REGIONAL MODELLING SYSTEM

Modelling Services Framework

West Regional Model

Active Modes Model Development Report

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National Transport Authority

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Foreword

The NTA has developed a Regional Modelling System (RMS) for Ireland that allows for the appraisal of a wide range of potential future transport and land use alternatives. The RMS was developed as part of the Modelling Services Framework (MSF) by the National Transport Authority (NTA), SYSTRA and Jacobs Engineering Ireland.

The National Transport Authority's (NTA) Regional Modelling System comprises the National Demand Forecasting Model, five large-scale, technically complex, detailed and multi-modal regional transport models and a suite of Appraisal Modules covering the entire national transport network of Ireland. The five regional models are focussed on the travel-to-work areas of the major population centres in Ireland, i.e. Dublin, Cork, Galway, Limerick, and Waterford.

The development of the RMS followed a detailed scoping phase informed by NTA and wider stakeholder requirements. The rigorous consultation phase ensured a comprehensive understanding of available data sources and international best practice in regional transport model development.

The five discrete models within the RMS have been developed using a common framework, tied together with the National Demand Forecasting Model. This approach used repeatable methods; ensuring substantial efficiency gains; and, for the first time, delivering consistent model outputs across the five regions.

The RMS captures all day travel demand, thus enabling more accurate modelling of mode choice behaviour and increasingly complex travel patterns, especially in urban areas where traditional nine-to-five working is decreasing. Best practice, innovative approaches were applied to the RMS demand modelling modules including car ownership; parking constraint; demand pricing; and mode and destination choice. The RMS is therefore significantly more responsive to future changes in demographics, economic activity and planning interventions than traditional models.

The models are designed to be used in the assessment of transport policies and schemes that have a local, regional and national impact and they facilitate the assessment of proposed transport schemes at both macro and micro level and are a pre-requisite to creating effective transport strategies.

1 Introduction

1.1 Regional Modelling System

The NTA has developed a Regional Modelling System for the Republic of Ireland to assist in the appraisal of a wide range of potential future transport and land use options. The Regional Models (RM) are focused on the travel-to-work areas of the major population centres of Dublin, Cork, Galway, Limerick, and Waterford. The models were developed as part of the Modelling Services Framework by NTA, SYSTRA and Jacobs Engineering Ireland.

An overview of the 5 regional models is presented below in Table 1.1 and Figure 1.1.

Table 1.1 List of Regional Models

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

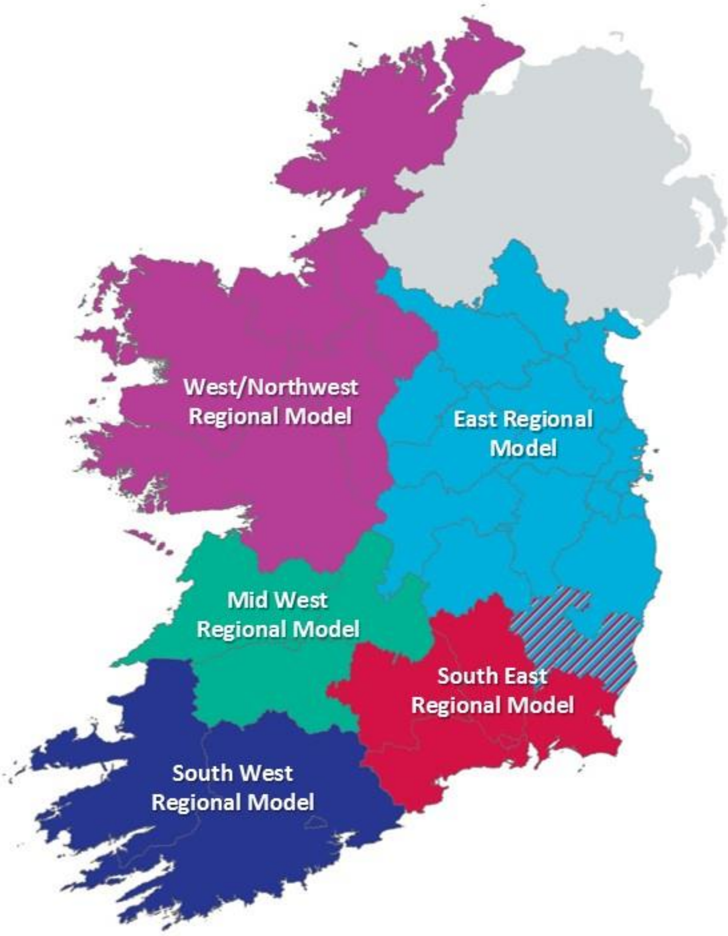

Figure 1.1 Regional Model Areas

1.2 Regional Modelling System Structure

Each regional model uses a consistent and standardised transport modelling approach, in which trip demand is generated by a demand model and assigned to the appropriate transport network using network assignment models. The general structure of the WRM, and the other four regional models is shown, in Figure 1.2.

1.2.1 National Demand Forecasting Model (NDFM)

The NDFM is a single, national system that provides estimates of the total quantity of daily travel demand produced by and attracted to each of the 18,488 Census Small Areas. Trip generations and attractions are related to zonal attributes such as population, number of employees and other land-use data. See the NDFM Development Report for further information.

1.2.2 Regional Models (RM)

A regional model is comprised of the following key elements:

Trip End Integration

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

The Full Demand Model (FDM)

The FDM processes travel demand and outputs origin-destination travel matrices by mode and time period to the assignment models. The FDM and assignment models run iteratively until an equilibrium between travel demand and the cost of travel is achieved.

