Railway Procurement Agency

RPA METRO NORTH

Scheme Traffic Management Plan Version 8

Appendix A

March 2009

Appendix A – MNTM Validation Report

Metro North EIS

Metro North Traffic Model

Base Year Validation Report

Report for Railway Procurement Agency

In Association With Environmental Resource Management

July 2007

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1 Background

1.1 Metro North Environmental Impact Assessment

1.1.1 Metro North is an 18km long mass transit rail system connecting Swords to the city centre, serving Dublin Airport and a number of important communities and institutions on the north side of Dublin. It was officially announced by the Government on November 1st, 2005, as part of the announcement of Transport 21.

1.1.2 The Railway Procurement Agency (RPA) is mandated by the Government with implementing Metro North. Part of the statutory process of Railway Order application is the development of an Environment Impact Statement (EIS). The EIS will comprehensively examine all potential environmental impacts of the Metro North project. Environment Resource Management (ERM) has been commissioned to undertake this work.

1.1.3 MVA Consultancy was commissioned as sub-consultant to ERM to undertake the traffic impact assessment element of the EIS. On completion, the traffic impact section of the EIS will focus on the impact Metro North will have on the surrounding road network during the construction year, the opening year, and a horizon of 15 years post opening. Thus, bothl short, medium and long term traffic impacts are considered.

1.1.4 The main aspects of the environmental assessment that are related to traffic flow include:

- Traffic noise;
- Air quality;
- Impact on vehicle travellers; and
- Pedestrian, cyclist and community effects.

1.1.5 This report describes the development, calibration and validation of the base year Metro North Traffic Model (MNTM). It will be used to inform analysis on the above points.

1.2 Traffic Impact Assessment Approach

1.2.1 The process for undertaking the traffic assessment of Metro North is as follows:

- Development of a suitable validated traffic model (presented in this report);
- Development of forecast year scenarios;
- Assessment of the traffic impact for the 'peak' construction year, the year of opening and a long term horizon year; and
- Extraction of traffic flow statistics to be used as an input into the environmental assessment of Metro North.

1.2.2 The development of robust forecast year traffic analysis for the Metro North assessment will depend on the creation of an appropriate and robust base year traffic model. This report details the development of a base year traffic model in the following terms:

- Traffic model requirements;
- the level required within the traffic model in terms of zonal and highway network detail;
- the development of the traffic model;
- the calibration of the traffic model vehicle matrices;
- the validation criteria adopted;
- the accuracy of the traffic model in terms of representing existing traffic conditions; and
- the appropriateness of the traffic model as a tool to be used for the Metro North traffic analysis and environmental impact assessment.

1.2.3 In summary the MNTM can be used to:

- Assess both the construction and operational impacts;
- Predict traffic impact for construction year, opening year and horizon year;
- Identify the impact over the whole alignment;
- Take full account of trip re-assignment impacts both within the Metro North corridor and beyond;
- Produce traffic flow outputs in terms of lights and HGV's to be used as an input into the EIS;
- Produce outputs that can be used for micro-simulation assessment, if required;
- Inform cycle, pedestrian, loading, parking, and bus impacts using the MNTM model to supplement other appraisal methods;
- Inform junction design and optimisation; and
- Develop traffic management scenarios.

1.3 Report Overview

1.3.1 In this report we describe the development of the base year Metro North Traffic Model (MNTM). We describe the type of traffic modelling software used and the background to the Dublin Transportation Office's model for the Greater Dublin Area, from which the base year MNTM was developed.

1.3.2 Foremost, we report on the type of analysis required by the EIS, and how this model is an appropriate tool to test impacts of interest to the environmental study. We then set out the validation guidance used to test the robustness of the model within the context of use for which it is designed.

1.3.3 Then the report documents the actual traffic model development process. Firstly the Metro North Traffic Model is described in general terms, i.e., the origins of the Metro North Traffic Model (MNTM), the type of software platform used, the model dimensions, and the type of road and demand detail represented. We then describe the technical details involved in the development the MNTM.

