Appendix A6.1

Modelling Report

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LIST OF ABBREVIATIONS

RMS: Regional Modelling System
WRM: West Regional Model
GTS: Galway Transport Strategy
LAM: Local Area Model
PT: Public Transport
EIAR: Environmental Impact Assessment Report

1. INTRODUCTION

This Transport Modelling Report is an appendix to Chapter 6 of the Environmental Impact Assessment Report (EIAR) which has considered the potential traffic & transport impacts associated with the Construction and Operational Phases of the BusConnects Galway Dublin Road Scheme (hereafter referred to as the Proposed Development).

The Proposed Development has an overall length of approximately 3.9km, and covers the Dublin Road and Old Dublin Road corridor between the Moneenageisha junction and the Doughiska Road junction. The scheme interfaces with the Galway Cross City Link at Moneenageisha and with the Martin Roundabout upgrade scheme at the eastern end.

The Proposed Development includes an upgrade of the existing bus priority and pedestrian and cycle facilities along the length of the scheme. The Proposed Development constitutes a substantial increase in the level of bus priority and active mode facilities on a major route into Galway city centre from the east, including the provision of full-length bus lanes and segregated cycle lanes and footpaths for the full lengths of the route. All major junctions along the route are upgraded to signalised junctions with pedestrian and cyclist provision.

Barry Transportation, on behalf of the National Transport Authority and Galway City Council, commissioned SYSTRA to perform the modelling to assess the transport impact of the Proposed Development. This report summarises the methodology and results of the modelling study.

1.1 Report Structure

The following outlines each Chapter of this Modelling Report:

- Chapter 2 summarises the modelling methodology
- Chapter 3 provides an overview of the NTA's Regional Modelling System (RMS)
- Chapter 4 describes the forecast land use assumptions used in the modelling
- Chapter 5 describes the individual modelled scenarios
- Chapter 6 outlines the main WRM results
- Chapter 7 focuses on the Local Area Model and its results

2. MODELLING METHODOLOGY AND ASSUMPTIONS

This chapter gives a high-level overview of the modelling methodology, assumptions and references the relevant Chapters that discuss each aspect in more detail.

2.1 Modelling Methodology

The modelling methodology can be summarised as follows:

- Modelling is based on use of the NTA's Regional Modelling System (RMS). Please see Chapter 3 for description of RMS and its components.
- A Highway Local Area Model (LAM) has been developed, calibrated, and validated for the base and three forecast years. Please see Chapter 7 for a description of the calibration and validation process.
- A micro-simulation model has been developed for the full continuous 'end-to-end' route of the Proposed Development. The 'end-to-end' Corridor Micro-simulation model has been developed to assist in the operational validation of the scheme designs and to provide visualisation of scheme operability along with its impacts and benefits. The term 'end-to-end' refers to the point of model 'entry' (start of Proposed Development) to the point of model 'exit' (end of Proposed Development) rather than the actual bus service terminus points which, in most cases, lies outside of the modelled area. The modelling of the Proposed Development shows the differences in travel time for buses along the full length of the Proposed Development, including delay at individual locations. For further information on the microsimulation model which was developed, see the *Galway Dublin Road Busconnects VISSIM Model Report*, in appendix 9.0 at the end of this report.
- Modelling was undertaken for the base year (2022), opening year (2028) and two forecast years (2043 and 2058). Please see Chapter 4 for description of the land use assumptions that were used to generate individual forecasts.
- Additionally, modelling was done for three scenarios (Base Year, Do Minimum and Do Something). Please see Chapter 5 for a description of the modelled scenarios and Chapter 6 for the overview of the modelling results.

Figure 2-1 shows a general overview of the modelling process.

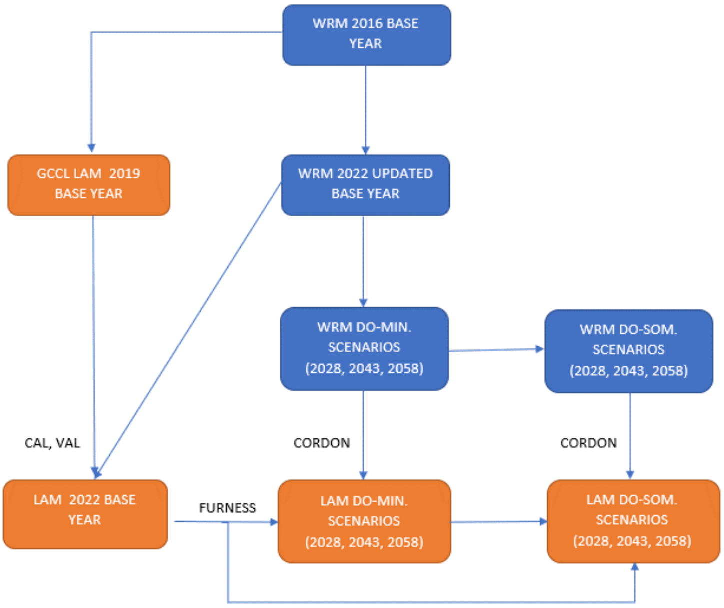


Figure 2-1: Modelling Process Overview

3. NTA REGIONAL MODELLING SYSTEM

3.1 Introduction

This chapter provides an overview of the NTA Regional Modelling System (RMS).

The NTA Regional Modelling System comprises five regional transport models covering the Republic of Ireland and centred on the five main cities of Dublin, Cork, Galway, Limerick, and Waterford (as summarised in Table 3.1 below).

Regional Modelling System	Abbreviation	Counties Covered
Eastern Regional Model	ERM	Louth, Monaghan, Cavan, Longford, Westmeath, Meath, Offaly, Laois, Kildare, Dublin, Wicklow, Carlow & Northern Wexford
South East Regional Model	SERM	Wexford, Kilkenny, Waterford & Tipperary South
South West Regional Model	SWRM	Cork & Kerry
Mid-West Regional Model	MWRM	Limerick, Clare & North Tipperary
West Regional Model	WRM	Galway, Mayo, Roscommon, Sligo, Donegal & Leitrim

Table 3.1: Regional Modelling System

Each regional model has the following key attributes:

- Full geographic coverage of the relevant region;
- A detailed representation of the road network;
- A detailed representation of the public transport network & services;
- A representation of all major transport modes including active modes (walking and cycling);
- A detailed representation of travel demand, e.g. by journey purpose, car ownership/availability, mode of travel, person types, user classes & socio-economic classes, and representation of five time periods (AM, Lunch Time, School Ride, PM and Off-Peak);
- A prediction of changes in trip destination in response to changing traffic conditions, transport provision and/or policy; and
- A prediction of mode-choice in response to changing traffic conditions.

Figure 3-1 illustrates the geographical extent of each of the Regional Models.

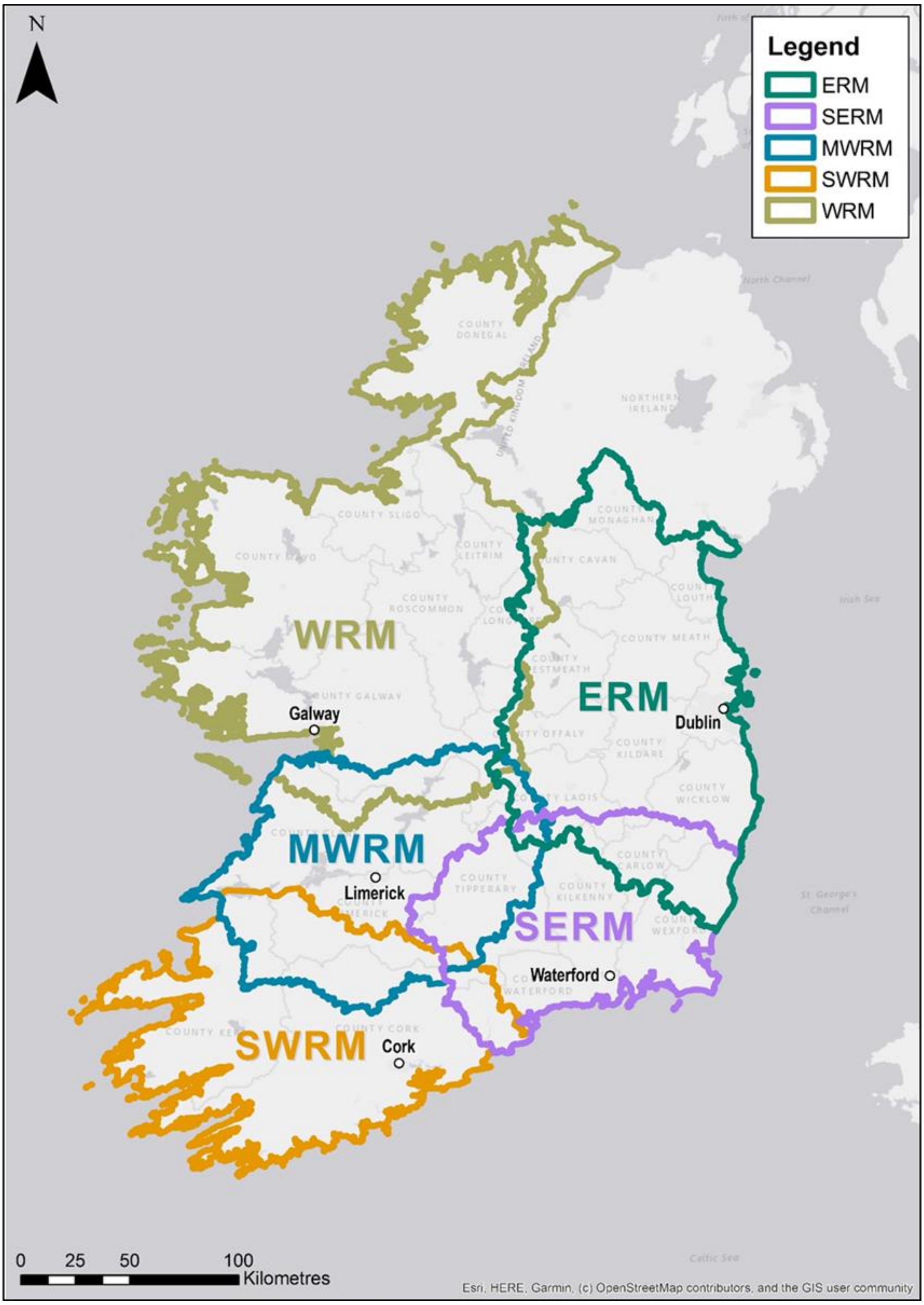


Figure 3-1: Regional Modelling Systems – Areas of Coverage

The West Regional Model (WRM), which is centred around Galway City and covers County Galway, Donegal, Leitrim, Sligo, Roscommon and Mayo, has been used to support the demand modelling and forecasting for the modelling and appraisal of the Galway Dublin Road scheme.

3.2 RMS Overarching Structure

All the regional models, including the WRM, include 3 core modelling processes (Demand Model, Road Assignment Model, Public Transport Assignment Model) which receive inputs from the National Demand Forecast Model (NDFM) and provide outputs for transport appraisal and secondary analysis. This process is shown in Figure 3-2.

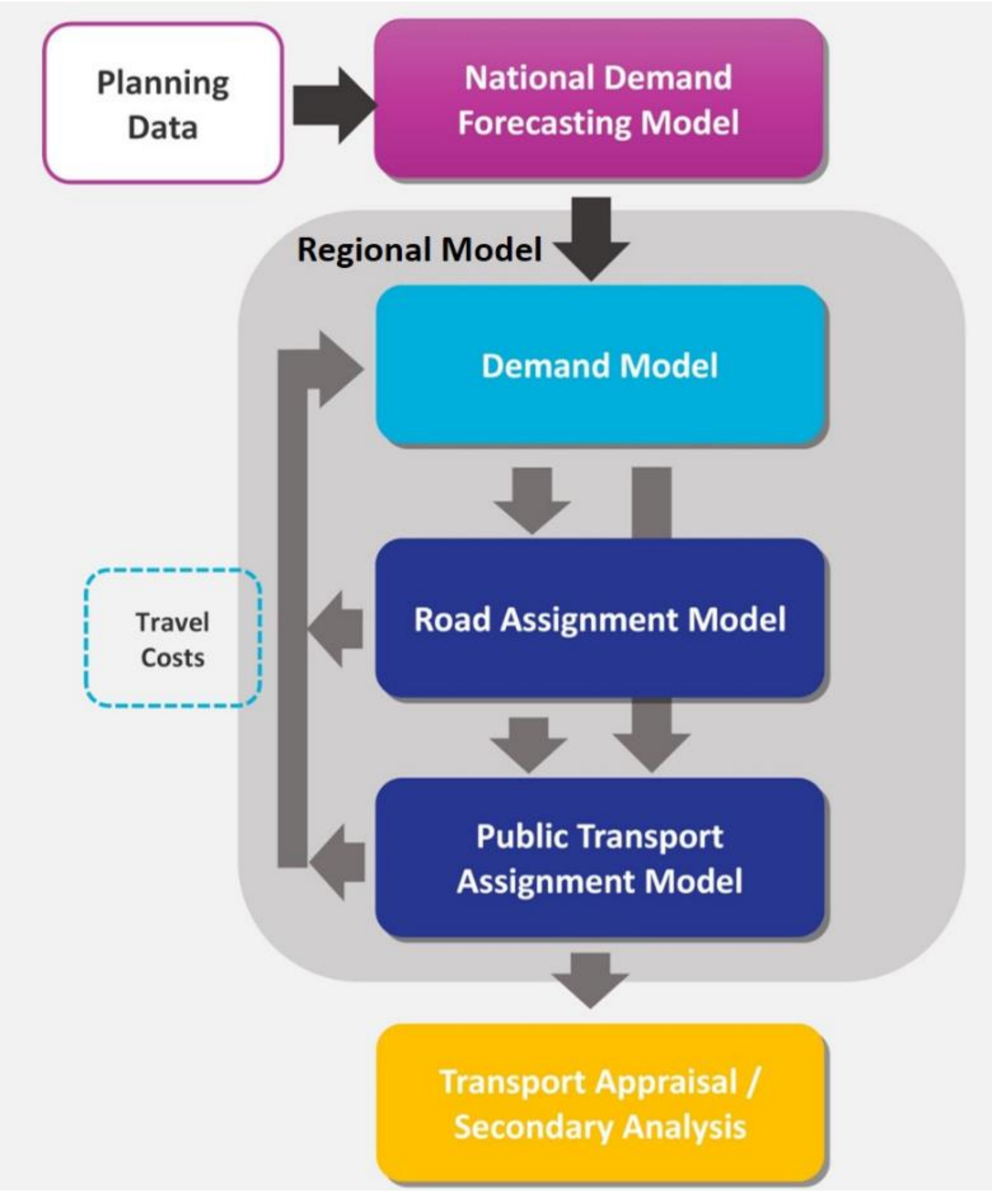


Figure 3-2: Regional Modelling System Structure

The two main RMS components (NDFM and Regional Model) are discussed in more detail below.

3.3 National Demand and Forecasting Model (NDFM)

The NDFM is a separate modelling system that estimates the total quantity of travel demand generated by, and attracted to, every Census Small Area (CSA) daily. The level of demand from, and to, each CSA (referred to as trip ends) is related to characteristics such as population, number of employees, educational establishments, and other land-use data. Trip ends are then used by Regional Models to create travel demand matrices for the internal area of each of the Regional Models.

Additionally, the NDFM also estimates the inter-regional demand (demand crossing the boundary of each of the Regional Models), which then forms the external demand for each of the Regional Models.

The NDFM consists of five interoperating components, as follows:

- Planning Data Adjustment Tool (PDAT) – prepares the planning data forecasts, which are then used by other applications within the NDFM suite.
- Car Ownership / Car Competition Models (COCMP) – forecasts car competition for each Census Small Area (proportion of households with no cars, with fewer cars than adults and with the same number or more cars than adults).
- National Trip End Model (NTEM) – provides a forecast on the numbers of trips to and from each CSA in Ireland for a typical weekday. NTEM derives trip ends by journey purpose based on various attributes of each CSA, such as levels of employment and population.
- Long Distance Model (LDM) – provides a forecast on the number of long-distance trips (trips longer than 20km) which are made on a typical weekday across Ireland and Northern Ireland.
- Regional Model System Integration Tool (RMSIT) – converts the long-distance trips generated by the LDM into external demand entering/exiting each Regional Model, with entry and exit points represented by route zones.

A high-level overview of the NDFM is shown in Figure 3-3.

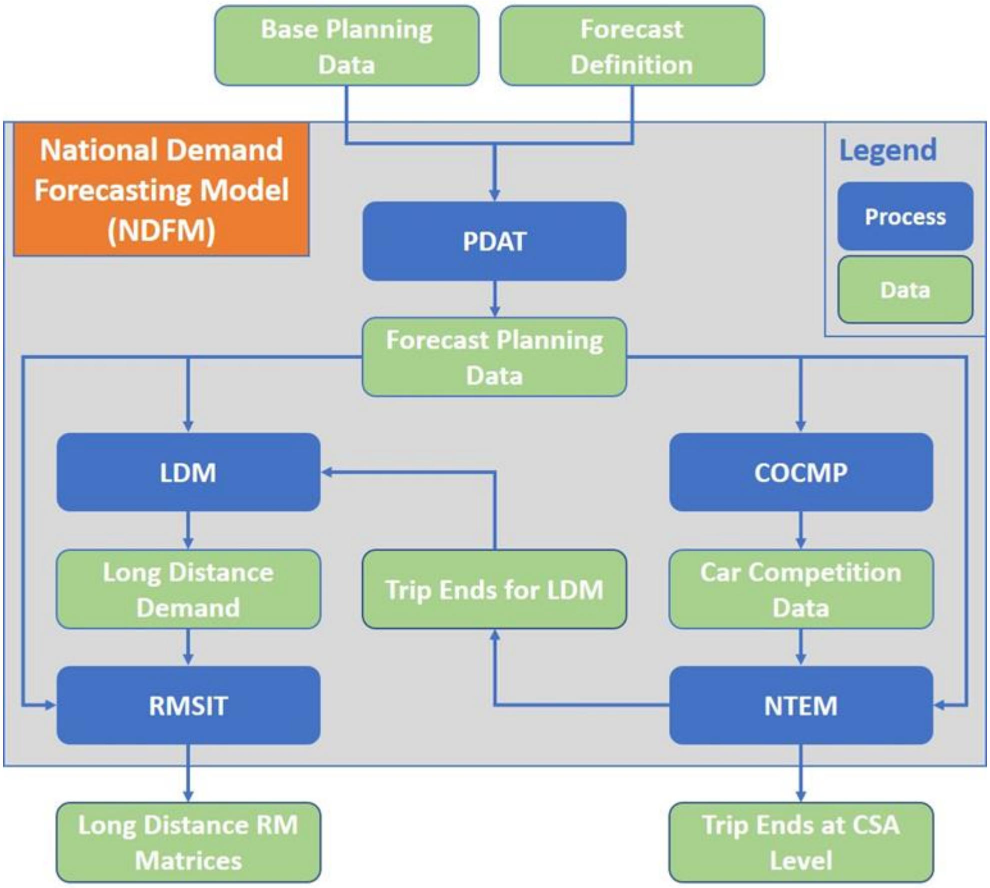


Figure 3-3: NDFM Structure

The Planning Data shown in Figure 3-3, represents a key input into the NDFM. It is a national database of 114 demographic and spatial variables for each of the 18,641 CSAs in the state. The main categories of planning data are:

- Spatial definitions (CSA/DED/NUTS names, area types etc.);
- Production related variables – demographic data about residents living in each CSA (e.g. total population living in each CSA, age bands, gender, employment status etc.);
- Attraction related variables – data related to employment and education in each CSA (e.g. number of jobs within each CSA, number of education places etc.).

Further details about the NDFM structure, its components and calibration can be requested from the NTA via the NTA's website[1]

[1] https://www.nationaltransport.ie/planning-and-investment/transport-modelling/regional-modelling-system/ndfm-overview-rtm/

3.4 West Regional Model (WRM)

3.4.1 Model Dimensions

The WRM dimensions are defined in terms of:

- Zone system;
- Modes of travel represented;
- Base year;
- Time-periods; and
- Demand segmentation.

3.4.1.1 Zone System

The zone system definitions for each of the regional models were based on Census Small Area (CSA) boundaries and Electoral Districts (EDs). The 2016 CSAs are the core base layer for each zoning system. The criteria used for developing zone boundaries for the WRM and other regional models included:

- Population, Employment and Education – maximum values were specified for zone population, number of jobs and persons in education;
- Activity Levels – limits were applied to zone activity levels ensuring that zones with either very low, or very high, levels of trips were not created;
- Intra-zonal Trips – threshold values were applied to the proportion of intra-zonal trips, within each zone, to avoid an underestimation of flow, congestion and delay on the network;
- Land Use – zones were created with homogeneous land use and socio-economic characteristics where possible;
- Zone Size/Shape – thresholds were applied to zone size, and irregularity of shape, to avoid issues with inaccurate representation of route choice;
- Political Geography – zone boundaries do not intersect ED boundaries;
- Special Generators/Attractors – large generators/attractors of traffic such as Airports, Hospitals, shopping centres etc. were allocated to separate zones.

The West Regional model includes 693 internal zones as follows:

- Galway City: 138
- Galway County: 201
- Donegal County: 108
- Leitrim County: 27
- Sligo County: 46
- Roscommon County: 48
- Mayo County: 123
- Special Zones: 2 (Knock Airport and Donegal Airport)

Figure 3-4 shows the WRM Zone System.

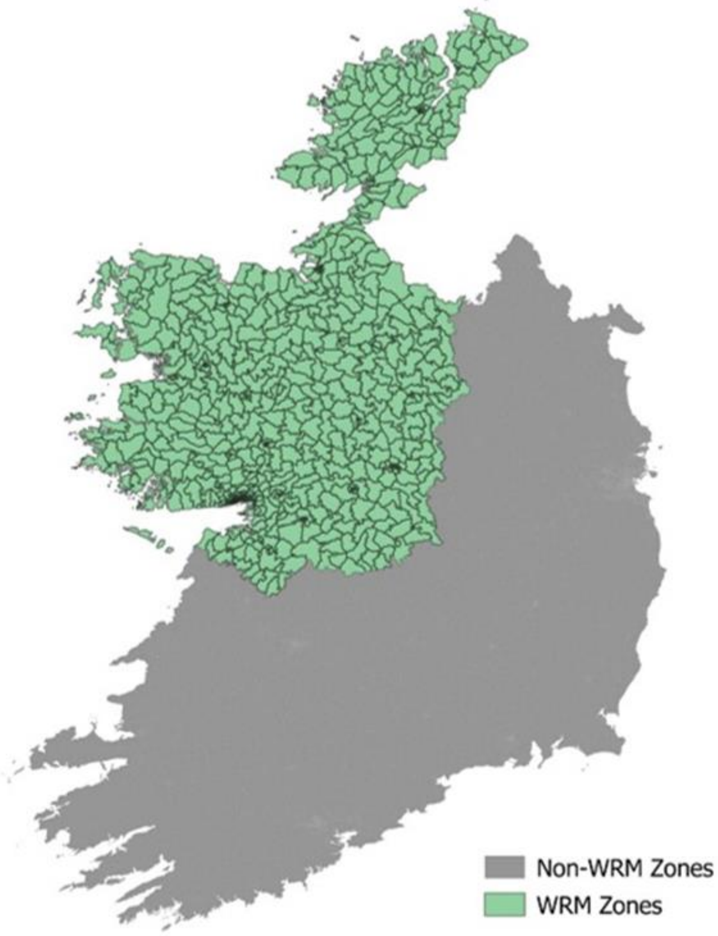


Figure 3-4: WRM Zone System

External zones represent demand from areas across the country to / from the West Regional Model study area. This demand is provided by the Long Distance Model, part of the NDFM. The LDM is a national model designed to provide external trips for each of the Regional Models, this includes both Road and PT demand. This demand is assigned to the WRM through route zones representing entry/exit points into the WRM study area by major roads and rail. There are 35 route zones in the WRM. Further information on the WRM Zone System can be found in the WRM zone system development report[2].

[2] https://www.nationaltransport.ie/wp-content/uploads/2018/06/WRM_Zone_System_Development_Report-1.pdf

3.4.1.2 *Modes of Travel*

The regional model covers all surface access modes for personal travel and goods vehicles:

- Private vehicles – taxis and cars;
- Public transport – bus, rail, Luas, BRT, Metro;
- Active modes – walking and cycling; and
- Goods vehicles – light goods vehicles and heavy goods vehicles.

3.4.1.3 *Base Year*

The base year of each regional model is 2016 with a nominal month of April. This is largely driven by the date of the Census (POWSCAR) and the National Household Travel Survey (NHTS).

3.4.1.4 *Time Periods*

The regional model represents an average weekday. The day is split into five time periods as detailed in Table 3.2 below. The periods allow the relative difference in travel cost between time periods to be represented.

Period Name	Demand Model Period	Assignment Period
AM Peak	07:00-10:00	08:00-09:00
Morning Inter Peak – Lunch Time (LT)	10:00-13:00	12:00-13:00
Afternoon Inter Peak – School Run (SR)	13:00-16:00	15:00-16:00
PM Peak	16:00-19:00	17:00-18:00
Off Peak	19:00-07:00	20:00-21:00

Table 3.2: Time Periods

3.4.2 Core Modelling Processes

The WRM includes the following core modelling processes:

- Demand Model;
- Road Assignment Model;
- Public Transport Assignment Model; and
- Active Modes Model

3.4.2.1 Demand Model

The Demand Model processes all-day travel demand from the NDFM through a series of choice models to represent combined mode, time of day, destination and parking decision making. The outputs of the demand model are a set of trip matrices which are assigned using the Road Assignment Model and Public Transport Assignment Model to determine the route-choice and generalised costs.

The demand model consists of several components:

- Macro Time of Day;
- Mode Choice;
- Destination Choice;
- Parking; and
- Tours and One-Way.

A simple representation of the model structure is shown in Figure 3-5.

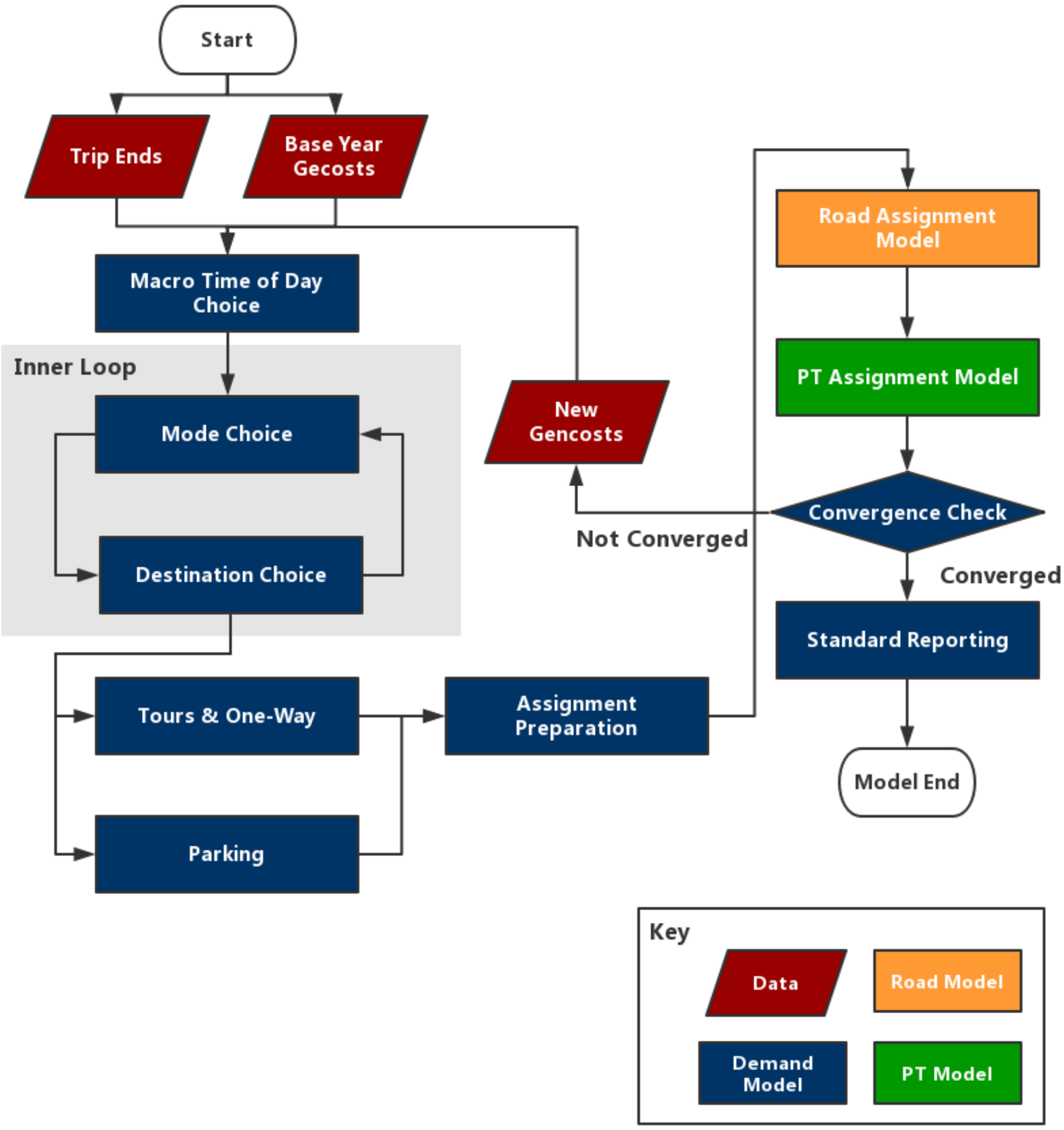


Figure 3-5: Demand Model Structure

3.4.2.2 Road Assignment Model

The main purpose of the Road Assignment Model (RDAM) is to assign road users to routes between their origin and destination zones. The RDAM is implemented in SATURN road assignment software and includes capacity restraint whereby travel times are recalculated in response to changes in assigned flows.

The inputs to the Road Assignment Model from the Demand Model are the road assignment matrices. The outputs from the Road Assignment Model back to the Demand Model consist of generalised cost of travel by time period.

3.4.2.3 Public Transport Assignment Model

To generate costs to update the Demand Model processes, a PT assignment must be undertaken to establish new generalised costs. The Public Transport Assignment Model (PTAM) is used to allocate PT users to services between their origin and destination zones. The model includes a representation of the public transport network and services for existing and planned modes within the modelled area. In addition, the PTAM network includes walk links to provide for improved permeability and access.

The model includes (where appropriate):

- Heavy Rail;
- Light Rail;
- Urban Bus;
- Inter-Urban Bus; and
- Bus Rapid Transit (BRT).

The outputs from the Public Transport Assignment Model for the Demand Model processes consist of the assigned networks which are passed on to the Active Modes Model and generalised cost skim matrices by user class for each of the assigned time periods that feed back into the main Mode and Destination choice demand model loop. An overview of the PTAM process is shown in Figure 3-6.

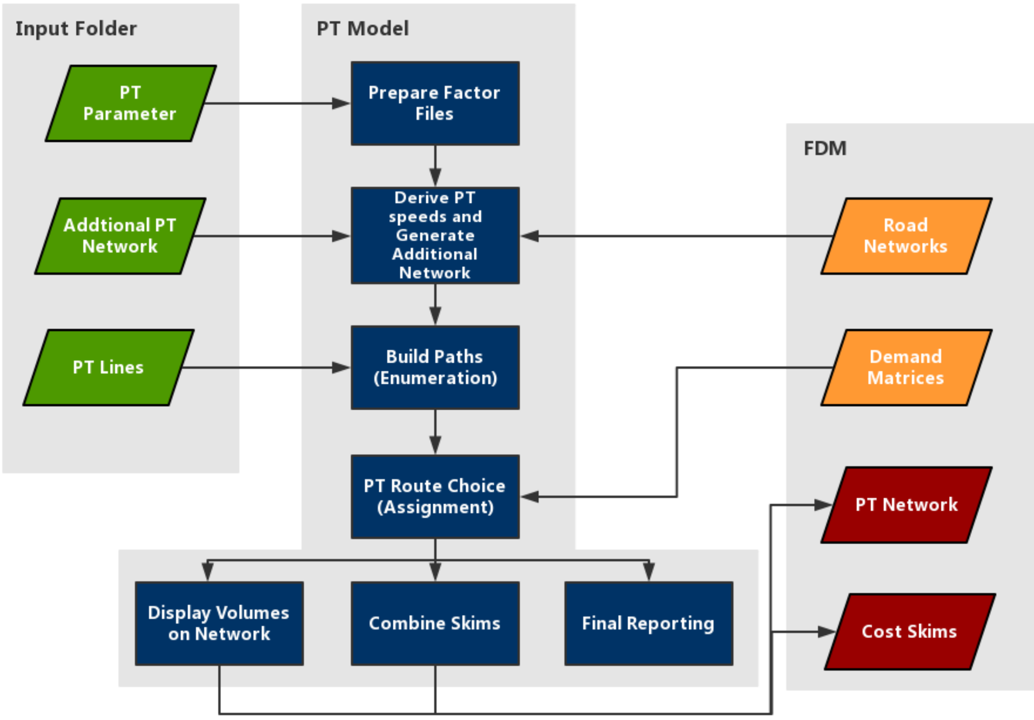


Figure 3-6: PT Model Process

3.4.2.4 Active Modes Model

The active modes assignment is run after the PTAM using the PT network with rail and motorway links removed. The active mode assignment is a shortest path assignment and does not include delays or crowding.

The inputs for the active assignment model are the output CUBE format PT networks, the demand model produced assignment matrices and separate input pedestrian only links and cycle lanes. The outputs of this process include an assigned network with walk and cycle flows by user class, and a set of generalised cost skims. The active assignment is a CUBE-based lowest cost path assignment model with no junction modelling based purely on distance and a constant speed by mode.

3.5 Suitability of West Regional Model

3.5.1 Model Calibration and Validation

The WRM has been subject to a comprehensive calibration and validation process in line with best practice guidelines whereby a substantial amount of observed data has been incorporated into both the demand model and the assignment models as presented in Table 3.3.

Demand Model	Assignment Models
Tour proportions	Road traffic volumes
Generalised cost distributions	Road journey times
Travel distance distributions	Road trip length distribution
Modal share	Public transport in-vehicle time factors
Journey time distribution	Public transport fares and ticket types
	Public transport passenger flows
	Public transport boardings and alightings
	Public transport journey times
	Public transport interchange/transfers

Table 3.3: Observed data used for Model Calibration and Validation

The calibration and validation process ensures that the WRM accurately reflects existing conditions and 'costs' associated with travel. This allows changes in the transport demand and impacts of strategic transport infrastructure schemes and transport policies to be modelled and tested using the WRM. Further details on the WRM calibration can be found in the Model Development and Calibration Reports available on the NTA's website[3].

3.5.2 Use of WRM for Strategic Transport Planning

The model has many strengths and features that make it the ideal tool to aid the strategic planning process. The WRM has been developed from first principles making best use of the most recently available data (POWSCAR and NHTS) to replicate travel choices and transport network conditions as accurately as possible.

Several distinct journey purposes and characteristics including car availability, employment status, and education level are considered within the model to evaluate travel choices more accurately. This carries through to forecasting whereby specific person type demand can be forecast to derive appropriate trip distributions and future year travel conditions.

3 https://www.nationaltransport.ie/planning-and-investment/transport-modelling/regional-modelling-system/regional-multi-modal-models/west-regional-model/

The model utilises a tour-based approach which allows for more accurate mode choice modelling and consideration of travel costs.

Four main modes of travel are included in the model: private car, public transport, walking, and cycling. Each mode has been calibrated individually, for each journey purpose, to replicate observed trip cost distributions.

The use of SATURN software in the road model allows for junction modelling to be included in the model which improves network representation in congested areas. Link speeds and delays are transferred to the public transport model which allows journey times of on-street modes (Bus, BRT) to reflect modelled traffic conditions, and changes in conditions, rather than being based strictly on timetables.

3.5.3 Summary

The West Regional Model provides a comprehensive representation of travel patterns across the Galway Dublin Road Study area and it is a suitable tool for providing the basis for assessing the effects of the Proposed Development.

4. FORECAST LAND-USE ASSUMPTIONS

4.1 Introduction

This Chapter describes the land use assumptions used in development of forecasts for the individual forecast years and present population and employment growth within the study area.

The land use forecasts have been prepared by the NTA for the required years including our new LAM Base year, opening year, design year, and horizon year (2022, 2028, 2043, and 2058). Reference to the individual NTA's NDFM forecast scenarios is shown in Table 4.1.

