower / Church Road junction and the Ballinrea Road / Cork Road junction will operate very close to capacity in the 2040 Do Something Scenario.

The final section of the results reviews journey time by comparing three routes to one another. In all cases the journey time for both the 2040 Do Minimum and 2040 Do Something scenarios is expected to increase due to an increase in traffic flow. The 2040 Do Something scenario also shows that the routes through the town centre will endure longer journeys due to the traffic restrictions that is proposed to accommodate active travel and public transportation priority.

This report is a model validation report and also provides model output results for the Carrigaline LAM. The validation results have shown that the model is representative of the input data and conforms to the TII and TAG criteria in terms of individual link flows and GEH.

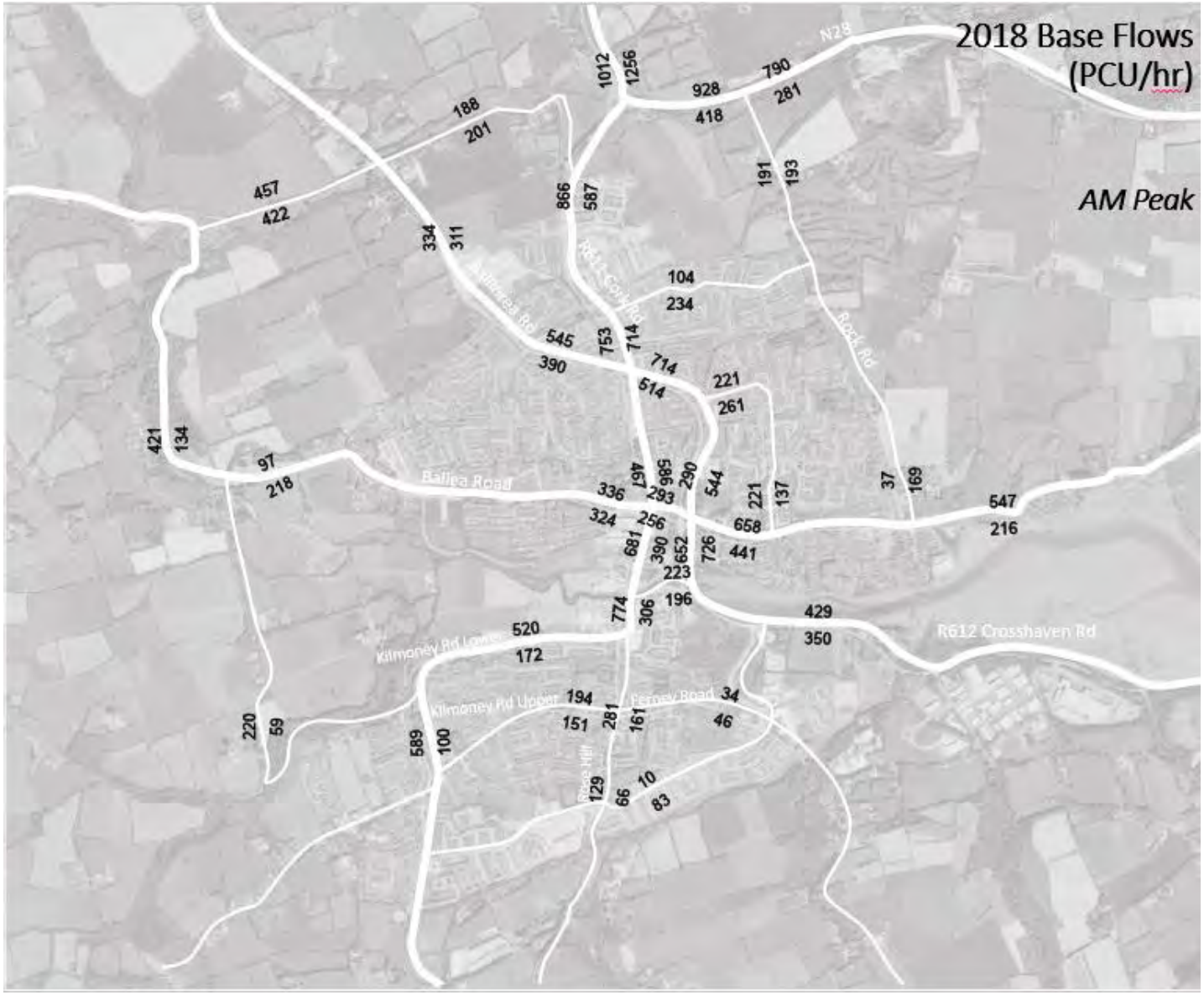
The modelling results shows that the preferred Transportation Strategy 7, achieves its objectives of attempting to reduce traffic flow within the town centre to provide space for active modes and public transport priority by employing traffic restrictions and providing two ring roads on the periphery of the town.