1.3.4 Further technical details are then given on how the model was calibrated and the results of this calibration process. At this stage a definition of what is actually meant by Calibration and by Validation should be given. Calibration involves the correction of network and demand errors to reduce discrepancy between measured data and modelled outputs. For the purposes of forecasting it is assumed that the parameters changed during calibration remain constant over time. Validation tests the ability of the model to predict behaviour. Validation therefore should test some independent count data against flows obtained from the calibrated model.

1.3.5 The following sources on traffic model calibration/validation guidance have been used to inform the model development process and model robustness reporting:

Model Calibration and Validation Guidance

- Department for Transport (UK) Advice on major scheme appraisal;
- Highway Capacity Manual 2000 (US);
- DMRB Volume 12 Section 2 Part 1 (UK). These guidelines are used predominantly to guide the validation of traffic models used for appraisal of new road schemes. These guidelines set out exacting criteria for statistically evaluating model accuracy as required by COBA based cost benefit analysis;
- Dublin Transportation Office validation criteria; and
- SATURN manual validation guidelines;

1.4 Report Structure

Chapter 2 - MNTM Description

In Chapter 2 we give a high level overview of the modelling software platform employed and model dimensions such the study area, time periods and vehicle types modelled. We also describe the origin of the MNTM, the Dublin Transportation Office Traffic Model (DTOTM).

Chapter 3 – MNTM Development

In Chapter 3 we specify in detail how the MNTM was developed from the DTOTM. We describe the additional data used to develop suitable trip matrices and how the DTOTM network is redefined to the appropriate level of detail required by the EIS.

Chapter 4 - MNTM Calibration Process and Results

Chapter 4 then outlines the calibration process adopted and assesses its accuracy using a statistical approach. The calibration methods employed to ensure the MNTM is 'fit for purpose' are presented. To calibrate the model changes are made to the highway network and vehicle trip matrices to obtain a better fit between observed and modelled traffic flows.

Chapter 5 – MNTM Validation

Chapter 5 presents the validation statistics which demonstrate that the MNTM is a suitable and robust tool to be used for the Metro North EIS and will show that test accuracy during forecasting is achievable both locally and globally

Chapter 6 - Conclusions

Finally, Chapter 6 summarises and concludes the main points in the report.

2 MNTM Description

2.1 Introduction

2.1.1 This section of the Model Validation Report describes the MNTM with reference to the various aspects below.

- Modelling software platform used;
- The Dublin Transportation Office Model;
- Extent of the model area;
- Time periods modelled;
- Vehicle types modelled; and
- The appropriateness of this model structure for the analysis required by the EIS.

2.2 Model Software Platform: SATURN

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

2.2.2 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 1000 junctions are not infrequent;
2) As a "conventional" traffic assignment model for the analysis of much larger networks (e.g., up to 6000 links in the standard PC version, 37500 in the largest)
3) As a simulation model of individual junctions;
4) As a network editor, data base 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.

2.2.3 Two consecutive 1-hour periods may be modelled in Saturn using its PASSQ facility. With this feature enabled, traffic prevented from making a complete journey within the first hour (due to congestion) is loaded as fixed queues at junctions in the next time period. In this manner, traffic delay and route choice in a subsequent period is influenced by residual over-capacity queuing from an earlier time period.

2.3 The DTO Traffic Model (DTOTM)

2.3.1 The Dublin Transportation Office traffic model (DTOTM) is used as a basis for the development of the Metro North Traffic Model (MNTM). The DTOTM is a SATURN based model and covers the Greater Dublin Area (GDA). All the main roads and areas of employment and population are well represented within the DTOTM so it is an ideal starting point for the development of the MNTM. Moreover, the DTOTM has been in development for many years with various updates taking place as the Dublin region has grown. It represents recent major infrastructural and land-use developments well.