Forecast Year	NDFM Forecast Scenario	NDFM Version
2022	D22	V045
2028	W_D1_28	V049d_06a
2043	W_D1_43	V049d_06a
2058	W_D1_58	V049d_06a

Table 4.1: NDFM Forecast Scenarios

Forecasts of population, employment and education data are defined by the National Transport Authority at the Census Small Area (CSA) level for the standard reference years of 2024 and 2040. The years required for this project (2022, 2028, 2043, and 2058) are derived by linear interpolation between these NTA's reference case planning sheets and the 2016 Census-based planning sheet. The National Demand Forecasting Model then converts planning data forecasts to trip forecasts (in total productions and attractions per zone) for input to the WRM.

4.2 Population Growth

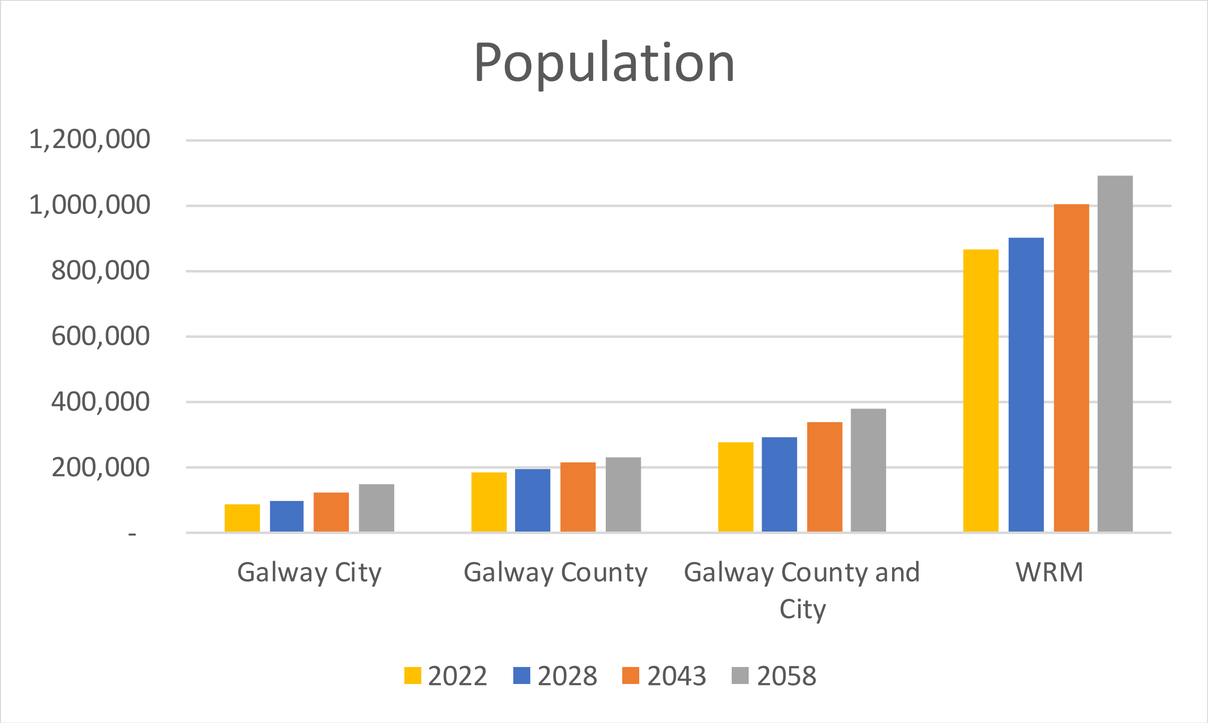


Figure 4-1: Population Growth

As can be seen from Figure 4-1, the population is expected to grow substantially in the future both in Galway City/County and across the WRM region.

Galway City will see an increase from 89,000 in 2022 to 99,000 in 2028, 124,000 in 2043, and 148,000 in 2058. This is a 67% increase in the period 2022 to 2058 or an average 1.4% p.a. The annual percentage increases are higher in earlier years with growth averaging 1.8% p.a. in the period 2022 to 2028 reducing to 1.2% p.a. in the 2043 to 2058 period.

Galway County has much lower levels of population increases than the city with the increase being 23% by 2058, translating to an average annual increase of 0.6%, with 0.7% earlier and 0.5% later in the period. Together with the city the increases are 37% to 2058 or 0.9% p.a. average through the period.

The WRM model area sees an increase from 864,000 in 2022 to 904,000 in 2028, to just over 1 million in 2043, and 1.1 million in 2058. This is a 26% increase in the period 2022 to 2058 or an average 0.6% p.a. The annual percentage increases are higher in earlier years with growth averaging 0.8% p.a. in the period 2022 to 2028 reducing to 0.6% p.a. in the 2043 to 2058 period.

4.3 Employment Growth

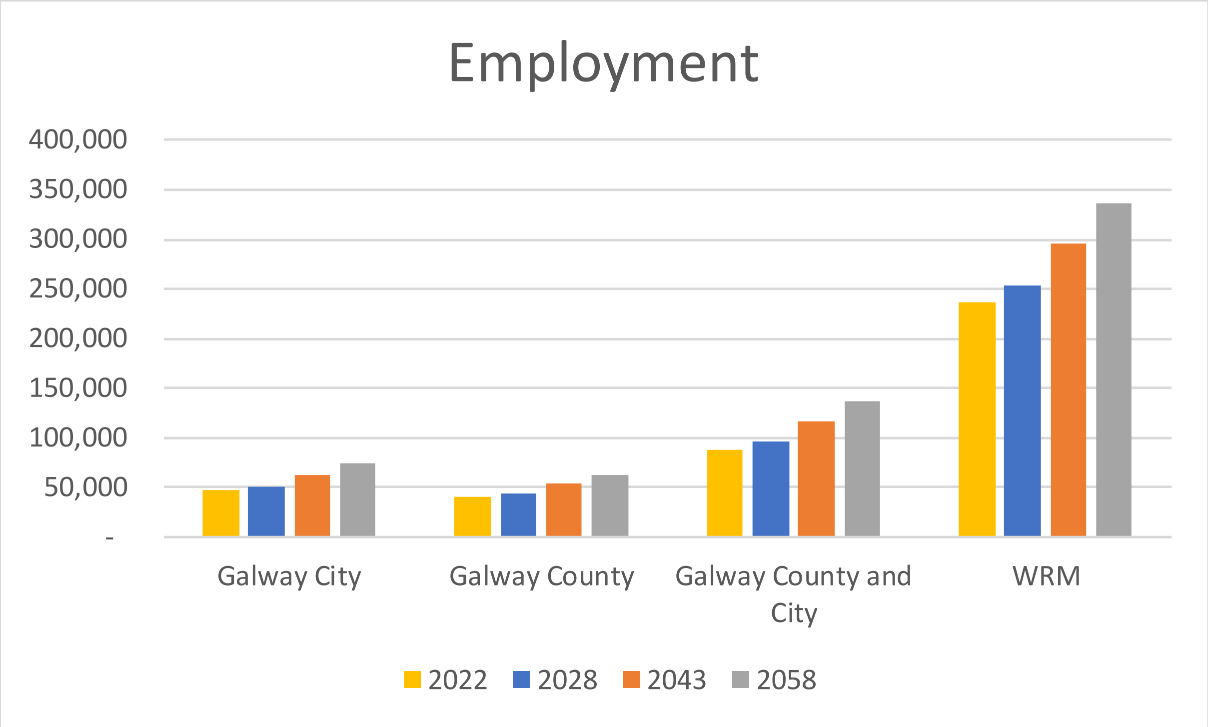


Figure 4-2: Employment Growth

Figure 4-2 shows the growth in employment attractions in the core forecast planning sheets, which is closely linked to the number of jobs. As the figure shows, this is forecast to grow significantly, both within Galway City and County, and across the WRM region.

Galway City will see in increase in jobs of around 60% in employment between 2022 and 2058 (average 1.3% p.a.) which is marginally lower than the 67% growth figure for population. Galway County is forecast to increase jobs by 51% (or 1.2% p.a.) in the same period, which is much higher than the forecast population increase of 23%.

This has the effect that across Galway City and County employment is forecast to increase by 56% between 2022 and 2058 compared with a population increase of 37%. The difference may be partly explained by an increase in participation in the employment market.

The WRM model area will see an increase in jobs of around 42% between 2022 and 2058 (average 1.0% p.a.) which is lower than the 26% growth figure for population, similar to the effect at the City + County level.

5. MODELLED SCENARIOS

5.1 Overview

Two main scenario types have been tested in the WRM to assess the impact of the scheme. These are:

- Do Minimum – committed schemes only; and
- Do Something – committed schemes and Proposed Development.

Each scenario has been tested in three forecast years: 2028, 2043, and 2058.

Along with these, a 2022 Base Year has been prepared to provide a comparison accounting for recent infrastructure development and growth since the 2016 Base Year. The 2022 Base Year model is also the starting scenario for calibrating and validating the Base Year Local Area Model (LAM), which is described in Chapter 7.

5.2 Base Year

The 2022 Base Year has been developed to take into consideration recent infrastructure developments that were not included in the 2016 calibrated WRM model. The 2022 WRM Base Year has been built starting from the calibrated 2016 WRM with the addition of the pieces of infrastructure listed in Table 5.1.

SCHEME	DESCRIPTION
Parkmore Widening	Widening of Ballybrit Crescent in the direction of Parkmore Road
Kirwan Roundabout	Upgrade from a roundabout to a large complex signalised junction
M17-M18	M17 and M18 motorways between Gort and Tuam with connection to the M6
Right Turn Bans	Right Turn bans at Moneenageisha Cross and Threadneedle/Taylors Hill
Martin Roundabout Construction Layout Nov 2022	Temporary layout due to upgrade works – roundabout with severely reduced capacity

Table 5.1: Additional infrastructure included in the 2022 Base Year

5.3 Do Minimum

The Do Minimum networks have been coded on top of the 2022 Base Year scenario and included the changes above as well as committed schemes to be implemented post-2022. Do Minimum networks have been coded for the future years 2028, 2043, and 2058.

The 2028 Do Minimum scenario includes the set of road and public transport schemes listed in Table 5.2.

The inclusion of the GTS bus services and the Cross City Link scheme was judged to be the most appropriate approach to building forecasts where the impacts of the Proposed Development would be considered robustly and in a consistent manner. The Galway City Ring Road has been excluded from the core Do Minimum scenario as the scheme has been remitted to An Bord Pleanala for further consideration. A sensitivity test has also been modelled whereby the GCRR has been added to an alternative Do Minimum scenario, in order to assess the Proposed Development alongside the GCRR.

SCHEME	DESCRIPTION
Martin Junction	Upgrade from a roundabout to a signalised junction
GTS Bus Services	Brown, red, blue, green and yellow bus routes to replace existing local bus services 401-412 and 414.
Galway Cross City Link Bus Connects Scheme	Scheme to upgrade bus priority and pedestrian and cycle provision through the city centre from University Road to Dublin Road

Table 5.2: Schemes included in the 2028 Do Minimum Scenario

The 2043 and 2058 Do Minimum networks are identical and have been coded on top of the 2028 Do Minimum Model networks and therefore include the full set of road and public transport schemes listed in both Table 5.2 and Table 5.3.

SCHEME	DESCRIPTION
N59 Dangan Upgrade	Speed limit increase

SCHEME	DESCRIPTION
W4 BC2 - Tuam Road Bus Corridor	It is proposed to install an outbound shared bus/cycle lane from the junction with Wellpark Rd/Connolly Av, north to the junction with the Tuam Rd and east to the junction with Bothar na dTreabh
W6 BC4 - Father Griffin Road Corridor	It is proposed to reduce vehicle speeds to advertise the presence of pedestrians and cyclists.
W7 BC5 - Monivea Road Scheme	Add an on-road bus priority to allow buses to travel to the Briarhill Junction.
W9 BC7 - Western Distributor Road Corridor	It is proposed to transform Blake and Athy roundabouts into signalised junctions and add bus lanes in both direction along the road.
W11 BC9 - Rahoon Road Bus Lane	Adding an inbound bus lane from Rahoon Cemetery to the junction with Seamus Quirke Road.
Galway City Speed Limit Changes[4]	30ph limit in city centre and other changes to speed limits on national roads

Table 5.3: Schemes included in the 2043 Do Minimum Scenario

5.4 Do Something

The Do Something network has been coded on top of the Do Minimum scenarios and includes the Proposed Development in 2028, 2043, and 2058.

The Proposed Development includes continuous bus and cycle lanes from Moneenageisha Junction to Doughiska Road Junction. Dublin Road remains two-way for general traffic. All major junctions along the route are upgraded to signalised junctions, including Skerritt Roundabout.

4 https://www.galwaycity.ie/gccfiles/?r=/download&path=L0RlcGFydG1lbnRzL1RyYW5zcG9ydC9Sb2Fkcy9EUkFGVCBTcGVjaWFsIFNwZWVkIExpbWl0cyBNYXBfSmFuLiAyMDIzLnBkZg%3D%3D

The Proposed Development also includes additional bus priority measures. These take the form of signal priority (hurry calls) for buses at signalised junctions. This assumption has been included following consultation with the National Transport Authority and Galway City Council and aligns with assumptions used in Bus Connects Dublin.

Figure 5-1 shows an overview of the Proposed Development.

Figure 5-1: Overview of the Proposed Development

5.5 Public Transport

The new bus routes, which are proposed in the Galway Transport Strategy, and have previously been considered as key within the appraisal of the Cross City Link, are included in both the Do Minimum and Do Something scenarios (in all forecast years) as the aim is to evaluate the impact of the Proposed Development only. Figure 5-2 shows the routing of the new bus routes. These lines are coded as indicated in Table 5.4.

As outlined in chapter 6 of the EIAR, bus journey time data for the length of Dublin Road was provided by the NTA from the Automatic Vehicle Location (AVL) dataset used to monitor bus performance. The data provides information on bus travel time between existing bus stops and has been used to inform the development of the transport models used to assess the impacts of the Proposed Development. Time factors have been calculated by comparing peak hour periods to interpeak (uncongested) periods and those factors have been applied to the bus routes in the Do Something scenarios to reflect the possible savings which are likely to be achieved.

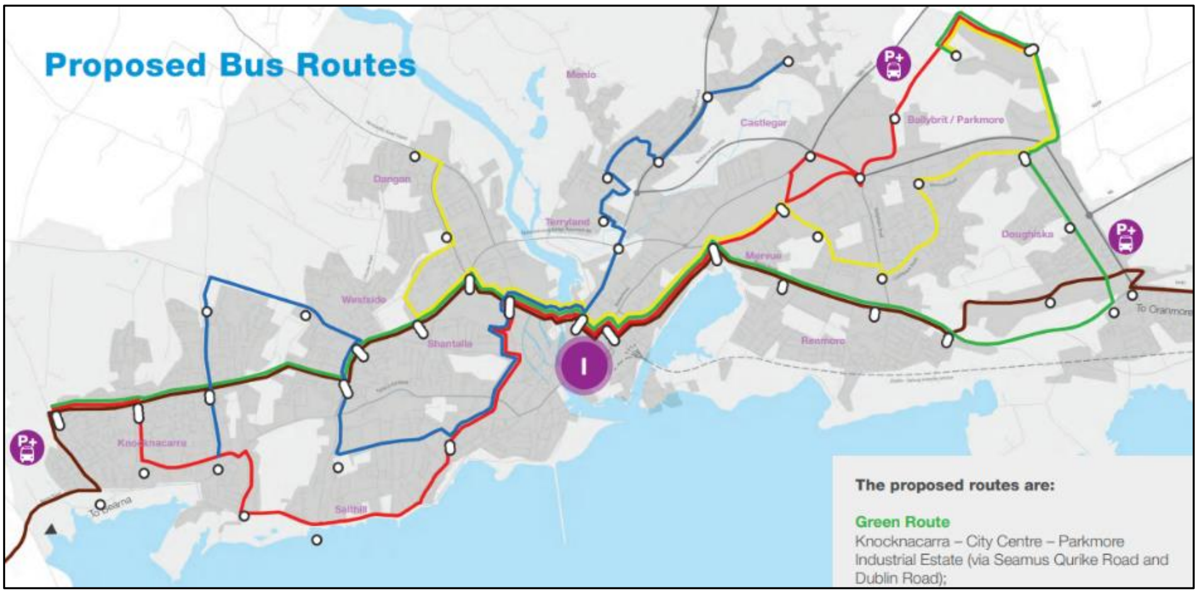


Figure 5-2: Galway Bus Connects bus routes

SERVICE	NAME	ROUTE	HEADWAYS [MIN]	TIME FACTORS (DS ONLY)
8001	Brown	Bearna-Oranmore: Eastbound	AM: 20 LT: 20 SR: 20 PM: 15 OP: 20	AM: 0.95 LT: 0.99 SR: 0.93 PM: 0.89 OP: 1
8002	Brown	Bearna-Oranmore: Westbound	AM: 20 LT: 20 SR: 20 PM: 15 OP: 20	AM: 0.94 LT: 0.96 SR: 0.97 PM: 0.96 OP: 1
8003	Red	Salthill - Parkmore: Eastbound	AM: 10 LT: 10 SR: 10 PM: 10 OP: 10	AM: 1 LT: 1 SR: 1 PM: 1 OP: 1
8004	Red	Salthill - Parkmore: Westbound	AM: 10 LT: 10 SR: 10 PM: 10	AM: 1 LT: 1 SR: 1 PM: 1

SERVICE	NAME	ROUTE	HEADWAYS [MIN]	TIME FACTORS (DS ONLY)
			OP: 10	OP: 1
8005	Blue	Knocknacarra - Tirellan: Eastbound	AM: 15 LT: 15 SR: 15 PM: 15 OP: 15	AM: 1 LT: 1 SR: 1 PM: 1 OP: 1
8006	Blue	Knocknacarra - Tirellan: Westbound	AM: 15 LT: 15 SR: 15 PM: 15 OP: 15	AM: 1 LT: 1 SR: 1 PM: 1 OP: 1
8007	Green	Knocknacarra - Parkmore: Eastbound	AM: 10 LT: 10 SR: 10 PM: 10 OP: 10	AM: 0.94 LT: 0.99 SR: 0.93 PM: 0.87 OP: 1
8008	Green	Knocknacarra - Parkmore: Westbound	AM: 10 LT: 10 SR: 10 PM: 10 OP: 10	AM: 0.94 LT: 0.96 SR: 0.96 PM: 0.96 OP: 1
8009	Yellow	Dangan - Parkmore: Eastbound	AM: 15 LT: 15 SR: 15 PM: 15 OP: 15	AM: 1 LT: 1 SR: 1 PM: 1 OP: 1
8010	Yellow	Dangan - Parkmore: Westbound	AM: 15 LT: 15 SR: 15 PM: 15 OP: 15	AM: 1 LT: 1 SR: 1 PM: 1 OP: 1

Table 5.4: GTS Bus Services coded in the modelling scenarios

The routes used for the Proposed Development are the same as those used previously for Cross City Link modelling and appraisal. A new proposed bus network was published which includes some changes along Dublin Road, including changes to services serving Merlin Park hospital, some changes on the outer part of Old Dublin Road, and to services serving the Ballybane, Mervue, and Renmore areas. Details of the new network are shown in Figure 5-3. These have not been included in the core modelling work for Galway Dublin Road. The impact of these changes will be largely on bus users, and it is considered that their omission will result in a conservative, low-side, estimation of benefits to bus users, as fewer buses use the Proposed Development in the older bus service definitions that are used for modelling and appraisal.

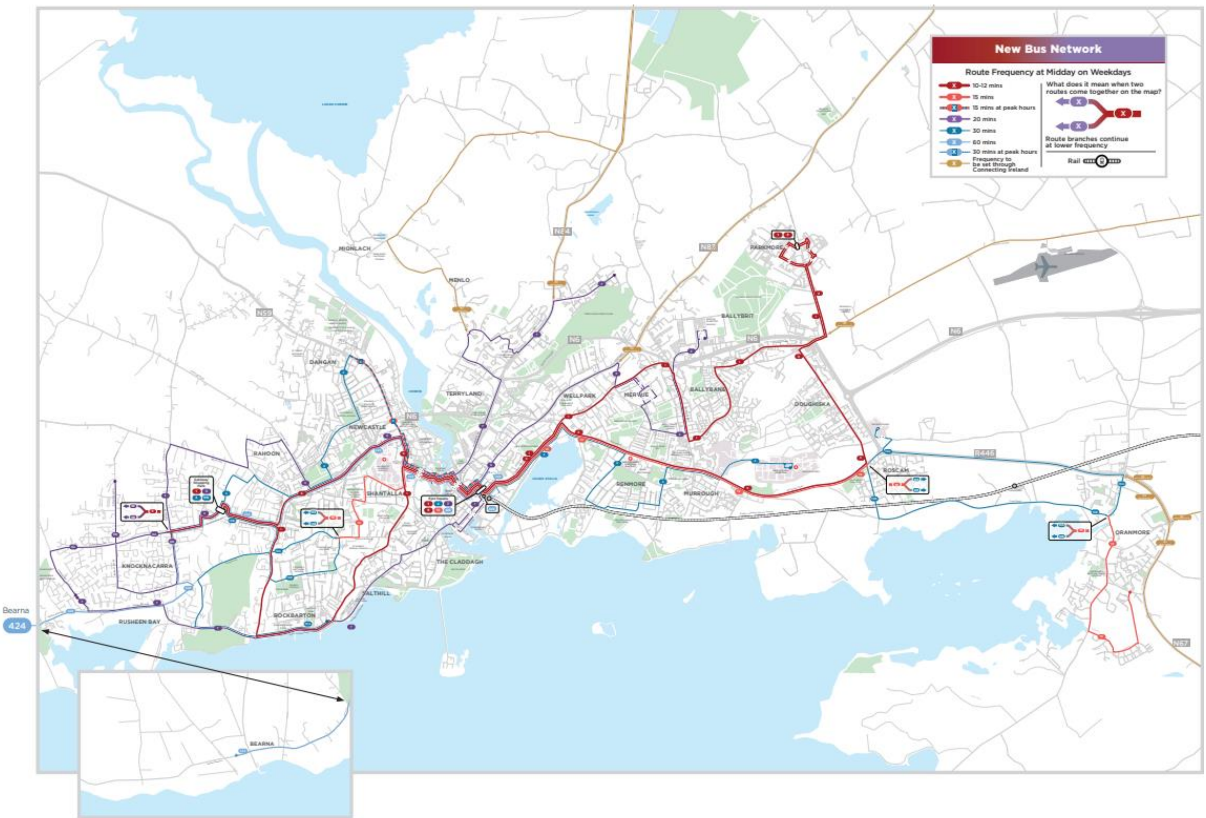


Figure 5-3: Galway Bus Connects Bus Routes

5.6 Galway City Ring Road Sensitivity Test

A sensitivity test was also modelled whereby the Galway City Ring Road (GCRR) was included in both the Do Minimum and Do Something scenarios. This test will enable the impact of the Proposed Development to be assessed, if the GCRR is built.

6. WRM MODELLING RESULTS

This chapter outlines the results of the modelling, listing the following key statistics for each modelled scenario:

- Number of trips and mode shares for Cycling, Walking, PT and Car;
- Public Transport Flows through the corridor
- Bus Journey Times

6.1 Trips and Mode Shares

This chapter outlines the number of trips over 24 hours and mode shares for the Galway City and Oranmore area shown below in Figure 6-1. Results are shown for the 2028 and 2043 Do Minimum and Do Something scenarios. Light and heavy goods vehicles are not included.

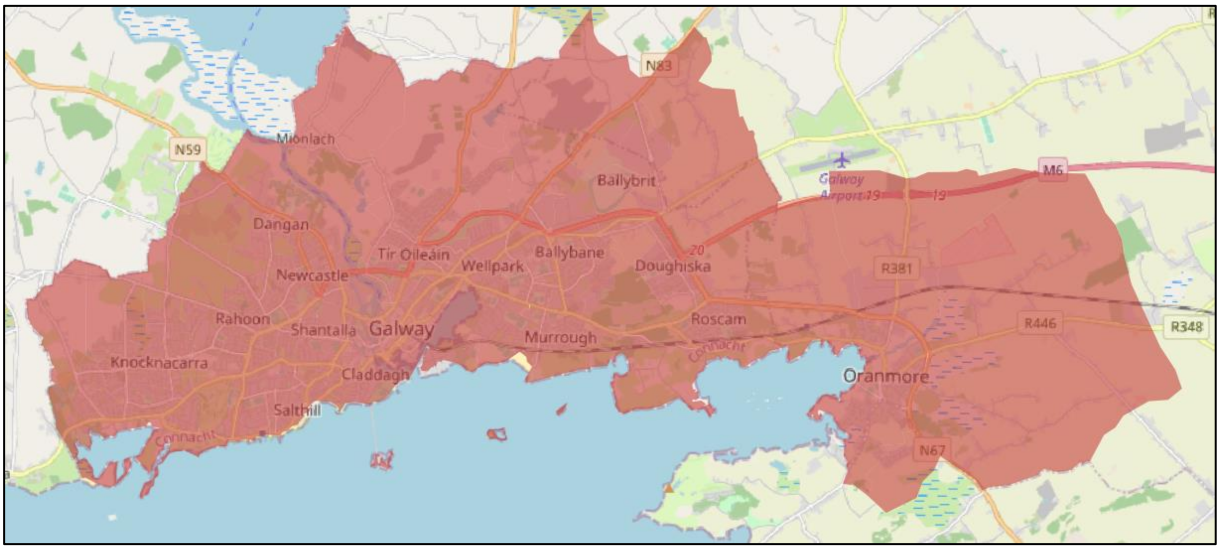


Figure 6-1: Galway City and Oranmore area used for reporting Mode Shares and Number of Trips

The number of trips per scenario over 24 hours is shown below for the Galway City and Oranmore area. Looking at the figure, we can see that the number of trips made by car reduces slightly in all scenarios, while walking, cycling and PT increases.

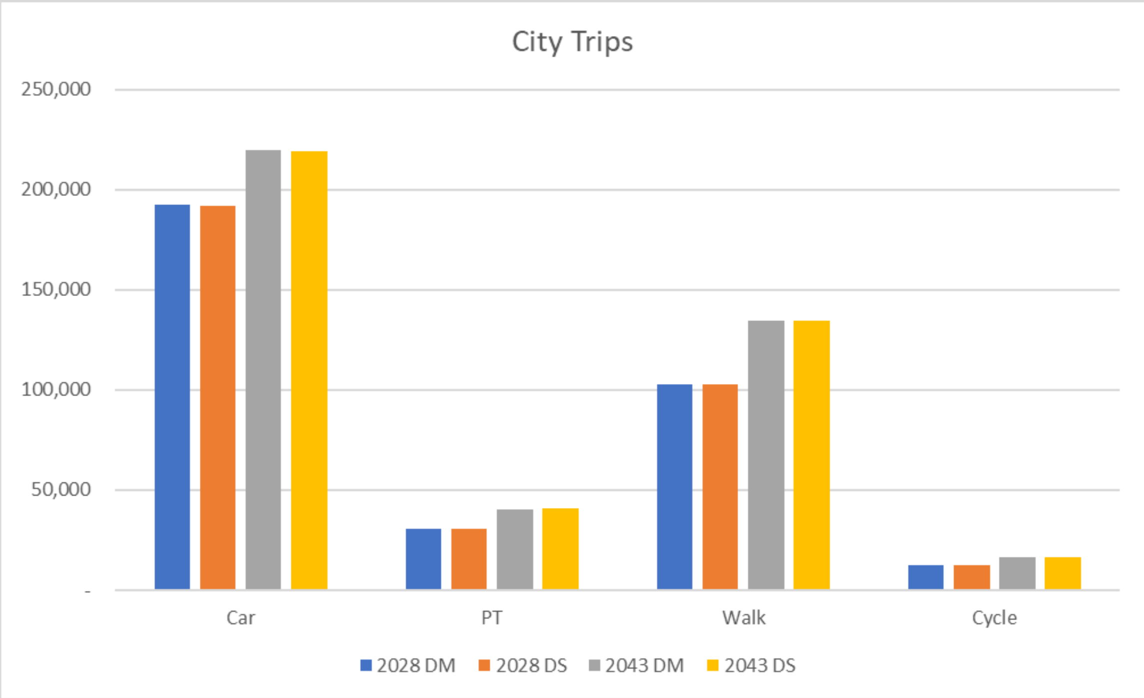


Figure 6-2: Number of trips by mode within Galway City

The AM and PM mode shares within Galway City and Oranmore are shown below in Figure 6-3 and Figure 6-4 respectively.

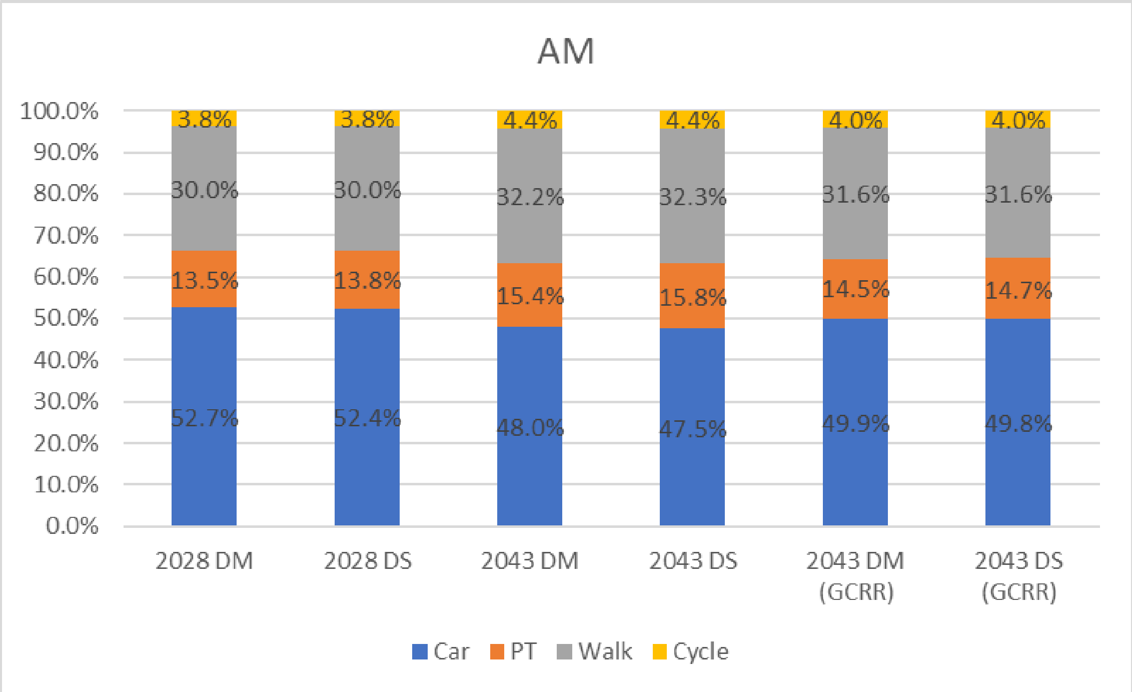


Figure 6-3: AM mode shares within Galway City & Oranmore

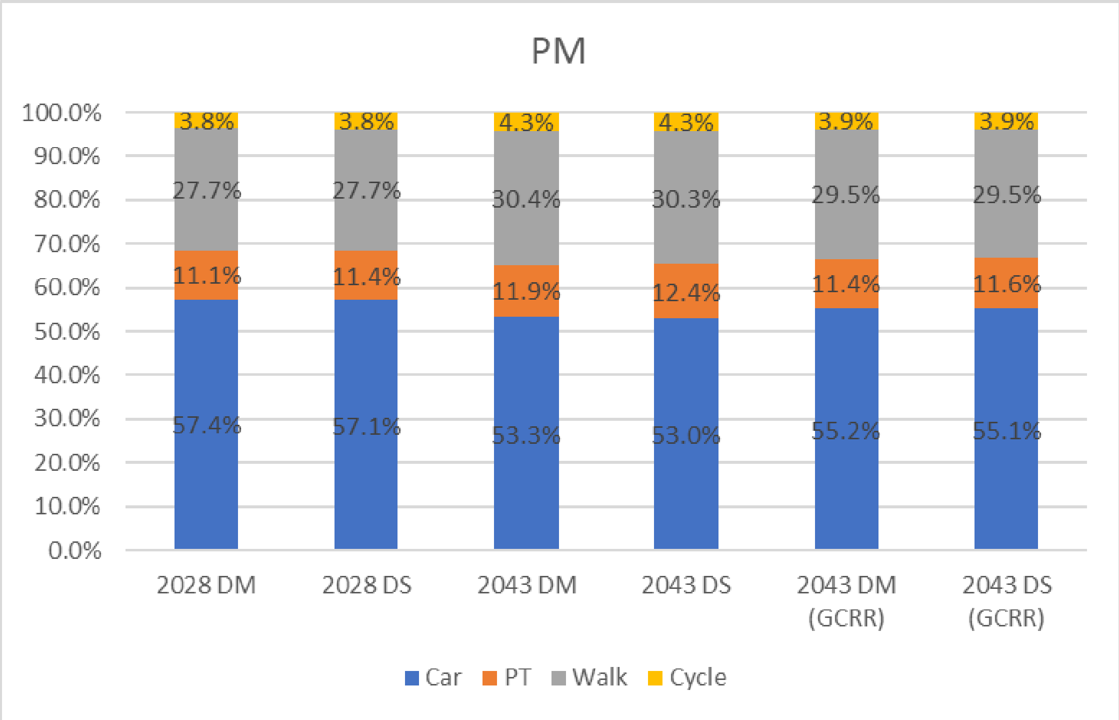


Figure 6-4: PM mode shares within Galway City & Oranmore

Figure 6-3 above shows a comparison of AM mode shares for each scenario within Galway City. In 2028 car usage decreases from 52.7% to 52.4% while we see an equivalent increase in the public transport mode share, which rises from 13.5% in the DM scenario, to 13.8% in the DS. We see a similar trend in 2043 in the AM, with the car mode share reducing from 48.0% in the DM scenario, to 47.5% in the DS scenario. We also see an increase in the public transport mode share from 15.4% in the DM, to 15.8% in the DS. In the 'with GCRR' scenario, we see the public transport mode share increase from 14.5% to 14.7% and the car mode decrease from 49.9% to 49.8%.

Figure 6-4 above shows a comparison of PM mode shares for each scenario within Galway City. In 2028 car usage decreases from 57.4% to 57.1% while we see an equivalent increase in the public transport mode share, which rises from 11.1% in the DM scenario, to 11.4% in the DS. We see a similar trend in 2043 in the PM, with the car mode share reducing from 53.3% in the DM scenario, to 53.0% in the DS scenario. We also see an increase in the public transport mode share from 11.9% in the DM, to 12.4% in the DS. In the 'with GCRR' scenario, we see the public transport mode share increase from 11.4% to 11.6% and the car mode decrease from 55.2% to 55.1%.

Given the large area covered and the local nature of the scheme, the results are deemed reasonable.

6.2 Public Transport Journey Times

The figures below shows the average journey times across the full length of the corridor in the AM and PM peaks in 2028. These journey times are from the microsimulation model which was used to assess the opening year of 2028. For further information on the microsimulation model which was developed, see the *Galway Dublin Road Busconnects VISSIM Model Report*.

It should be noted that additional bus priority measures, on top of the proposed bus lanes, were coded in the microsimulation models. These additional measures take the form of signal priority for buses at signalised junctions. This key assumption has been included following consultation with the National Transport Authority and Galway City Council and aligns with assumptions used in the Bus Connects Dublin scheme. This signal priority means that buses which travel through the corridor, will receive a hurry call at signalised junctions when they activate a detector in advance of the junction. This enables them to avoid waiting at the stop line for their relevant signal stage and thus travel through the junction faster and leads to reduced journey times through the corridor.