See the RMS Spec Full Demand Model Specification Report, RM Full Demand Model Development Report and SERM Full Demand Model Calibration Report for further information.

Assignment Models

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

The Road Model assigns FDM outputs (passenger cars) to the road network and includes capacity constraint, traffic signal delay and the impact of congestion. See the RM Spec Road Model Specification Report for further information.

The Public Transport Model assigns FDM outputs (person trips) to the PT network and includes the impact of capacity restraint, such as crowding on PT vehicles, on people’s perceived cost of travel. The model includes public transport networks and services for all PT sub-modes that operate within the modelled area. See the RM Spec Public Transport Model Specification Report for further information.

Secondary Analysis

The secondary analysis application can be used to extract and summarise model results from each of the regional models.

1.2.3 Appraisal Modules

The Appraisal Modules can be used on any of the regional models to assess the impacts of transport plans and schemes. The following impacts can be informed by model outputs (travel costs, demands and flows):

- Economy;
- Safety;
- Environmental;
- Health; and
- Accessibility and Social Inclusion.

Further information on each of the Appraisal Modules can be found in the following reports:

- Economic Module Specification Report;
- Safety Module Specification Report;
- Environmental Module Specification Report;
- Health Module Specification Report; and
- Accessibility and Social Inclusion Module Specification Report.

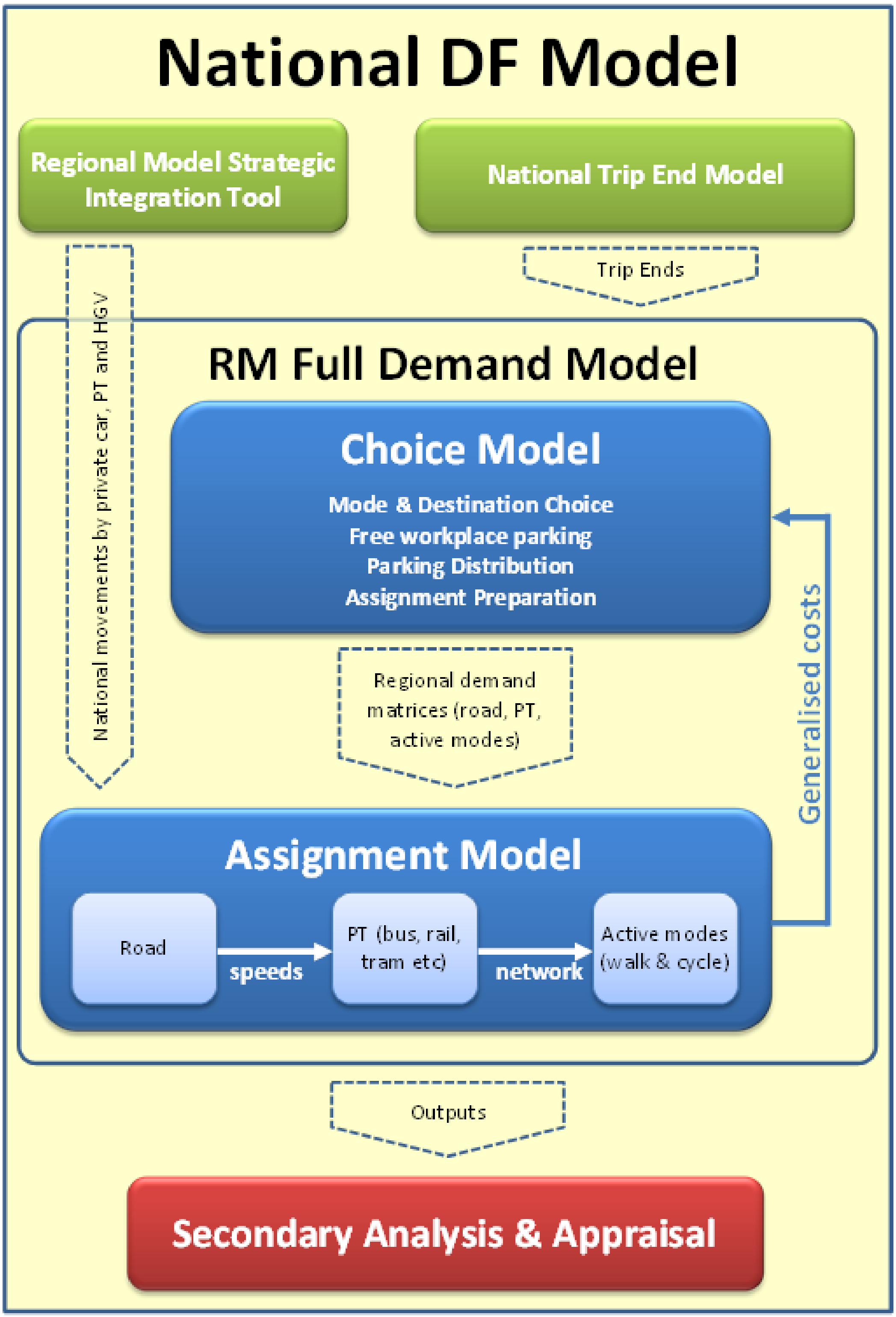

Figure 1.2 National and Regional Model Structure

1.3 WRM Active Modes Model

The development of the West Regional Model (WRM) Active Modes Model (AMM) is based on the specification set out in the *Active Modes Model Specification Report*. The AMM implementation described within this report for the WRM relates only to Version 1 of the WRM model. The AMM component of WRM v1 differs from this original specification in that it was necessary to reduce the number of time periods to be consistent with the WRM v1 PT Model (see the Public Transport Model Specification Report).