2.3.2 The DTOTM is a component of a three-hour multi-modal transportation model covering the Greater Dublin Area including the counties of Dublin, Meath, Kildare, Louth and Wicklow. The DTO also possesses a 1-hour inter-peak multi-modal model, with all other characteristics being the same as the AM model. It uses 666 zones to represent origin-destination trip demand, over 5100 simulated links and 1900 simulated junctions representing the road network.

2.3.3 The AM model is made up of three separate 1-hour assignments between the hours of 7am and 10am; the Inter peak hour is defined as 2pm to 3pm. Both model suites include bus flows, which are extracted from the DTO Public Transport model and pre-loaded on the MNTM highway network.

2.3.4 Peak spreading effects are also accounted for in the AM (i.e., some road users retime their trips to avoid congestion) using the PASSQ facility described above in *2.2.3*.

2.3.5 The DTOTM is designed for the assessment of wide area transport responses attributable to large scale infrastructural improvements, such as those proposed in A Platform for Change[1] and Transport 21. It is a very useful tool for the measurement of global affects due to the provision of strategic infrastructure.

2.3.6 The DTOTM does not have the required detail around the Metro North alignment to allow robust conclusions to be formed about local traffic impacts during forecasting. There is therefore a requirement to modify the DTOTM along the alignment and especially around proposed Metro stops to allow localised analysis within the wide area model. This enhancement is described in detail in Chapter 3.

[1] A Platform for Change is an integrated transportation strategy for the Greater Dublin Area. Published by the DTO in 2000.

2.4 MNTM Overview and Dimensions

2.4.1 The MNTM was developed and calibrated to represent the following time periods:

- Morning pre-peak hour: 07h00 to 08h00;
- Morning peak hour: 08h00 to 09h00; and
- Inter peak hour: 14h00 to 15h00.

2.4.2 Both AM hours must be considered in order to reflect the normal amount of delay experienced on the network. Each one hour demand matrix is based on trips that depart within that hour alone. Therefore, if the 8am to 9am hour is taken alone, the assignment will not reflect trips that departed in the previous hour but have not reached their destination due to congestion. Therefore the PASSQ feature of SATURN used by the DTO (as described in *2.2.3*) is retained. The 9am to 10am period is not considered since the most severe traffic impacts are concentrated in the 8am to 9am period.

2.4.3 The MNTM base year is 2006, for the following reasons:

- The DTOTM is available for 2006;
- A substantial number of traffic count surveys were available for this year; and
- All traffic surveys were taken prior to the opening of the Dublin Port Tunnel. Any surveys taken post Port Tunnel opening may not reliably account for its full impact, since new routing alternatives may take several months to be fully realised.

2.4.4 The demand matrices are segregated into two vehicle types (or user classes):

- Cars and Light Goods Vehicles (LGV). All cars and two axle trucks or other type commercial vehicle are considered LGVs. This category will be referred to henceforth as the Light Vehicle (LV) user class; and
- Heavy Goods Vehicles (HGV). This user class is comprised of goods vehicles with 3 or more axles.

2.4.5 Passenger car unit (PCU) factors of 1 have been applied to LV and factors of 3 applied to HGV and bus.

2.4.6 Bus flows are also included as fixed flows on links as per the original DTOTM.

2.4.7 The final calibrated model will represent the 7am to 8am and 8am to 9am AM hours and 2pm to 3pm inter-peak hour. All subsequent AM analysis as part of the overall EIS will utilise the 8am to 9am period only. The calibration of this hour is dependant on the calibration of 7am to 8am, therefore full calibration statistics are presented for both.