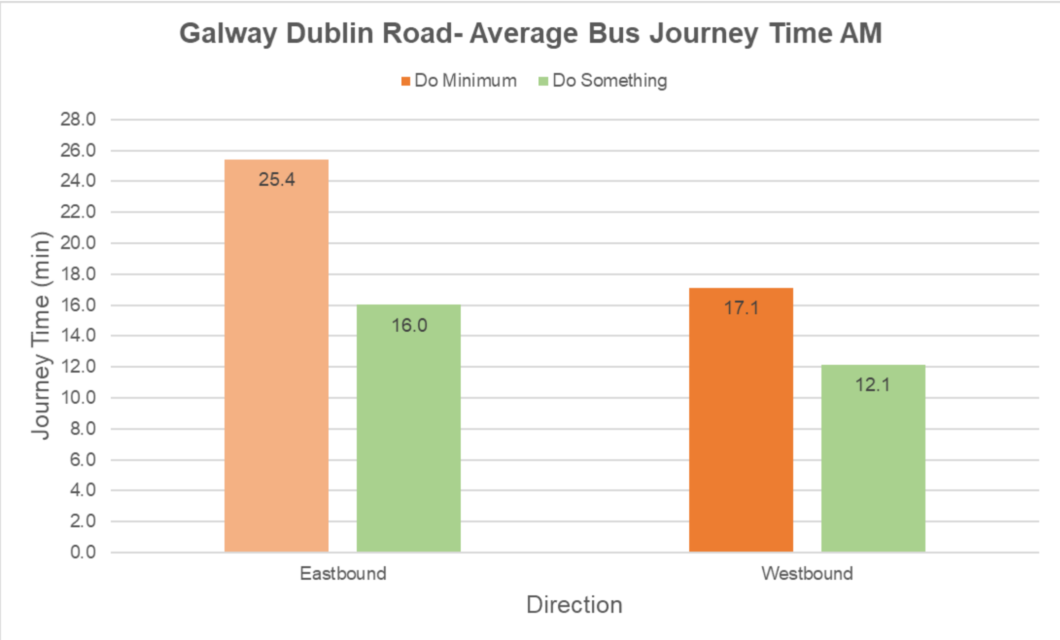


Figure 6-5: Average Bus Journey Times – AM Peak

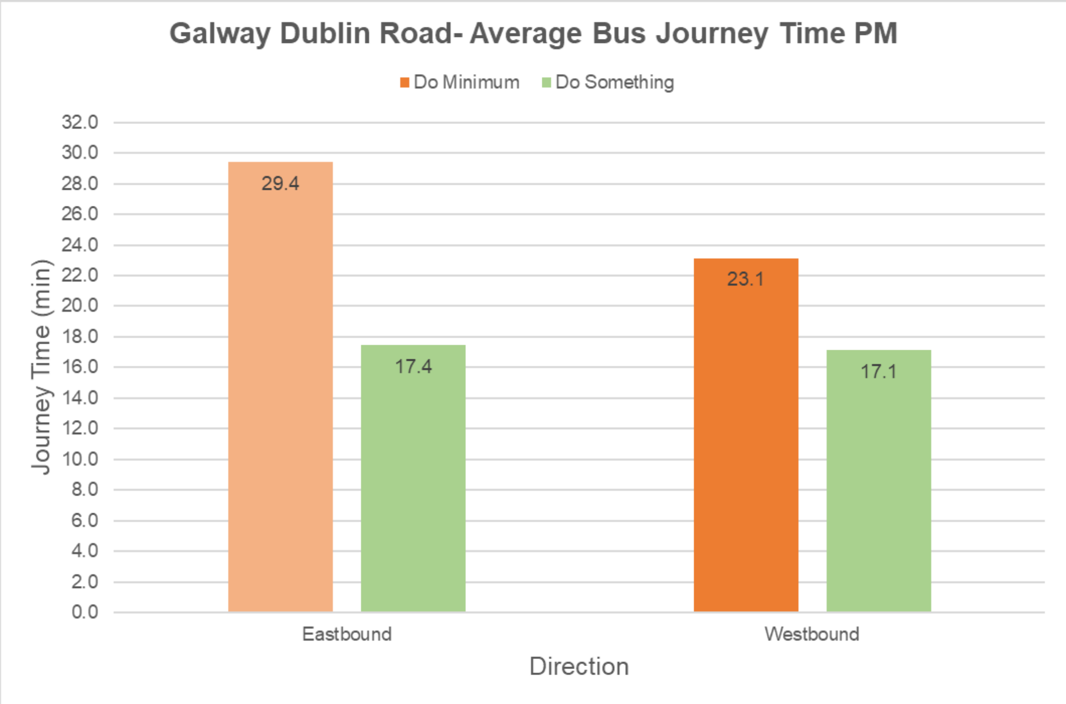


Figure 6-6: Average Bus Journey Times – PM Peak

The results show that the Do Something scenario has lower average bus journey times for both directions and both peaks when compared to the Do Minimum scenario. In the eastbound direction, there is a decrease of 8 minutes in the AM peak and 12 minutes in the PM peak. This is due to a combination of the inclusion of bus lane is the eastbound direction and signal priority for buses at signalised junctions. In the westbound direction, there is a decrease of 5 minutes in AM peak and 6 minutes in the PM peak. These are smaller decreases compared to the eastbound direction because a bus lane already exists for the majority of the corridor in that direction.

6.3 Public Transport Flows

In this section the number of Bus Passengers which travel through the corridor is reported. Table 6.1 and Table 6.2 below shows the hourly numbers of Bus Passengers which travel through the corridors in both directions in 2028 and 2043 (in the AM and PM peak hours).

Overall, bus passengers increase between the Do Something and Do Minimum scenarios in both directions and in both forecast years. The biggest increases are observed in 2043, which in the morning shows a 12% increase in bus passengers travelling westbound through the corridor and an additional 9% in the opposite direction. In the PM, we see a 32% increase in bus passengers travelling eastbound through the corridor and an additional 9% in the opposite direction. The bigger increases in the eastbound direction in the PM are mostly related to the introduction of a bus lane in that direction whereas the westbound direction, currently already has a bus lane for the majority of the route.

In the 'with GCRR' scenarios, we a similar picture with bus passengers increasing through the corridor following the Proposed Development being implemented but the increases are smaller. The morning shows a 10% increase in bus passengers travelling westbound through the corridor and an additional 8% in the opposite direction. In the PM, we see a 25% increase in bus passengers travelling eastbound through the corridor and an additional 4% in the opposite direction.

	AM				PM			
	DM	DS	Diff	Diff (%)	DM	DS	Diff	Diff (%)
Westbound	906	1008	102	11%	423	449	26	6%
Eastbound	358	394	36	10%	716	905	189	26%

Table 6.1: 2028 AM and PM hourly Bus Passengers travelling through the corridor

	AM				PM			
	DM	DS	Diff	Diff (%)	DM	DS	Diff	Diff (%)
Westbound	1320	1480	160	12%	520	567	47	9%
Eastbound	468	512	44	9%	863	1142	279	32%

Table 6.2: 2043 AM and PM hourly Bus Passengers travelling through the corridor

	AM				PM			
	DM	DS	Diff	Diff (%)	DM	DS	Diff	Diff (%)
Westbound	1236	1361	125	10%	457	476	19	4%
Eastbound	412	446	34	8%	835	1047	212	25%

Table 6.3: 2043 (With GCRR) AM and PM hourly Bus Passengers travelling through the corridor

7. GALWAY CITY LOCAL AREA MODEL

7.1 Introduction

The analysis undertaken within the WRM regional model provided a valuable measure of the impact that the Proposed Development has on transport within Galway City and environs, in particular to evaluate the effects on public transport and active modes. However, for more detailed analysis, a Local Area Model (LAM) is more suitable to assess traffic impacts caused by the new scheme on the highway network. LAMs provide an additional level of confidence in the assessments due to the greater detail and updated calibration of the road network. The LAM for example has been developed from the larger regional model with additional focus on the accuracy of e.g. signal times, turning flows and delays.

This Chapter describes the steps undertaken to develop, calibrate and validate a Base Year LAM. It then explains how the future year LAM scenarios have been produced by combining the cordoned WRM networks with future demand, the latest obtained by pivoting the Base Year matrix using the Furness Method. Finally, the main results of the local area modelling are reported. This Chapter is structured as follows:

- **Methodology**: Chapter 7.2 provides an overview of the methodology used to develop, calibrate and validate the Base Year LAM.
- **Model Specification:** Chapter 7.3 presents information on the Galway City LAM specification including the defined model area, demand segmentation, time periods modelled, model software and key assignment parameters.
- **Traffic Data:** Chapter 7.4 outlines the traffic data used to facilitate the calibration and validation of the Galway City LAM.
- **Road Network and Zone System Development:** Chapter 7.5 describes the development of the LAM road network and zone system to ensure that it provides an accurate representation of existing conditions.
- **Model Calibration Process and Results:** Chapter 7.6 outlines the calibration process adopted and the results achieved to ensure that the LAM is meeting relevant Transport Infrastructure Ireland (TII) and NTA guidelines.
- **Model Validation:** Chapter 7.7 presents the validation process and results, which demonstrate that the model is a suitable and robust tool to be used to assess the impact of the Proposed Development within the boundary area.
- **Future Year Scenarios:** Chapter 7.8 outlines the steps undertaken for developing the future year scenarios.
- **Results:** Chapter 7.9 presents the main results obtained from the future year LAM scenarios.

7.2 Methodology

The methodology for developing the Galway City LAM from the RMS is illustrated in Figure 7-1.

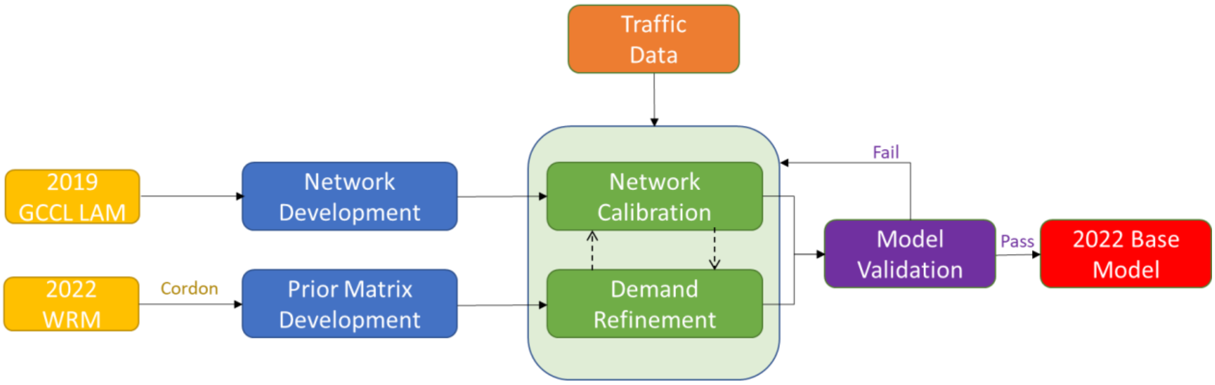


Figure 7-1: Galway City LAM Development Methodology

In Summary:

- **2019 GCCL LAM:** The LAM previously developed for the Galway Cross City Link has been used as a starting point for the network development.
- **2022 WRM Run:** the WRM has been run with 2022 NTA planning data using inputs from the 2016 model and the addition of recent infrastructure developments as reported in chapter 5.
- **WRM Cordon:** the 2022 WRM road assignment was cordoned to extract the matrix covering the Galway City LAM extent.
- **Network and Prior Matrix Development:** the initial WRM cordoned road network was reviewed in greater detail for the study area for items including junction layouts, network speeds, missing links etc. The zone system from the WRM was maintained. Further details on the network and zone system development are provided in chapter 7.
- **Traffic Data:** Traffic count data was collected from the Galway Annual Road Surveys 2022 and used to calibrate the LAM (refer to chapter 7 for further information).
- **Calibration:** calibration is the process of adjusting the model to better represent observed data. This is normally undertaken in two steps:
  - **Network Calibration:** adjustments to the road network based on observations extracted from traffic survey data e.g. altering turning capacities at junctions, updating link speeds etc.; and
  - **Demand Refinement:** adjustments to the prior matrix to better represent observed travel movements from count data.

  The Galway City LAM was calibrated in-line with Transport Infrastructure Ireland's (TII) Project Appraisal Guidelines (PAG) and the UK Department for Transport (DfT) TAG guidance, and further information is provided in Chapter 7.6.
- **Validation:** validation is the assessment of the validity of the calibrated model and its robustness in representing observed traffic conditions. Calibration and validation is an

iterative process. If the results of the validation checks are unsatisfactory, then adjustments will be made as required in order to achieve a better representation of reality. The Galway City LAM was validated in-line with TII and TAG guidance, and further information is provided in this chapter.

7.3 Model Specification

This chapter provides an overview of the key parameters that define the Galway City LAM, with specific reference to the following aspects:

- Model Area;
- Model Time Periods;
- Demand Segmentation;
- Model Software; and
- Assignment Parameters.

7.3.1 Model Area

The area to be analysed in detail is based on the same geographical area as the LAM previously developed for the Galway Cross City Link. The area has been reviewed to ensure sufficient network coverage for the Proposed Development and is illustrated in Figure 7-2.

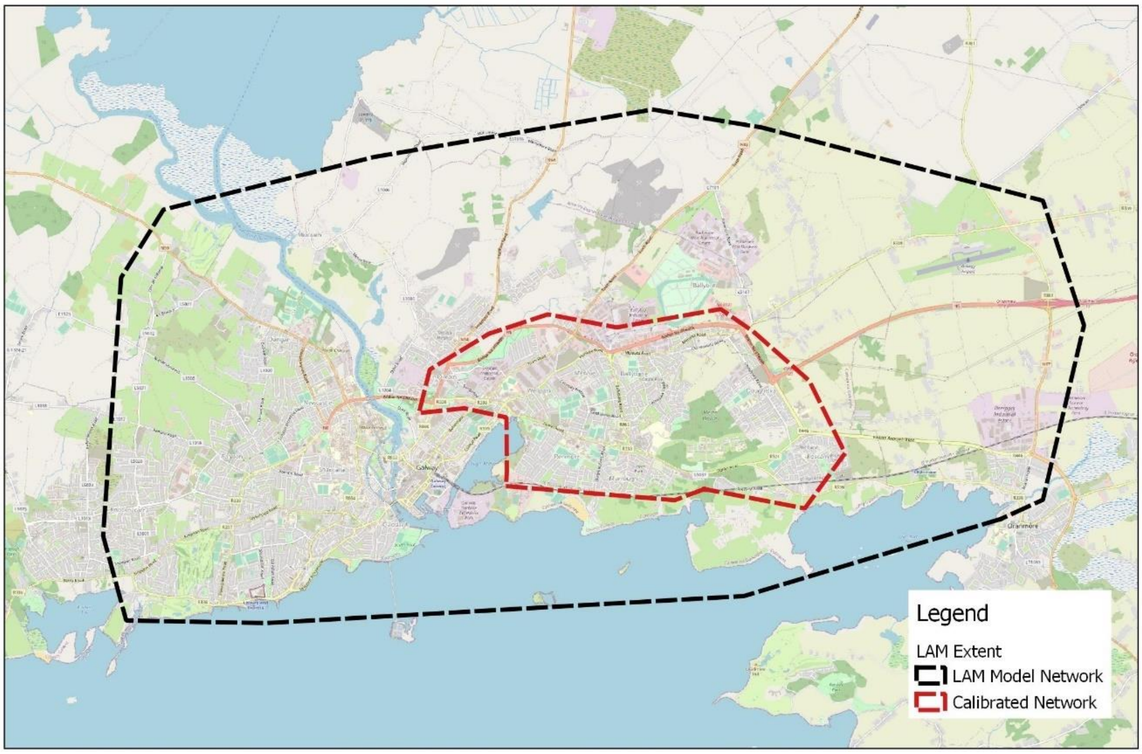


Figure 7-2: LAM Extension

7.3.2 Model Time Periods

The analysis of existing traffic data allowed to identify the typical profile of traffic demand within the study area throughout an average weekday. The results follow a typical trend with peaks in traffic volumes in the morning and evening. The count data suggests that the hours experiencing the highest levels of traffic are from 08:00-09:00 in the AM, and 16:00-17:00 in the PM.

Therefore, the Galway City LAM was developed, calibrated and validated to represent the following time periods:

- AM Morning peak : 08:00 to 09:00
- Average IP (Interpeak) Period: 10:00 to 16:00
- PM Evening peak: 16:00 to 17:00

7.3.3 Demand Segmentation

The prior travel demand for the Galway City LAM was derived from the NTA's WRM. The WRM assignment matrices contain the following ten user classes:

- Car Employer's Business (in work time)
- Car Commute (travel to/from work);
- Car Other (other non-work purposes such as shopping, visiting friends, etc);
- Car Education (travel to/from school);
- Car Retired;
- Taxi;
- Light Goods Vehicles (LGV);
- Other Goods Vehicles (OGV) 1;
- OGV2 Permit Holder (5 or more axles and allowed drive in Dublin city centre – not used in WRM); and
- OGV2 (5 or more axles and not allowed drive in Dublin city centre).

Each user class has its own defined set of generalised cost parameters based on a price per kilometre and a price per minute. To ensure consistency with the larger strategic WRM, the ten user classes and their associated generalised cost parameters were retained for the Galway City LAM.
The ten assigned user classes were then grouped in to three broader vehicle classes, based on the availability of disaggregated survey data. The three vehicle classes represented are:

- All Car;
- LGV; and
- All other Goods Vehicles.

7.3.4 Model Software

The model software used to develop the Galway City LAM is the SATURN (Simulation Assignment of Traffic to Urban Road Networks) suite of transportation modelling programs.

SATURN has 6 basic functions:

1. As a combined traffic simulation and assignment model for the analysis of road-investment schemes ranging from traffic management schemes over relatively localised networks (typically of the order of 100 to 200 nodes) through to major infrastructure improvements where models with over 1,000 junctions are not infrequent;
2. As a "conventional" traffic assignment model for the analysis of much larger networks (e.g., up to 6,000 links in the standard PC version, 37,500 in the largest);
3. As a simulation model of individual junctions;
4. As a network editor, database and analysis system;
5. As a matrix manipulation package for the production of, for example, trip matrices; and
6. As a trip matrix demand model covering the basic elements of trip distribution, modal split, etc.

7.3.5 Assignment Parameters

The Galway City LAM was developed in SATURN and the model was calibrated and validated using release version 11.4.07H MC of the software. The SATURN application SATNET was used to build the various data files in to an assignable road network (UFN) file.

Matrices were then assigned to the network using the SATALL application, where it iterates through assignment and simulation loops until the user defined levels of convergence are reached (RSTOP and STPGAP), or the model reaches the user defined maximum number of assignment and simulation loops (MASL). SATALL uses a converged equilibrium assignment method to assign the traffic to the road network over successive iterations, until user defined convergence criteria are achieved.

The key convergence criteria are presented in Table 7.1.

VARIABLE	DESCRIPTION	VALUE
MASL	Maximum number of assignment / simulation loops.	150
PCNEAR	Percentage change in flows judged to be "near" in successive assignments	1%

VARIABLE	DESCRIPTION	VALUE
RSTOP	The assignment / simulation loops stop if RSTOP % of link flows change by less than PCNEAR % in successive assignments	98%
NISTOP	Number of successive loops which must satisfy the RSTOP criteria for convergence	4
STPGAP	Critical gap value (%) used to terminate assignment / simulation loops	0.05

Table 7.1: SATURN Convergence Criteria

7.4 Traffic Data

This Chapter provides an overview of the traffic count data used to facilitate calibration and validation of the Galway City LAM.

7.4.1 Junction Turning Counts (JTCs)

The JTCs are 12-hour counts broken down into 15-minute segments over a full day. All main junctions within the study area have been included and provide information on the volume, and types of vehicles, making turning movements at each location. This data is utilised within the models to ensure that the flow of vehicles through the main junctions on the network is being represented accurately.

The locations of the 122 JTCs collected in 2022 and used for this study are displayed in Figure 7-3 .

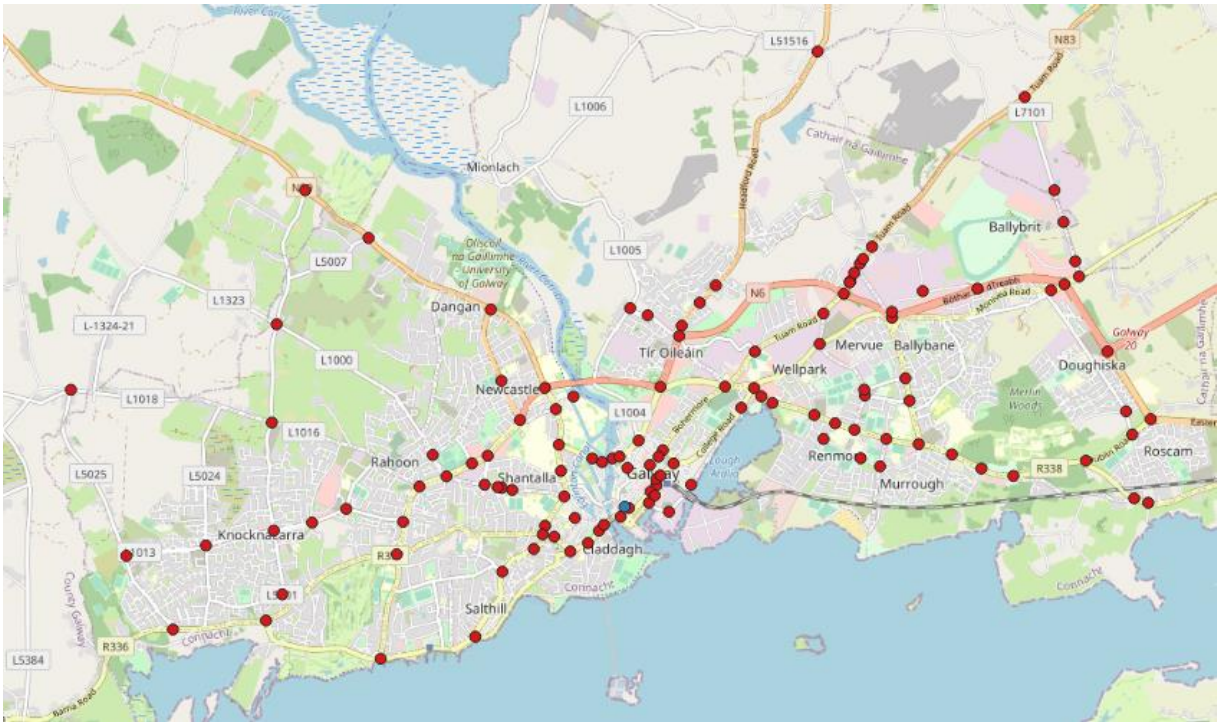


Figure 7-3: Location of the JTC counts

7.4.2 Automatic Traffic Counts (ATCs)

The ATC data provides information on:

- The daily and weekly profile of traffic along the Proposed Development; and
- Busiest time periods and locations of highest traffic demand on the network.

ATCs are collected over a 24hr period for a 7 day period.

In Figure 7-4 the location of the 25 ATCs collected in 20122 and used for this study are displayed.

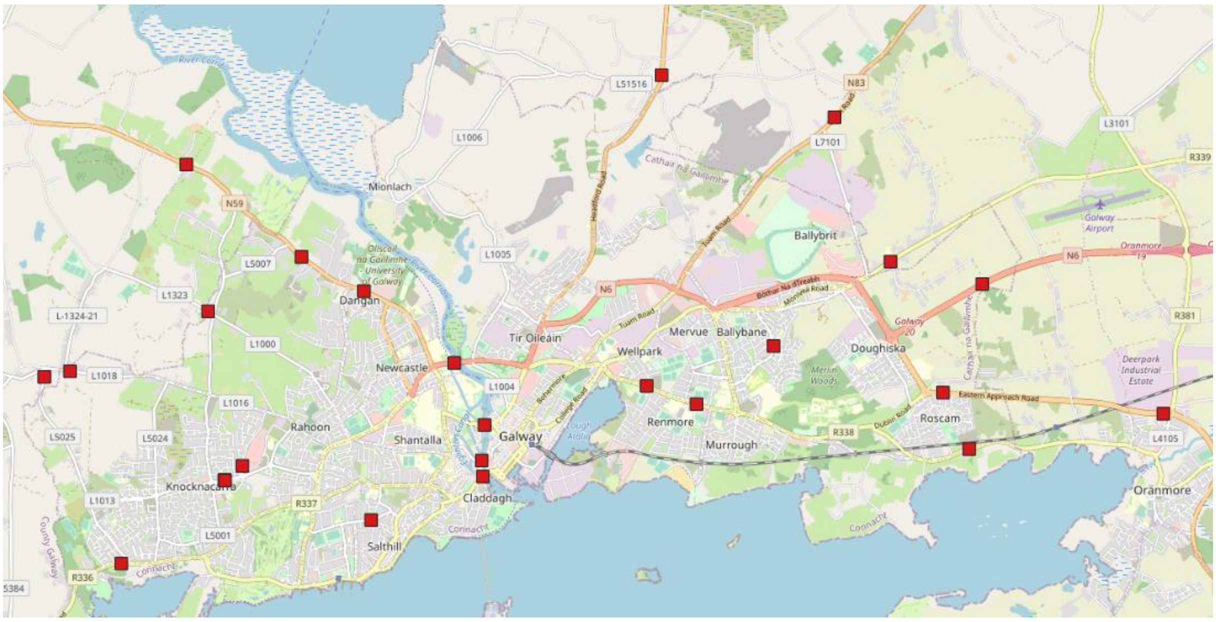


Figure 7-4: Location of the ATC counts

7.4.3 TomTom Road Journey Time Data

Journey time data for road validation has been collected from TomTom data through the NTA's license agreement with TomTom. TomTom data is aggregate data collected from GPS-enabled devices and provides an alternative to traditional surveyed journey time routes.

A total of 20 journey time routes were extracted from the TomTom database, shown in Figure 7-5 below.

SYSTRA

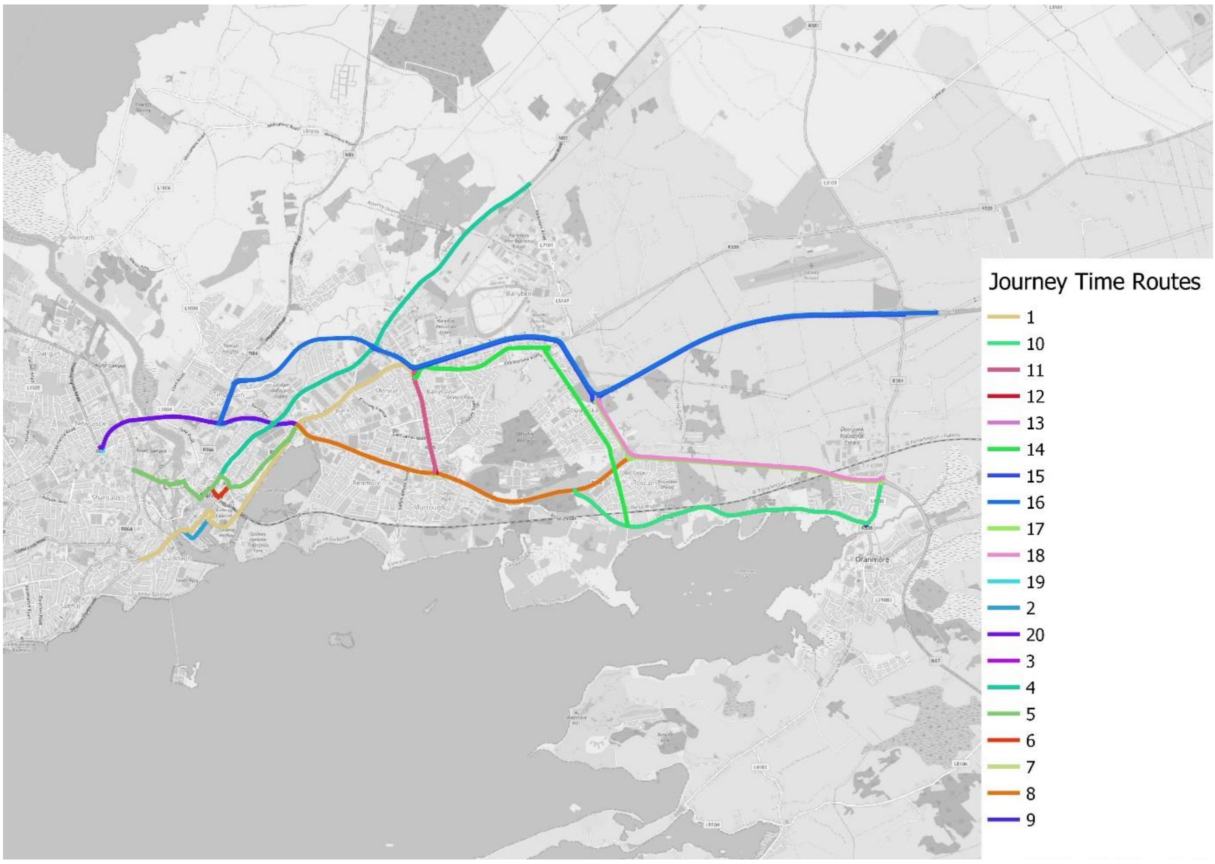


Figure 7-5 TomTom Journey Time Routes

7.5 Road Network and Zone System Development

7.5.1 Network Development

The Galway City LAM road network was developed from the GCCL LAM which overlapped the study are for this project. The GCCL LAM had been developed previously from the NTA's WRM and calibrated for a 2019 base year.

The Galway City LAM road network is illustrated in Figure 7-6 overleaf. A detailed review was undertaken of all model coding in the study area using digital mapping systems such as Google Earth to ensure it represented, as accurately as possible, the existing road network. This included aspects such as network speed limits, availability of bus lanes, junction layouts, pedestrian crossing points etc.

Junction capacities and saturation flows were adopted from the Network Coding Guidelines developed for the NTA as part of the RMS development, and were further reviewed during the calibration process.

Where required, additional detail was added to ensure that traffic was loading onto the road network at the correct locations.

As illustrated in Figure 7-6, the Galway City LAM provides a detailed representation of all significant roads within the study area. To ensure full network coverage and route choice, all roads have been considered, from the national primary routes to minor residential streets. The short dead-end links in Figure 7-6 are “spigots” used to load traffic from the zones accurately onto the network, and reflect the further developed zone system that is outlined below.

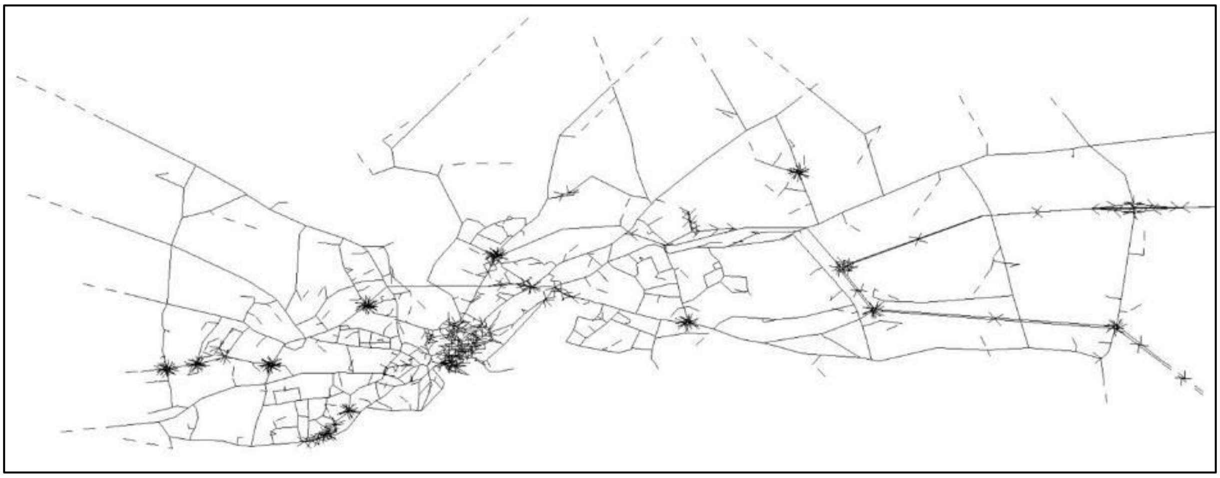


Figure 7-6: Galway City LAM highway network

7.5.2 Zone System Development

Similarly to the road network described previously, the base Galway City LAM zone system was adopted from the GCCL LAM.

The GCCL LAM zone system was developed from the WRM zone system, which utilises Census Small Area Population Statistics (SAPS) and Place of Work, School or College Census of Anonymised Records (POWSCAR) to get detailed information on population, employment and education centres across the model area.

To account for development between 2019 and 2022, and for future planned development the zone system was adjusted to ensure that an even distribution of trips can be applied to the network in the base year and future year.

This refinement of zone systems used sources such as MyPlan and Geo Directory to obtain information on specified land-use zoning and location of commercial development. The following rules were then applied to refine the zone system:

- **Population, Employment and Education** – the number of zones with values of population, number of jobs and persons in education above a certain threshold should be minimised;
- **Activity Levels** – the number of zones with activity levels that have very low or very high levels of trips should be minimised;
- **Intra-zonal Trips** – threshold values should be applied to the proportion of intra-zonal trips within each zone, to avoid an underestimation of flow, congestion and delay on the network;
- **Land Use** – zones should be created with homogeneous land use and socio-economic characteristics where possible;
- **Zone Size/Shape** – zone size and the regularity of zone shape should be considered in order to avoid issues with inaccurate representation of route choice; and
- **Special Generators/Attractors** – large generators/attractors of traffic such as Airports, Hospitals, shopping centres etc. should be allocated to separate zones.

Figure 7-7 illustrates the base WRM zone system within the study area. As the area of interest is relatively close to Galway City Centre, the zones are represented in quite a high level of detail. The WRM zones become larger and more aggregate in nature around the city centre primarily due to the low levels of activity (population and employment) in these areas.

It has been agreed that the WRM zoning system provided sufficient level of detail for the purpose of this study and therefore, no zone disaggregation was performed for the LAM.

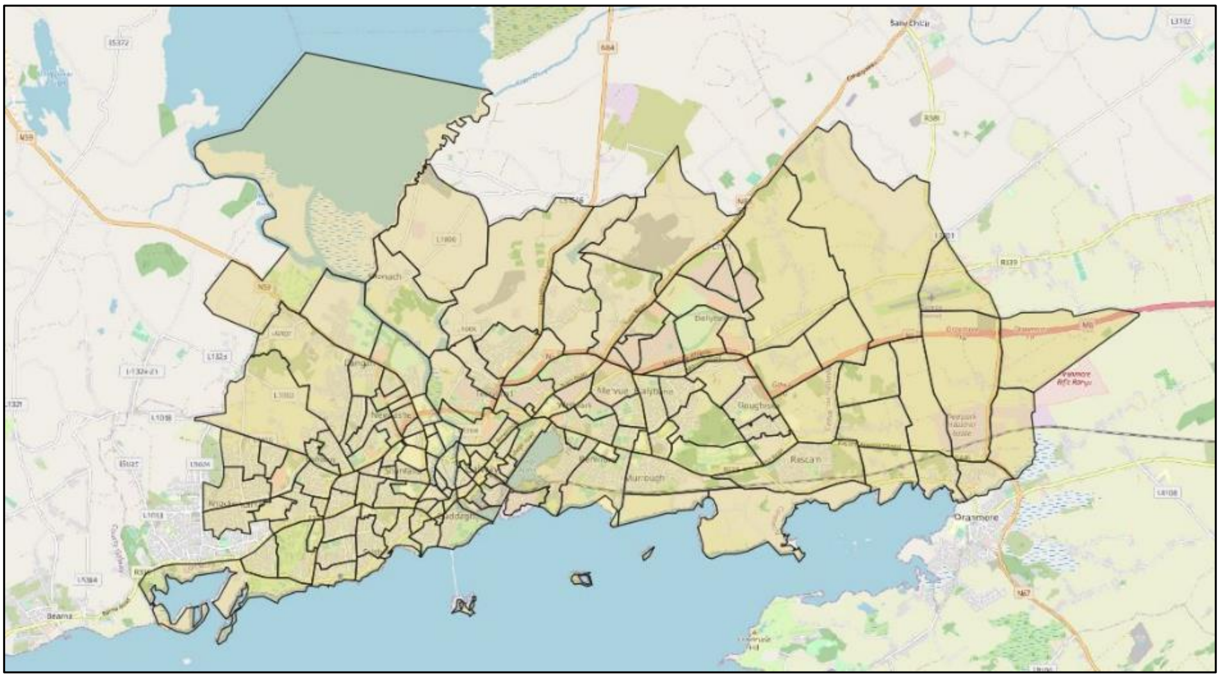


Figure 7-7: LAM zones derived from the WRM

7.6 Model Calibration Process and Results

7.6.1 Introduction

Calibration is the process of adjusting the LAM network and demand to ensure that it provides a robust estimate of assignment when compared to 2022 observed traffic characteristics. Generally, the components of the model that may be adjusted on the demand side are trip distribution and trip production/generation levels, and this usually involves trip 'Matrix Estimation'.

On the supply side (network), modelled junction and link characteristics may be altered if sufficient new information is available to justify changes to the existing network.

The Galway City 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)*. This is a widely accepted standard in Ireland that provides robust calibration and validation criteria to which certain types of highway models should adhere. Additionally, the LAM development has followed guidance from the UK's Department for Transport's Transport Analysis Guidance (TAG) unit M3-1, particularly in terms of matrix estimation controls.