1.3.1 WRM Zone System

The AMM zone system is consistent with the overall WRM as described in the WRM Zone System Development Report and illustrated in Figure 1.3.

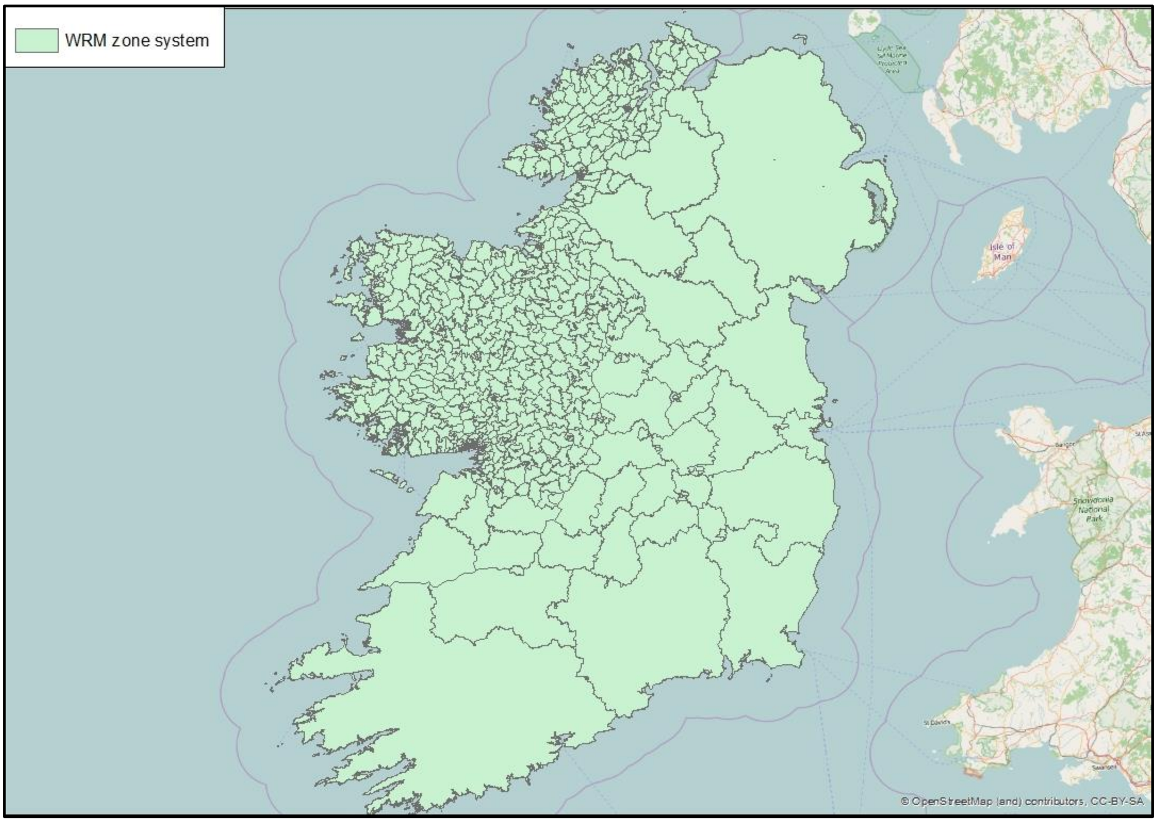

Figure 1.3 WRM Zone System

The key zone system statistics include:

- Total zones: 749:
  - Galway City: 138;
  - Galway County: 206;
  - Donegal County: 109;
  - Leitrim County: 28;

- Sligo County: 43;
- Roscommon County: 44;
- Mayo County: 123;
- Special Zones (Airport and Port of Galway): 2; and
- External zones: 56.

The high level of zonal detail allows the AMM to be modelled to a greater degree of accuracy. Increased zonal density in urban areas such as Galway City allows for the accurate representation of walk and cycle times. This allows the cost of travel by active modes to be calculated with greater accuracy within the model.

1.3.2 Base Year

The base year of the model is 2012 with a nominal month of April. This is largely driven by the date of the Census (POWSCAR) and other travel surveys (e.g. the National Household Travel Survey). It should be noted that the POWSCAR dates to 2011 but the travel patterns are assumed to be broadly the same in 2012.

1.3.3 Time Periods

The five weekday periods modelled in the WRM are detailed in Table 1.2. The periods allow the relative differential in travel cost to be represented. Travel cost by active modes is the same through all time periods as no congestion is represented for walk and cycle in the model. The five time periods have been kept to be consistent with the other assignment models (Road and PT), and to allow mode share comparison across all time periods.

The table below also shows the period to hour factors employed to reduce the period demand (output by the demand model) to the assignment demand (1-hour demand to be assigned to the network). The period to peak hour factors were derived from count data.

Table 1.2 WRM Time Periods

Period	Demand Model Full Period	Assignment Period	Period To Peak Hour Factors (walk)	Period To Peak Hour Factors (cycle)
AM Peak	07:00-10:00	Peak hour (factored from period)	0.498	0.445
Morning Interpeak (IP1)	10:00-13:00	Average hour from full period	0.333	0.333
Afternoon Interpeak (IP2)	13:00-16:00	Average hour from full period	0.333	0.333

PM Peak	16:00-19:00	Peak hour (factored from period)	0.368	0.360
Off Peak	19:00-07:00	Not Assigned	N/A	N/A

1.4 This Report

This report focuses on the development of the Active Modes Model (AMM) within the West Regional Model (WRM) and includes the following chapters:

- Chapter 2: WRM AMM Development provides information on the specification of the AMM and an overview of its development;
- Chapter 3: WRM AMM Validation sets out the specification and execution of the model validation process; and
- Chapter 4: Conclusion and Recommendations outlines the key points of the AMM development and next steps required to improve the modelling of active modes.