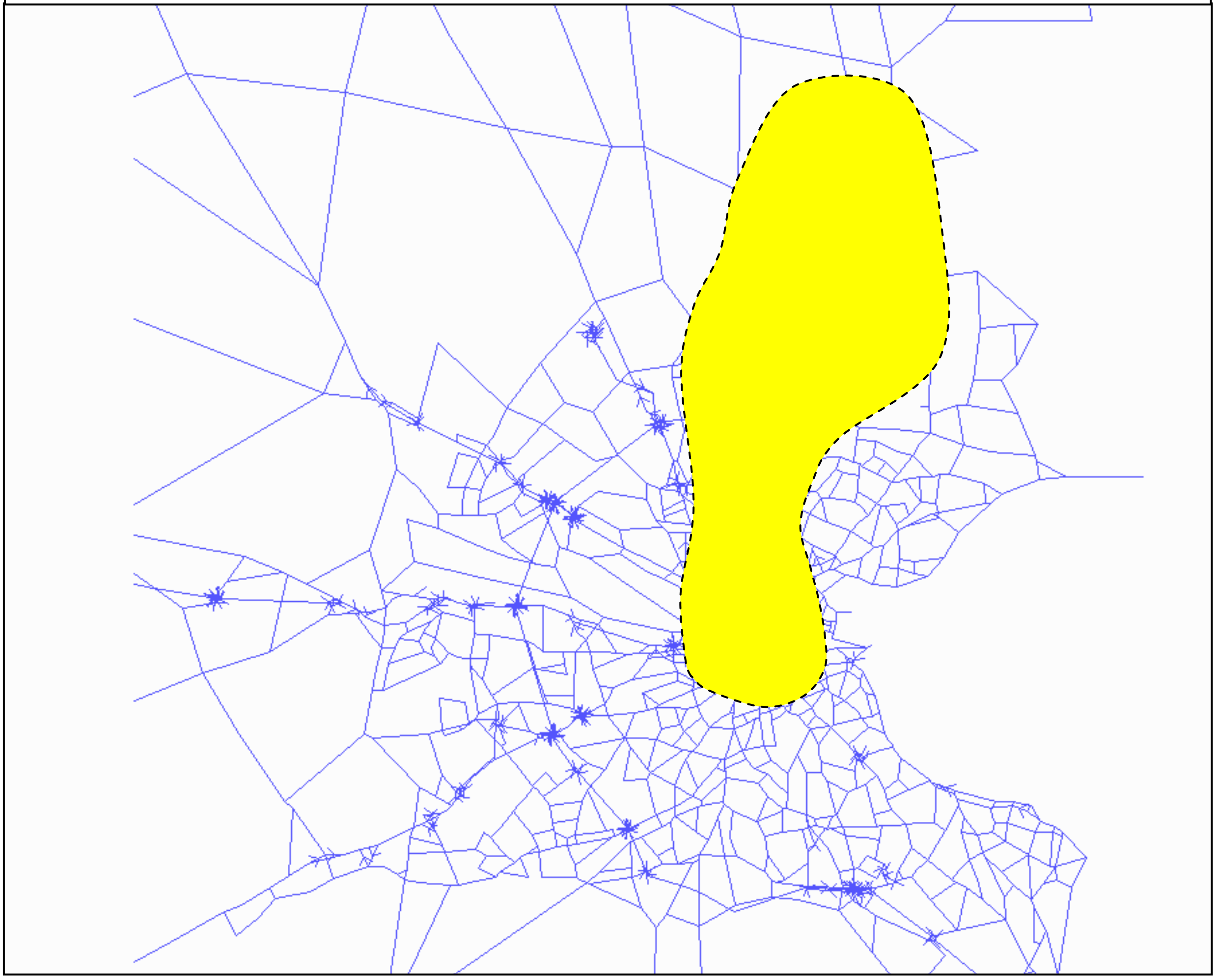
2.5 Model Area

2.5.1 The definition of the study area for Metro North can be defined as the area within which link flows or journey times or delays will be significantly affected by the implementation of the scheme. The scale of the model area required is determined with consideration to:

- Current use of routes (or likely future use) by traffic affected by the scheme;
- Where significant relief to congestion may be provided by the scheme;
- Impacts of traffic level changes in affected areas; and
- Where dis-benefits produced by any extra traffic induced by Metro North may occur.