The method for the calibration of the Galway City LAM is illustrated in Figure 7-8 overleaf, and comprises of the following key elements:

- **Network and Zone System Development:** As outlined earlier in chapter 7, the initial LAM network and zone system is derived from the WRM with further detail added where necessary to provide an accurate representation of existing conditions;
- **Network Adjustments:** A detailed review is undertaken of the road network coding taking cognisance of surveyed traffic volumes and network speeds with adjustments made where necessary;
- **Prior Matrix:** The initial prior matrix is extracted from a cordon of the WRM;
- **Calibration Criteria Check:** The LAM is then assessed against guideline calibration criteria in terms of modelled versus observed traffic volumes;
- **Matrix Estimation:** If the model is not passing the initial calibration check, a process known as 'Matrix Estimation' is undertaken to adjust the trip demand in order to provide an improved correlation between counts and modelled flows;
- **Post-Estimation Calibration Check:** The model is then re-tested against the calibration criteria with a focus on correlation between modelled and observed flows, along with an analysis of the demand changes introduced by 'Matrix Estimation'; and
- **Validation:** Once all the calibration criteria have been achieved, the model is passed forward to validation.

The rest of this Chapter provide an overview of the steps outlined above along with the calibration guidelines for LAM development.

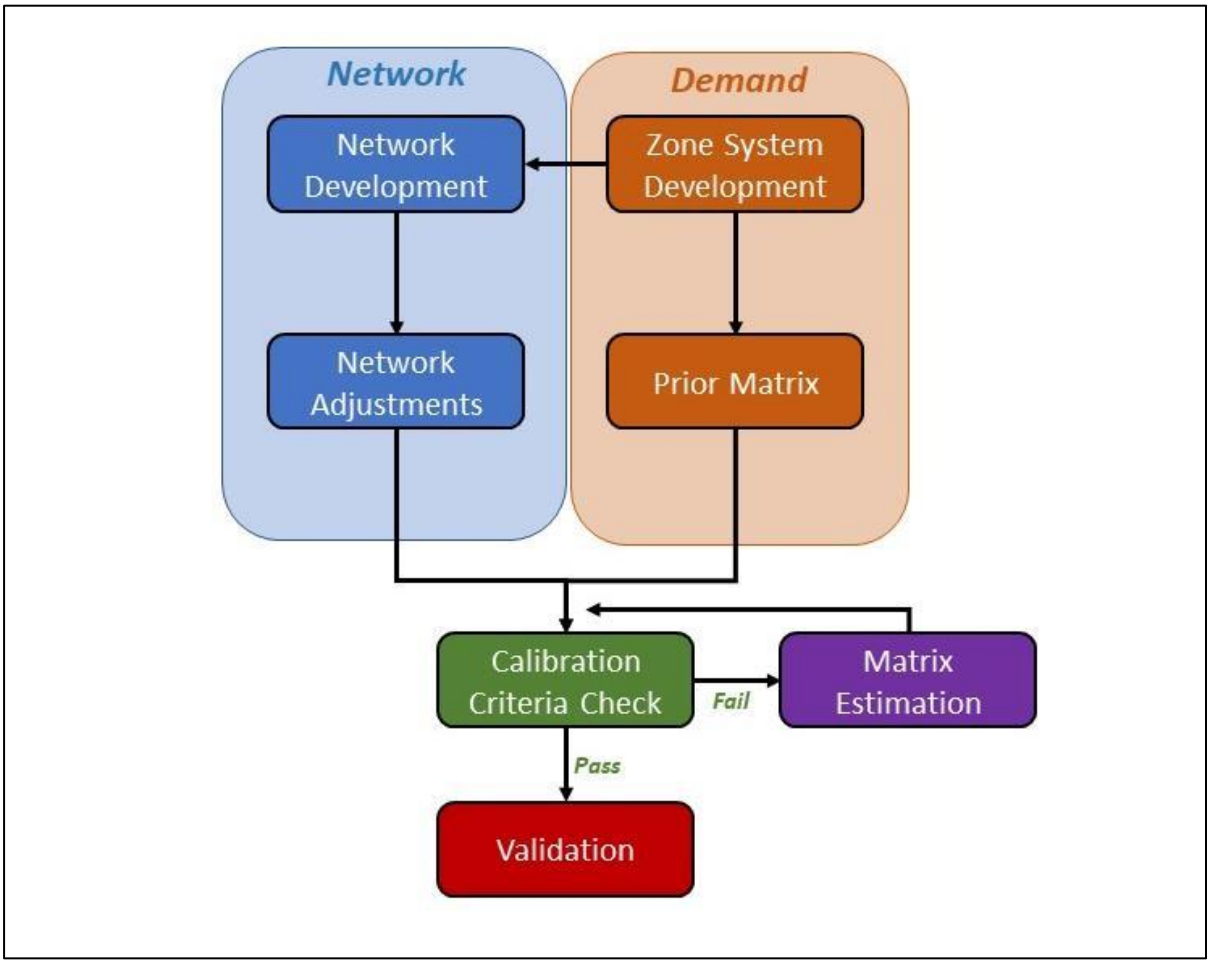


Figure 7-8: LAM calibration process

7.6.2 Calibration Criteria

The guidelines for calibration of the Galway City LAM have been taken from the following:

- Transport Infrastructure Ireland's (TII) Project Appraisal Guidelines (PAG) for National Roads Unit 5.1 - Construction of Transport Models;
- UK Department for Transport (DfT) TAG Unit M3.1 Highway Assignment Modelling; and
- NTA guidance on LAM development from Regional Models.

The TII guidelines are a widely accepted standard in Ireland and have been developed in cognisance with the UK DfT TAG guidance. They focus on correlations between modelled and observed traffic flows at an individual count level, and at a Screenline level, along with monitoring of demand changes introduced by 'Matrix Estimation'.

7.6.2.1 Traffic Flow Calibration

Table 7.2 outlines the TII PAG criteria for permissible differences between observed and modelled traffic flows. The guidelines are measured as absolute and percentage differences at various link flows, and also make use of the Geoffrey E. Havers (GEH) statistic.

The GEH statistic is a measure that considers both absolute and proportional differences in flows. Thus, for high levels of traffic volumes a low GEH may only be achieved if the percentage difference in flow is small. For lower flows, a low GEH may be achieved even if the percentage difference is relatively large. GEH is formulated as:

$$GEH = \sqrt{\frac{(Observed - Modelled)^2}{0.5\ X\ (Observed + Modelled)}}$$

The reason for introducing such a statistic is the inability of either the absolute difference or the relative difference to cope over a wide range of flows. For example, an absolute difference of 100 passenger car units per hour (pcu/h) may be considered a big difference if the flows are of the order of 100 pcu/h, but would be unimportant for flows in the order of several thousand pcu /h. Equally a 10% error in 100 pcu/h would not be important, whereas a 10% error in, say, 3000 pcu/h might mean the difference between adding capacity to a road or not.

In general, the GEH parameter is less sensitive to the above statistical biases since a modeller would probably feel that an error of 20 in 100 would be roughly as bad as an error of 90 in 2,000, and both would have a GEH statistic of roughly 2.

As a rule of thumb in comparing assigned volumes with observed flows, a GEH parameter of 5 or less would be an acceptable fit, while GEH parameters greater than 10 would require closer attention.

CRITERIA	ACCEPTABILITY GUIDELINE
Individual flows within 100 v/h for flows less than 700 v/h	>85% of cases
Individual flows within 15% for flows between 700 & 2,700 v/h	
Individual flows within 400 v/h for flows greater than 2,700 v/h	
Individual flows – GEH < 5	>85% of cases

Table 7.2: Model Flow Calibration Criteria

Screenline Analysis

Screenlines represent an amalgamation of count sites that capture key movements across the model network. TII guidelines suggest that an additional check on the quality of trip matrices should be undertaken by comparing modelled and observed flows across screenlines by vehicle type and modelled time period using the following criteria:

CRITERIA	ACCEPTABILITY GUIDELINE
Total screen line flows (> 5 links) to be within 5%	> 85% of cases
GEH statistic: screenline totals < 4	> 85% of cases
Notes: Screenlines containing high flow routes (such as motorways) should be presented both with and without such routes	

Table 7.3: Screenline Calibration Criteria

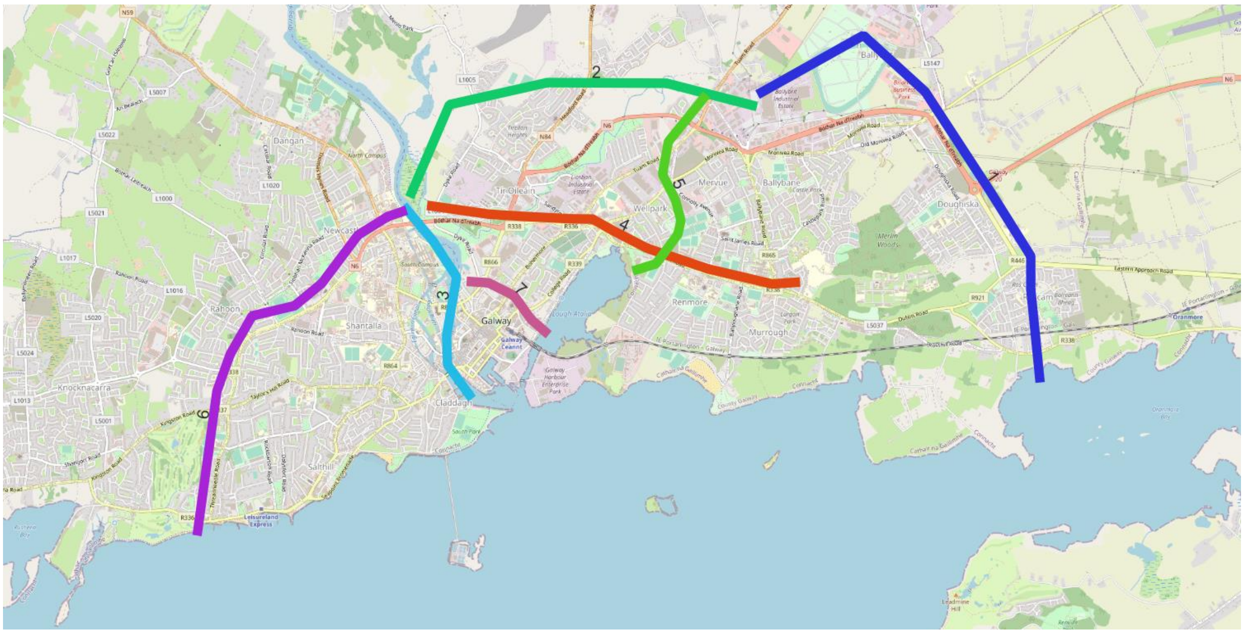


Figure 7-9: Screenlines

7.6.2.2 Analysis of Trip Matrix Changes

Regression Analysis

As noted previously, 'Matrix Estimation' was used to adjust the prior trip matrix in order to provide a better correlation between modelled and observed flows. However, both TII and TAG guidance suggest that caution should be taken when using estimation, and that the changes introduced should be monitored to ensure that the original matrices are not overly distorted, thus providing irregular movement patterns.

Table 7.4 outlines the matrix estimation change criteria, as specified in WebTAG Unit M3-1, Section 8.3, Table 5. The guidelines use regression analysis to identify the correlation/relationship between the demand pre and post 'Matrix Estimation', and suggest careful monitoring by the following means:

- Scatter plots of matrix zonal cell values, prior to and post matrix estimation, with regression statistics (slopes, intercepts and R^2 values); and
- Scatter plots of zonal trip ends, prior to and post matrix estimation, with regression statistics (slopes, intercepts and R^2 values).

MEASURE	SIGNIFICANCE CRITERIA
Matrix zonal cell value	Slope within 0.98 and 1.02; Intercept near zero; R2 in excess of 0.95
Matrix zonal trip ends	Slope within 0.99 and 1.01; Intercept near zero; R2 in excess of 0.98.

Table 7.4: Significance of Matrix Estimation Changes

Trip Length Distribution Analysis

A further calibration step recommended by TII guidance is to compare trip length distributions for the prior and post calibrated matrices to ensure they have not been overly distorted by the 'Matrix Estimation' process.

'Matrix Estimation' can sometimes generate increased short distance trips to match count information, thus distorting the profile of trip making on the network. PAG suggests that the coincidence ratio[5] should be used to compare trip length distributions before and after estimation, with a desirable range between 0.7 and 1.0

A coincidence ratio can be used to compare two distributions by examining the ratio of the total area of those distributions that coincide. The coincidence ratio is defined as:

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

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.

Figure 7-10: Coincidence Ratio Calculation – TII PAG Page 20

5 The coincidence ratio is a calculation used to examine the how the total area under different distributions coincide, with a value of 1 representing an identical distribution.

7.6.3 Network Adjustments

The Galway City LAM was coded based on best practice approaches developed during the NTA Regional Model Scoping Process, and as such, the model provided an accurate and up-to date representation of the existing road network.

When the traffic survey data was processed and analysed, the network coding was re-checked with the following edits undertaken where there was a clear justification for doing so:

- **Junction Capacity:** The SATURN software flags an error where a junction has insufficient modelled capacity to achieve the observed traffic flow. All these instances were reviewed in detail and remedial action was taken where required. This included:
  - Adjusting Signal Timings (mostly synthesised within the model area);
  - Adding/removing flared lanes;
  - Adding/removing approach lanes; and
  - Adjusting saturation flows through junctions.
- **Network Speeds:** The capacity and speeds of modelled links were checked to ensure they were broadly in line with survey information;
- **Zone Connectors:** A review was undertaken on the location of zone connectors in close proximity to count sites to ensure they were providing an accurate representation of traffic loading onto the road network.

7.6.4 Prior Matrix Development

As noted previously in Chapter 3, the Full Demand Model carries out mode and trip destination choice for all zones within the WRM. The FDM has been calibrated using Census data, and hence, provides a robust and accurate representation of trip distributions across the model network. In order to generate prior matrices for the Galway City LAM, a cordon was extracted from a run of the WRM, which has been updated to include 2022 planning data. The cordon function within SATURN, facilitates the extraction of trip matrices for a subset area of the WRM whilst still maintaining route and destination choice from the full model.

Since the LAM used the same zoning system of the WRM, there was no need to disaggregate the demand.

7.6.5 Pre-Estimation Calibration Check

The prior matrix was assigned to the updated road network to determine how well the Galway City LAM replicated observed traffic volumes, and the total results are outlined in Table 7.5. Detailed results divided by Vehicle Class can be found in Appendix 8.1.1.

CRITERIA	AM	IP	PM
Individual flows within 100 v/h for flows less than 700 v/h			
Individual flows within 15% for flows between 700 & 2,700 v/h	54%	70%	65%
Individual flows within 400 v/h for flows greater than 2,700 v/h			
Individual flows – GEH < 5	47%	60%	56%

Table 7.5: Total Traffic Count Calibration Statistics (pre Matrix Estimation)

The results indicate a low match to flow criteria and GEH across all vehicles. This poor performance is driven mostly by car flow calibration fall short of the required targets with less than half of AM car counts meeting GEH targets.

Therefore, further calibration adjustments including 'Matrix Estimation' were carried out on the AM, IP and PM prior matrices to improve the fit between model flows and observed traffic volumes.

7.6.6 Matrix Estimation

'Matrix Estimation' is a process used to adjust trip demand so that there is an improved correlation between counts and modelled flows. Matrix estimation (ME) is handled by within SATURN using SATME2. The ME process adjusts origin-destination patterns to produce a trip demand matrix that better replicates traffic counts when assigned to the network.

As ME adjusts zonal demand to match traffic count data it can overload or underload demand from particular zones. For this reason, ME is run with several constraints;

- XAMAX – This parameter determines the overall magnitude of change allowed to meet traffic counts and ranges between 2 and 10.
- Trip end constraint – Origin and Destination trip ends can be constrained to prevent too much deviation for the prior matrix.

To ensure that the prior matrix inputs are not distorted too much several checks are undertaken;

- R^2 – this measure compares the change between the prior and post ME individual matrix cells. Criteria for this is above 0.95;

- Slope and intercept – as with the R^2 this compares the change in matrix cells but holistically by plotting the pre and post ME values and determining a trend line. The criteria for this is a slope equal to a value between 0.8 and 1.02 and an intercept close to 0.
- Trip Length Comparison – ME tends to replace longer trips with more short trips, to ensure this change is constrained trip lengths before and after ME are compared.

7.6.7 Post-Estimation Calibration

The Post ME matrix is used to test the network with the best match that the algorithm can achieve. At this stage the network is refined further to address;

- Route choice – speeds, delay, capacity and signal timings are all adjusted to encourage traffic onto the correct routes and away from incorrect routes; and
- Zonal demand – changes in zonal demand from the ME process are analysed to see if any areas are being increased or decreased closed to defined limits highlighting a requirement to check travel patterns.

A calibration and validation dashboard was created to identify areas of the network requiring adjustment/improvement and not meeting the calibration guidelines. Once all options for network improvement were exhausted, 'Matrix Estimation' was re-run to try and achieve a better match between modelled and observed flows.

The calibration process is iterative with network adjustments being made, then ME being carried out and further adjustments made as shown in Figure 7-11 below. This is continued until TII and TAG criteria a met, or until no further action is possible.

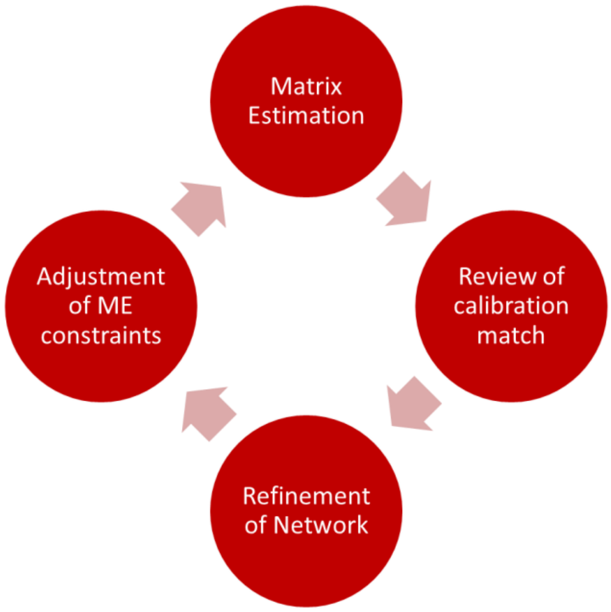


Figure 7-11 Calibration and ME process

7.6.7.1 *Traffic Flow and GEH Calibration Results*

Table 7.6 summarises the traffic flow and GEH calibration results for the Galway City LAM after the matrix estimation process, for each of the modelled time periods.

CRITERIA		AM	IP	PM
Individual flows within 100 v/h for flows less than 700 v/h	>85% of cases	88%	94%	92%
Individual flows within 15% for flows between 700 & 2,700 v/h				
Individual flows within 400 v/h for flows greater than 2,700 v/h				
Individual flows – GEH < 5	>85% of cases	87%	91%	88%

Table 7.6: Total Traffic Count Calibration Statistics (Post Matrix Estimation)

The results in Table 7.6 demonstrate that a satisfactory calibration has been achieved in the model for all peak periods, with GEH values within TII and TAG standards.

The full list of flow calibration results for each traffic count location are presented in Appendix 8.1.2.

7.6.7.2 *Screenline Flows*

As noted in chapter 4 previously, counts have been grouped into screenlines covering movements across four screenlines. The comparison between modelled and observed traffic flows at each of the screenlines is presented in Table 7.7 to Table 7.9 for the AM and PM peak hours.

Table 7.7: AM Screenline Calibration Statistics (Post-Estimation) – Total Flows

Screenline	Direction	Observed Flow	Modelled Flow	% Difference	GEH
1) Outer East	Eastbound	2400	2423	1%	0.5
1) Outer East	Westbound	3380	3596	6%	3.6
2) Outer North	Northbound	987	869	-12%	3.9
2) Outer North	Southbound	2075	2033	-2%	0.9
3) River	Eastbound	3382	3487	3%	1.8
3) River	Westbound	2889	2921	1%	0.6

Screenline	Direction	Observed Flow	Modelled Flow	% Difference	GEH
4) GDR North	Northbound	3521	3543	1%	0.4
4) GDR North	Southbound	3927	3876	-1%	0.8
5) Inner East	Eastbound	2876	2818	-2%	1.1
5) Inner East	Westbound	3362	3426	2%	1.1
6) Outer West	Eastbound	4666	4612	-1%	0.8
6) Outer West	Westbound	2499	2366	-5%	2.7
7) CCNE	Northbound	1654	1571	-5%	2.1
7) CCNE	Southbound	1888	1912	1%	0.6

Table 7.8 IP Screenline Calibration Statistics (Post-Estimation) – Total Flows

Screenline	Direction	Observed Flow	Modelled Flow	% Difference	GEH
1) Outer East	Eastbound	2411	2385	-1%	0.5
1) Outer East	Westbound	2327	2415	4%	1.8
2) Outer North	Northbound	1150	1071	-7%	2.4
2) Outer North	Southbound	1182	1131	-4%	1.5
3) River	Eastbound	2587	2609	1%	0.4
3) River	Westbound	2518	2525	0%	0.1
4) GDR North	Northbound	3081	2862	-7%	4.0
4) GDR North	Southbound	3190	2961	-7%	4.1
5) Inner East	Eastbound	2723	2660	-2%	1.2
5) Inner East	Westbound	2811	2788	-1%	0.4
6) Outer West	Eastbound	2875	2594	-10%	5.4
6) Outer West	Westbound	2765	2515	-9%	4.9
7) CCNE	Northbound	1552	1553	0%	0.0
7) CCNE	Southbound	1542	1532	-1%	0.3

Table 7.9 PM Screenline Calibration Statistics (Post-Estimation) – Total Flows

Screenline	Direction	Observed Flow	Modelled Flow	% Difference	GEH
1) Outer East	Eastbound	3879	3912	1%	0.5
1) Outer East	Westbound	2595	2848	10%	4.8
2) Outer North	Northbound	2115	1975	-7%	3.1
2) Outer North	Southbound	1184	1038	-12%	4.4
3) River	Eastbound	2870	2790	-3%	1.5
3) River	Westbound	2823	3019	7%	3.6
4) GDR North	Northbound	3562	3288	-8%	4.7
4) GDR North	Southbound	3527	3246	-8%	4.8
5) Inner East	Eastbound	3027	3018	0%	0.2
5) Inner East	Westbound	2916	2916	0%	0.0
6) Outer West	Eastbound	2951	2812	-5%	2.6
6) Outer West	Westbound	4054	3948	-3%	1.7
7) CCNE	Northbound	1707	1701	0%	0.1
7) CCNE	Southbound	1490	1461	-2%	0.8

Table 7.10 Screenline Calibration Criteria Check

TIME PERIOD	SCREENLINES WITHIN 5%	SCREENLINES WITHIN 10%	GEH <5
AM	71%	93%	100%
IP	64%	100%	93%
PM	57%	93%	100%

The results in Table 7.10 indicate that the majority of screenlines in all time periods are within the 5% required by TAG criteria. However, PM performs more poorly than the other time periods. This is driven by the outer screenlines, which have low match to observed. However, when taking GEH into account, all AM and PM screenlines have a GEH less than 5, and only one LT screenline has a GEH greater than 5.

Considering the performance of individual screenlines, screenline 2, Outer North, is low in all time periods. The greatest difference is in the Northbound direction in the AM and Southbound direction in the PM suggesting that a commuting movement out of the city has not been fully represented. However, the difference is relatively low and the screen line is removed from the main study area so is considered acceptable.

Screenlines 3, 4, 5 and 7 are key screenlines relative to the study area, as such it is important that these provide an acceptable match. In the AM and IP all these screenlines provide a good match, however in the PM Screenline 3 and 4 provide a poorer match, however in both cases these screenlines still achieve a GEH less than 5 and variation in traffic flow is considered within acceptable amounts.

Overall, most screenlines provide an accurate representation of key traffic movements within the model area in the AM, IP and PM peak hours. The key screenlines around the study area are well represented and provide a good match to observed data.

7.6.7.3 Analysis of Trip Matrix Changes - Regression

As noted in Chapter 7.6.7 previously, both TII and TAG model development guidance recommend that care is taken when applying ‘Matrix Estimation’, and stringent checks should be carried out to ensure that the model demand is not overly distorted.

Pre and Post ‘Matrix Estimation’ matrices were plotted and the slope, and R^2 measure of goodness of fit were calculated for trips. The results of this analysis are outlined in Table 7.11, Table 7.12Table 7.13 below. Table 7.11 shows the matrix zonal cell regression analysis for all user classes in the model, while Table 7.12 shows the same analysis but only for the Goods vehicle user classes.

Within the WRM, the Goods Vehicle matrices are not calculated as accurately as for car traffic as they are not generated by the Full Demand Model. As such, SATME2 was allowed to make more changes to the prior Goods Vehicle matrices to match traffic count data. Constraints were applied to restrict unrealistic Goods Vehicle movement patterns. However, the changes made to the prior Goods Vehicle matrix were not restricted to adhere with DfT TAG guidance.

MEASURE	SIGNIFICANCE CRITERIA	AM	IP	PM
R^2	R^2 in excess of 0.95	0.54	0.57	0.56
Slope	Within 0.98 and 1.02	0.86	0.80	0.70
Intercept	Intercept near zero	0.02	0.02	0.03

Table 7.11: AM, IP and PM Matrix Zonal Cell Regression Analysis (All User Classes)

MEASURE	SIGNIFICANCE CRITERIA	AM	IP	PM
R^2	R^2 in excess of 0.95	0.19	0.44	0.38
Slope	Within 0.98 and 1.02	0.40	0.66	0.59
Intercept	Intercept near zero	0.08	0.05	0.05

Table 7.12: AM, IP and PM Matrix Zonal Cell Regression Analysis (Goods Vehicles)

MEASURE	SIGNIFICANCE CRITERIA	AM	IP	PM
R^2	R^2 in excess of 0.98	0.92	0.92	0.86
Slope	Within 0.99 and 1.01	1.00	0.97	0.90

Table 7.13: AM, IP and PM Matrix Trip End Regression Analysis (Origin and Destination)

On the trip end level, the regression statistics indicate a good correlation between the prior and post matrices with the slope and r^2 values falling just outside the recommended values. But on the matrix cell level, the calibration struggles to achieve a satisfactory level of correlation between the post calibrated and prior matrices, particularly on the r^2 values. As mentioned above, the goods vehicles in the WRM are not calculated as accurately as for car traffic and thus matrix estimation was allowed to make more changes to these matrices to match the traffic count data. This is reflected in Table 7.12 which shows a poor correlation between the prior and post matrices.

7.6.7.4 Analysis of Trip Matrix Changes – Trip Length Distribution

TII guidance recommends comparing trip length distributions for the prior and post calibrated matrices to ensure they have not been overly distorted by the 'Matrix Estimation' process.

The 'Matrix Estimation' programme SATME2 can sometimes generate increased short distance trips to match count information, thus distorting the profile of trip making on the network. PAG suggests that the coincidence ratio should be used to compare trip length distributions before and after estimation, with a desirable range between 0.7 and 1.0.

Table 7.14 below outlines the coincidence ratios for each of the calibrated LAM time periods. The coincidence ratios suggest that there has been some minor distortion of trip lengths but that it is within acceptable bounds.

MEASURE	SIGNIFICANCE CRITERIA	AM	LT	PM
Coincidence Ratio	Between 0.7 and 1.0	0.98	0.98	0.98

Table 7.14: Trip Length Analysis - Coincidence Ratios

The trip length distributions illustrated in Figure 7-12, Figure 7-13 and Figure 7-14 below display the proportion of trips travelling various distances for both the pre and post estimation matrices. The results indicate that there have been some changes, however, the general shape of the distributions are similar. The changes overall are not large, and therefore, it is considered that 'Matrix Estimation' has not overly distorted the overall trip length distribution inherited from the WRM.

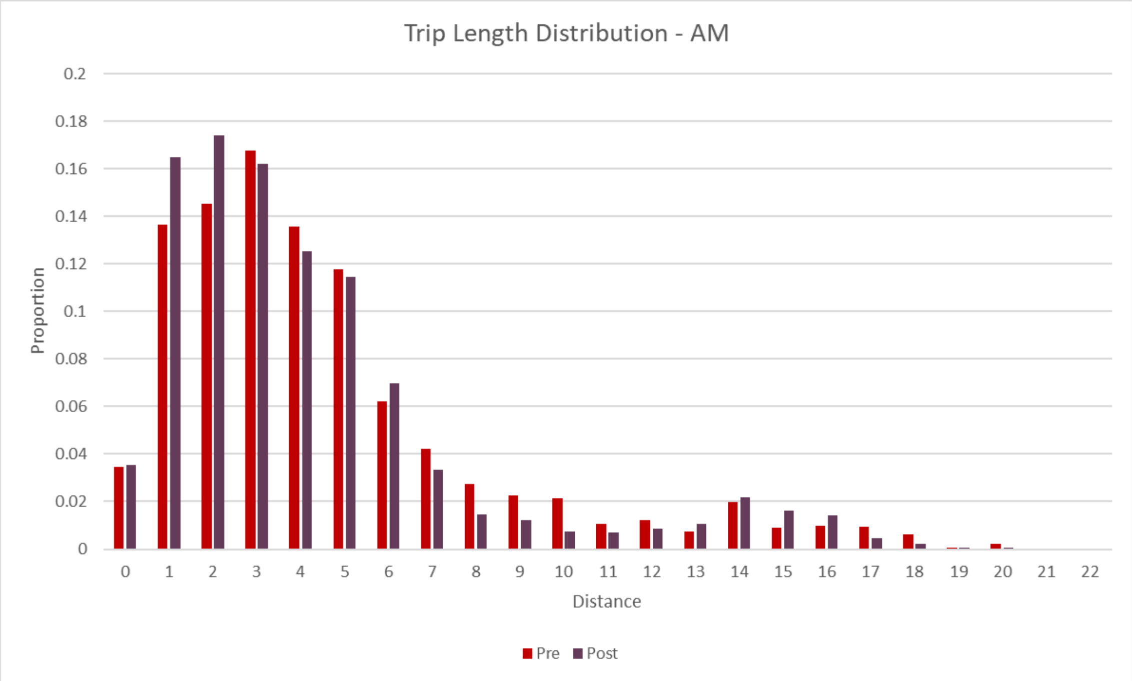


Figure 7-12: AM Peak Trip Length Distribution

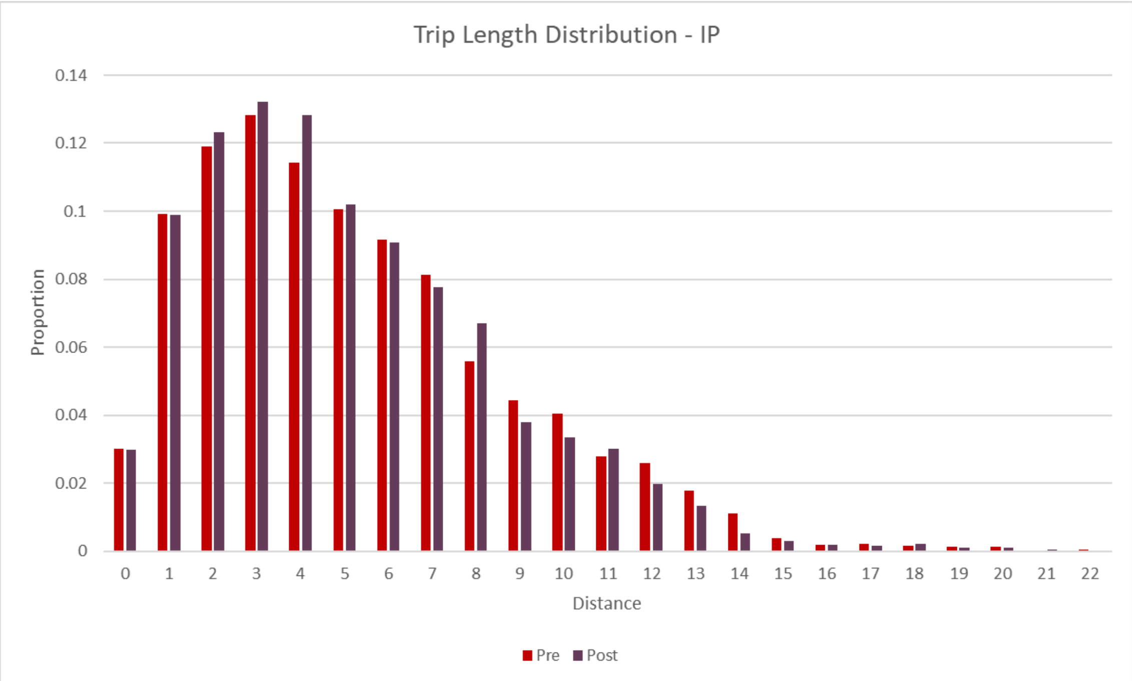


Figure 7-13: IP Peak Trip Length Distribution

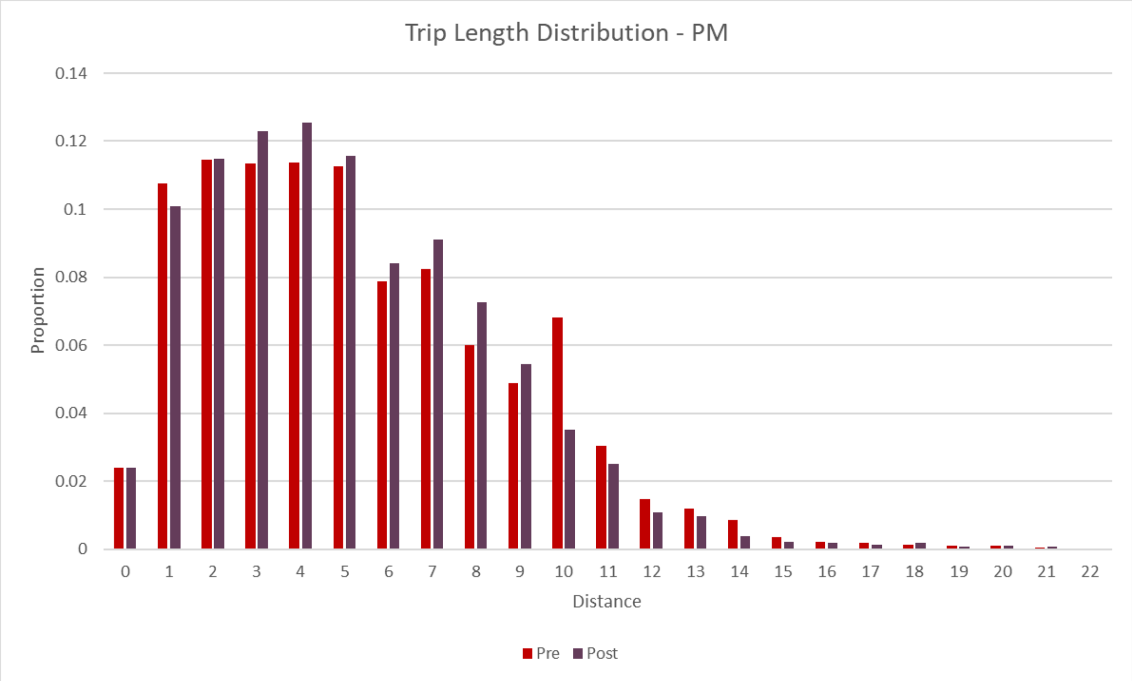


Figure 7-14: PM Peak Trip Length Distribution

7.6.8 Calibration Summary

This chapter has outlined the methodology used to calibrate the Galway City LAM to better reflect observed traffic survey data. In summary:

- A combination of network edits and 'Matrix Estimation' have been used to provide a better correlation between modelled and observed traffic flows;
- The model meets a satisfactory level of calibration following TII and DfT TAG criteria regarding GEH and individual link flows;
- The Screenline Analysis shows key traffic movements are strongly represented within the study area, in particular the cross-river movements;
- Analysis of 'Matrix Estimation' changes to the prior matrices (derived from the WRM), show a good correlation on the trip end level but with some differences on the matrix cell level. The goods vehicles in the WRM are not calculated as accurately as for car traffic and thus matrix estimation was allowed to make more changes to these matrices to match the traffic count data. This is reflected in the comparison which shows a poor correlation between the prior and post Goods Vehicle matrices.; and

- The coincidence ratio is well within TII guidelines and, as such, it is considered that 'Matrix Estimation' has not overly distorted the overall trip length distribution inherited from the WRM.

7.7 Model Validation

7.7.1 Introduction

The validation of the model uses additional comparative measures against which the robustness of the calibrated model may be judged. Calibration and validation are separate concepts, however, in reality these two elements are part of an iterative process. If the results of the validation checks are not satisfactory, then the modeller will review the inputs and coding within the model and adjust as required in order to achieve a better representation of reality.

It is important that the information used in calibrating the model, including count data for matrix estimation, is kept separate from that used for validation if it is to be a true independent test of the model. As such two main data sources were used in the validation of the Galway City LAM:

- Junction turning counts not utilised during model calibration; and
- Observed journey times on key routes.

The guidelines for model validation are very similar to those described previously for calibration in Chapter 7.6.2, and are outlined in Table 7.15.