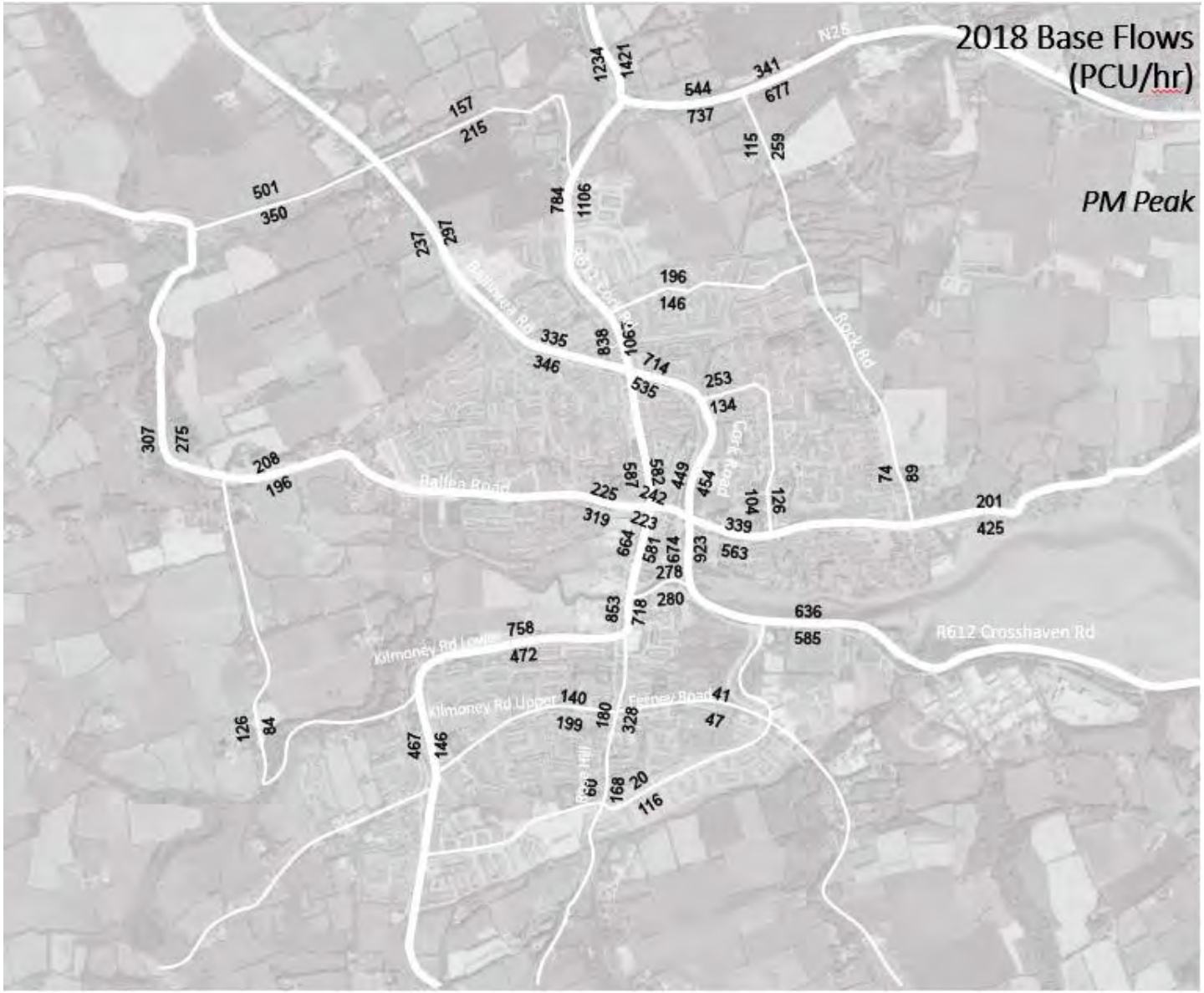
Appendix A

Traffic Flows

A1 Central Corridor

Sector	Location	Description	Direction	2018		2040 Do Min		2040 Preferred Strategy (TS7)	
				AM	PM	AM	PM	AM	PM
Cork Road / Main Street / Rose Hill / Church Hill	R611 Cork Road	North of West Ave (Carrig Na Curra)	NB	866	784	1026	1006	901	849
			SB	587	1106	856	1066	711	821
		Between Heron's Wood and Ballinrea Road	NB	753	838	980	1107	723	917
			SB	714	1067	999	1089	670	760
		Between Church Road and Glenwood Close	NB	586	582	770	763	333	489
			SB	467	587	640	657	185	117
	R611 Cork Road (Main Street)	Between Old Waterpark and Church Road	NB	681	664	589	488	55	67
			SB	390	581	404	457	0	0
		Between R612 Strand Road and Kilmoney Road Lower	NB	774	853	595	669	48	43
			SB	306	718	372	546	61	150
	Church Hill	Between Kilmoney Road Upper and Kilmoney Road Lower	NB	281	180	516	441	-	-
			SB	161	328	291	437	77	163
	Rose Hill	Between Clover Hill and Fuschia Avenue	NB	129	60	382	264	0	0
			SB	66	168	123	219	58	63
Total				**6,761**	**8,517**	**8,543**	**9,207**	**3,821**	**4,438**


2018 Base Flows
(PCU/hr)
AM Peak
N28
R612 Crosshaven Rd
Ballea Road
Kilmoney Rd Lower
Kilmoney Rd Upper
Rock Rd
1012
1256
928
790
281
418
188
201
457
422
866
587
191
193
334
311
104
234
545
753
714
390
714
514
221
261
421
134
97
218
336
461
985
293
290
544
221
137
37
169
547
216
324
256
658
681
390
652
726
441
223
196
774
306
520
172
429
350
194
151
281
161
34
46
220
59
589
100
129
66
10
83


2018 Base Flows
(PCU/hr)
PM Peak
N25
R612 Crosshaven Rd
Ballea Road
Rock Rd