2.5.2 Given the scale and length of Metro North, the study area required to assess the impact of such a scheme is large. Metro North will have a strategic and localised impact. The traffic model should enable analysis of both wide area and local impacts. For this reason the DTOTM is used in full as the starting point for the development of the MNTM. The DTOTM is not cordoned or sectioned for this project; rather the road network around the alignment is enhanced with all other features being retained. This approach will ensure the full strategic and local impact of the scheme both during construction and operation is considered.

Figure 2.1 MNTM Study Area



2.5.3 The yellow shaded area shown above in Figure 2.1 is the section of the full GDA model in which most traffic impacts of Metro North will be concentrated. This area contains road network 1 to 2 km either side of the full Metro North alignment (shown in red). Most significant local traffic impacts will be contained within this range and it is therefore termed the study area.

2.5.4 The network is enhanced within this area to improve local traffic representation along the alignment. A study area definition also gives a convenient reference for reporting on forecast year analysis.

2.6 Appropriateness of MNTM for the Metro North Assessment

2.6.1 For any model it is important to demonstrate that it is an appropriate tool for the full range of traffic impact assessment types it is designed for. For a major public transport scheme, like Metro North, it is crucial that the traffic model incorporates the level of detail required for localised analysis and that it demonstrates the anticipated responses to the scheme during construction and operation.

2.6.2 The MNTM will provide useful results for reasonably localised alterations to the road network or to traffic demand. It will provide insight into where to implement strategic traffic management measures and how such measures will affect surrounding road network. Because the network for the full GDA has been retained from the DTO model an understanding of all construction and alignment related traffic impacts can be determined, without the limitation of a study area boundary. Furthermore, the MNTM is a single tool for the assessment of potentially many different construction scenarios over the full 18km Metro route. It is crucial to understand the cumulative global impact a number of concurrent construction schemes could have, and not just to analyse local construction effects in isolation.

2.6.3 This Validation Report will demonstrate that the MNTM is an appropriate model for the Metro North traffic impact assessment by:

- Detailing that the model calibration achieved is of an acceptable standard;
- Showing that the calibration is particularly good close to the Metro North alignment and the locations of proposed stations; and
- Validating the calibrated model against measured journey times and other count data not used in the calibration.

2.6.4 Within the context of the range of analysis required of the model it must be understood that there is no one source that establishes the validation requirements of a general purpose model. Each such model must be considered with the context for which it will be used and validated accordingly, without sacrificing any of the desirable responses listed above in return for the perfect reproduction of observed volumes on link flows.

3 MNTM Development

3.1 Introduction

3.1.1 The DTOTM, comprising of a road network model and trip demand matrices, is the basis for the development of a model suitable for the assessment of Metro North traffic impacts. This section details the methodology and data inputs used to enable this model development exercise.

3.1.2 The DTOTM is the most comprehensive traffic analysis tool for the GDA available at present. Its intended function is to allow strategic level analysis of major changes to the supply of transportation infrastructure. The DTOTM road network representation is well defined in the city centre area bounded by the canals. Between the canal cordon boundary and the M50 network detail is slightly coarser, though most roads are represented. Outside the M50, the level of network detail is largely limited to strategic level trunk roads.

3.1.3 The level of detail included in the DTOTM is insufficient in local road and trip loading detail to allow traffic analysis in the areas of interest to the Metro North EIS, especially outside the M50 and in the Swords area, in particular. Therefore significant refinements were made to create a more robust and realistic traffic analysis tool for the purpose of the Metro North EIS.

3.2 DTOTM Enhancement

3.2.1 The goal of the enhancement stage is to develop a traffic model that reflects traffic responses to scenarios of interest to the EIS. To achieve this goal, the model must be refined in terms of road network and trip demand representation. The number of zones available in each matrix is increased in the study area, allowing greater control over traffic origin-destination patterns, and improved representation of short trips not accounted for in the DTOTM.