CRITERIA	ACCEPTABILITY GUIDELINE
Assigned hourly flows compared with observed flows	
Individual flows within 100 v/h for flows less than 700 v/h	>85% of cases
Individual flows within 15% for flows between 700 & 2,700 v/h	
Individual flows within 400 v/h for flows greater than 2,700 v/h	
Individual flows – GEH < 5	>85% of cases
Modelled journey times compared with observed times	
Times within 15% or 1 minute if higher	>85% of cases

Table 7.15: Validation Criteria

The rest of this Chapter present the results of the validation checks carried out on the Galway City LAM to ensure that it is providing a robust representation of existing traffic conditions within the model area.

7.7.2 Traffic Flow Validation

Traffic flow validation was carried out for turning counts not initially included within calibration (513 turns in total). Link counts could not be used as they were all used for calibration. Table 7.16 summarises the traffic flow and GEH validation results for the Galway City LAM for each of the modelled time periods. The list of full Validation results can be found in Appendix 8.2.

The validation results show a reasonable level of agreement between model and observed, albeit with lower results than obtained for calibration, but within acceptable levels. The GEH results for individual flow less than five exhibits more than 70% match. It is noted that around 90% of flows agree with the other criteria, indicating that broadly speaking the model validates well especially for links with higher levels of traffic.

CRITERIA		AM	IP	PM
Individual flows within 100 v/h for flows less than 700 v/h	>85% of cases	91%	94%	91%
Individual flows within 15% for flows between 700 & 2,700 v/h				
Individual flows within 400 v/h for flows greater than 2,700 v/h				
Individual flows – GEH < 5	>85% of cases	73%	75%	71%

Table 7.16: Traffic Count Validation Statistics

7.7.3 Journey Time Validation

As outlined in Table 7.15, TII guidelines recommend that modelled journey times should be within +/- 15% of the observed time, or 1 minute if higher, in more than 85% of cases. Journey Times have been validated comparing Joy Ride Journey Times extracted from Saturn with TomTom data on five different routes (in both directions).

The 5 routes can be seen in Figure 7-15 while Table 7.17, Table 7.18 and Table 7.19 report the validation results for the 10 routes (five for each direction) for each time period. Overall, the LAM achieves acceptable journey time validation results with 6 out of 10 routes falling within the +/-15%

TII criteria in the AM and 7 in the PM. The Interpeak (IP) time period is the better performing with only one route failing the criteria.

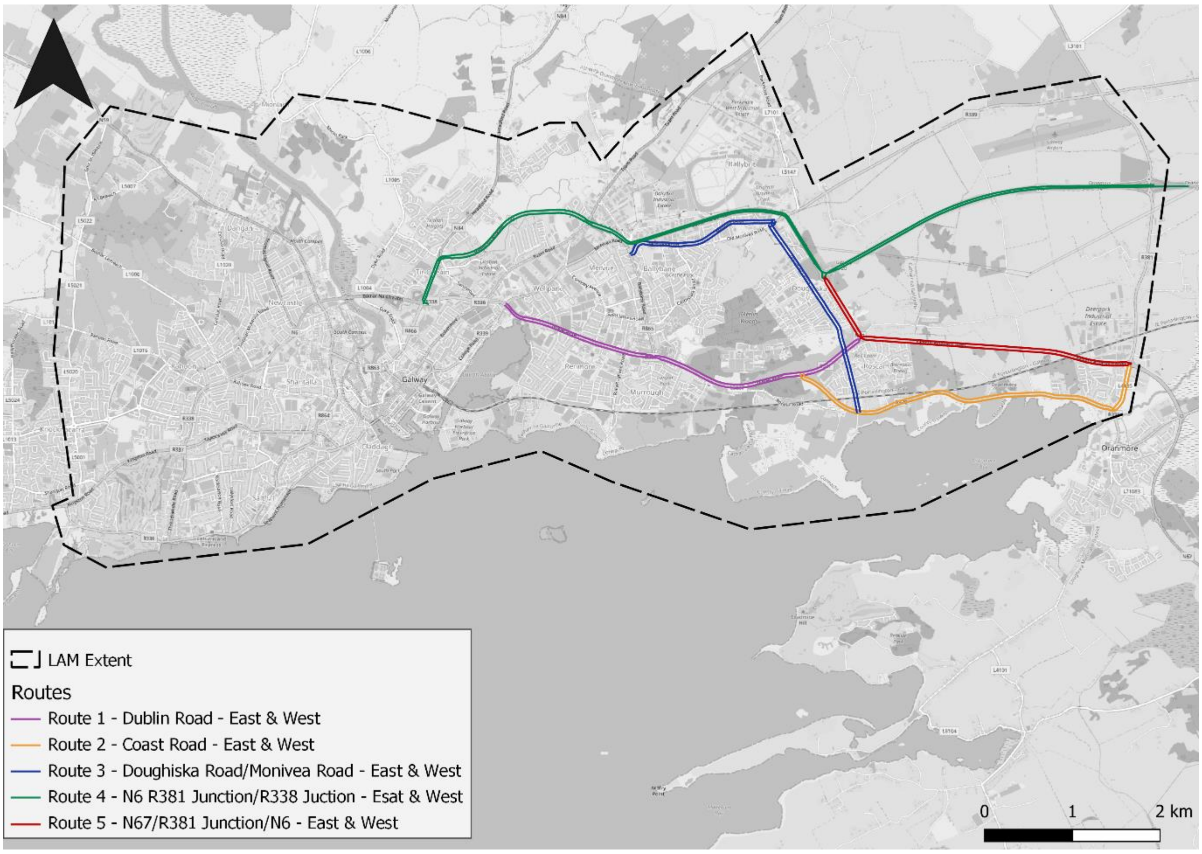


Figure 7-15: Routes used for Journey Time Validation

Route	Direction	Modelled	Observed	Diff	% Diff	Pass/Fail
1A	W	1077.41	1213.589	-136	-11%	Pass
1B	E	686.23	708.7927	-23	-3%	Pass
2A	W	484.31	601.7167	-117	-20%	Fail
2B	E	307.01	333.2993	-26	-8%	Pass
3A	NW	879.47	909.666	-30	-3%	Pass
3B	SE	624.45	620.1187	4	1%	Pass
4A	W	1138.37	1509.926	-372	-25%	Fail
4B	E	845.63	802.4687	43	5%	Pass

5A	W	273.28	686.556	-413	-60%	Fail
5B	E	213.34	394.1383	-181	-46%	Fail

Table 7.17: validation results for the 5 routes in the AM peak

Route	Direction	Modelled	Observed	Diff	% Diff	Pass/Fail
1A	W	701.97	618.3747	84	14%	Pass
1B	E	614.39	651.3372	-37	-6%	Pass
2A	W	338.92	317.9821	21	7%	Pass
2B	E	299.73	301.6956	-2	-1%	Pass
3A	NW	685.93	540.9212	145	27%	Fail
3B	SE	562.66	547.5893	15	3%	Pass
4A	W	871.89	791.0631	81	10%	Pass
4B	E	794.96	802.6547	-8	-1%	Pass
5A	W	255.49	230.2497	25	11%	Pass
5B	E	250.11	230.675	19	8%	Pass

Table 7.18: validation results for the 5 routes in the IP peak

Route	Direction	Modelled	Observed	Diff	% Diff	Pass/Fail
1A	W	659.46	657.1453	2	0%	Pass
1B	E	909.82	1179.153	-269	-23%	Fail
2A	W	338.08	342.9107	-5	-1%	Pass
2B	E	343.26	329.4507	14	4%	Pass
3A	NW	694.9	800.6427	-106	-13%	Pass
3B	SE	792.36	1005.387	-213	-21%	Fail

4A	W	857.7	831.748	26	3%	Pass
4B	E	977.26	1268.811	-292	-23%	Fail
5A	W	257.99	232.936	25	11%	Pass
5B	E	345.09	305.8517	39	13%	Pass

Table 7.19: validation results for the 5 routes in the PM peak

Route 1 is the one covering the path of the Proposed Development and it can be seen in Figure 7-16. The full set of charts for all routes is available in Appendix 8.3.

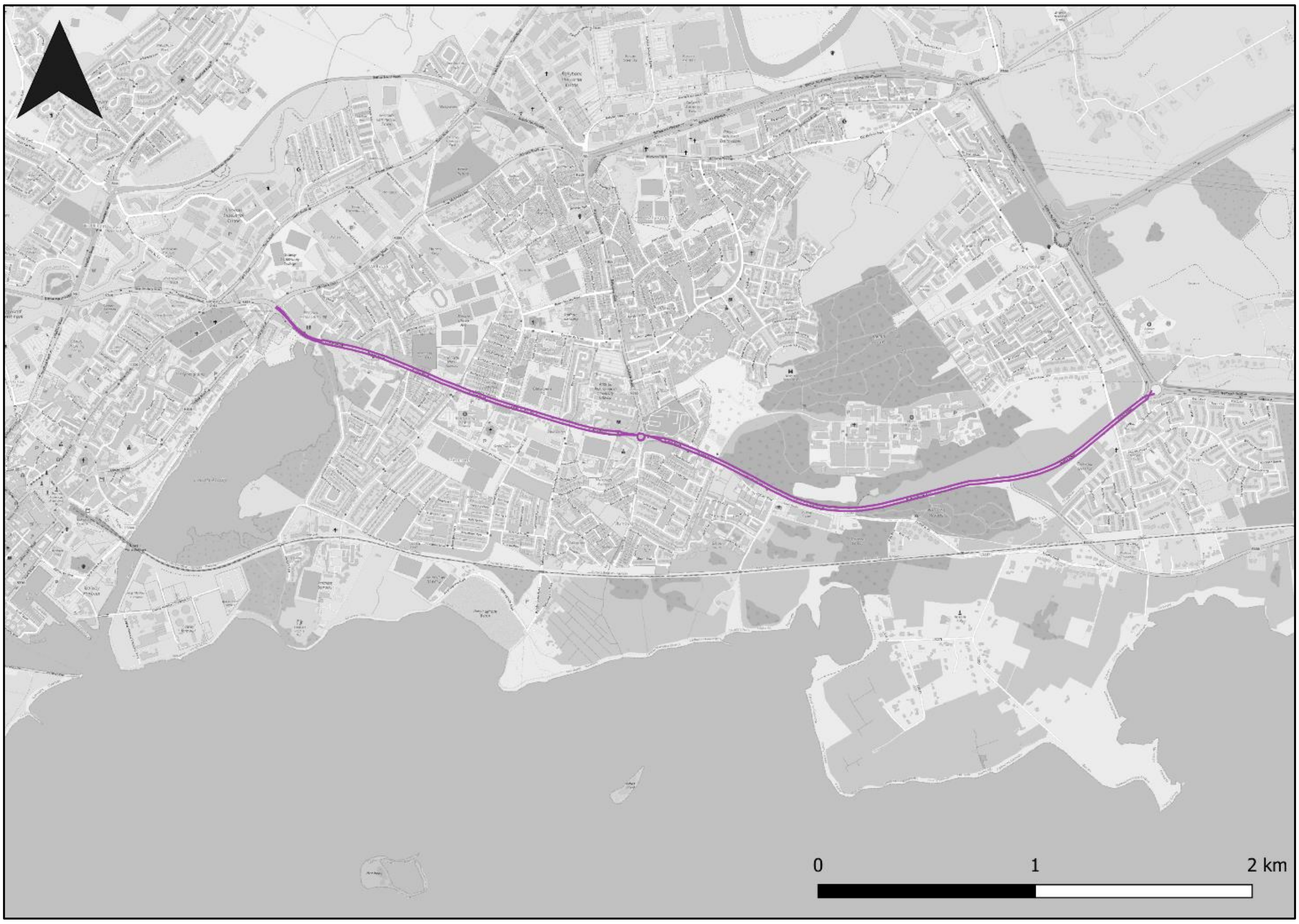


Figure 7-16: route 1 for Journey Time Validation

AM Results

Figure 7-17 and Figure 7-18 illustrate the comparison between modelled and observed journey times for route 1 westbound and eastbound in the AM peak.

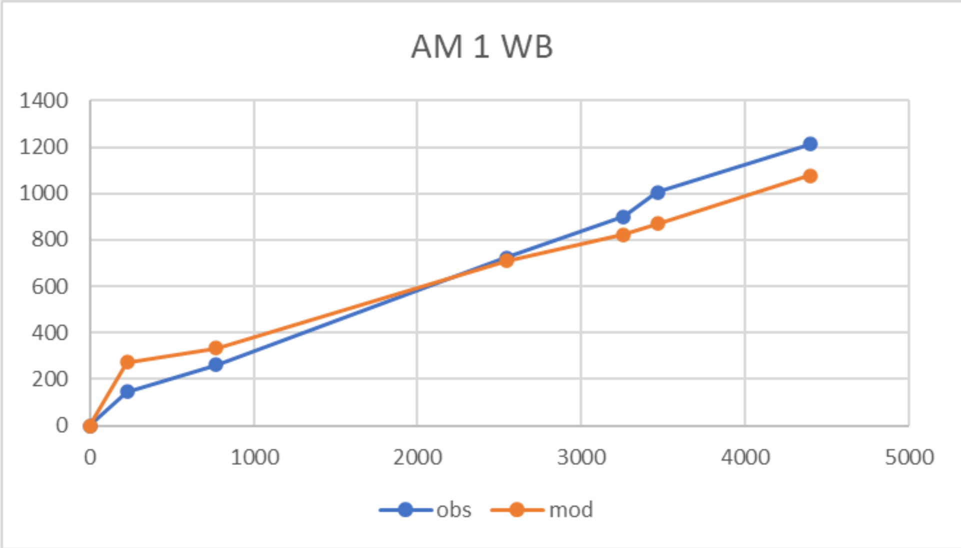


Figure 7-17: Journey Time Validation Plot - Route 1 Westbound AM

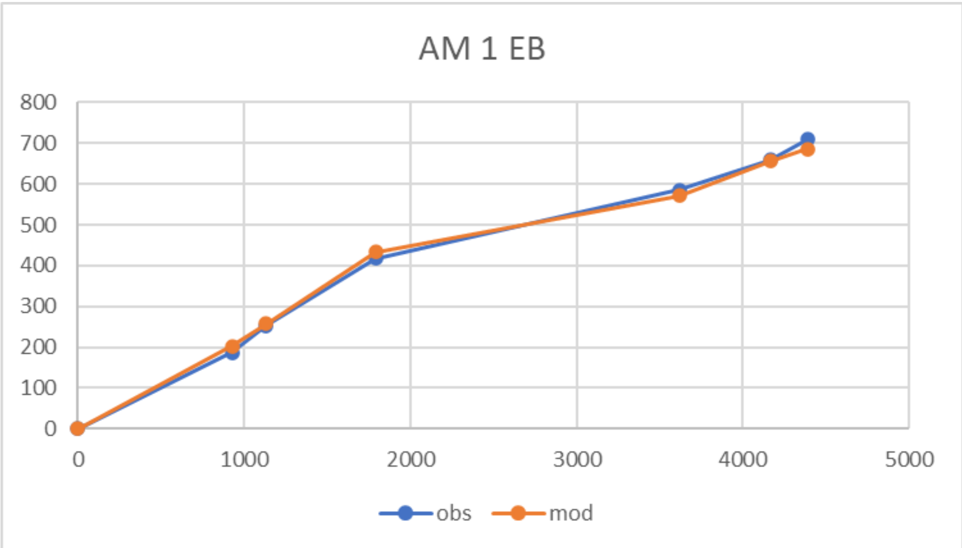


Figure 7-18: Journey Time Validation Plot - Route 1 Eastbound AM

The results indicate that the model is slightly overestimating delay along this route westbound in the AM peak hour. However, in this instance the journey time validation is deemed acceptable as the difference between modelled and observed journey times of 11% falls within the TII guidelines. The eastbound route shows a better performance with an overall difference between observed and modelled of 3%.

IP Results

Figure 7-19 and Figure 7-20 illustrate the comparison between modelled and observed journey times for route 1 westbound and eastbound in the IP peak.

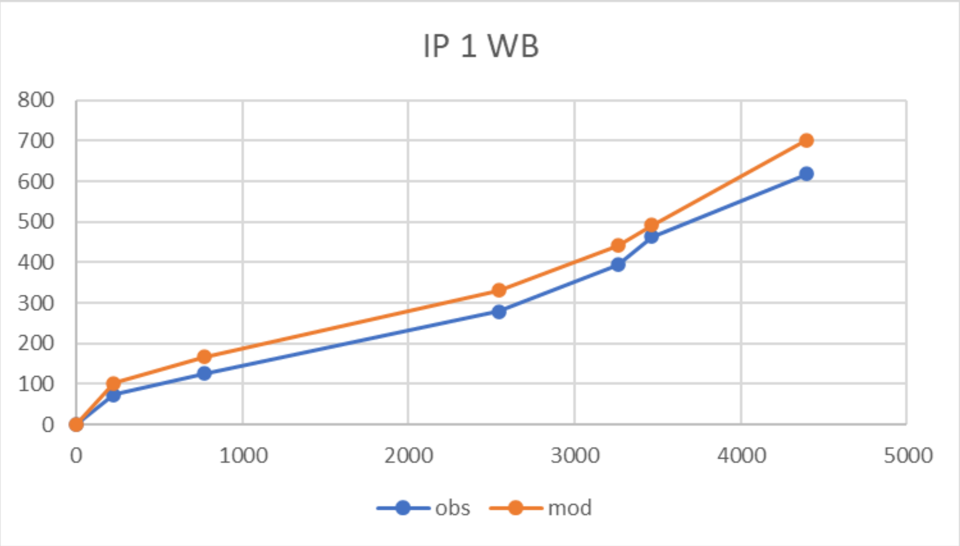


Figure 7-19: Journey Time Validation Plot - Route 1 Westbound IP

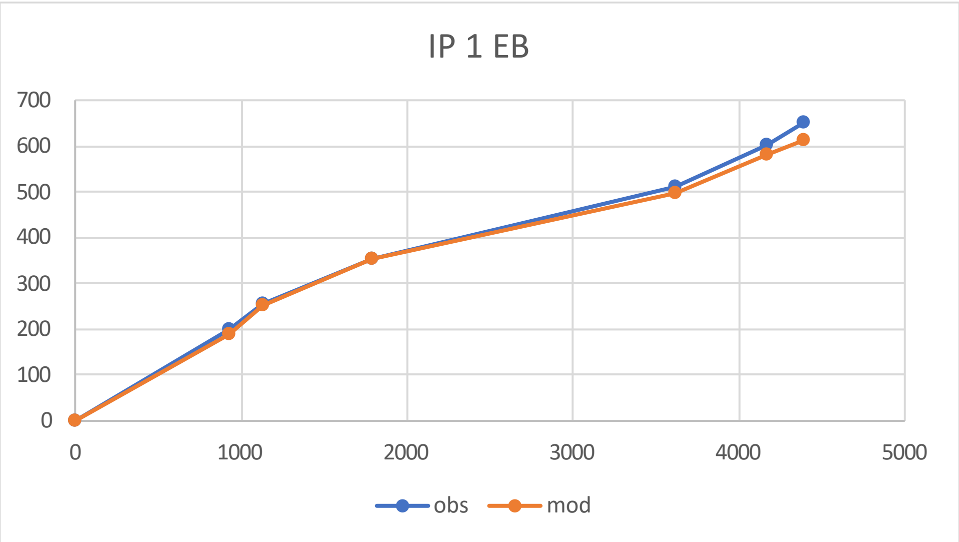


Figure 7-20: Journey Time Validation Plot - Route 1 Eastbound IP

The results indicate that the model is slightly overestimating delay along this route westbound in the AM peak hour. However, in this instance the journey time validation is deemed acceptable as the difference between modelled and observed journey times of 14% falls within the TII guidelines. The eastbound route shows a better performance with an overall difference between observed and modelled of 6%.

PM Results

Figure 7-21 and Figure 7-22 illustrate the comparison between modelled and observed journey times for route 1 westbound and eastbound in the PM peak.

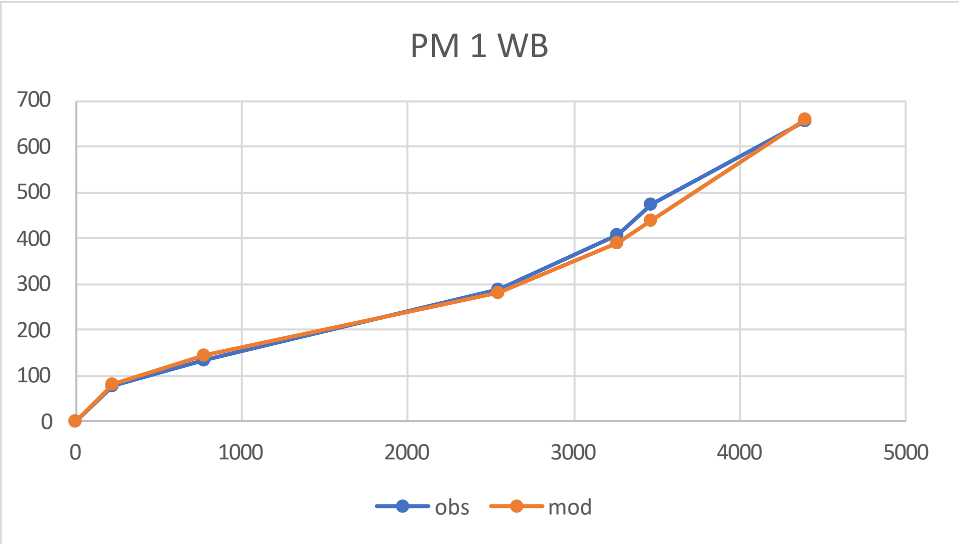


Figure 7-21: Journey Time Validation Plot - Route 1 Westbound PM

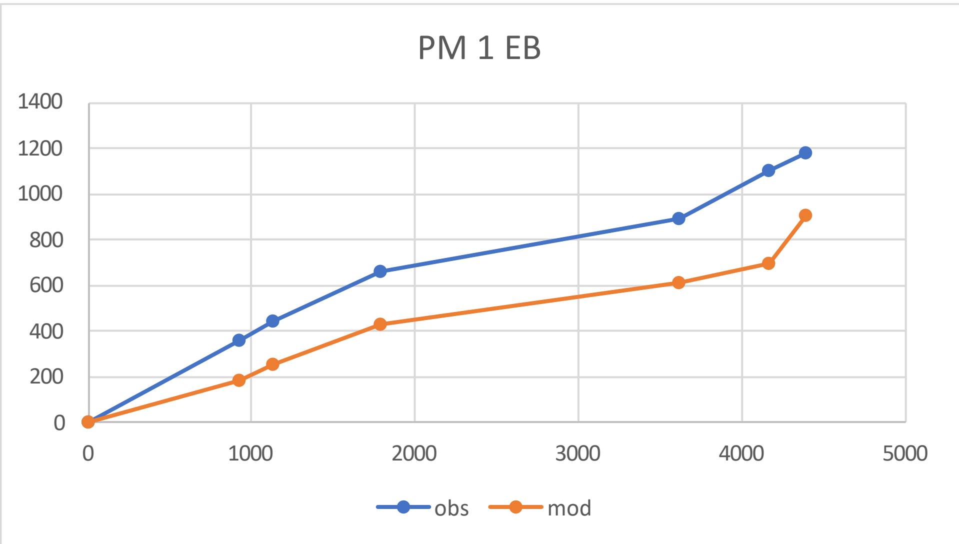


Figure 7-22: Journey Time Validation Plot - Route 1 Eastbound PM

The results indicate that the model is performing well in terms of journey time along the westbound route in the PM peak hour since the modelled and observed figures do not show notable differences.

The opposite eastbound route, on the other hand, fails the validation criteria as the overall modelled journey times are 23% lower compared to the observed ones.

7.7.4 Validation Summary

The previous sections of this Chapter have outlined the validation checks undertaken to assess the robustness of the calibrated LAM. Overall, the Galway City LAM partially meets all TII and DfT TAG validation criteria: while GEH was just below the target, the individual link flows show a good performance . Moreover, a good correlation has been achieved between modelled and observed journey times in all time periods.

7.8 Future Year Scenarios

This section covers the development of the future year scenarios for the Local Area Model (LAM). While future year scenarios have been tested in the WRM, as shown in previous sections, the LAM provides a more detailed forecast of the road impacts of the schemes.

The future year LAM was developed on top of the 2022 base year calibrated LAM but utilises information from the WRM future year run to provide. The reason for this approach is;

- The Base LAM is calibrated to more recent counts than the WRM so provides a more recent and localised demand matrix; and
- The Base LAM contains more detail for the study area, so provides a better base to test study specific schemes.

To retain the detail of the developed LAM but utilise the WRM future demand, a furnessing process was applied to factor the 2022 LAM demand matrix up to 2028, 2043 and 2058 demand levels utilising growth factors from the WRM runs.

7.8.1 Future Year Demand – Furness Method

The Furness Method (also known as *Doubly Constrained Growth Factor Method* – or as *Fratar* in the US) is an iterative process typically used when the future number of trips originating and terminating in each zone is known. The method calculates "*a set of intermediate correction factors which are then applied to cell entries in each row or column as appropriate. After applying these corrections to say, each row, the totals for each column are calculated and compared with the target values. If the differences are significant, new correction coefficients are calculated and applied as necessary*" *(Modelling Transport, Ortuzar, Willumsen, 2011)*.

Figure 7-23 provides an overview of the Furness method applied to produce the Galway Future Year LAM demand. The steps on the left side of the diagram represent the process of calibrating the Base Year LAM as reported in Chapter 7.6. The first two rectangles on the right side of the diagram refer to the cordoning of the WRM forecast scenarios and conversion into an LAM matrix through zone disaggragtion (Unadjusted Forecast Year LAM Demand).

The procedure involves the calculation of growth factors at origin and destination level between the 2019 Prior and the Forecast Year Prior. These factors are then applied to the 2022 Calibrated Base Year

LAM (2022 Calibrated LAM Demand) in an iterative process that "pivots" the 2022 demand to match the growth trends observed between the two starting matrices. This results in a final pivoted Forecast Year demand matrix.

This process has been performed using Cube Voyager and the "FRATAR" internal program, which performs the Furnessing procedure.

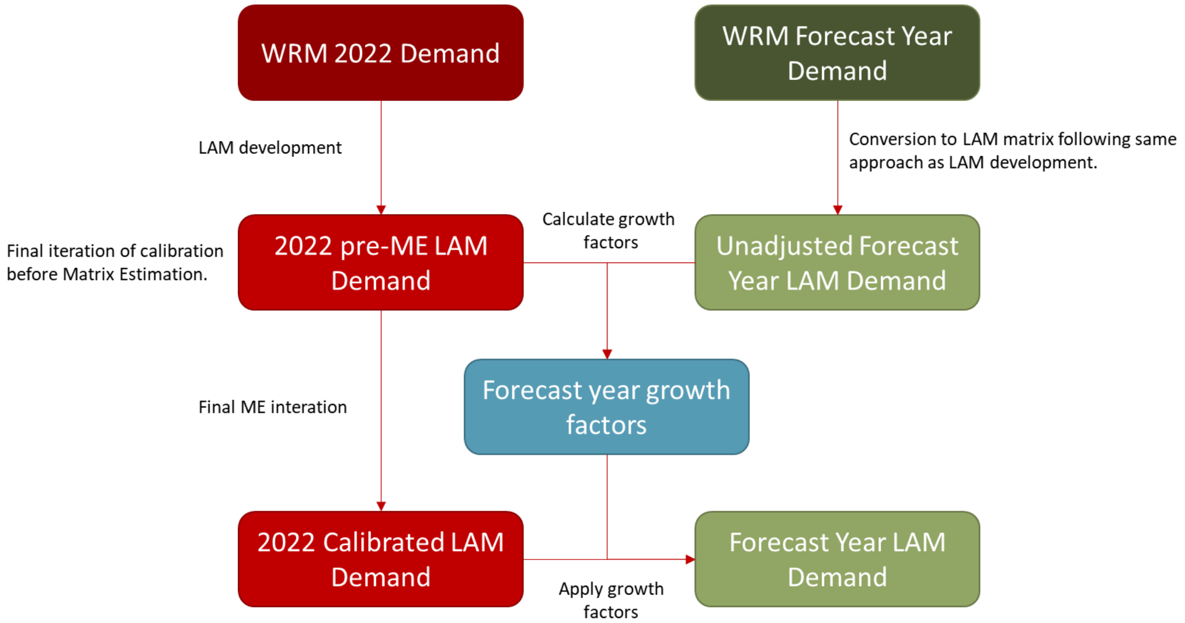


Figure 7-23: Overview of the Furnessing method for the Galway City LAM

To check the Furnessing process, analysis of the total trip ends was carried out to ensure the growth trends of the demand remained consistent across the LAM

The entire process has been repeated for all forecast scenarios in both 2028, 2043 and 2058.

7.8.2 Future Year LAM Networks

To develop the future year networks, a cordon of the future year WRM was taken and then overlayed on the base LAM. This ensures consistency between the coding in the WRM while retaining the additional detail of the LAM.

Further refinement was made through an iterative process, adjustments were made to improve assignment convergence by reducing congestion, delays and blocking back. Main interventions involved the optimization of signal times and changes to zone access through increased zone loaders or increased zone loader capacity to accommodate growth.

7.9 LAM Modelling Results

7.9.1 Network Performance Indicators

High level network performance indicators for the LAM network were extracted for all modelled scenarios in the AM, Inter-peak and PM peak hours and are presented in Table 7.20 below. It is important to note that the results presented cover the full LAM network, therefore the impact of transport scenarios along the Dublin Road corridor may be viewed as relatively marginal in consideration of the entire network. For each scenario the following network statistics are presented:

- Transient Queues: this is expressed in total pcu.hours which is essentially the volume of vehicles on the network multiplied by the time spent in transient queues and it represents time spent in queues at junctions which are not over capacity (e.g. at a signalised junction where the queue is able to clear during a single cycle).
- Over-capacity queues: expressed in total pcu.hours, this occurs where the volume of turning movements exceeds junction capacity, such that a permanent queue builds (e.g. at a signalised junction where a queue is unable to clear in a single cycle).
- Average Speed: represents the average speed of all vehicles travelling on the network within the modelled time period measured in km/h.
- Total Travel Distance: represents the total distance travelled by vehicles on the road network in the modelled period measured in pcu.km.
- Total Travel Time: represents the total time travelled by vehicles on the road network in the modelled period measured in pcu.kmhr.

Overall, transient queues show a slight increase (<5%) between in each Do Something, when compared to its equivalent Do Something scenario across all time periods. This slight increase is caused by the additional signalised junctions within the Proposed Development. Although the average speed across the entire Local Area Model, shows very little change between the Do Something and equivalent Do Minimum scenarios in both years. This is the same for the total travel distance and total travel time, which both show very little change between the Do Something and Do Minimum scenarios.

	Time Period	Transient Queues [pcu-hrs]	Over Capacity Queues [pcu-hrs]	Average Speed [km/h]	Total Travel Distance [pcu-km]	Total Travel Time [pcu-hrs]
2028 DO MIN	AM	2,091	1,004	22.4	163,667	7,299
	IP	1,320	254	26.7	124,222	4,650
	PM	1,860	665	25.0	162,865	6,514
2028 DO SOM	AM	2,138	896	22.6	162,711	7,200
	IP	1,364	251	26.5	123,903	4,675
	PM	1,907	614	25.0	162,135	6,479
2043 DO MIN	AM	2,703	2,406	19.2	192,128	9,994
	IP	1,853	878	23.5	151,280	6,437
	PM	2,326	1,344	22.7	188,317	8,300
2043 DO SOM	AM	2,839	2,185	19.4	191,855	9,887
	IP	1,928	906	23.2	151,514	6,531
	PM	2,439	1,411	22.3	188,279	8,453
2043 DO MIN (With GCRR)	AM	2,004	540	29.9	226,668	7,587
	IP	1,313	154	33.8	176,643	5,219
	PM	2,178	1,158	27.5	222,309	8,095
2043 DO SOM (With GCRR)	AM	2,128	427	29.8	225,465	7,566
	IP	1,372	151	33.5	176,649	5,267
	PM	2.285	1.177	27.1	222,823	8,208

Table 7.20: Local Area Model – Network Performance Indicators

7.9.2 Highway Flows

Figure 7-24 and Figure 7-25 present the 2028 AM and PM traffic flow differences between the core DM and DS scenarios.

During the 2028 AM peak, a noticeable reduction in traffic volume of approximately 20% was observed along the west-to-east corridor of Dublin Road, while conversely, a substantial increase of 25% in traffic flow was noted in the opposite direction. Additionally, a noteworthy traffic rerouting pattern emerged, with traffic being redirected from Ballyloughane Road to Renmore Park, primarily serving the Renmore area.

In the PM hours of 2028, a 16% reduction in traffic congestion was identified along Dublin Road in the west-to-east direction, with this reduction further intensifying to 31% along Coast Road.

These changes in the AM and PM peak hours are mostly caused by the new signalised junctions along the corridor i.e. Skerrit roundabout which is being signalized. Following these additional signals, which are optimized for all movements, some traffic reroutes onto other roads as they have less priority than they had in the Do Minimum scenario.

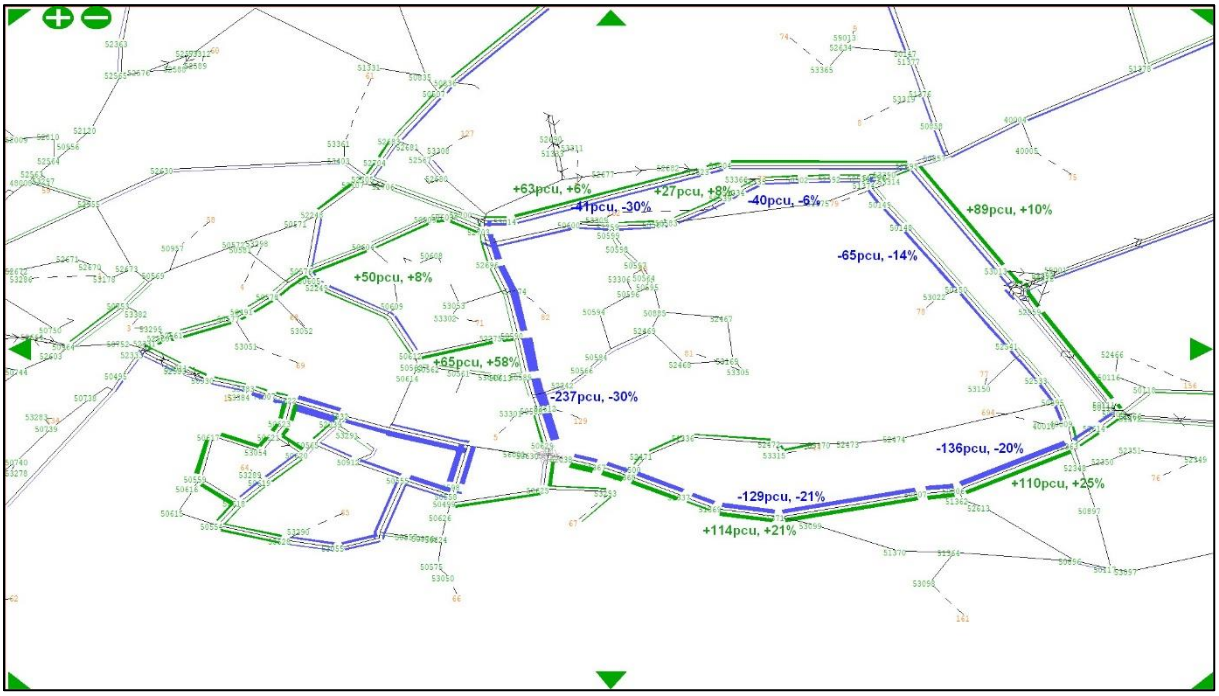


Figure 7-24: 2028 AM flow differences

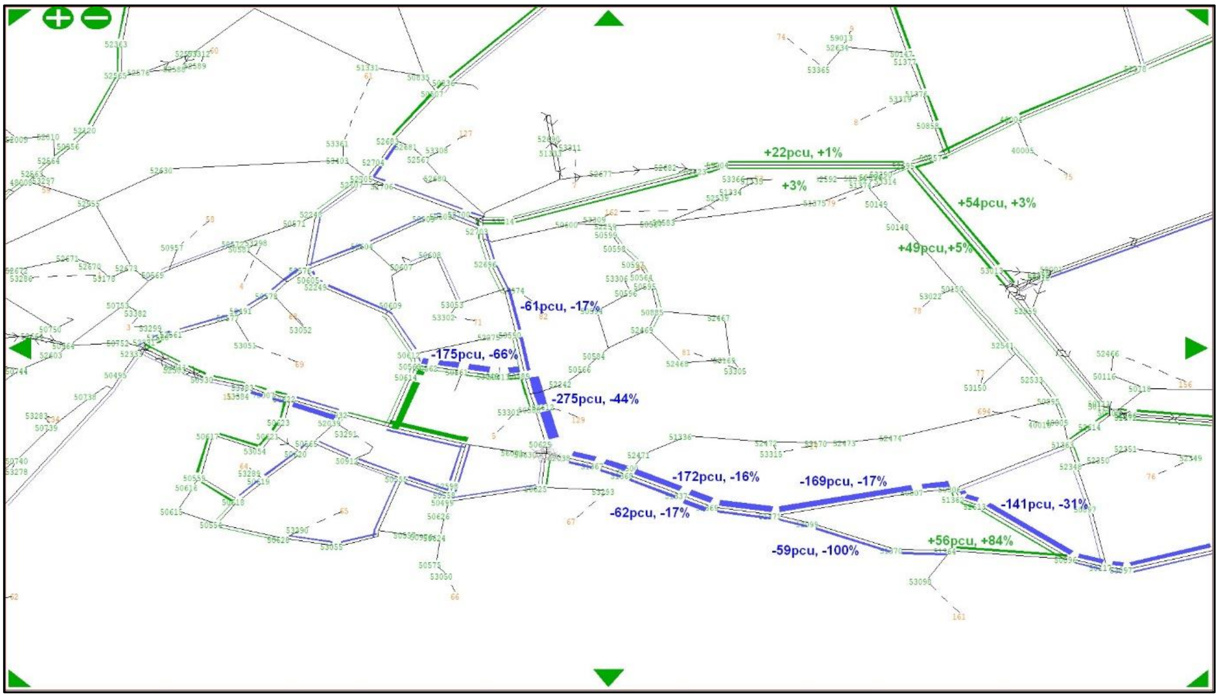


Figure 7-25: 2028 PM flow differences

Figure 7-26 and Figure 7-27 present the 2043 AM and PM traffic flow differences between DM and DS scenarios.