Kilmoney Rd Upper
Fernev Road
1234
1421
544
737
341
677
157
215
115
259
501
350
784
1106
237
297
196
146
335
346
838
714
535
253
134
307
275
208
196
225
242
449
454
104
126
74
89
201
425
319
223
339
664
581
674
923
563
278
280
853
718
636
585
758
472
140
199
180
328
41
47
126
84
467
146
168
20
116

A2 Western Corridor

ID	Sector	Location	Description	Direction	2018		2040 Do Min		2040 Preferred Strategy (TS7)	
					AM	PM	AM	PM	AM	PM
8	West	Ballinrea Road (north-south)	Northern End	NB	334	237	263	241	385	354
				SB	311	297	201	264	203	315
9			Between Glenwood and Carrigmore	EB	545	335	467	302	353	265
				WB	390	346	344	322	360	345
10		Ballinrea Road (east-west)	Between Ballea Road and Ballinrea Road (north-south)	EB	457	501	464	601	654	806
				WB	422	350	518	512	820	797
11			Ballinrea Road (north-south) and Cork Road	EB	188	157	255	289	472	587
				WB	201	215	324	316	531	630
12		R613 Ballea Road (north-south)	South of Ballinrea Road	NB	421	307	427	209	496	356
				SB	134	275	176	227	286	437
13			Between Captains Boreen and Forest Road	NB	220	126	160	116	302	254
				SB	59	84	119	137	193	280
14		R613 Ballea Road (east-west)	Western End	EB	97	208	66	91	102	147
				WB	218	196	239	102	202	112
15			West of Nova Ct	NB	336	225	201	65	179	38
				SB	324	319	216	170	116	89
16		R611 Kilmoney Road Lower (north-south)	Between Kilmoney Road Upper and Forest Road	NB	589	467	520	456	749	624
				SB	100	146	110	124	198	331
17		R611 Kilmoney Road Lower (east-west)	West of Main Street	EB	520	758	147	318	89	122
				WB	172	472	148	209	24	80