2 WRM AMM Development

2.1 Overview

As per Section 3.9 of the AMM Specification Report, the WRM AMM network comprises a number of input components, as follows:

- Road network links (e.g. the same links database that holds the road component of the PT Cube Voyager network);
- Walking links (e.g. any walk links included in the WRM PT model plus any further links that allow walk access);
- Cycle speeds on any cycle accessible link – these were set as per Section 3.9.3 of the AMM Specification Report; and
- Zone connectors (the connection points from zone centroids to ‘physical’ network) – these are completely consistent with the PT Model; therefore, please see WRM Public Transport Model Development Report for further information.

shows the location of cycle facilities in Galway City and a description of each facility listed.

A default cycle speed is defined on the network, which can be overwritten if better information on cycling facilities is available. More details on this in the following sections.

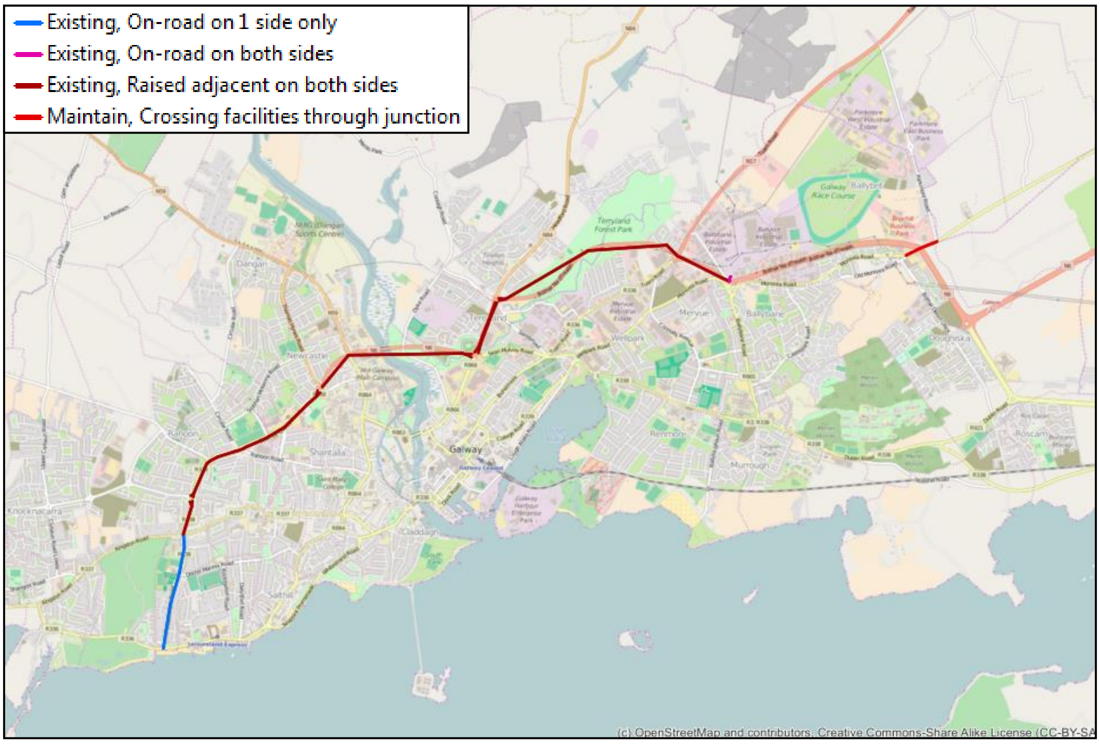

Figure 2.1 Map of Galway City cycle facilities included in the WRM

2.1.1 Cycle Speeds

As detailed in the AMM Specification Report, the "cycle-friendliness" of infrastructure is modelled by an increase in cycle speed. The cost of cycling will then be lower on links with cycle facilities and this will make them more attractive at the assignment stage. The location and characteristics of cycling facilities are imported from a GIS shape file used in the NTA cycle planner (Introute – see Section 3.2 of the AMM Specification Report for further information).

The cycle data GIS shape file has been linked to the modelled PT network, using automatic ArcGIS spatial join tool. Special care was taken to ensure link directions were coded correctly.

Figure 2.2 Estimated Cycle Speeds based on Infrastructure

As per the AMM Specification Report, base cycle speed (without any specific cycling infrastructure) was modelled as 12 km/h. Maximum cycle speed was set to 20 km/h. A cycle speed on each cycle facility type, between 12km/h and 20km/h, was assigned based on the rules set out in the AMM Specification Report.

Average walk and cycle speeds differ by age. To take this into account in the AMM, three age categories have been defined and average walk and cycle speeds calculated based on NHTS 2012 data. Age categories considered are:

- 0 to 20 years;
- 20 to 60 years; and

- Over 60 years.

Default walk and cycle speeds coded in the AMM are values corresponding to the 20 to 60 years age category. Additional factors are applied to walk and cycle speeds for Education (EDU) and Retired (RET) user classes. The youngest age category (0-20 years) speeds are used for EDU and the oldest age category (over 60 years) speeds are used for RET. Table 2.1 provides walk and cycle speed factors used in the AMM.