During the 2043 AM peak, an increase in traffic flow ranging from 20% to 30% was evident along both directions of Dublin Road, particularly in the segment between Skerritt Junction and the N67. A similar rerouting pattern observed in 2028 re-emerged in the Renmore area.

Conversely, in the PM scenario of 2043, a substantial 23% reduction in traffic congestion was identified on the westbound section of Dublin Road, extending from Skerritt Junction to Coast Road.

These changes in the AM and PM peak hours are mostly caused by the new signalised junctions along the corridor i.e. Skerrit roundabout which is being signalized. Following these additional signals, which are optimized for all movements, some traffic reroutes onto other roads as they have less priority than they had in the Do Minimum scenario.

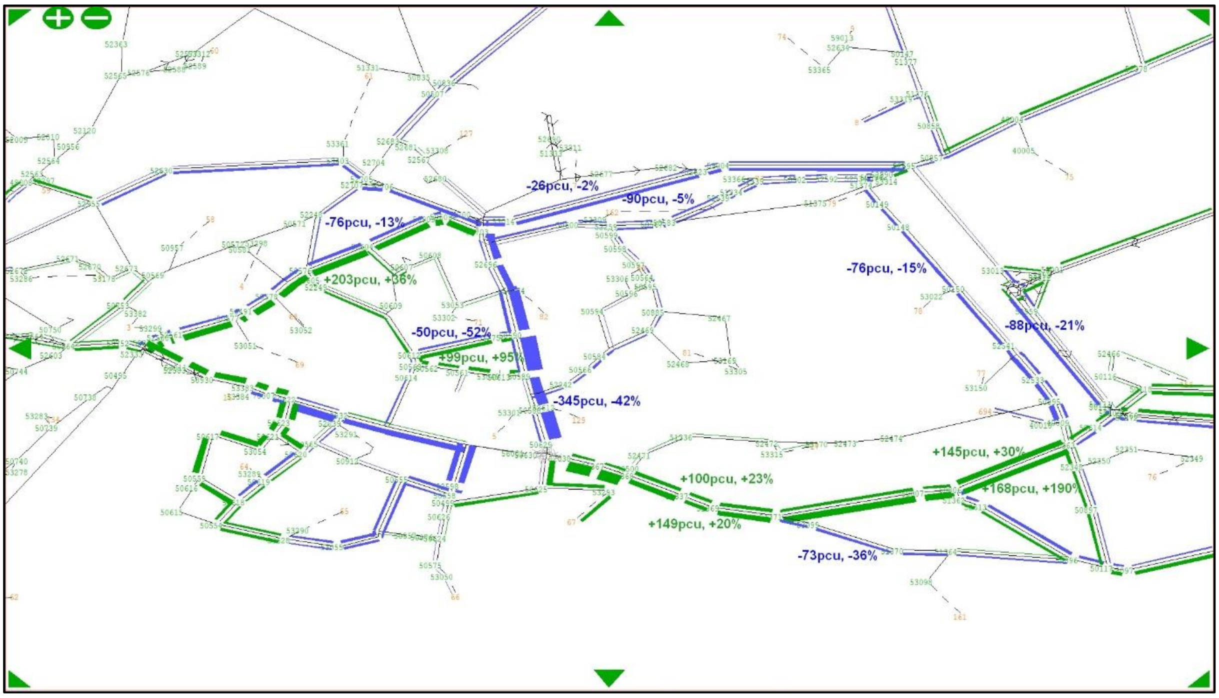


Figure 7-26: 2043 AM flow differences

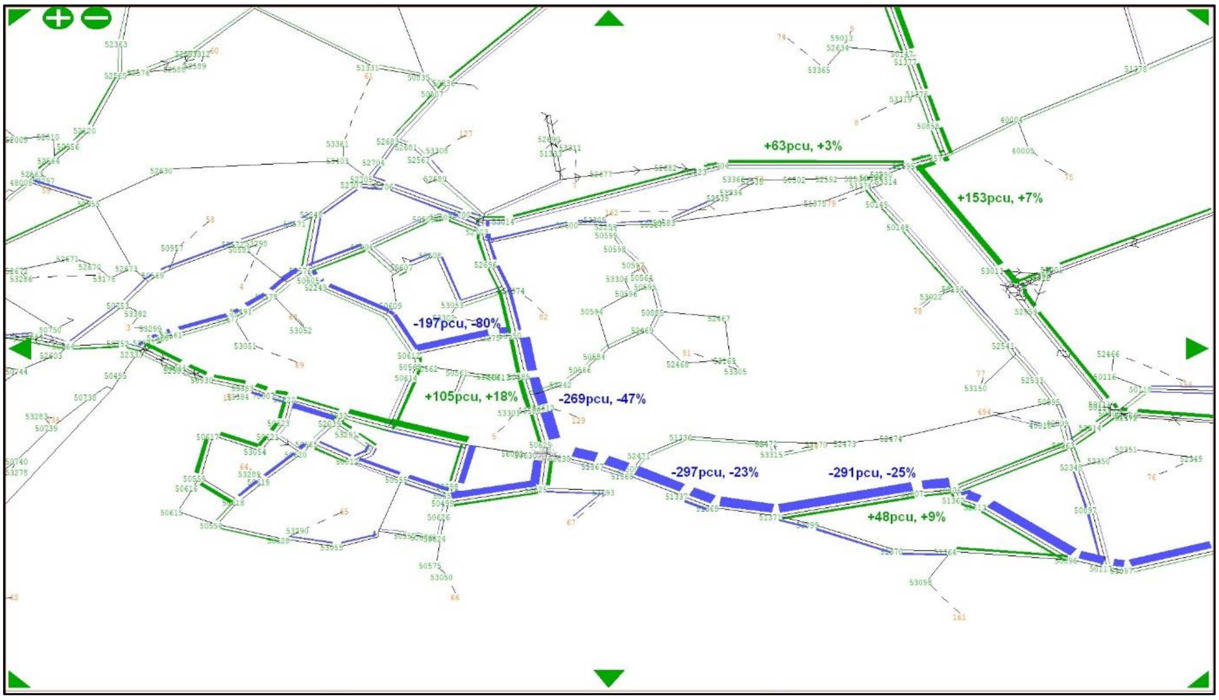


Figure 7-27: 2043 PM flow differences

7.10 Construction Scenario

7.10.1 Assumptions

In Chapter 5 of the EIAR, a Construction Scenario has been developed to accommodate the necessary construction work needed to build the Proposed Development. As these works will have some impact to traffic during that period, a scenario has been modelled to assess the impacts of these temporary traffic management measures during the construction phase.

The Proposed Development has been divided into the following three principal sections, and multiple sub-sections, in relation to construction:

- **Section 1:** East of Moneenageisha Junction to Skerritt Junction
- **Skerritt Junction**
- **Section 2:** Skerritt Junction to Doughiska Road Junction

The location of each section can be seen in Figure 7-28.

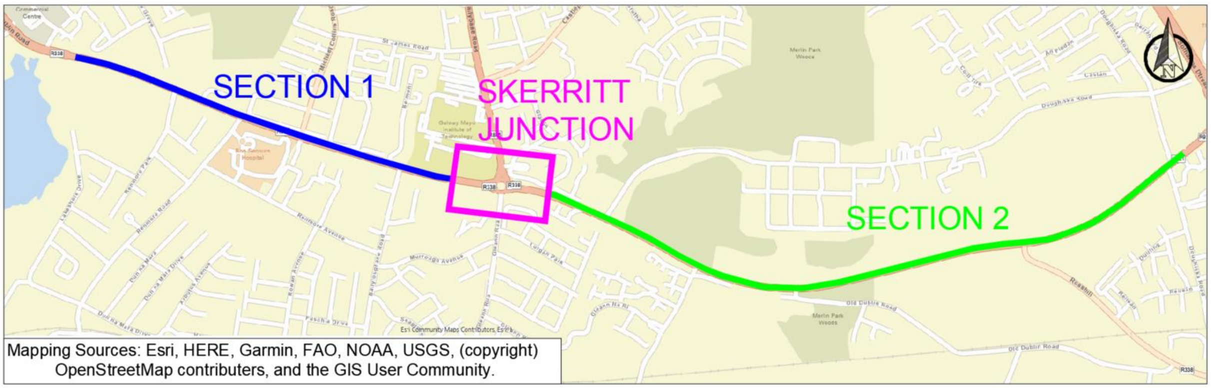


Figure 7-28: Sections of the Proposed Development

Following discussions with Barry Transportation, it has been decided to model traffic restrictions during months 10 to 13 before the traffic restrictions as part of the Proposed Development are being implemented. This includes the following measures:

- One lane of traffic in each direction will be maintained along the Dublin Road
- Phased lane closures as required (i.e. lane narrowing or realignment of lanes) to facilitate the works
- Speed limits reduced to 30km/h

The 2028 Do Minimum Local Area Model has been used as a starting point for the Construction Scenario.

7.10.2 Results

Figure 7-29 below shows the flow differences during the AM peak period as a result of the temporary traffic management measures. Due to the restriction of road space to only one lane per direction and the reduction of speed limit to 30km/h, outbound traffic reroutes from Dublin Road to the N6 via the R339. In the east section of the Proposed Development, traffic arriving from the Coast Road is expected to shift from the Coast Road junction to Rosshill Road junction instead.

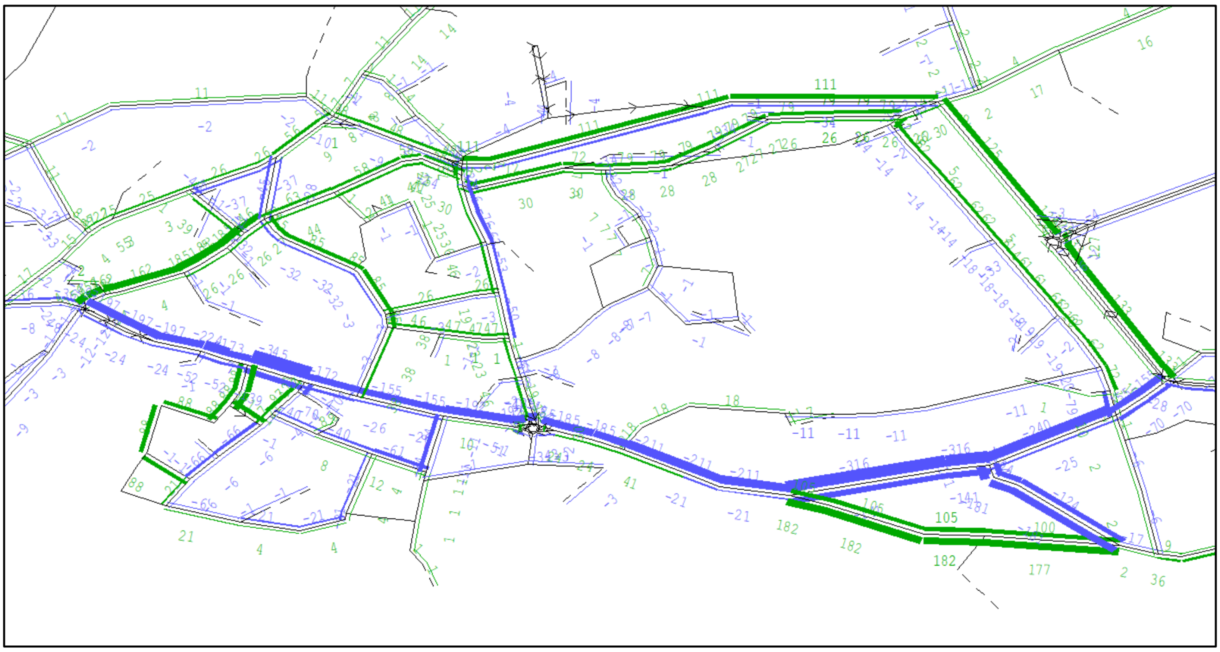


Figure 7-29: 2028 Flow Differences Construction Scenario minus Do Minimum (AM)

Figure 7-30 below shows the impacts of the Construction Scenario compared to the Do Minimum scenario during the PM peak period. This scenario shows similar trend to the AM peak period, with traffic rerouting from Dublin Road to the N6 and some traffic choosing to access the Coast Road, via the Rosshill Road junction, instead of the Coast Road junction.

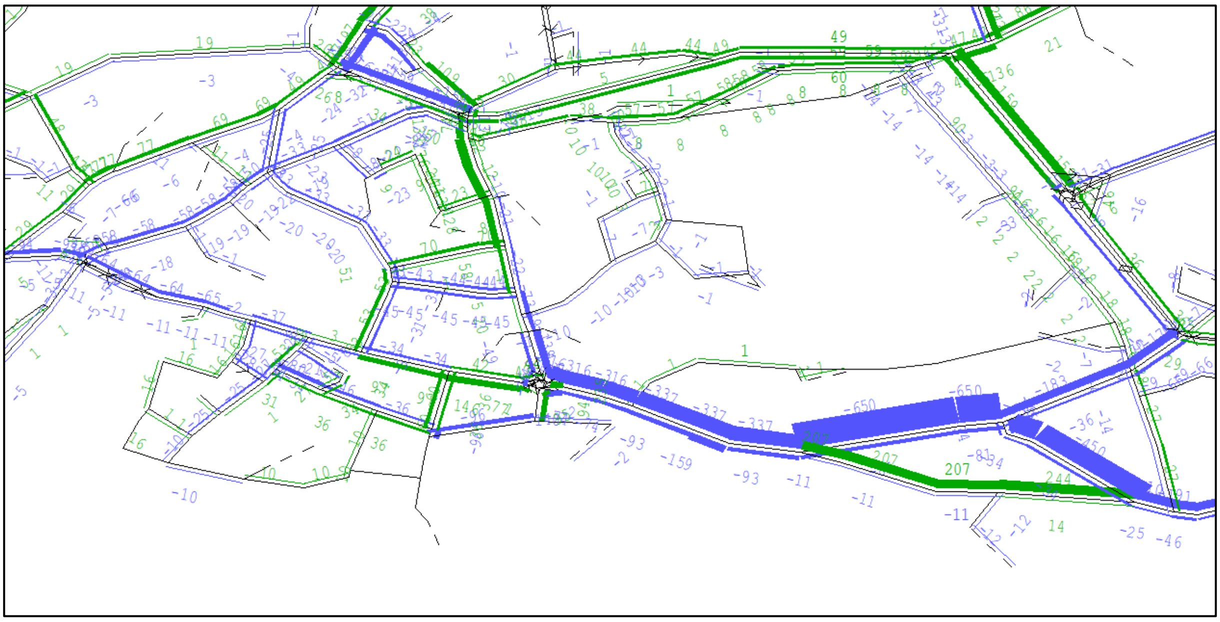


Figure 7-30: 2028 Flow Differences Construction Scenario minus Do Minimum (PM)

Overall, the temporary traffic management measures as part of the Construction Scenario involve a rerouting of traffic from Dublin Road to the N6 and Rosshill Road.

8. APPENDIX (CALIBRATION/VALIDATION RESULTS)

8.1 Flow Calibration

8.1.1 Prior

Links			AMCar	AMLGV	AMHGV	AMTOT	LTCar	LTLGV	LTHGV	LTTOT	PMCar	PMLGV	PMHGV	PMTOT
	WebTAG	Count Pass	309	571	573	300	426	577	577	396	370	571	577	364
		Count Fail	268	6	4	277	151	0	0	181	207	6	0	213
		Total	577	577	577	577	577	577	577	577	577	577	577	577
		% Pass	53.6%	99.0%	99.3%	52%	74%	100%	100%	69%	64%	99%	100%	63%
		% Fail	46.4%	1.0%	0.7%	48%	26%	0%	0%	31%	36%	1%	0%	37%
	> 85% of cases?		NO	YES	YES	NO	NO	YES	YES	NO	NO	YES	YES	NO
	GEH Criteria	Count GEH<5	270	468	499	272	358	513	500	347	312	468	515	321
		Count GEH>=5	307	108	69	305	219	63	77	230	264	108	47	256
		Total	577	576	568	577	577	576	577	577	576	576	562	577
		% GEH<5	46.8%	81.3%	87.9%	47%	62%	89%	87%	60%	54%	81%	92%	56%
		% GEH>=5	53.2%	18.8%	12.1%	53%	38%	11%	13%	40%	46%	19%	8%	44%
	> 85% of cases?		NO	NO	YES	NO	NO	YES	YES	NO	NO	NO	YES	NO
Turns			AMCar	AMLGV	AMHGV	AMTOT	LTCar	LTLGV	LTHGV	LTTOT	PMCar	PMLGV	PMHGV	PMTOT
	WebTAG	Count Pass	42	64	63	46	58	64	64	54	54	64	64	52
		Count Fail	22	0	1	18	6	0	0	10	10	0	0	12
		Total	64	64	64	64	64	64	64	64	64	64	64	64
		% Pass	65.6%	100.0%	98.4%	72%	91%	100%	100%	84%	84%	100%	100%	81%
		% Fail	34.4%	0.0%	1.6%	28%	9%	0%	0%	16%	16%	0%	0%	19%
	> 85% of cases?		NO	YES	YES	NO	YES	YES	YES	NO	NO	YES	YES	NO
	GEH Criteria	Count GEH<5	27	53	48	31	41	60	61	37	38	60	50	36
		Count GEH>=5	35	7	4	31	23	3	3	27	26	2	2	28
		Total	62	60	52	62	64	63	64	64	64	62	52	64
		% GEH<5	43.5%	88.3%	92.3%	50%	64%	95%	95%	58%	59%	97%	96%	56%
		% GEH>=5	56.5%	11.7%	7.7%	50%	36%	5%	5%	42%	41%	3%	4%	44%
	> 85% of cases?		NO	YES	YES	NO	NO	YES	YES	NO	NO	YES	YES	NO

8.1.2 Post

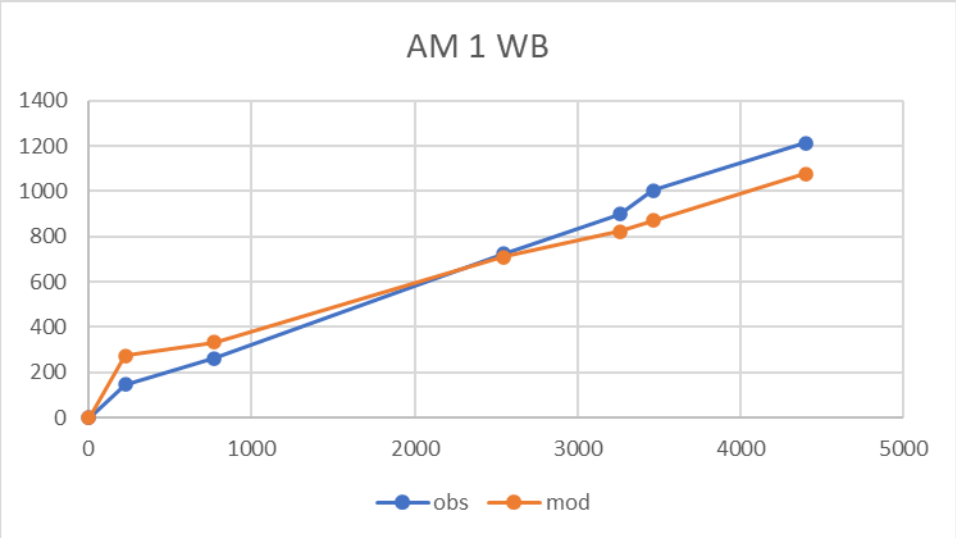
Links			AMCar	AMLGV	AMHGV	AMTOT	LTCar	LTLGV	LTHGV	LTTOT	PMCar	PMLGV	PMHGV	PMTOT
	WebTAG	Count Pass	523	577	577	505	552	577	577	540	533	577	577	529
		Count Fail	54	0	0	72	25	0	0	37	44	0	0	48
		Total	577	577	577	577	577	577	577	577	577	577	577	577
		% Pass	91%	100%	100%	88%	96%	100%	100%	94%	92%	100%	100%	92%
		% Fail	9%	0%	0%	12%	4%	0%	0%	6%	8%	0%	0%	8%
	> 85% of cases?		YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
	GEH Criteria	Count GEH<5	505	550	546	500	523	558	554	520	512	543	538	507
		Count GEH>=5	72	25	18	77	54	18	23	57	64	33	12	70
		Total	577	575	564	577	577	576	577	577	576	576	550	577
		% GEH<5	88%	96%	97%	87%	91%	97%	96%	90%	89%	94%	98%	88%
		% GEH>=5	12%	4%	3%	13%	9%	3%	4%	10%	11%	6%	2%	12%
	> 85% of cases?		YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Turns			AMCar	AMLGV	AMHGV	AMTOT	LTCar	LTLGV	LTHGV	LTTOT	PMCar	PMLGV	PMHGV	PMTOT
	WebTAG	Count Pass	63	64	64	59	64	64	64	64	64	64	64	63
		Count Fail	1	0	0	5	0	0	0	0	0	0	0	1
		Total	64	64	64	64	64	64	64	64	64	64	64	64
		% Pass	98%	100%	100%	92%	100%	100%	100%	100%	100%	100%	100%	98%
		% Fail	2%	0%	0%	8%	0%	0%	0%	0%	0%	0%	0%	2%
	> 85% of cases?		YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
	GEH Criteria	Count GEH<5	57	60	50	56	63	63	64	63	58	59	45	58
		Count GEH>=5	6	1	0	7	1	0	0	1	6	3	0	6
		Total	63	61	50	63	64	63	64	64	64	62	45	64
		% GEH<5	90%	98%	100%	89%	98%	100%	100%	98%	91%	95%	100%	91%
		% GEH>=5	10%	2%	0%	11%	2%	0%	0%	2%	9%	5%	0%	9%
	> 85% of cases?		YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

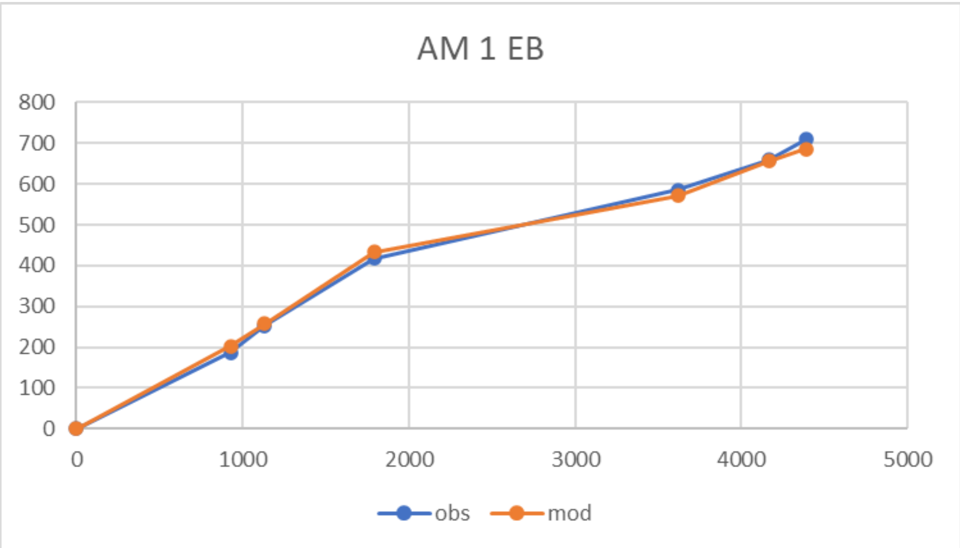
8.2 Flow validation

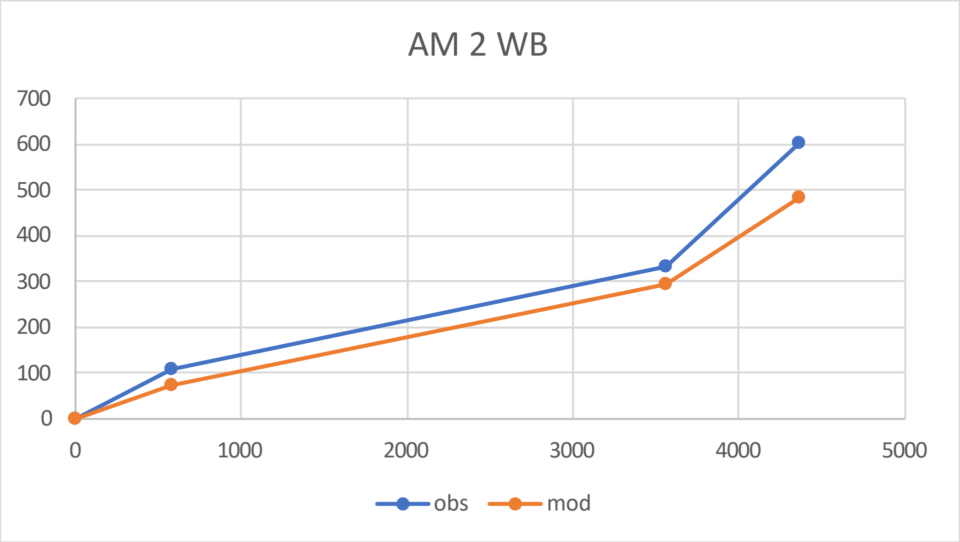
Turns			AMCar	AMLGV	AMHGV	AMTOT	LTCar	LTLGV	LTHGV	LTTOT	PMCar	PMLGV	PMHGV	PMTOT
	WebTAG	Count Pass	477	513	513	467	492	513	513	482	479	513	513	466
		Count Fail	36	0	0	46	21	0	0	31	34	0	0	47
		Total	513	513	513	513	513	513	513	513	513	513	513	513
		% Pass	93%	100%	100%	91%	96%	100%	100%	94%	93%	100%	100%	91%
		% Fail	7%	0%	0%	9%	4%	0%	0%	6%	7%	0%	0%	9%
	> 85% of cases?		YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
	GEH Criter	Count GEH<5	374	463	421	370	393	489	473	386	366	468	367	358
		Count GEH>=5	135	31	8	139	119	15	14	126	140	23	6	149
		Total	509	494	429	509	512	504	487	512	506	491	373	507
		% GEH<5	73.5%	93.7%	98.1%	72.7%	76.8%	97.0%	97.1%	75.4%	72.3%	95.3%	98.4%	70.6%
		% GEH>=5	26.5%	6.3%	1.9%	27.3%	23.2%	3.0%	2.9%	24.6%	27.7%	4.7%	1.6%	29.4%
	> 85% of cases?		NO	YES	YES	NO	NO	YES	YES	NO	NO	YES	YES	NO

8.3 Journey Time Validation Charts

8.3.1 AM Peak






AM 2 WB
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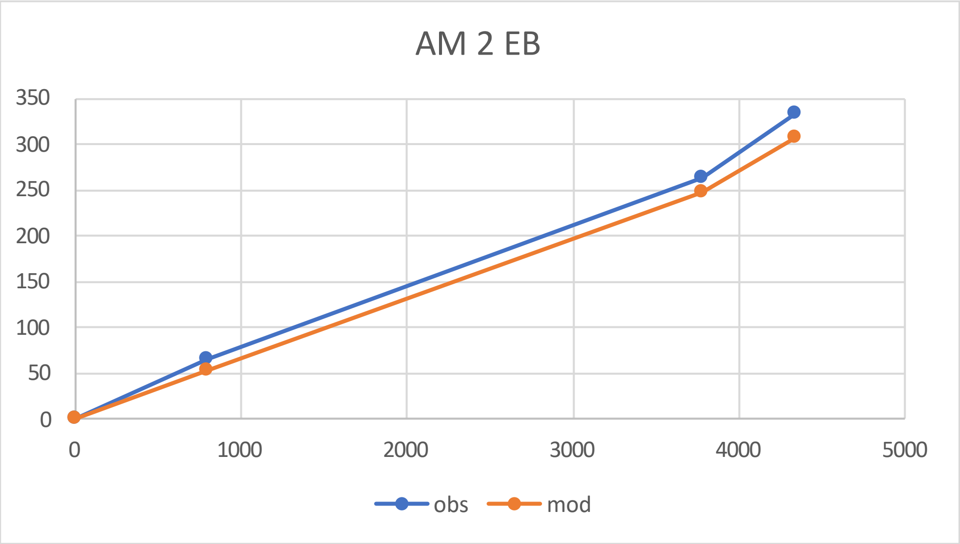
400
300
200
100
0
0
1000
2000
3000
4000
5000
obs
mod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100
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4000
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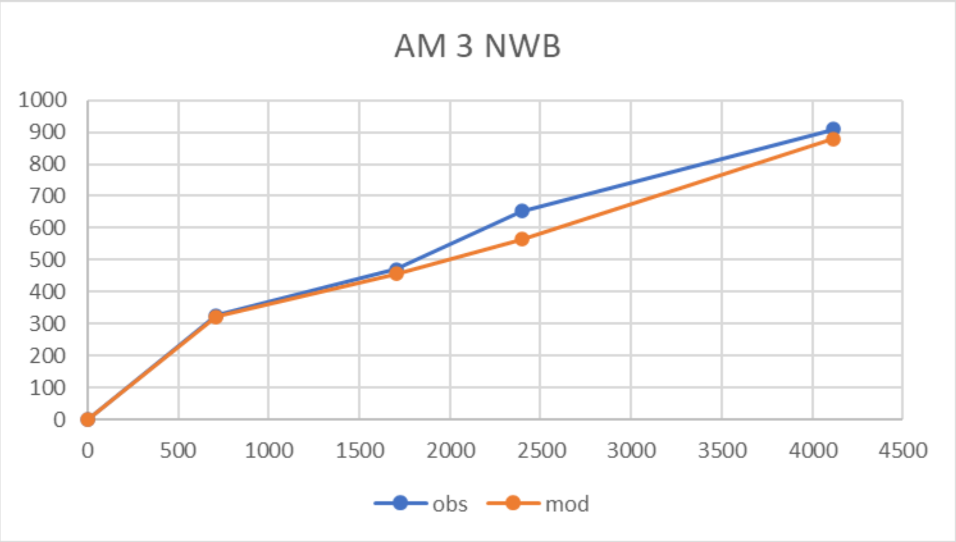
obs
mod


AM 3 NWB
1000
900
800
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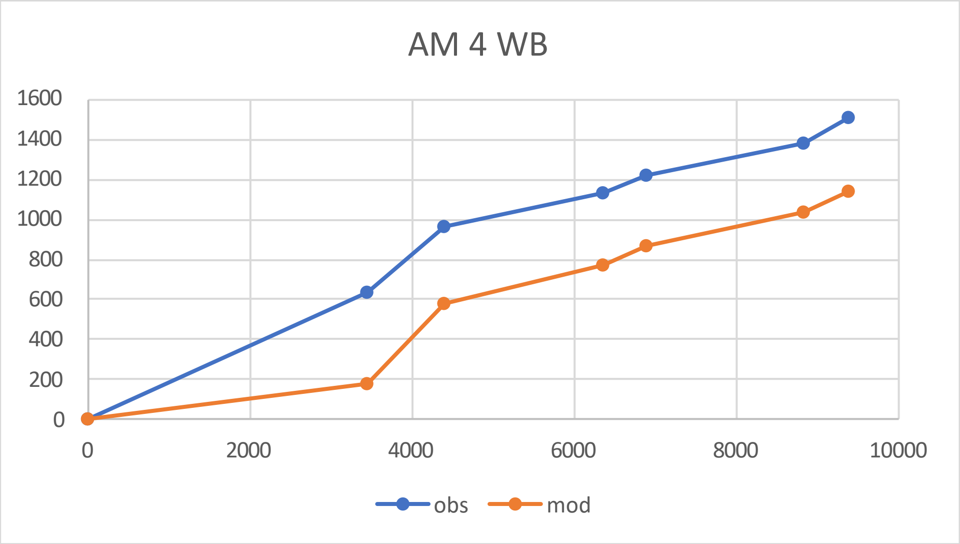
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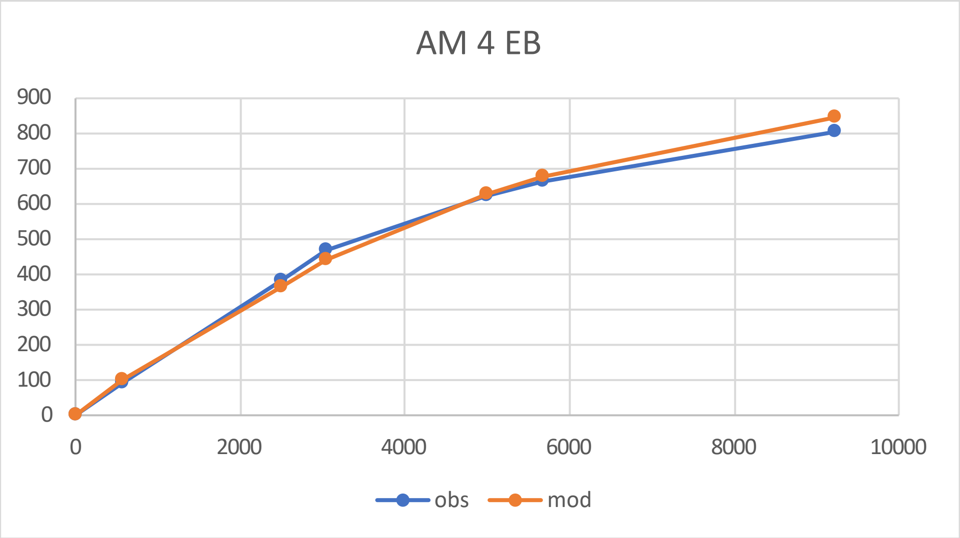
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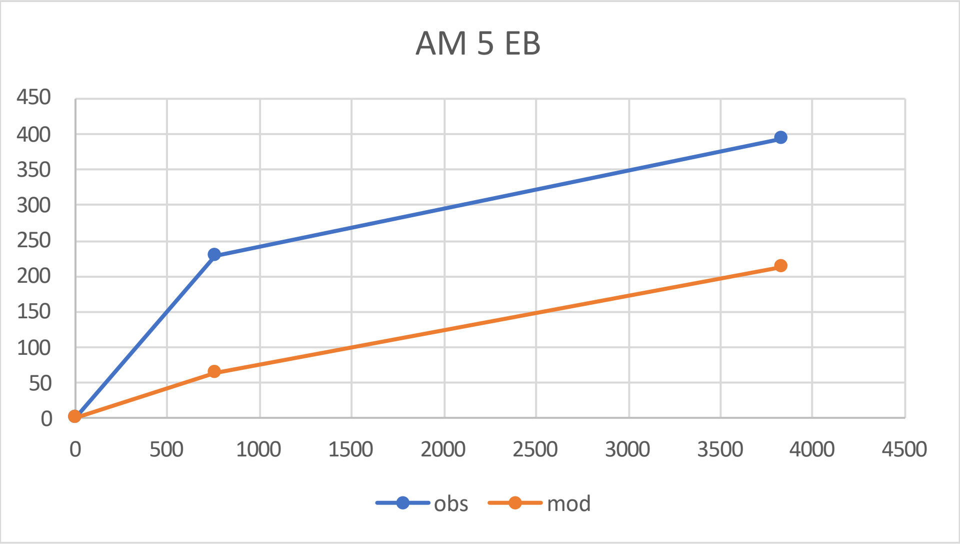
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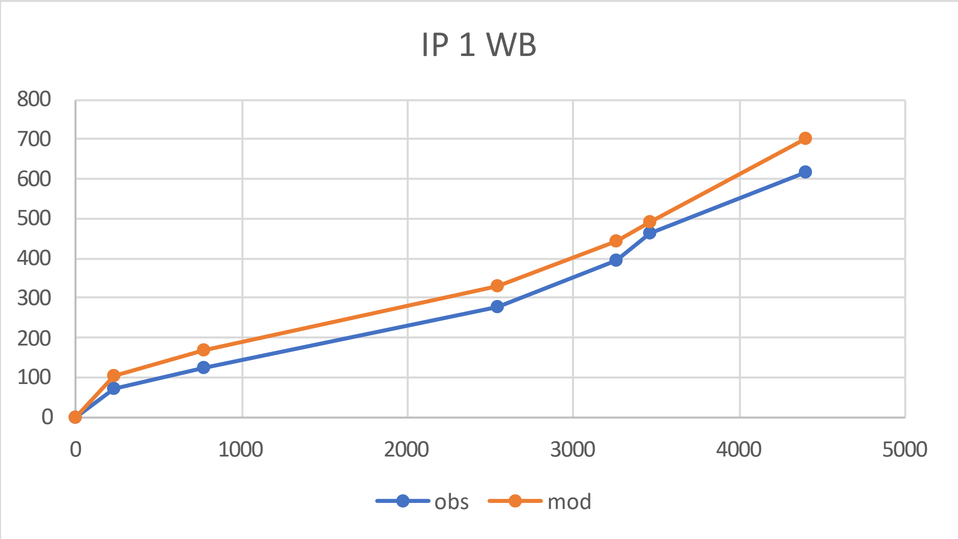