ID		Location	Description	Direction	2018		2040 Do Min		2040 Preferred Strategy (TS7)	
					AM	PM	AM	PM	AM	PM
18		Kilmoney Road Upper	West of Church Hill	EB	194	140	191	137	138	130
				WB	151	199	251	351	143	271
19		Castle Heights Link Road	East of Kilmoney Road Lower	EB	-	-	216	136	71	135
				WB	-	-	17	104	71	60
20		Inner Link Road (South)	North of Kilmoney Road Lower	NB	-	-	289	360	394	428
				SB	-	-	99	175	104	241
21		Inner Link Road (East)	South of Ballea Road	NB	-	-	255	319	366	401
				SB	-	-	73	152	113	213
22		Inner Link Road (West)	South of Ballea Road	NB	-	-	56	34	49	34
				SB	-	-	67	30	51	30
	Total				**6,383**	**6,360**	**6,881**	**6,870**	**8,214**	**8,915**


2040 Do Min Flows
(PCU/hr)
AM Peak
M28
N28
R612 Crosshaven Rd
Ballea Road
Kilmoney Rd Lower
Kilmoney Rd Upper
Ferney Road
Rock Rd
Cork Road
1269
1095
220
402
713
572
549
486
327
556
122
255
324
976
464
518
1026
856
464
328
263
201
199
265
467
344
980
999
750
516
267
248
427
176
66
239
640
770
238
230
201
479
253
157
49
207
419
212
56
67
255
216
171
601
73
589
404
535
762
528
186
289
99
595
372
249
401
435
147
148
191
251
516
291
40
126
160
119
520
110
382
123
43
101
216
17


2040 Do Min Flows
(PCU/hr)
PM Peak
M28
N28
R612 Crosshaven Rd
Rock Rd
Ferney Road
Killmoney Rd Lower
Killmoney Rd Upper
Ballea Road
1367
1612
336
350
1167
420
451
222
487
200
569
289
316
1041
601
512
241
264
1006
1066
215
449
208
210
302
322
1107
1085
617
575
235
191
209
227
91
102
65
657
763
272
464
416
159
134
165
154
185
488
34
30
319
170
248
463
152
488
457
692
940
736
251
360
175
669
546
173
698
593
318
209
137
351
441
437
38
121
116
137
456
124
264
219
96
260
136
104

A3 Eastern Corridor

ID	Sector	Location	Description	Direction	2018		2040 Do Min		2040 Preferred Strategy (TS7)	
					AM	PM	AM	PM	AM	PM
23	East	Herons Wood	Between Silverhill and Woodvale	EB	104	196	199	208	196	243
				WB	234	146	265	210	230	183
24		Cork Road (Inner Relief Road)	West of Ashgrove Drive	EB	714	714	750	617	774	875
				WB	514	535	516	575	717	758
25			Between Church Road and Heatherfield Lawn	NB	290	449	238	464	521	602
				SB	544	454	479	416	713	913
26		R612	South of Church Road Bothar Guidel	NB	652	674	535	692	521	602
				SB	726	923	762	940	713	913
27			Kilnageary west of Carrigaline GAA Club	EB	429	636	401	698	393	689
				WB	350	585	435	593	434	584
28			Strand Road north of Carrigaline Fire Station	EB	223	278	186	251	0	0
				WB	196	280	249	173	132	224
29		Church Road	West of Bothar Guidel Junction	EB	293	242	230	272	465	250
				WB	256	223	171	248	407	409
30			East of Bothar Guidel Junction	EB	658	339	601	463	550	320
				WB	441	563	528	736	401	426
31			West of Rock Road	EB	547	201	419	185	382	156
				WB	216	425	212	488	183	421
ID		**Location**	**Description**	**Direction**	**2018**		**2040 Do Min**		**2040 Preferred Strategy (TS7)**	