Table 2.1 Default Walk and Cycle speed factors coded in the AMM

User Class	Walk Speed Factor	Cycle Speed Factor
EMP, COM and OTH	1.00	1.00
EDU	0.96	0.83
RET	0.86	0.79

2.2 Importing Cycle Data into the Model

Table 2.2 Cycle speed coded on links with Characteristics data

Quality Of Service	Mandatory (Solid Line) Cycle Speed (km/h)
Primary-2-way off road cycle only	19.5
Primary-Crossing facilities through junction	15.2
Primary-On-road on 1 side only	15.2
Primary-On-road on both sides	15.2
Primary-Raised adjacent on both sides	15.2
Primary-Shared facility with buses	12.8
Primary-Signage only	12.8

The link by link cycle speeds are stored in a dbf file, named “Cycle_Speed.dbf”, to be included in the model input folder. This file stores all cycle infrastructure information, and thus any cycle scheme for testing in the model is coded in this file.

In the WRM, 87 links have been coded in the “Cycle_Speed.dbf” file.

2.2.1 Pedestrian Only Links

Certain links are restricted to pedestrians only, and do not allow access for cyclists. These links are defined as inputs to the model in the file PED_ONLY.DBF. This information has been coded based on local knowledge, supported by a review of mapping / Street View.No such links have been coded in the WRM.

2.3 WRM AMM Cube Voyager Implementation

Figure 2.3 below is a screenshot of the AMM Cube Application. It shows the different steps and the sequential order different tasks are executed.

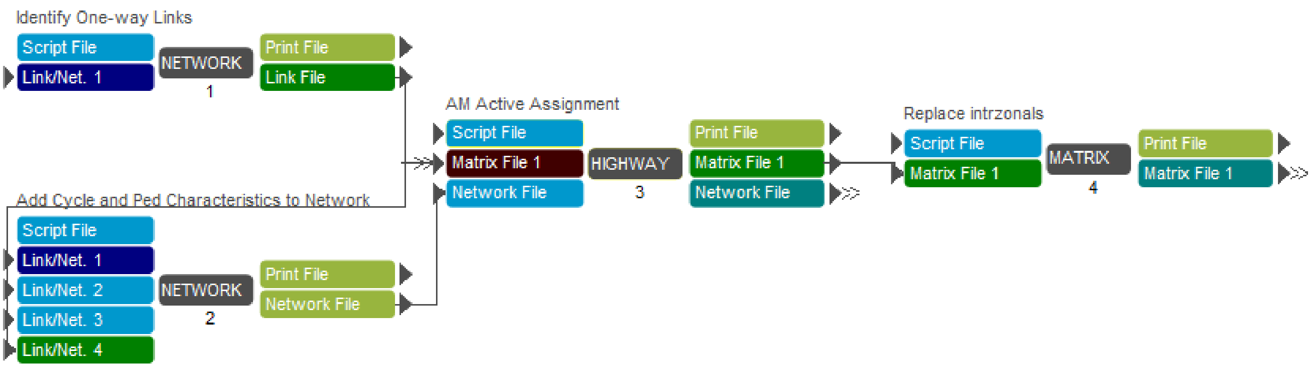

Figure 2.3 Screenshot of the Active Modes Cube application

The role of the Cube application modules shown in the figure above **Error! Reference source not found.**are detailed below:

- Network module (execution order 1): Take the network links from the PT model, delete the rail links (no walking or cycling on those links) and generate reversed links for walking.
- Network module (execution order 2): Add cycle speeds (when defined) to the network, delete links banned from walking/cycling (such as motorways). Pedestrian only links (as discussed in 2.2.1) and specific Cycle speed (as discussed in 2.1.1) are input at that stage.
- Highway module (execution order 3): All-or-nothing assignment of both walk and cycle matrices onto the network. Fastest path considered. Different speeds by user class (as discussed in 2.1.1) are coded in that module.
- Matrix module (execution order 4): Calculate intrazonal cost as the minimum between 40% of the quickest route and 30 minutes.

3 WRM AMM Validation

3.1 Introduction

This section presents the validation of the WRM v1 Active Modes Model. As discussed in the AMM Specification report individual link flows are not calibrated and direct matrix estimation is not used. However, modelled flows can be compared against count data as a sense check. In the case of WRM v1, only observed cycle count data was available in the Galway city area. Pedestrian and cyclist counts were undertaken in November 2014 but the pedestrian counts were for pedestrians crossing at junctions and were not origin and destination counts. Therefore, this pedestrian count data could not be compared against the pedestrian flows in the model.

3.2 Active Modes Demand

The overall walk and cycle demands are compared to the National Household Travel Survey (NHTS) 2012, by time period. For further information on the demand, please refer to WRM Full Demand Model Calibration Report.

Figure 3.1 and Figure 3.2 below are extracted from the demand dashboard for the Base Year 2012.

For each time period, total Walk demand modelled is within +/- 30% of the factored NHTS demand, used as the reference the model should replicate.

The cycle demand is overestimated for AM & SR and underestimated for LT, PM & OP. The overall cycle demand is underestimated by 18%.