3.2.2 The availability of existing survey information that accurately describes the road network and traffic observations are crucial inputs to the calibration process. At the outset of the calibration process the following data inputs were obtained:

- **Traffic Count Data**: Turning and link count data was obtained from various sources for 2005 and 2006 covering 68 junctions and 10 main line locations. An inventory of surveyed junctions is presented in **Appendix A**.
- **Road Network Data:** Data was gathered from site visits of areas within the MNTM that were inadequately represented. Junction layout details, such as allowed or banned turns, junction priority, and signal phase timings, were collected. A detailed list of surveyed junctions is included in **Appendix B**.

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3.2.3 Refinement to the model will generally result in a better fit between modelled and observed traffic conditions. In general, the following approaches to enhancing the model are available:

- **Improved traffic access points**: Traffic access in the model is enabled by connecting zones to the network at chosen points. Network detail is sparse at the strategic level with zones usually spanning linking and connecting directly to junctions. This type of coding does not reflect reality because traffic does not normally enter a road network directly at junctions. The network is therefore recoded to model realistic traffic accessing to and from developments, such as at minor access roads to housing estates or shopping centres;
- **Additional local roads**: The areas immediate to each proposed Metro North station location were examined for roads not included in the model. Any road that may carry critical traffic movements or provide an alternative in congested conditions (i.e., allow through movements or 'rat-runs') was included in the MNTM;
- **Additional zones**: Again, strategic networks such as the standard DTOTM contain insufficient zonal detail in suburban areas. To allow a more detailed level of analysis, distinct land use activities were identified with DTO zones along the Metro North corridor. These large zones are subdivided to allow each identified activity its own zone and trip distribution. Additional zones imply lower inter-zonal separation and greater scope for increased network detail in urban areas. This extra detail allows more control over how traffic is assigned to the network and more flexibility during calibration; and
- **Matrix Estimation**: This process adjusts the level of demand between zones in order to improve the fit between modelled flows and observed traffic counts. A base (or prior) matrix is fed into a SATURN based software routine called ME2. This process is described in detail in Section 4.2.

3.3 Highway Network Enhancement

3.3.1 Network was added with regard to the localised type of traffic impact analysis required by the Metro North EIS. Most of the added detail was required in the Swords locality; however, a significant amount of network was added in Ballymun and Drumcondra. This additional local network will also allow more flexible analysis when forecast models are produced from the base year model.

3.3.2 Further detail was added by providing dedicated access roads that allow traffic to enter and leave the network from main roads in a realistic manner. Access points are provided by splitting an existing link and inserting a new junction. Access to or from the zone must be gained via the new junction and associated access road. Traffic in the network therefore behaves more realistically than before, when traffic was transmitted to zones invisibly at junctions.

3.3.3 Other instances of direct interaction between zones and important junctions were removed by reconnecting such a zone to local feeder roads. This change removed any ambiguity from the definition of traffic flows on main roads. For example, in the Ballymun area, zone 17518 is removed from its direct connection to Ballymun Road (Figure 3-3) and replaced with direct connection onto Balbutcher Lane only (see Figure 3-4)

3.3.4 A full list of enhancements included in the MNTM is included below in Table 3.1.

Table 3.1 MNTM Additional Network

Area	New Road / Junction	Comment
Swords	Jugback Lane	Allows traffic to enter network correctly from new north Swords development
Swords	Balheary Road	Same as above
Swords	Scotchtown Bridge	
Swords	Church Road / Main St	New signalised junction
Swords	Bridge St / Main St	Changed from roundabout to signalised junction
Swords	Seatown West / Swords Bypass (R132)	Added Estuary Road eastern approach to r'bout
Swords	Seatown Road / R132	Added slip road onto southbound R132
Swords	Seatown R'bout / Estuary Road	Added Estuary Road eastern approach to r'bout. Enables access from industrial area