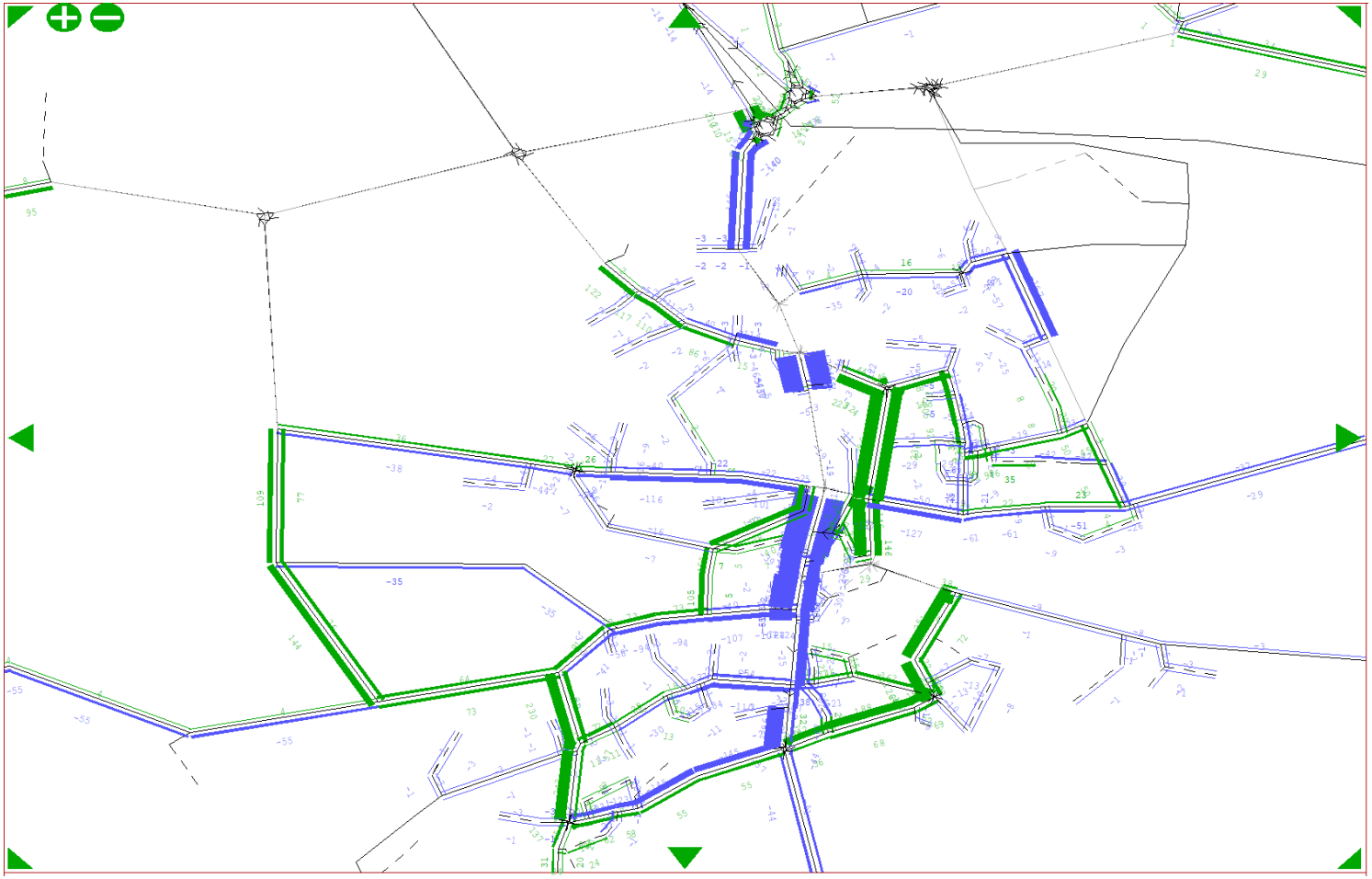
					AM	PM	AM	PM	AM	PM
32		Bridgemount	East of Heatherfield Lawn	EB	221	253	267	235	253	186
				WB	261	134	248	191	360	423
33		Waterpark	North of Church Road	NB	221	126	253	159	226	162
				SB	137	104	157	134	136	16
34		Ferney Road	West of Fuschia Avenue	EB	34	41	40	38	95	158
				WB	46	47	126	121	126	146
35		Fuschia Avenue	Between Fern Grove and Bellflower Close	EB	10	20	43	96	229	327
				WB	83	116	101	260	168	327
36		Fernhill Road	South (Between Castle Hill and Laurelmount Drive)	NB	37	74	49	165	99	90
				SB	169	89	207	154	210	108
37			North (South of N28)	NB	191	115	464	215	410	204
				SB	193	259	328	449	287	523
38		N28	North of Shannonpark Interchange	NB	1012	1234	220	336	219	257
				SB	1256	1421	402	350	404	352
39			East of Shannonpark Interchange	EB	928	544	572	420	544	541
				WB	418	737	549	451	514	445
40			East of Fernhill Road	EB	790	341	486	222	507	248
				WB	281	677	327	487	353	471
41		M28 (Mainline)	North of Shannonpark Interchange	NB	-	-	1095	1612	1082	1615
				SB	-	-	1269	1367	1255	1365
42			East of Fernhill Road	EB	-	-	556	200	556	200
				WB	-	-	122	569	122	570
ID		**Location**	**Description**	**Direction**	**2018**		**2040 Do Min**		**2040 Preferred Strategy (TS7)**	