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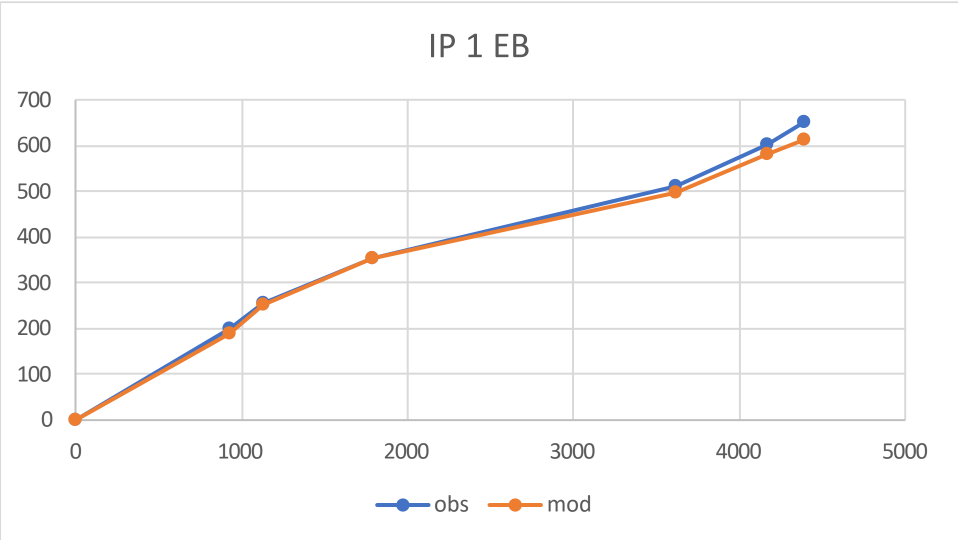

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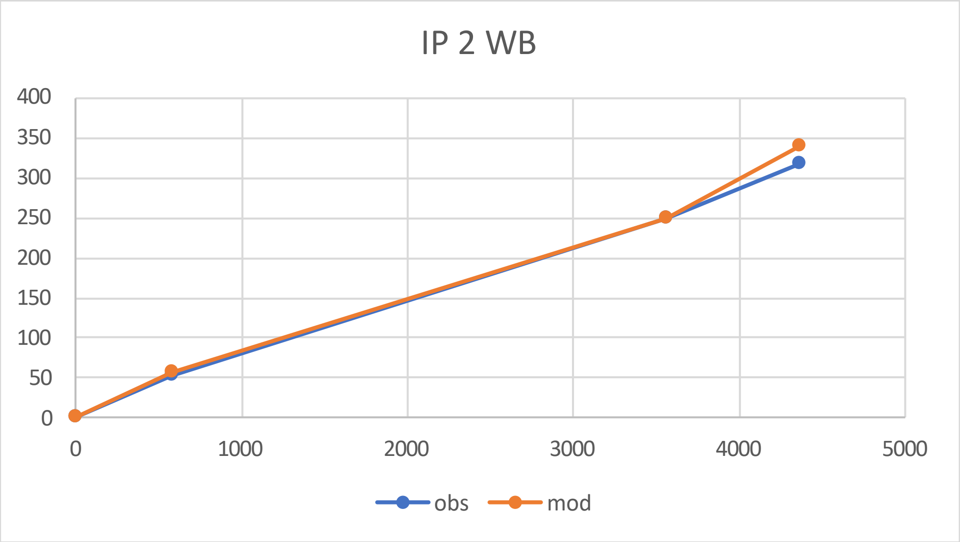
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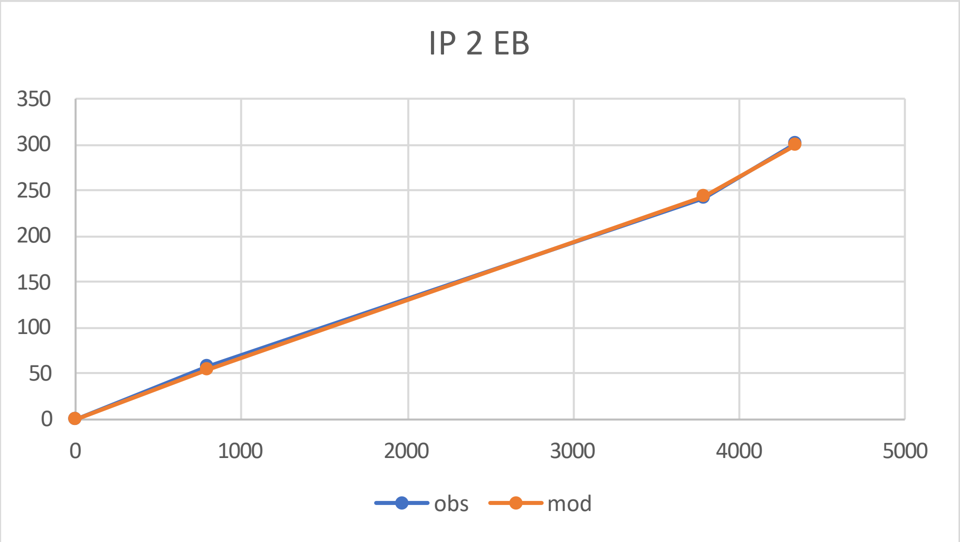
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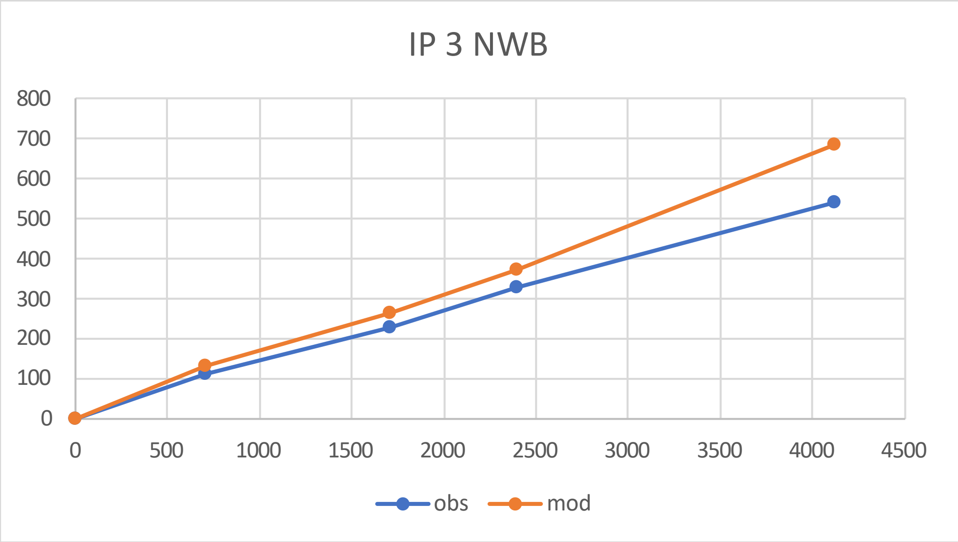
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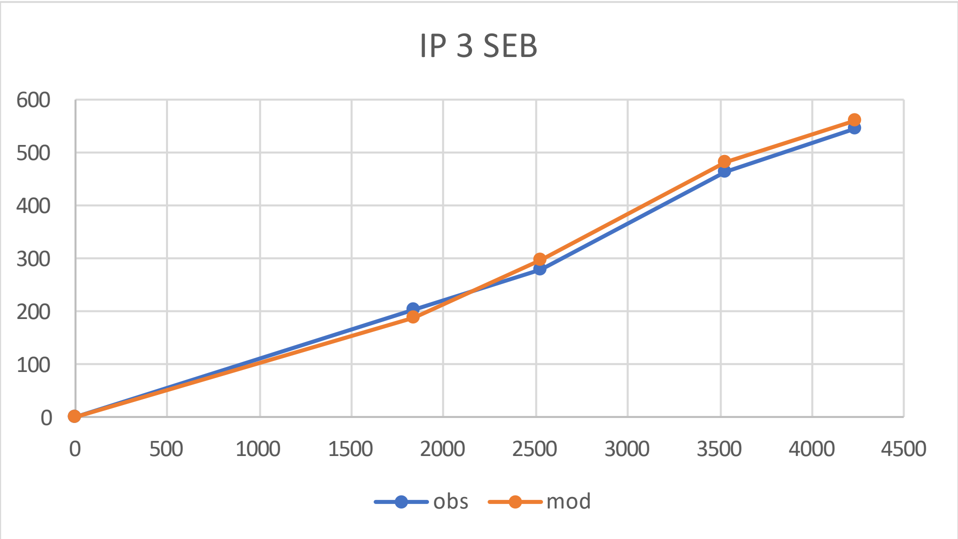
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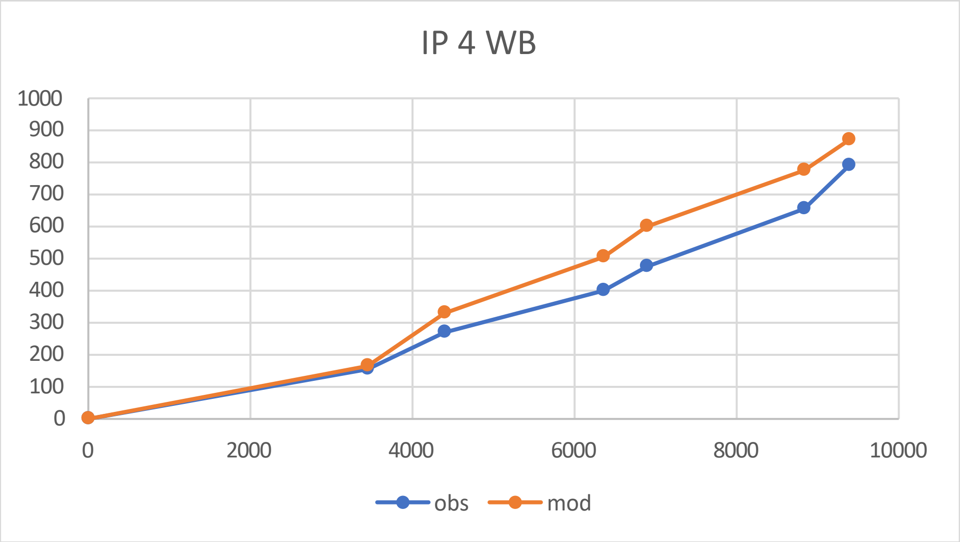
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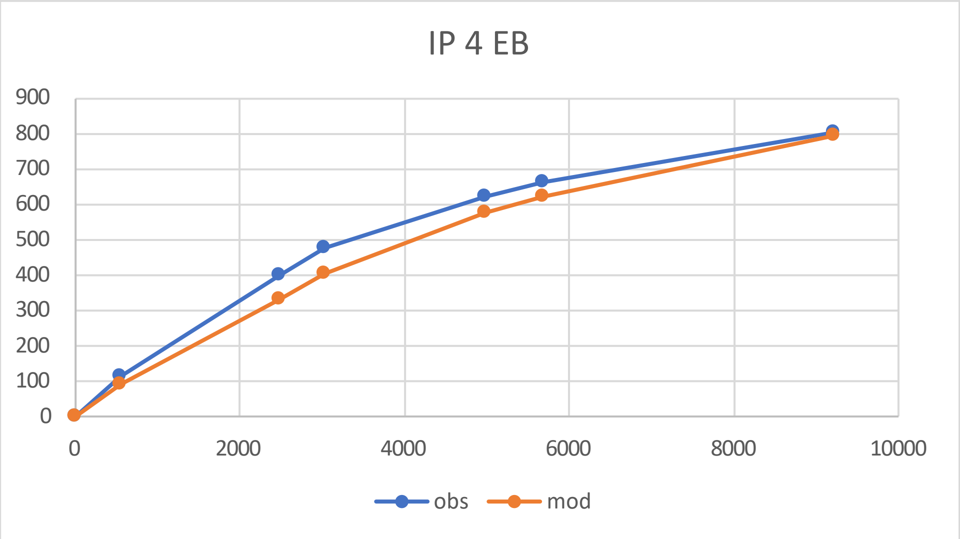
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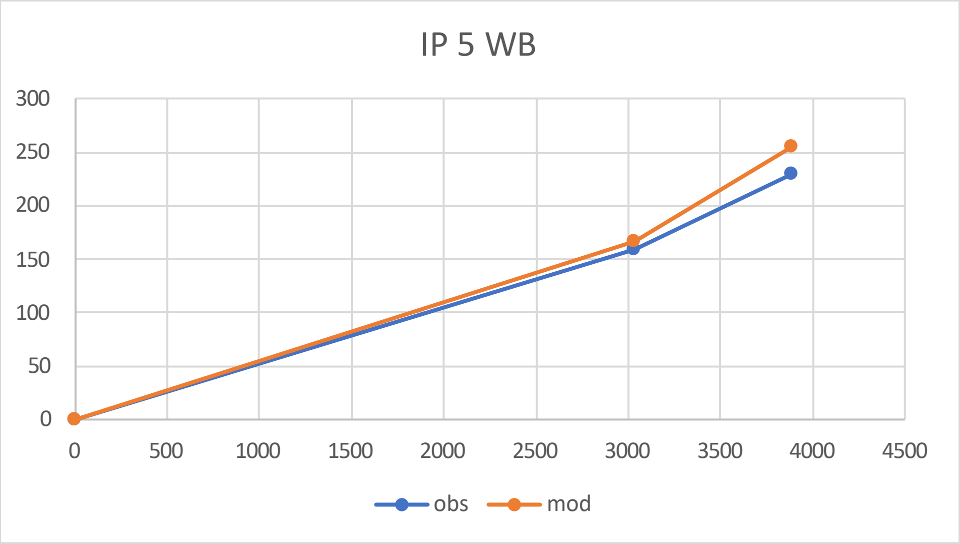
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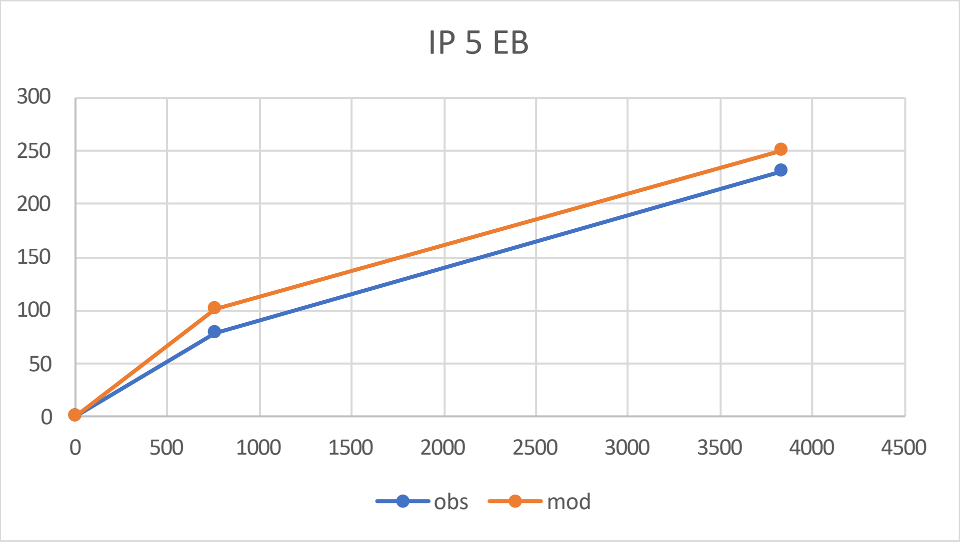
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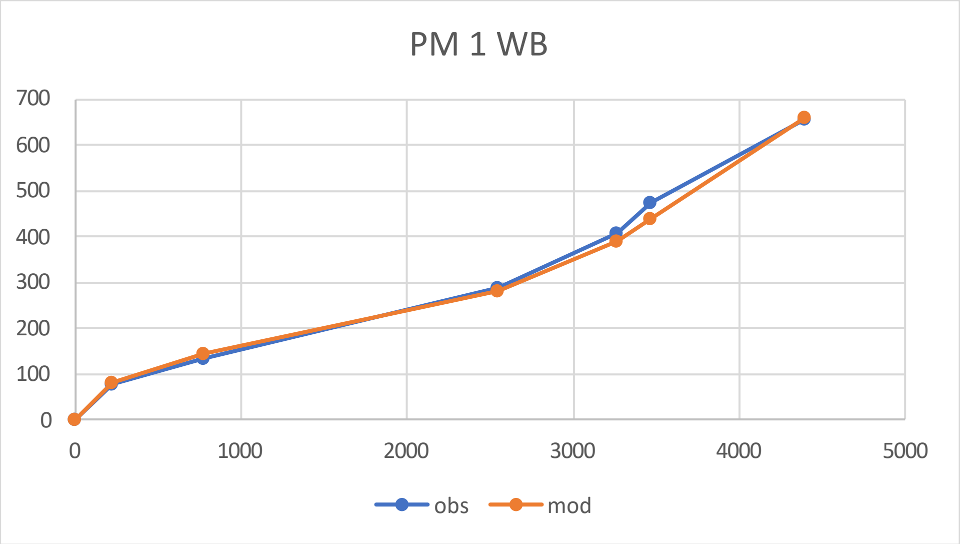
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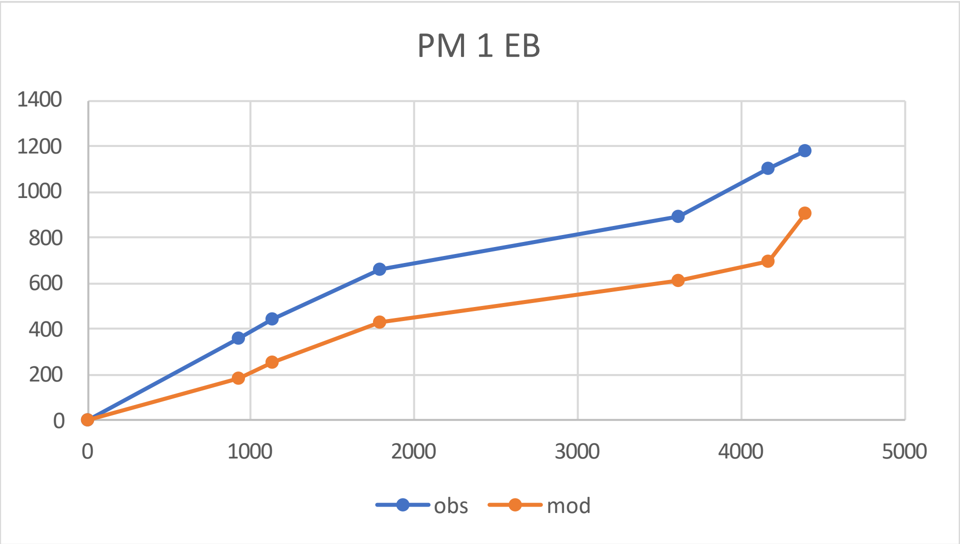
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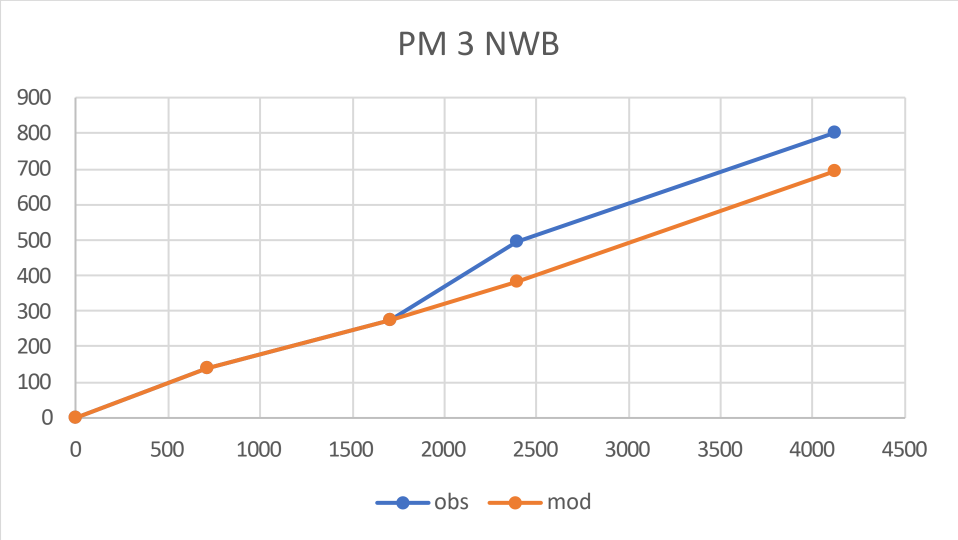
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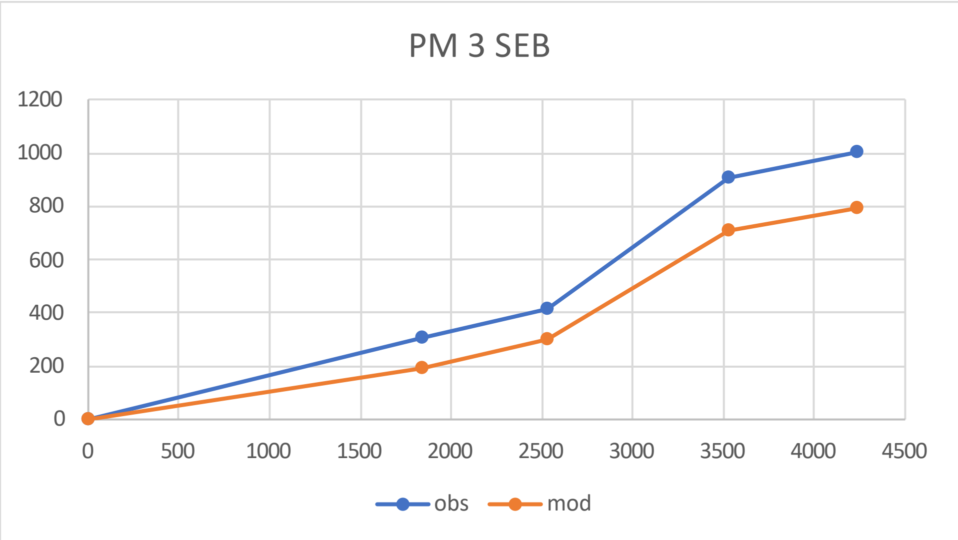
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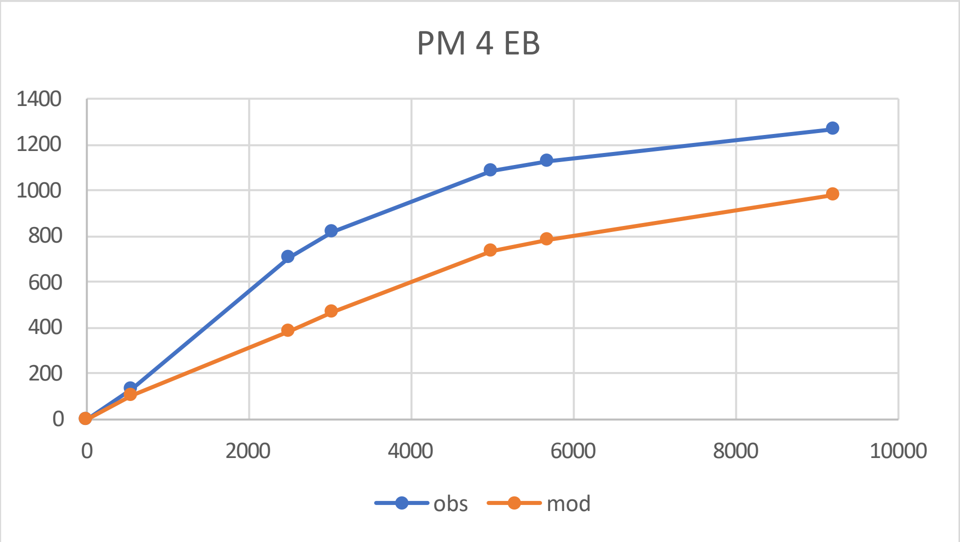
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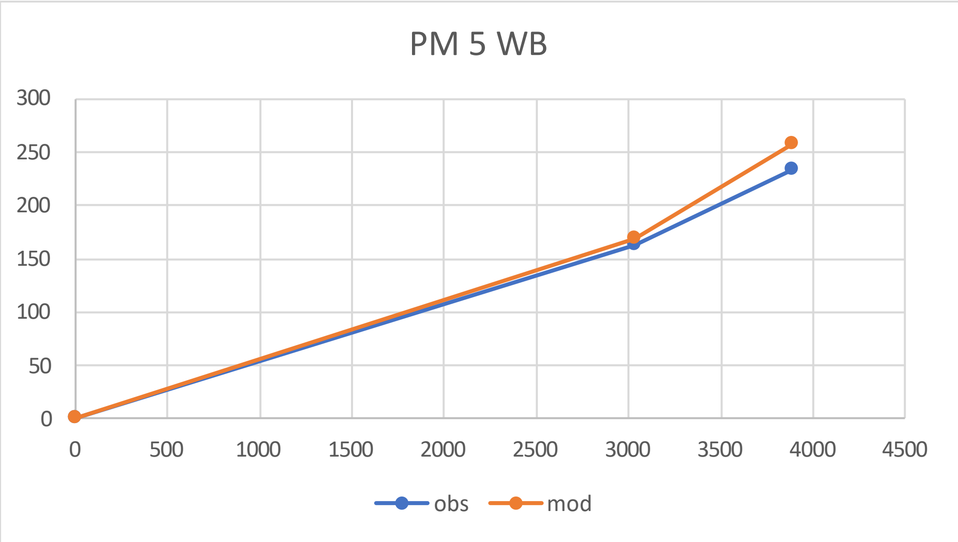
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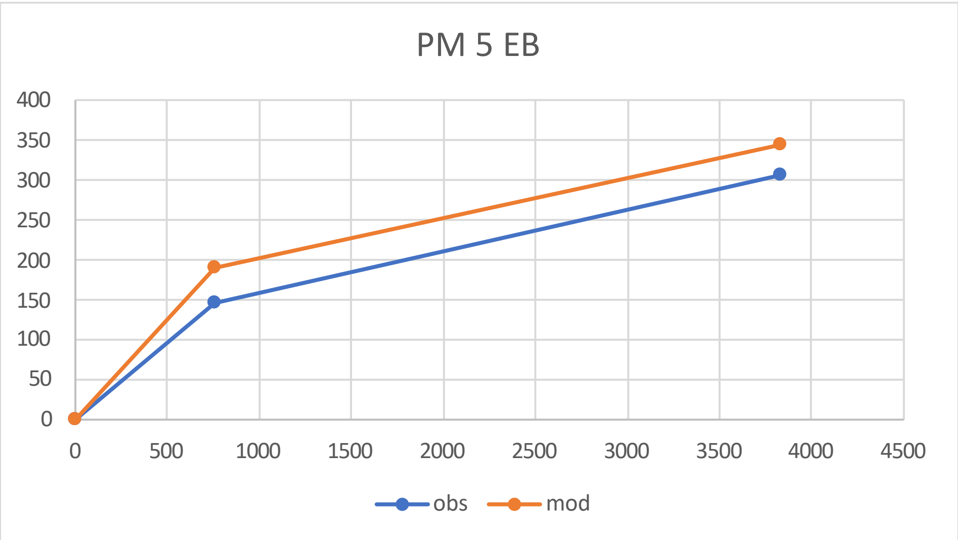
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9. APPENDIX (MICROSIMULATION REPORT)

BusConnects Galway Dublin Road

Microsimulation VISSIM

Model Development and Forecasting Report

September 2023

VISSIM MODEL DEVELOPMENT AND FORECASTING REPORT

BUSCONNECTS GALWAY DUBLIN ROAD

IDENTIFICATION TABLE	
Client/Project owner	Barry Transportation
Study	BusConnects Galway Dublin Road
Type of document	VISSIM Model Development and Forecasting Report
Date	08/09/2023
Reference number	300945

SYSTRA

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1. INTRODUCTION

1.1 Project Overview

SYSTRA is working with Barry Transportation for Galway City Council (GCC) to develop the scheme and business case for the Dublin Road Bus Connects project. The primary role of the micro-simulation model has been to provide bus journey time information for the determination of benefits of the Proposed Development. This describes the development of the 2022 model for AM and PM peak periods for the Galway Dublin Road corridor covering from Martin Roundabout to Moneenageisha Road/Wellpark Road Junction and the forecast year model development and results.

The Proposed Development micro-simulation model is the third tier in hierarchy of modelling tools that have been developed to support the design development and assessment of the Proposed Development. Further detail on the development process, the traffic data inputs used, the calibration, validation and forecast model development for the suite of transport models can be found in the Transport Modelling Report, in Appendix A6.1 (Transport Modelling Report) of this EIAR.

This report references guidance set out in Project Appraisal Guidelines for National Roads Unit 5.1 - Construction of Transport Models – Transport Infrastructure Ireland (PE-PAG-02015). Where necessary, the report identifies any weaknesses in the model and provides an indication of the likely impacts on future use.

1.2 Background to the Modelling

The model used was built and assigned using the microsimulation package PTV VISSIM, version 2023.

Table 1.1 below presents the modelled time periods and their respective warm up and cool down periods of 1 hour, giving 3 hours modelled period. The focus of the model evaluation is the peak hour within the model period.

Table 1.1: Modelled Time Periods

Period	Pre-Peak	Peak Hour	Post-Peak
AM	07:00 – 08:00	08:00 – 09:00	09:00 – 10:00
PM	15:00 – 16:00	16:00 - 17:00	17:00 – 18:00

The VISSIM model has been developed to replicate, as far as feasible, the following vehicle classes:

- Cars;
- Light Goods Vehicles (LGVs);
- Heavy Goods Vehicles Class (HGV);
- Pedal Cycles; and
- Public Transport Vehicles.

The following report provides an overview of the VISSIM model development and demonstrates the model's "fit for purpose" status in accordance with the guidance set out in Project Appraisal Guidelines for National Roads Unit 5.1 - Construction of Transport Models – Transport Infrastructure Ireland (PE-PAG-02015).

The model has been created to represent base conditions for 2022.

1.3 Report Structure

The structure of the report is as follows:

- **Section 2:** Model Development including an overview of software specification, model coverage, durations and any changes made to default software parameters.
- **Section 3:** Model Calibration including an overview of the data collection and matrix estimation processes and resulting ‘goodness of fit’ of modelled flows.
- **Section 4:** Model Validation including an overview of the ‘goodness of fit’ of modelled journey times along key routes and sections.
- **Section 5:** Forecast Model including an overview of the forecast year model development, scheme testing, and results output for bus journey times.
- **Section 6:** Model Summary including an overview of the model, its overall ‘goodness of fit’ and its suitability for future use.

2. MODEL DEVELOPMENT

2.1 Software Specification

The Proposed Development micro-simulation model has been developed using PTV VISSIM version 2023 service pack 04. The decision to use PTV VISSIM over an alternative simulation package was based on the following considerations:

- The software offers an increased level of flexibility and control when modelling at-capacity networks including junctions which interact with one another;
- The software offers the ability to simulate cyclists in mixed flow traffic conditions;
- The software offers a high-quality visual output which has been shown to have aided discussions with both technical and non-technical audiences; and
- The software is in keeping with other NTA and TII traffic modelling tools developed in recent years.

A simulation resolution of 10 time-steps per simulation second has been adopted. This is in keeping with the software default.

2.2 Model Extents

The micro-simulation model has been developed for the full continuous ‘end-to-end’ route of the Proposed Development. The ‘end-to-end’ corridor micro-simulation model has been developed to assist in the operational assessment of the scheme and to provide visualisation of scheme impacts and benefits to bus journey times.

The model network extent is shown in Figure 2.1.

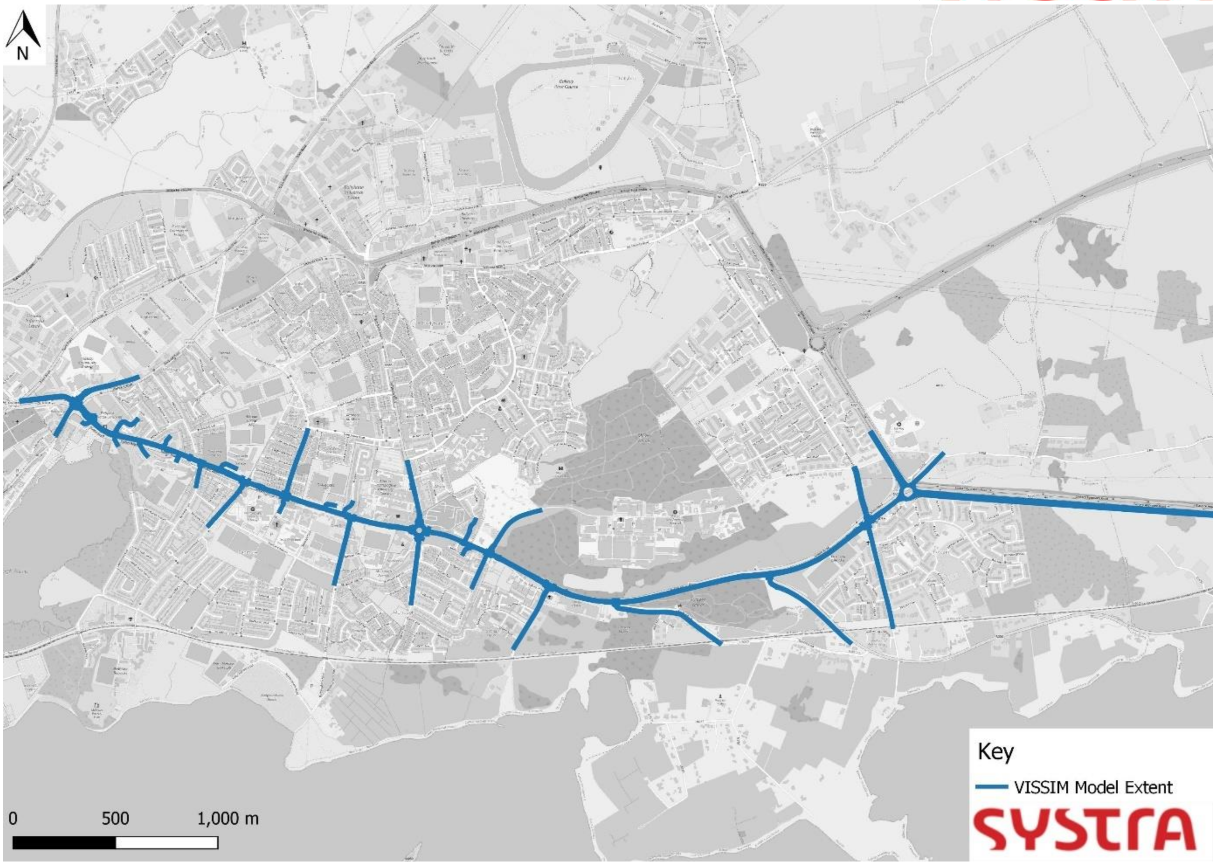

Figure 2.1: VISSIM Model Network Extents

2.3 Digital Background Modelling

The model has been built on a OS topographical survey mapping that has been provided which includes all lane markings, street furniture, visible services, utility covers and boundary information.