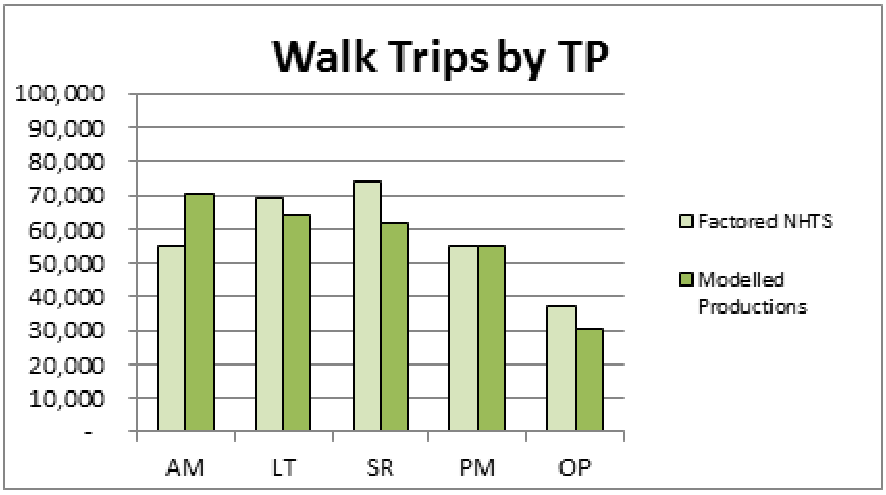

Figure 3.1 Total walk demand by time period – NDFM Base Year 2012

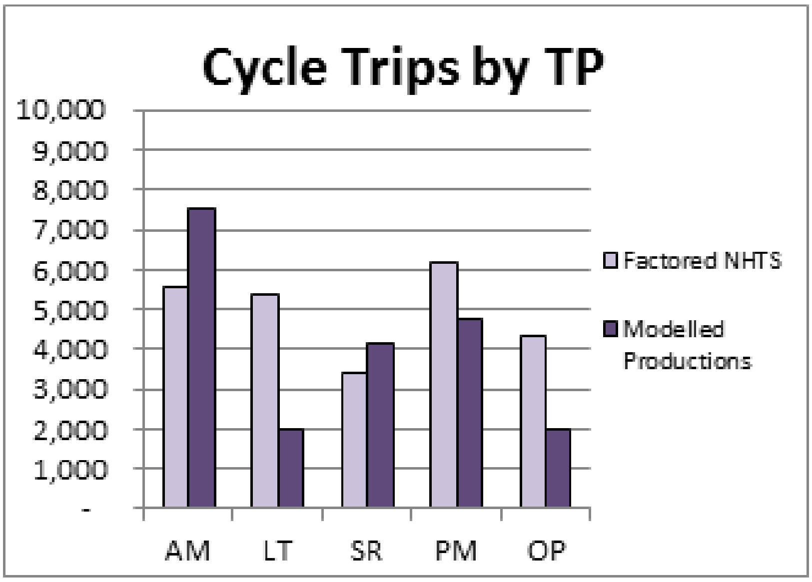

Figure 3.2 Total cycle demand by time period – NDFM Base Year 2012

3.3 Cycle mode

Cycle flows considered in the validation are shown in the tables below.

3.3.1 AM Inbound

Table 3.1 Modelled Cycle Flows vs. Counts - AM peak hour Inbound

Location		Cycle Flow (AMM)	Count	Difference	GEH
226	N17	8	1	8	3.7
226	N17	2	1	1	1.2
226	N17	2	1	1	1.2
226	N17	11	1	11	4.5
226	N18	3	1	3	2.1
226	N18	2	1	2	1.4
238	N15	0	0	0	0.0
238	N15 Slip	0	0	0	0.3
238	N15 Slip	0	0	0	0.1
238	N15	0	0	0	0.0
238	N15	0	0	0	0.0
239	N15	0	0	0	0.0
239	N15	0	0	0	0.0
239	N15	0	0	0	0.0
239	N15	0	0	0	0.0

239	N15 Slip	0	0	0	0.0
246	N4	5	1	4	2.6
246	N4	0	2	-2	1.8
246	Lord Edward Street	18	6	11	3.3
246	Lord Edward Street	2	0	2	2.1
246	N4	4	1	3	1.8
246	N4	0	1	-1	1.0
246	Lord Edward Street	2	0	2	2.1
246	Lord Edward Street	11	6	5	1.9
250	Manorhamilton Road	4	0	4	2.7
250	Manorhamilton Road	0	4	-4	2.5
250	Ash Lane	4	2	3	1.7
250	Ash Lane	15	0	15	5.5
250	The Mall	1	3	-1	0.9
250	The Mall	4	0	4	2.7
250	R286	13	0	13	5.0
250	R286	3	0	3	2.4
251	R870	5	0	5	3.2
251	R870	0	1	-1	1.0
251	R287	2	0	2	1.8
251	R287	3	0	3	2.4
251	Pearse Road	17	1	17	5.6
251	Pearse Road	4	0	4	2.8
252	Lower Knox Street	0	2	-2	1.8
252	Lower Knox Street	0	0	0	0.0
252	Stephen Street	2	0	2	2.1
252	Stephen Street	0	0	0	0.0
	TOTAL	**148**	**30**	**118**	**13**