					AM	PM	AM	PM	AM	PM
43		M28 ramps	NB on-ramp north of Shannonpark Interchange	NB	-	-	973	1041	960	1044
				SB	-	-	-	-	-	-
44			SB off-ramp north of Shannonpark Interchange	NB	-	-	-	-	-	-
				SB	-	-	713	1167	699	1165
45		Eastern Outer Relief Road	Between Fernhill Road and Heron's Wood Extension	NB	-	-	-	-	116	98
				SB	-	-	-	-	256	242
46		Heron's Wood Extension	Between Fernhill Road and Heron's Wood Extension	EB	-	-	-	-	229	46
				WB	-	-	-	-	41	185
	Total				**13,676**	**14,196**	**16,744**	**18,670**	**18,189**	**20,083**

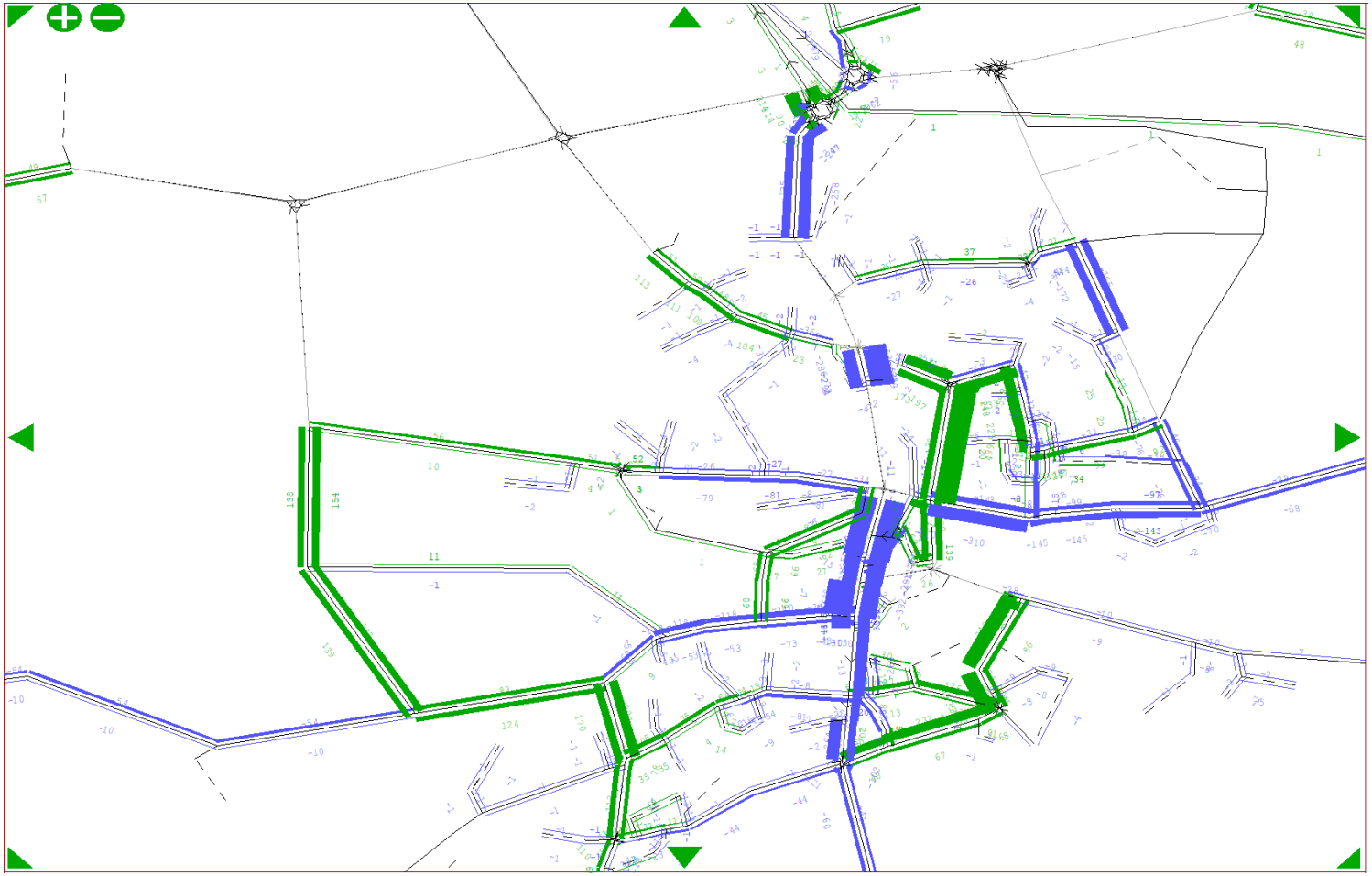

2040 Preferred Strategy Flows
(PCU/hr)
AM Peak
M28
Ballea Road
R612 Crosshaven Rd
Kilmoney Rd Upper
Ferney Road
Rose Hill
Rock Rd
Ballinrea Rd
1087
1255
219
404
699
544
507
353
514
556
122
472
531
096
654
820
901
711
410
287
229
41
385
203
196
230
353
723
670
774
717
253
360
116
256
496
286
102
202
179
185
333
521
713
226
136
99
210
382
183
49
51
366
116
407
550
113
55
521
713
401
394
104
48
61
132
393
434
89
24
138
143
77
95
126
302
193
749
198
58
229
168
71
71


2040 Preferred Strategy Flows
(PCU/hr)
PM Peak
M28
Ballea Road
Kilmoney Rd Lower
Kilmoney Rd Upper
Perney Road
Rose Hill
Rock Rd
Cork Road
R612 Crosshaven Rd
1365
1615
257
351
1165
541
248
470
587
630
1044
444
200
570
806
797
849
821
204
522
354
315
46
185
243
183
265
345
917
760
875
758
186
423
98
242
356
437
147
112
38
117
489