Area	New Road / Junction	Comment
Swords	Southbound R132 access between Estuary Road / Malahide Road	Access from new development (zone 98912)
Swords	Pavilion Shopping Centre Access	R'bout access from Malahide Road and directly to R132
Airside	New road layout connecting Drynam Road and Malahide Road	Allows direct access to network from new Feltrim Hall development
Ballymun	Balbutcher Lane / Shangan Road	New signalised junction layout
Ballymun	Coultry Road	Allows traffic to enter Ballymun Road southbound from East
Ballymun	Sillogue Road	Additional network to the West of Ballymun Road
Ballymun	Shanard Drive	Access between Collins Av and Shanliss Road
Ballymun	Shanowen Avenue	Access between Collins Av and Shanliss Road
Ballymun	Shanowen Road	Local road directly serving an industrial estate
Santry	Larkhill Road	Interacts with important Swords Road exit to Shantall Road
Glasnevin North	St. Pappins Road	Residential Street allowing east-west through movements to Ballymun Road
Glasnevin North	St. Canice's Road	Residential Street allowing east-west through movements to Ballymun Road
Glasnevin North	Iveleary Road	Generates trips directly onto Swords Road
Drumcondra	Rathlin Road / Lambay Road / Bantry Road / Valentia Road / Clare Road	Narrow residential roads allowing some movement between Griffith Av and Homefarm Rd

Area	New Road / Junction	Comment
Drumcondra	Walsh Rd / Ferguson Rd / Millbourne Avenue	Allows traffic movement between Homefarm and Drumcondra Roads
Drumcondra	Hollybank Rd / St. Joseph's Av / Lindsay Rd / St. Patrick's Rd	Local roads around Drumcondra Station

3.4 Trip Demand Enhancement

3.4.1 Improvements to the network are not helpful unless accompanied by a finer representation of trip demand through the use of smaller zone sizes in the study area. Large zones within the study are broken up based on the identification of different land uses with the zone. Each land use is then given its own distinct zone to represent a proportion of trips from the disaggregated zone. Trip distribution for each such zone can be determined from either the original zone or a nearby zone. .

3.4.2 To illustrate, the DTO zone, 35540, covers a large part of Swords town centre. This zone extends from Church Road and Watery Lane in the West to an eastern edge defined by the alignment of the Swords Bypass (R132). Clearly within the centre of Swords there is a wide variety of land uses (commercial activity, schools, shops, residences) that generate car trips and that one zone is insufficient for representing how such trips interact with the network. Consequently, this zone is broken up into different zones thus allowing car trips to access the road network in different places, according to the location of each trip generator. In the case of Swords town centre, five new zones are formed: Swords Pavillion S.C., Seatown Villas, Main Street, Watery Lane Industrial Estate, and the area between Seatown and Malahide Roads. Each one of these is assigned a proportion of trips from the original DTO zone, based on estimates by the modeller.

3.4.3 Table 3.2 below lists each DTOTM zone that was disaggregated to develop the base year MNTM, and the disaggregation factors used for LV trips in the AM and the inter peak hours. An equivalent table for the HGV user class is included in Appendix D. A factor of 0.01 was used to retain a seed value from each zone, which is important during the matrix estimation process (described in Chapter 4).