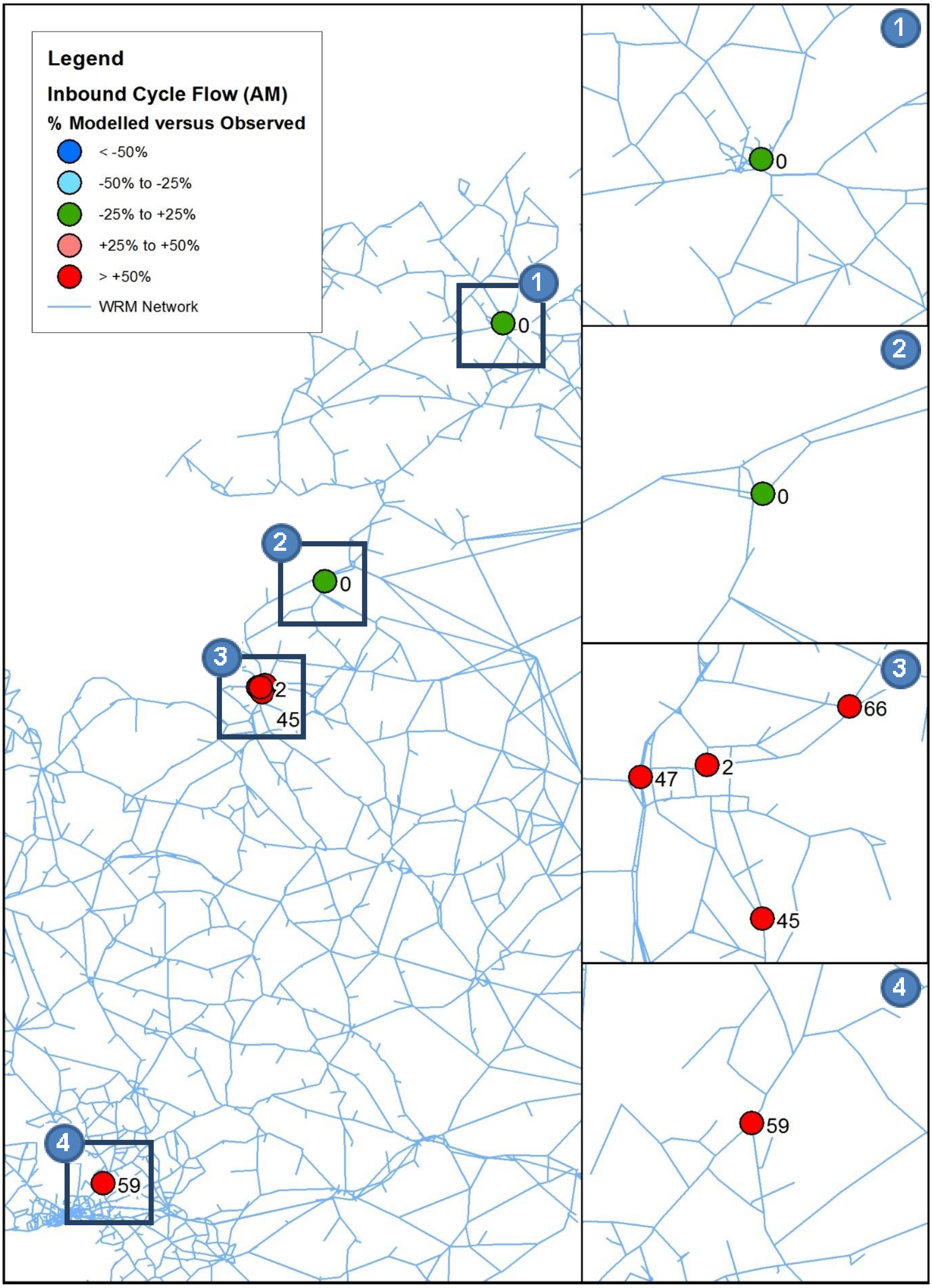

Figure 3.3 Modelled Cycle Flows vs. Counts - AM peak hour Inbound

3.3.2 PM Outbound

Table 3.2 Modelled Cycle Flows vs. Counts - PM peak hour Outbound

Location		Cycle Flow (AMM)	Count	Difference	GEH
226	N17	1	0	1	1.6
226	N17	5	1	4	2.3
226	N17	7	0	7	3.5
226	N17	2	0	2	1.8
226	N18	1	0	1	0.8
226	N18	2	0	2	1.9
238	N15	0	0	0	0.0
238	N15 Slip	0	0	0	0.1
238	N15 Slip	0	0	0	0.2
238	N15	0	0	0	0.0
238	N15	0	0	0	0.0
239	N15	0	0	0	0.0
239	N15	0	0	0	0.0
239	N15	0	0	0	0.0
239	N15	0	0	0	0.0
239	N15 Slip	0	0	0	0.0
246	N4	13	1	12	4.5
246	N4	0	0	0	0.0
246	Lord Edward Street	2	2	0	0.1
246	Lord Edward Street	10	2	8	3.2
246	N4	2	0	2	2.0
246	N4	0	0	0	0.0
246	Lord Edward Street	10	2	8	3.5
246	Lord Edward Street	1	3	-1	0.8
250	Manorhamilton Road	1	0	1	1.0
250	Manorhamilton Road	2	0	2	2.2
250	Ash Lane	9	0	9	4.2
250	Ash Lane	4	1	3	1.9
250	The Mall	3	2	1	0.8
250	The Mall	1	0	1	1.4
250	R286	2	0	2	2.1
250	R286	7	1	7	3.3
251	R870	15	1	14	5.0
251	R870	0	1	-1	1.3
251	R287	5	0	4	2.6

251	R287	2	1	2	1.2
251	Pearse Road	2	2	1	0.4
251	Pearse Road	17	1	16	5.2
252	Lower Knox Street	0	3	-3	2.2
252	Lower Knox Street	0	0	0	0.0
252	Stephen Street	4	0	4	2.6
252	Stephen Street	0	0	0	0.0
	TOTAL	**131**	**23**	**108**	**12**