250
602
913
16
162
90
108
156
420
34
30
401
89
409
213
67
602
913
320
426
428
241
43
150
224
689
584
122
80
130
162
158
271
163
146
254
280
624
331
63
327
135
60
327

A4 SATURN Difference Plot (Do Something v Do Minimum) – AM Peak



A5 SATURN Difference Plot (Do Something v Do Minimum) – PM Peak



Appendix B

Junction Analysis Results

B1 Junction Analysis Results

Junction	Scenario	2040 Do Minimum		2040 Do Something (TS7)	
	Time Period	AM	PM	AM	PM
Bothar Guidel / Church Road / Cork Road	Queue (PCU)	14.8	13.5	36.7	28.7
	Delay (s)	77.2	68.8	232.7	110.9
	DOS	79.30%	76.20%	106.50%	86.80%
Kilmoney Road Lower / Church Hill	Queue (PCU)	60.8	43.4	1.6	2.9
	Delay (s)	444.68	324.44	28.8	30.3
	RFC / DOS	1.22	1.17	14.70%	25.60%
Main Street / Crosshaven Road	Queue (PCU)	10.2	8.8	0.4	0.7
	Delay (s)	39.4	45.5	8.36	9.29
	RFC / DOS	62.70%	58.40%	0.26	0.39
Bothar Guidel / Crosshaven Road	Queue (PCU)	3	20.2	21.5	28
	Delay (s)	13.39	72.42	25.2	30.8
	RFC / DOS	0.76	0.99	82%	86.50%
Ballea Road / Cork Road	Queue (PCU)	1.6	1.4	12.1	11.4
	Delay (s)	12.43	10.41	67.9	88.3
	RFC / DOS	0.62	0.58	72.80%	77.30%
Ballinrea Road / Cork Road	Queue (PCU)	11.5	8.1	23.7	25.3
	Delay (s)	39.69	25.67	19.5	29.3
	RFC / DOS	0.94	0.9	76.10%	83.80%
Inner Relief Road (south) / Kilmoney Road Lower	Queue (PCU)	2.7	4.3	3.9	4.2
	Delay (s)	41.7	43.9	25.6	27.1
	RFC / DOS	27.40%	50.90%	34.10%	36.40%