Background mapping has been supplemented by video footage of the major junctions. This has been used to better reflect how drivers treat yellow-box/hatched markings and (in the case of left-turning vehicles) other features such as the ends of bus lanes.

2.4 Random Seed Value

In order to optimise the modelling process, the model was run using a fixed random seed of 42 with an increment of 1. The model has been assigned for a total of 10 iterations with the average results presented in our analysis.

2.5 VISSIM Parameters

VISSIM default parameters are recommended to be adjusted as part of model calibration.

2.6 Vehicle Types

The base model includes a range of vehicle, bike and pedestrian types as outlined in Table 2.1.

Table 2.1: Vehicle and Pedestrian Types

Vehicle Type	Vehicle Name
100	Car
110	LGV - Van
200	HGV - OGV1
210	HGV - OGV2
300	Bus
510	Man
520	Woman
610	Bike Man
620	Bike Woman

2.7 Desired Speed Distributions

The base model includes a range of 'desired speed distributions' as outlined in Table 2. All speeds shown are in KPH.

Table 2. Desired Speed Distributions

Number	Name	Lower Bound	Upper Bound
1001	30 km/h - LV	25	35
1002	30 km/h - HV	20	30
2001	40 km/h - LV	35	45
2002	40 km/h - HV	30	40
3001	50 km/h - LV	45	55
3002	50 km/h - HV	40	50
3501	60 km/h - LV	55	65
3502	60 km/h - HV	50	60
4001	80 km/h - LV	75	85
4002	80 km/h - HV	70	80
5001	100 km/h - LV	88	130
5002	100 km/h - HV	75	110

2.8 Traffic Data Collection

SYSTRA's sub-contractor IDASO Ltd was commissioned to provide traffic data relating to the modelled corridor. On Wednesday 9th November 2022, 14 MCCs and associated queue length surveys were undertaken. Data, in all locations, was collected from 07:00 to 19:00.

Counts included the following vehicle type classifications:

- Cars;
- Taxis;
- LGV – Light Goods Vehicle;

- OGV1 – Other Goods Vehicles Type 1;
- OGV2 – Other Goods Vehicles Type 2;
- Pedal Cycles.

2.8.1 Manual Classification Counts (MCC) Data

MCC data was collected at 14 sites on 09th November 2022 as listed below in which 12 sites are used for model calibration for turning flows and site 11 and site 12 are used for link count validation.

- Site 11 - Martin Roundabout;
- Site 43 - Doughiska Road/Old Dublin Road;
- Site 49A - Coast Road/Old Dublin Road;
- Site 42 - Rosshill Road/Old Dublin Road;
- Site 103 - Old Dublin Road/Lios An Uisce;
- Site 41 - Old Dublin Road/Merlin Access;
- Site 12 - Skerritt Roundabout;
- Site 40 - Ballyloughane Road/Old Dublin Road;
- Site 102 - Old Dublin Road/Michael Collins Road;
- Site 39 - Renmore Road/Old Dublin Road;
- Site 38 - Renmore Park/Old Dublin Road;
- Site 101 - Old Dublin Road/Wellpark;
- Site 84/85 - Old Dublin Road/The Huntsman Inn;
- Site 13 - Wellpark Road/Moneenageisha Road/R339/Old Dublin Road.

The junction locations of the collected data are shown in the Figure 2.

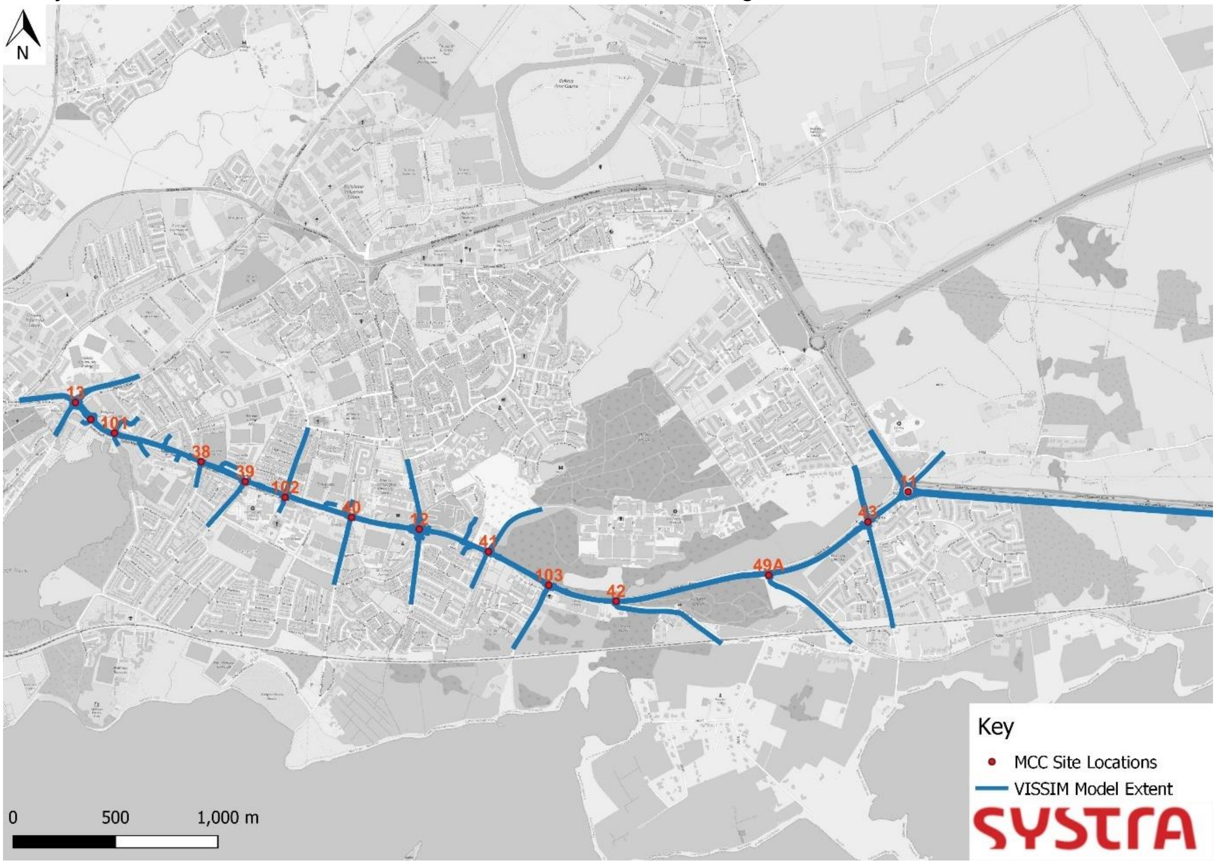

Figure 2. Location of the MCC Sites

2.8.2 Journey Time Routes

TomTom data has been provided for model validation purposes. The dataset provides average link-based journey time information for 9th November 2022.

Journey time routes as illustrated in Table 3 was coded in the model and used to validate the journey times.

Table 3. Journey Time Routes

S. No	Route	From	To
1	Eastbound	Wellpark Road/Moneenageisha Road/R339/Old Dublin Road	Martin Roundabout
2	Westbound	Martin Roundabout	Wellpark Road/Moneenageisha Road/R339/Old Dublin Road

2.8.3 Queue Length Data

Queue length data was received for the following junction approaches within the modelled area:

- Doughiska Road/Old Dublin Road;
- Coast Road/Old Dublin Road;
- Rosshill Road/Old Dublin Road;
- Skerritt Roundabout
- Renmore Road/Old Dublin Road;
- Wellpark Road/Moneenageisha Road/R339/Old Dublin Road.

2.9 Matrix Development

The matrix development was developed by cordoning the wider LAM SATURN model to the microsimulation VISSIM model extents for the following time periods:

- AM Peak Period 08:00 to 09:00; and
- PM Peak Period 16:00 to 17:00.

The SATURN model prior matrices were estimated to the surveyed turning count information using SATURN's inbuilt matrix estimation tool.

This process was followed to create matrices for Vehicle Class (VC) from 1 to 6 which represent cars, VC7 represents LGVs and VC8 and VC9 represents OGV1 and OGV2 respectively. SATURN matrices for VC1 to VC7 were added together and created matrix for light vehicles and for VC8 to VC9 were added together and created matrix for heavy vehicles.

Splitting factors were applied to the lights matrices and heavy matrices within VISSIM. This allowed for greater accuracy in modelled vehicle classes. Split factors were derived based on surveyed MCCs. Split factors were calculated based on MCC data rather than SATURN matrices as this is the most accurate data for the study area. Matrices were split in following way:

- Light vehicles: Cars and LGVs
- Heavy matrices: OGV1 and OGV2.

Using the MCC data collected, these peak hour matrices were profiled to 15-minute matrices, to reflect the entry times of traffic more accurately into the modelled network area.

2.10 Static Vehicle Inputs and Routes

The demand for cycles was applied to the model using vehicle inputs and static routes. The values for the inputs and routes were obtained from the JTC data and coded exactly for each 15-minute interval modelled.

Demand for pedestrians was applied to the model using pedestrian inputs. Values for the inputs was obtained from the observed pedestrian count data exactly for each 15-minute interval modelled.

2.11 Signalised Junctions

There are six signalised junctions and two signalised pedestrian crossings within the modelled area.

Signalised Junctions

- Doughiska Road/Old Dublin Road;
- Coast Road/Old Dublin Road;
- Old Dublin Road/Lios An Uisce;
- Ballyloughane Road/Old Dublin Road;
- Old Dublin Road/Michael Collins Road;
- Renmore Road/Old Dublin Road;
- Wellpark Road/Moneenageisha Road/R339/Old Dublin Road.

Pedestrian Crossings

- Brothers of Charity;
- Dawn Dairies.

Signal specifications were provided by Barry Transportation and were used to develop base signal programs.

2.12 Public Transport

A review of existing services was undertaken through the use of online maps and timetables. A summary of modelled public transport services and service headway is summarised in Table 4 below.

Table 4. Public Transport Services

Service	Route	Typical Service Frequency (Weekday)	
		AM	PM
51	Galway - Renmore - Gort - Shannon - Bruree - Mallow - Cork	1 hr	1 hr
52	Galway - Renmore - Balla - Castlebar - Foxford - Ballina	2.5 - 3 hours	2.5 - 3 hours
251	Galway – Renmore – Limerick - Cork	2-3 hours	3 hours
251X	Galway – Renomore – Cork	3 services	No services

350	Galway – Kinvarra – Craggagh – Doolin – Inagh – Ennis	1-3 hours	2-3 hours
64	Galway – Knock – Luga – Sligo – Bundoran – Letterkenny - Derry	4 services	4 services
402	Renmore - Galway - Shantalla - Knocknacarra	30 mins	30 mins
404	Ballybrit - Doughiska - Renmore - Galway - Eyre Square	10 mins	30 mins
409	Galway – Wellpark-Doughiska - Ballybrit	10 mins	10 mins
430	Galway – Tuam – Ballindine – Castlebar – Foxford - Ballina	2.5 – 3 hours	2.5 – 3 hours
434	Galway – Adrahan - Galway	1 service	NA
706	Galway – Renmore – Athlone – Maynooth - Dublin	4 services	4 services
706X	Galway – Renmore – Athlone – Dublin	4 services	4 services
763	Galway – Loughrea – Athlone – Kinnegad – Lucan – Dublin	2 hours	2 hours
844	Galway – Renmore – Loughrea – Portumna – Birr	30 mins	2 services
920	Loughrea – Craughwell – Galway – Shantella	1 hour	1 hour

2.13 Route Choice in the VISSIM Model

There is no route choice within the model.

3. MODEL CALIBRATION

3.1 Introduction

Model calibration is the process of adjusting the key model parameters so that these parameters reflect an appropriate proxy to the observed traffic conditions. These parameters include:

- Demand volume adjustments;
- Network parameter adjustments, including:
- Gap acceptance;
- Vehicle speeds including signed restrictions and speed reductions on bends / approaches to junctions;
- Speed distributions;
- Bus stops and dwell times;
- Lane allocations and restrictions; and
- Lane change decision distances.

3.2 Calibration Criteria

Flow calibration is a process whereby modelled flow outputs are compared and calibrated to match observed traffic flows throughout the network. In this instance this refers to the turning counts.

3.2.1 Individual Flows

The model calibration and validation processes have been undertaken based on the criteria set out in TII's PAG Unit 5.1: Construction of Traffic Models. The PAG specify the acceptable values for modelled and observed flow comparisons and suggests how calibration or validation should relate to the magnitude of the values being compared. A summary of these targets is shown in below.

Table 5. Model Calibration and Validation Criteria: Individual Flows

Class Test	Criteria & Measure	Acceptability Guidance
1	Individual flows within 100 vph for flows <700 vph	>85% of cases
2	Individual flows within 15% for flows 700 – 2700 vph	
3	Individual flows 400 vph for flows > 2700 vph	

3.2.2 GEH Statistic

When comparing modelled and observed counts, the magnitude of the observed volume is clearly important when deciding on what is a reasonable error. Therefore, in addition to considering percentage or absolute differences as outlined above, the Geoffrey E. Havers (GEH) statistic (a form of the Chi-squared statistic) is also used as a calibration measure as it incorporates both relative and absolute errors.

The GEH statistic has the benefit of removing bias that exists when comparing flows of different magnitudes using percentages, such that a difference of 10 in a flow of 100 vehicles per hour (vph) is less significant (GEH = 3) than a difference of 100 in a flow of 1000 vph (GEH = 11.5).

The GEH statistic is calculated by: $GEH = \sqrt{\frac{(M-C)^2}{(M+C)/2}}$

Whereby: GEH = GEH statistic, M = modelled flow and C = Observed flow.

The target for GEH is that the GEH of a flows should be < 5.

Furthermore, the percentage difference is also examined between observed and modelled flows.

The PAG criteria for GEH results are outlined in. In addition to the criteria given, it is generally accepted that GEH values should not be greater than 10 and values greater than 10 should be examined and where an improvement in the results is not possible a reasonable explanation given.

Table 6. Model Calibration and Validation Criteria: GEH Statistic

Class Test	Criteria & Measure	Acceptability Guidance
GEH Statistic	Turning Flows GEH<5.0	>85% of cases

3.3 Turn Flow Calibration Statistics

Table 7 below summarises the turn flow comparisons for all traffic flows and compares them against the PAG Unit 5.1 criteria. The results indicate that the individual turning flows criteria has been met for all vehicle classes have been fully satisfied in both the AM and PM Peak periods and therefore the turn flows are compliant with the PAG acceptability criteria (>85%).

Table 7. Model Calibration: Individual Turning Flows – AM Peak

Class Test	Criteria & Measure	Acceptability Guidance	Flows Test
Cars	99%	>85% of cases	**PASS**
LGVs	100%		**PASS**
HGVs	100%		**PASS**
Total Vehicles	99%		**PASS**

Table 8. Model Calibration: Individual Turning Flows – PM Peak

Class Test	Criteria & Measure	Acceptability Guidance	Flows Test
Cars	98%	>85% of cases	**PASS**
LGVs	100%		**PASS**
HGVs	100%		**PASS**
Total Vehicles	98%		**PASS**

The GEH statistic has been adopted as the main indicator of the extent to which modelled flows match the corresponding observed values. In keeping with PE-PAG-02015, GEH values of less than 5 have been targeted in at least 85% of cases. A summary of the 'goodness of fit' achieved by the model in each of the calibration hours can be seen in Table 9.

Table 9. Model Calibration: Turning Flows GEH – AM Peak

Vehicle Class	GEH<5	GEH<10	GEH>10
Cars	99%	1%	0%
LGV	100%	0%	0%
HGV	100%	0%	0%
Total Vehicles	99%	1%	0%

Table 10. Model Calibration: Turning Flows GEH – PM Peak

Vehicle Class	GEH<5	GEH<10	GEH>10
Cars	97%	3%	0%
LGV	100%	0%	0%
HGV	100%	0%	0%
Total Vehicles	97%	3%	0%

Analysis of the calibration criteria indicates that a good level of calibration has been achieved. Full calibration results for AM and PM peak can be seen in the Appendix A.

4. MODEL VALIDATION

4.1 Introduction

Model validation is the process of comparing the model performance against a set of data which is independent of the model calibration process. The validation process is designed to demonstrate that the model is capable of simulating traffic conditions which are representative of the actual conditions, based on the performance observations.

It is important that the information used in calibrating the model, including count data for matrix estimation, is kept separate from that used for validation if it is to be a true independent test of the model.

The following data sets have been identified for the validation of the models:

- Link counts for Entry and Exit arms at Site 11 (Martin Roundabout) and Site 12 (Skerritt Roundabout); and
- Car Journey times; and
- Bus Journey times.

The modelled and observed queue lengths have also been compared for sensibility and presented here to demonstrate that the model is representative of onsite conditions.

In the context of the journey time validation, PAG specifies that 85% of the observed routes should be within the following criteria:

- Modelled times along the route should be within 15% of the surveyed time (or 1 minute, if higher).

The remainder of this section provides a summary of the outcome of the model validation process. Full validation results can be seen in the Appendices.

4.2 Link Flow Validation Statistics

Table 11 below summarises the link flow comparisons for all traffic flows and compares them against the PAG Unit 5.1 criteria. As turning count calibration is not possible at Site 11 (Martin Roundabout) and Site 12 (Skerritt Roundabout), validation was undertaken at these sites. The results indicate that the PAG criteria for all vehicle classes have been fully satisfied in both the AM and PM Peak periods and therefore the link flows are compliant with the acceptability criteria (>85%). Only one movement across both periods, has a GEH value, which is greater than 5 (Skerrit roundabout, Dublin Road eastern approach arm). This arm has a GEH of 5.2, which is marginally above the 5.0 criteria. Although the entire validation statistics in that time period, the AM, show an excellent match to the observed values with a 97% pass rate.

Table 11. Link Flow Validation: Individual Link Flows – AM and PM Peaks

Link Flows	Acceptability Guideline
AM Peak	
100%	>85% of cases
PM Peak	
97%	>85% of cases

Table 12. Link Flow Validation: Total Vehicles GEH – AM Peak

Site No	Road Name	Observed	Modelled	Diff	GEH
11	N67 North Entry	309	311	2	0.1
11	N67 North Exit	442	437	-5	0.2
11	Old Dublin Rd Entry	441	396	-45	2.2
11	Old Dublin Rd Exit	454	421	-33	1.6
11	Oranmore Rd Entry	587	577	-10	0.4
11	Oranmore Rd Exit	416	408	-8	0.4
11	Clinic Rd Entry	90	94	4	0.4
11	Clinic Rd Exit	115	97	-18	1.7
12	Ballybane Rd Entry	535	497	-38	1.7
12	Ballybane Rd Exit	729	632	-97	3.7
12	Dublin Rd West Entry	589	566	-23	1.0
12	Dublin Rd West Exit	898	797	-101	3.5
12	Gleann Rua Entry	308	300	-8	0.5
12	Gleann Rua Exit	309	265	-44	2.6
12	Dublin Rd East Entry	1167	996	-171	5.2
12	Dublin Rd East Exit	663	656	-7	0.3

Table 13. Link Flow Validation: Total Vehicles GEH – PM Peak

Site No	Road Name	Observed	Modelled	Diff	GEH
11	N67 North Entry	610	613	3	0.1
11	N67 North Exit	629	722	93	3.6
11	Old Dublin Rd Entry	747	786	39	1.4
11	Old Dublin Rd Exit	464	476	12	0.6
11	Oranmore Rd Entry	398	498	100	4.7
11	Oranmore Rd Exit	713	736	23	0.9
11	Clinic Rd Entry	131	128	-3	0.3
11	Clinic Rd Exit	80	90	10	1.1
12	Ballybane Rd Entry	619	651	32	1.3
12	Ballybane Rd Exit	450	440	-10	0.5
12	Dublin Rd West Entry	618	613	-5	0.2
12	Dublin Rd West Exit	716	719	3	0.1
12	Gleann Rua Entry	367	363	-4	0.2
12	Gleann Rua Exit	184	181	-3	0.2
12	Dublin Rd East Entry	721	729	8	0.3
12	Dublin Rd East Exit	975	1010	35	1.1

4.3 Travel Time Validation Statistics

The below tables present the journey time comparisons through the corridor for both car and bus. The PAG requirement is that the modelled and observed journey times are within 15% (or 60 seconds for journey time sections) The tables show that in all time periods the modelled journey times satisfy these criteria.

Table 14. Journey Time Validation: Cars - AM Peak

S. No	Route name	Observed [s]	Modelled [s]	Difference [s]	Difference [%]	Pass/ Fail
1	Moneenageisha Rd to Martin Roundabout (Eastbound)	787	841	53.9	6.84%	PASS
2	Martin Roundabout to Moneenageisha Rd (Westbound)	1263	1382	119.2	9.44%	PASS

Table 15. Journey Time Validation: Cars - PM Peak

S. No	Route name	Observed [s]	Modelled [s]	Difference [s]	Difference [%]	Pass/ Fail
1	Moneenageisha Rd to Martin Roundabout (Eastbound)	1128	1059	68.7	6.09%	PASS
2	Martin Roundabout to Moneenageisha Rd (Westbound)	1263	1208	55.0	4.35%	PASS

Table 16. Journey Time Validation: Bus - AM Peak

S. No	Route name	Observed [s]	Modelled [s]	Difference [s]	Difference [%]	Pass/ Fail
1	Moneenageisha Rd to Martin Roundabout (Eastbound)	1422	1316	105.9	7.45%	PASS
2	Martin Roundabout to Moneenageisha Rd (Westbound)	718	770	52.2	7.26%	PASS

Table 17. Journey Time Validation: Bus - PM Peak

S. No	Route name	Observed [s]	Modelled [s]	Difference [s]	Difference [%]	Pass/ Fail
1	Moneenageisha Rd to Martin Roundabout (Eastbound)	1558	1468	90.0	5.78%	PASS
2	Martin Roundabout to Moneenageisha Rd (Westbound)	1124	1101	23.3	2.08%	PASS

4.4 Queue Length Comparison

As surveying queue lengths on site contains a large element of subjectivity, and the variation of this is large from day to day, WebTAG does not recommend validating to queue lengths. However, a comparison of modelled and observed queue lengths has been undertaken which demonstrates that queuing in the VISSIM model correlates with observed queues and that the VISSIM model is representative of these conditions.

The main location of queues in the AM peak are:

- Rosshill Rd/Old Dublin Rd ;
- Old Dublin Road East.
- Doughiska Rd/Old Dublin Rd;
- Doughiska Road South.

The main location of queues in the PM peak are:

- Skerritt Roundabout;
- Ballybane Road.
- Doughiska Rd/Old Dublin Rd;
- Doughiska Road North.

5. FORECAST YEAR MODELLING

The forecast models have been developed for the opening year 2028 to align with Proposed Development across the corridor. As it has been mentioned, the purpose of the microsimulation VISSIM modelling was to act as a visualisation aide of the scheme on the network and for this reason, only the opening year of 2028 was considered instead of the design year 2043.

The scenarios tested as part of this study include:

- 2028 Do Minimum scenario; and
- 2028 Do Something scenario.

5.1 Do-Minimum and Do-Something Network Changes

5.1.1 Network Changes

The design changes at the Martin Roundabout as shown in Figure 3 is included in the Do-Minimum model.

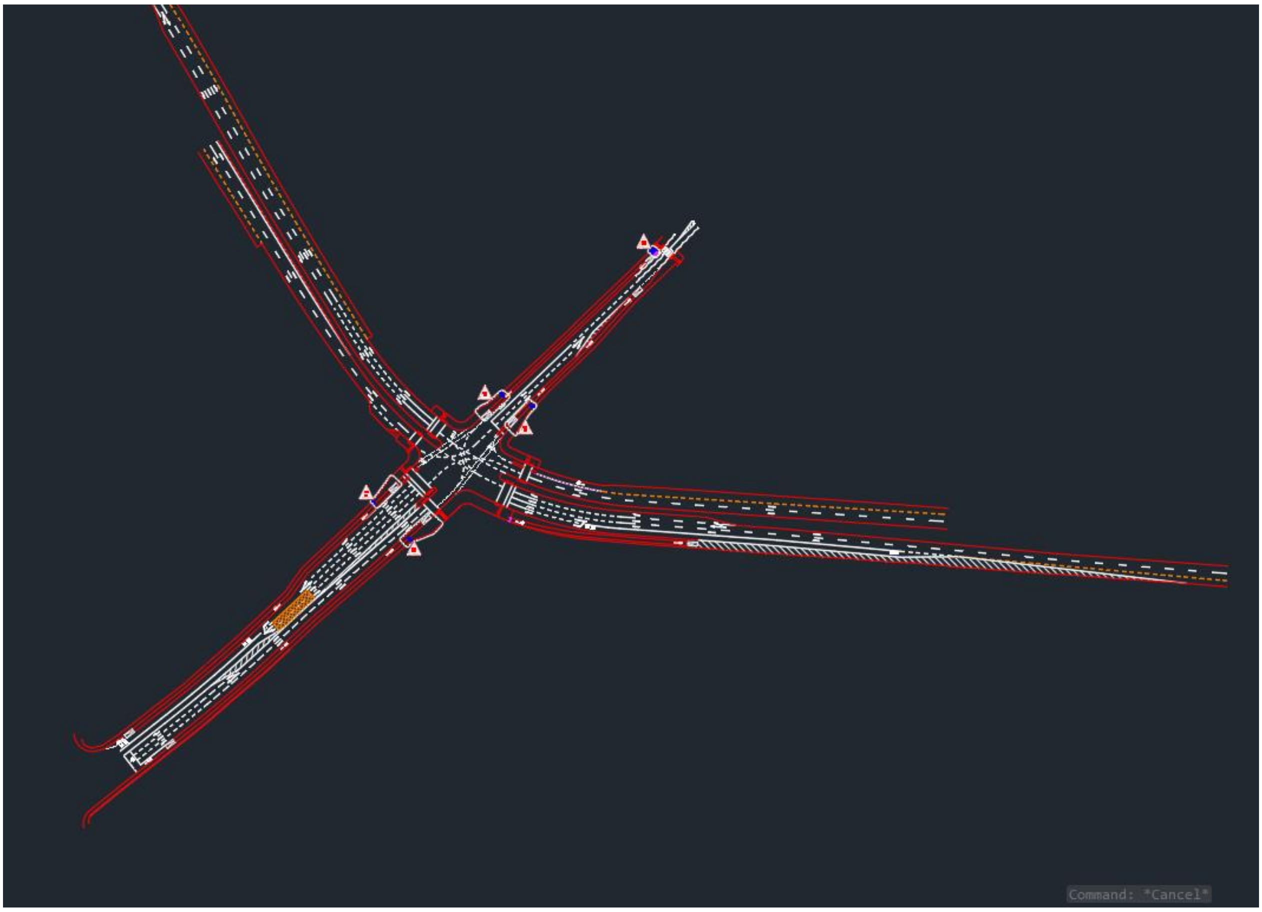

Figure 3. Martin Roundabout Upgrade

In the Do-something model, the implementation of scheme across the corridor as shown in Figure 4 is included along with the changes to the Martin Roundabout.

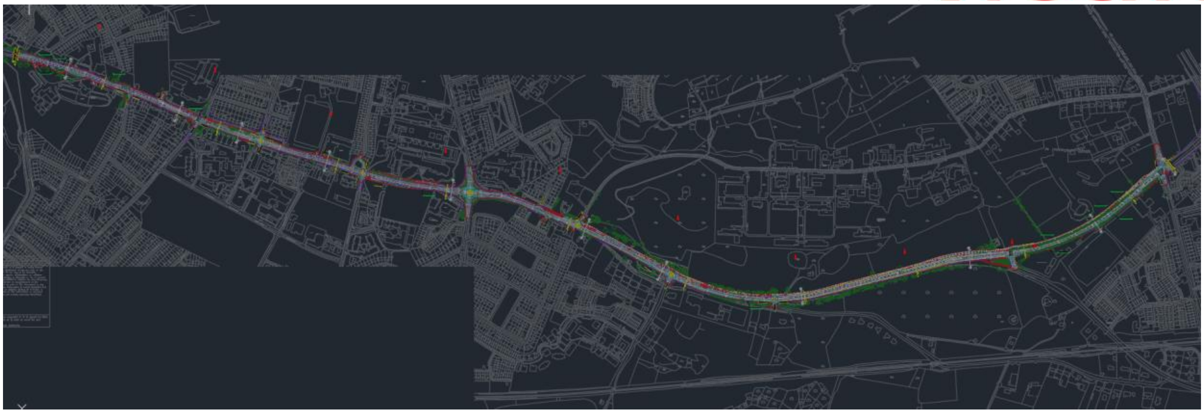

Figure 4. Scheme in Do-Something scenario

5.1.2 Bus Connects City Services

The bus services modelled are those which form part of the current Bus Connects Network in Galway City. The same services are included in both the Do Minimum and Do Something scenarios, with the only difference that the bus routes follow the proposed bus-only links in the Do Something scenario. The proposed bus routes along with their hourly frequencies can be seen from the below Figure 5.

Figure 5. Proposed Bus Network Map

The details of the routes and frequencies are given in the below Table 18.

Table 18. Bus Routes Description and Frequency

Route No	Description	Frequency
4	Gateway to Merlin Hospital	30 mins

9	Gateway to Parkmore Business Park	10 mins
10A	Salthill to Oranmore via N67	30 mins
10B	Gateway to Oranmore via Roscam	30 mins

5.1.3 Bus Dwell Times

The dwell times at bus stops for all services are consistent with the times which have been observed in the base year and are consistent between both the DM and DS scenarios.

5.1.4 Bus Priority Measures

In addition to the above changes, the Do Something network has additional bus priority measures in the form of signal priority for buses at signalised junctions. This key assumption has been included following consultation with the National Transport Authority and Galway City Council. This signal priority means that buses which travel through the corridor, will receive a hurry call at signalised junctions when they activate a detector in advance of the junction. This enables them to avoid waiting at the stop line for their relevant signal stage and thus travel through the junction faster and leads to reduced journey times through the corridor.

5.2 Forecast Year Demand

The future year matrices for Do-minimum and Do-something were taken from the SATURN LAM model for 2028. These were further calculated by adding the differences of the SATURN forecast year and base year demand to the final VISSIM base matrices.

The matrices are then profiled to 15-minutes using the same profile percentages as in the base year.

5.3 Forecast Year Model Results

The focus of the forecast year models for 2028 opening year was testing the scheme in the Do-something model for bus journey times along the Galway Dublin Road corridor.

The bus journey times were compared for both directions (eastbound and westbound) from the scheme starting point at Old Dublin Road/Sailin junction until the junction of Old Dublin Road/Doughiska Road junction.

The bus journey time comparison between the 2028 Do Minimum and the Do-Something scenario can be seen in Figure 6 and Figure 7 for AM and PM peaks respectively.

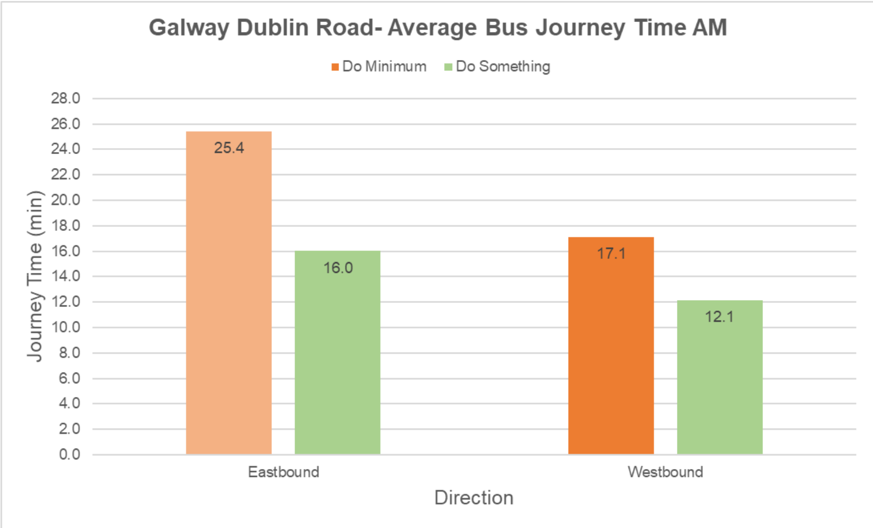

Figure 6. Average Bus Journey Times – AM Peak

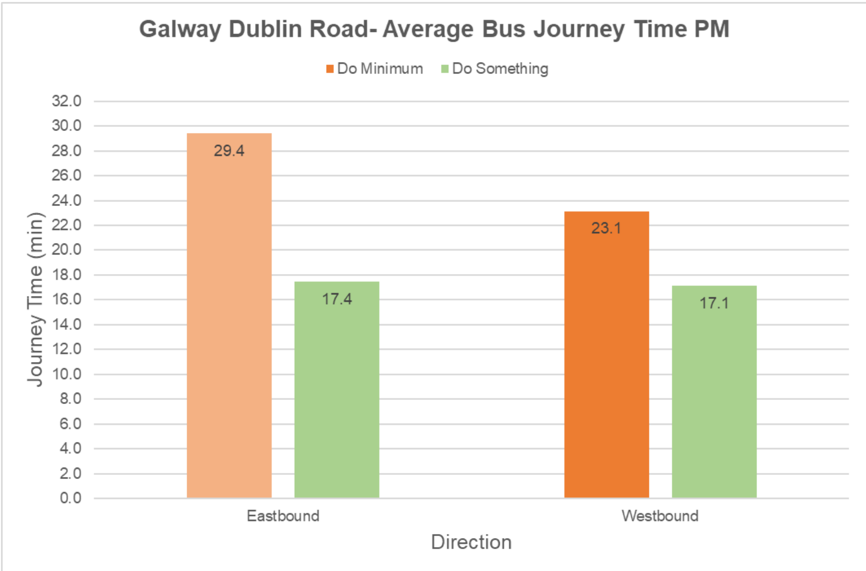

Figure 7. Average Bus Journey Times – PM Peak

The results show that the Do something scenario has lower average bus journey times for both directions and both peaks following the scheme being implemented. In the eastbound direction, there is a decrease of 8 minutes in the AM peak and 12 minutes in the PM peak. This is due to a combination of the inclusion of bus lane is the eastbound direction and signal priority for buses at signalised junctions. In the westbound direction, there is a decrease of 5 minutes in AM peak and 6 minutes in the PM peak. These decreases are lesser compared to the eastbound direction because a bus lane already exists for the majority of the corridor in that direction.

6. SUMMARY

This report describes the development of the 2022 Weekday AM and PM Peak Galway Dublin Road Busconnects Proposed Development micro-simulation model covering from Martin Roundabout and Wellpark Road/Moneenageisha Road/R339/Old Dublin Road junction.

The input matrix has been developed using demand from the LAM as the starting point with further spreadsheet-based flow adjustments to match the JTC count data (collected on Thursday the 09th of November 2022).

The base year model has been calibrated against JTC data collected in November 2022. The model has been calibrated to a good standard for modelled turning movements with more than 95% of turning movements with GEH statistic below 5 in the AM Peak (08:00-09:00) and PM Peak (16:00-17:00). At an individual vehicle level, a GEH statistic below 5 was achieved for all modes for both the AM and PM peak for more than 85% of turning movements. Based on the average results presented in this report, the model can be shown to display a good fit against the observed data which meets and exceeds criteria set out by TII in PE-PAG-02015.

The link flow validation shows that the individual link flow criteria is met in 88% of cases in the both the AM and in the PM peak hour, meeting criteria (> 85% of cases). The base year models have also been validated against Tom Tom car journey time data from 2022. Except for one section in the 17:00-18:00 PM peak hour, modelled car journey times on all validation sections can be shown to meet the 15% or < 1-minute criteria. But when considering the 'complete' end-to-end car travel times, all routes meet the criteria.

In addition, bus journey times (including dwell times) have been validated against AVL data. The end-to-end journey times on the corridor shows a good fit. The modelled end-to-end bus journey times (without dwell times) are within 15% of the corresponding Google Maps data for both directions and both peak hours.

Based on the average results presented in this report, the model can be shown to display a good fit against the observed data which meets and exceeds criteria set out by TII in PE-PAG-02015.

The forecast year model was developed for the opening year 2028 for Do-Minimum and Do-Something scenarios in which the upgrade of the Martin Roundabout was included in both scenarios. While the scheme itself was included in the Do-something scenario only.

The implementation of the scheme in the Do something scenario has resulted in improved average bus journey times of 8 minutes in the AM peak and 12 minutes in the PM peak in the eastbound direction and 5 minutes in the AM peak and 6 minutes in the PM peak in the westbound direction when compared with the Do-minimum scenario.