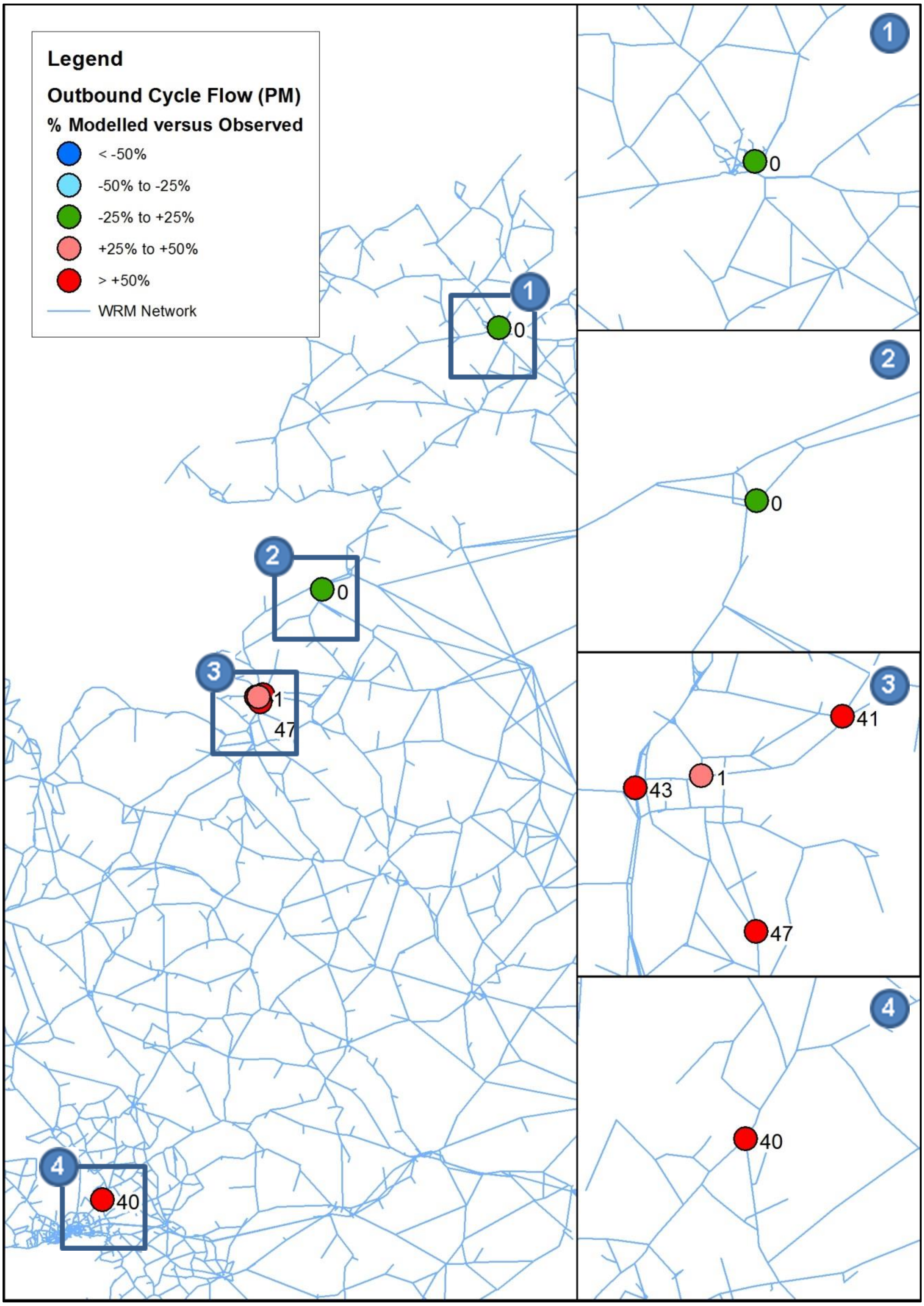

Figure 3.4 Modelled Cycle Flows vs. Counts - PM peak hour Outbound

4 Conclusion and Recommendations

4.1 Overview

This report provides information on the development and validation of the Active Modes Model component of the West Regional Model. This section summarises the key points of the model development, the strength and weakness of the model and a set of recommendations for possible further enhancements.

4.2 Model Development – Key points

The AMM network is the aggregation of different networks (road and walking), with equivalent node, link, zone connectors, and numbering convention.

Network speeds are set based on fixed assumptions for walking, and on a rule-based approach for cycling. Walking is assumed at a constant rate of 5.1kph, independent of link type, for Employee (EMP), Commuter (COM) and Others (OTH) user classes. Following a similar approach as for cycling (see 2.1.1), Education and Retired user classes walk speeds are factored (by 0.96 for EDU and by 0.86 for RET). Assignment is based on a shortest distance path.

For cycling, a system was developed during model specification to assign speeds based on link type, where information on Quality of Service, and/or descriptions of other characteristics (road type, presence of marked cycle lanes, etc.) were used to assign speeds of between 12kph and 20kph. As for walking, assignment is based on shortest path. For both walk and cycle, no account of congestion is taken account of in determining route choice.

The Active Modes Model is used to output costs skims, based purely on time travelled, to the demand model. Otherwise, it is not intended for analysis of actual walking and cycling journeys, as there is insufficient representation of the on-the-ground conditions that influence the speed and routing of such trips.

4.3 Model Validation

Modelled flows for cycling are substantially higher in both of the peak (AM & PM) periods. No attempt has been made to address this, but is deemed acceptable for this version of the WRM.

4.4 Recommendations

Following the development and the calibration/validation of the overall WRM, some areas have been identified where potential improvements could be made, as follows:

- Conduct surveys of walking and cycling speeds and routing across a range of road users, which would allow development of more refined assignment;

- Conduct surveys which differentiate visitors from the standard modelled journey purposes;
- Consider how cyclists in particular are affected by congestion effects and/or particular characteristics of junctions; and
- Classify links using pedestrian oriented characteristics (pedestrianized area, number of shops, large sidewalks) to reflect their attractiveness for walking in the assignment.

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No. XXXXXXXX 22-12-2016