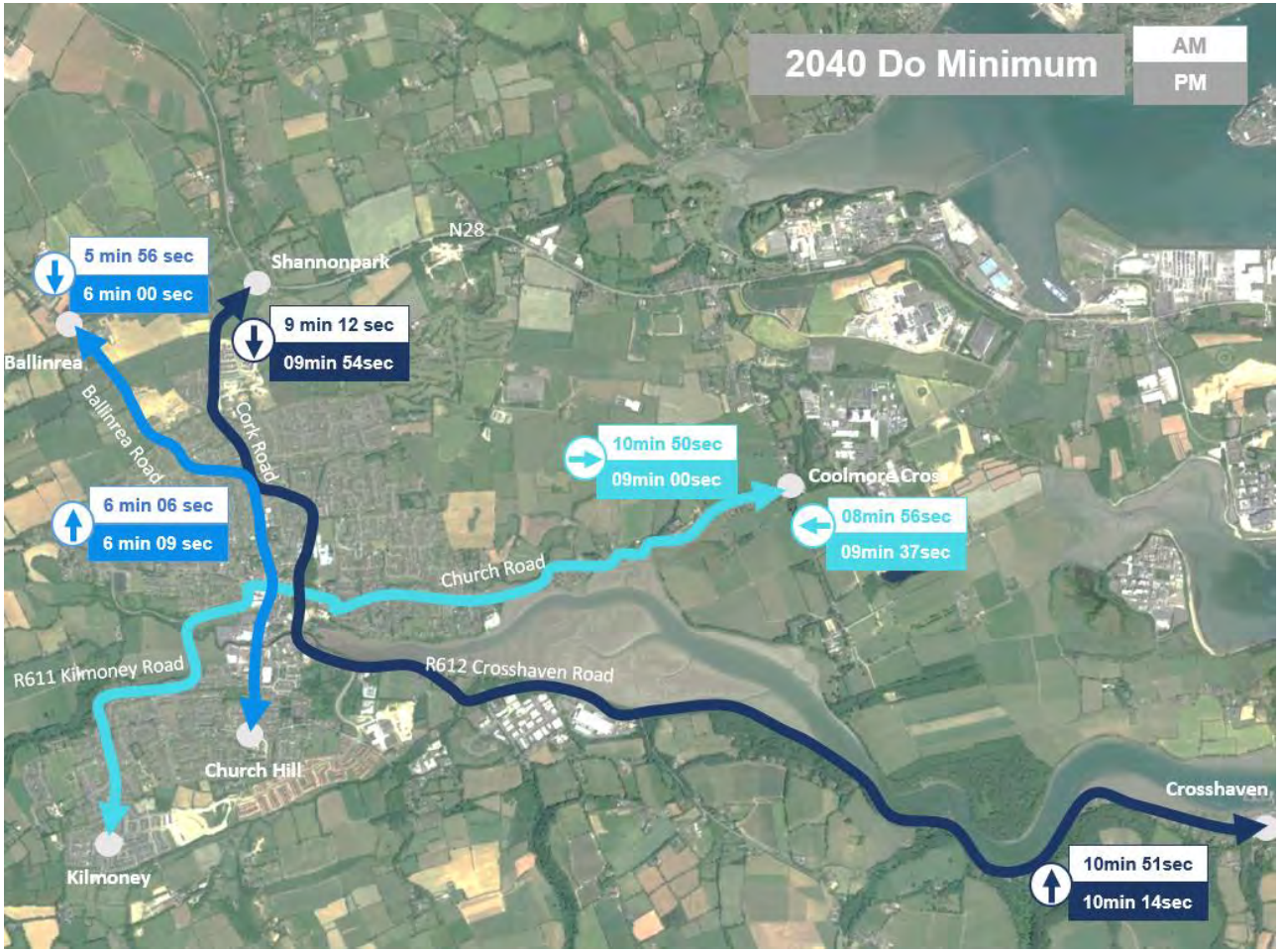
Junction	Scenario	2040 Do Minimum		2040 Do Something (TS7)	
	Time Period	AM	PM	AM	PM
Inner Relief Road / Pottery site access / New Link Road	Queue (PCU)	5.8	7.6	8.8	9.7
	Delay (s)	50.8	52.7	50.8	50.7
	RFC / DOS	46.00%	56.80%	62.70%	67.50%
Inner Relief Road / Ballea Road	Queue (PCU)	10.1	10.8	9.9	11.7
	Delay (s)	49.2	49.5	49.3	54
	55.70%	64.40%	61.00%	69.90%	55.70%

Appendix C

Journey Time

C1 2018 Base Year

C2 2040 Do Minimum



C3 2040 Do Something (TS7)