Table 3.2 DTO Zone Disaggregation Detail

DTO Zone	MNTM Zone	AM Disagg Factor		Inter-peak Disagg		New Zone Description
		Trips Out	Trips In	Trips Out	Trips In	
35540	98901	0.01	0.30	0.50	0.50	Swords Pavillion Shopping Centre
	98902	0.35	0.05	0.10	0.10	Seatown Villas
	98903	0.10	0.30	0.20	0.20	Along Main Street
	98904	0.01	0.30	0.10	0.10	Watery Lane Industrial Estate
	98905	0.55	0.05	0.10	0.10	Between Seatown & Malahide Roads
35541	98910	0.60	0.10	0.40	0.40	Fronting Seatown Rd / Estuary Rd
	98911	0.01	0.70	0.15	0.15	Seatown Roundabout Access
	98912	0.01	0.10	0.05	0.05	Fronting Swords Bypass Southbound Side
	98913	0.15	0.01	0.10	0.10	Ashley Avenue Area
	98914	0.25	0.01	0.10	0.10	Foxwood
	98915	0.01	0.10	0.20	0.20	Feltrim Industrial Park
35427	98916	0.10	0.85	0.45	0.45	Airside Business Park North
	98917	0.01	0.15	0.40	0.40	Airside Business Park South
	98918	0.90	0.01	0.15	0.15	Feltrim Hall Area
17491	98920	0.60	0.01	0.15	0.15	Shanowen Residential Area
	98921	0.01	1.00	0.70	0.70	Palmgrove Industrial Estate
	98922	0.40	0.01	0.15	0.15	Larkhill Road area
17517	98930	0.75	1.00	0.50	0.50	Shangan Area
	98931	0.25	0.01	0.50	0.50	Shanliss Area
17492	98935	0.01	1.00	0.90	0.90	Omni Shopping Centre
	98936	0.20	0.01	0.05	0.05	Oakpark Avenue
	98937	0.80	0.01	0.05	0.05	Magenta Hall

DTO Zone	MNTM Zone	AM Disagg Factor		Inter-peak Disagg		New Zone Description
		Trips Out	Trips In	Trips Out	Trips In	
17490	98940	0.20	0.01	0.05	0.05	Albert College Roads
	98941	0.01	1.00	0.85	0.85	Dublin City University
	98942	0.40	0.01	0.05	0.05	Iveragh Road
	98943	0.40	0.01	0.05	0.05	Walnut Roads
35442	98923	0.40	0.01	0.10	0.10	Knights Wood
	98924	0.30	0.01	0.10	0.10	Santry Close
	98925	0.30	1.00	0.80	0.80	Turnapin Residential / Industrial Estate
36603	98926	0.01	0.50	0.50	0.50	DOE Test Centre
	98927	1.00	0.50	0.50	0.50	Along Swords Road
36604	98929	0.01	0.85	0.30	0.30	Northwood Area
	98928	1.00	0.15	0.70	0.70	Lymewood Mews and Commercial Area
16147	98960	0.65	0.01	0.05	0.05	Marino Area Residential
	98961	0.01	0.55	0.85	0.85	St. Vincent's Hospital
	98962	0.15	0.45	0.05	0.05	All Hallow's School and Surrounding Schools
	98963	0.20	0.01	0.05	0.05	Ormond Road
16110	98965	0.50	0.20	0.50	0.50	West of Russell Av
	98966	0.50	0.80	0.50	0.50	East of Russel Av
17127	98945	1.00	0.01	0.10	0.10	Fronting Finglas Road Old
	98947	0.01	1.00	0.90	0.90	Enterprise Ireland / Bon Secours Hos.
17149	98950	0.01	0.70	0.60	0.60	St. Patrick's College
	98951	0.01	0.30	0.30	0.30	Colaiste Caolmhin
	98952	1.00	0.01	0.10	0.10	Residential Streets Fronting

DTO Zone	MNTM Zone	AM Disagg Factor		Inter-peak Disagg		New Zone Description
		Trips Out	Trips In	Trips Out	Trips In	
						Homefarm Road
16148	98955	0.01	1.00	0.75	0.75	Holycross College
	98956	1.00	0.01	0.25	0.25	Residential Streets Fronting Clonliffe Road

3.5 Final Network (including new zones)

3.5.1 The following screen captures (Figure 3-1 to Figure 3-8) illustrate the extent of all refinements made to both zone loaders and road network in the DTOTM, resulting in the final version of the MNTM.

3.5.2 The disaggregated zone boundaries corresponding to the refined DTO zonal representation are illustrated in **Appendix D**.

Figure 3-1 Swords / Airside Road Network (DTOTM)

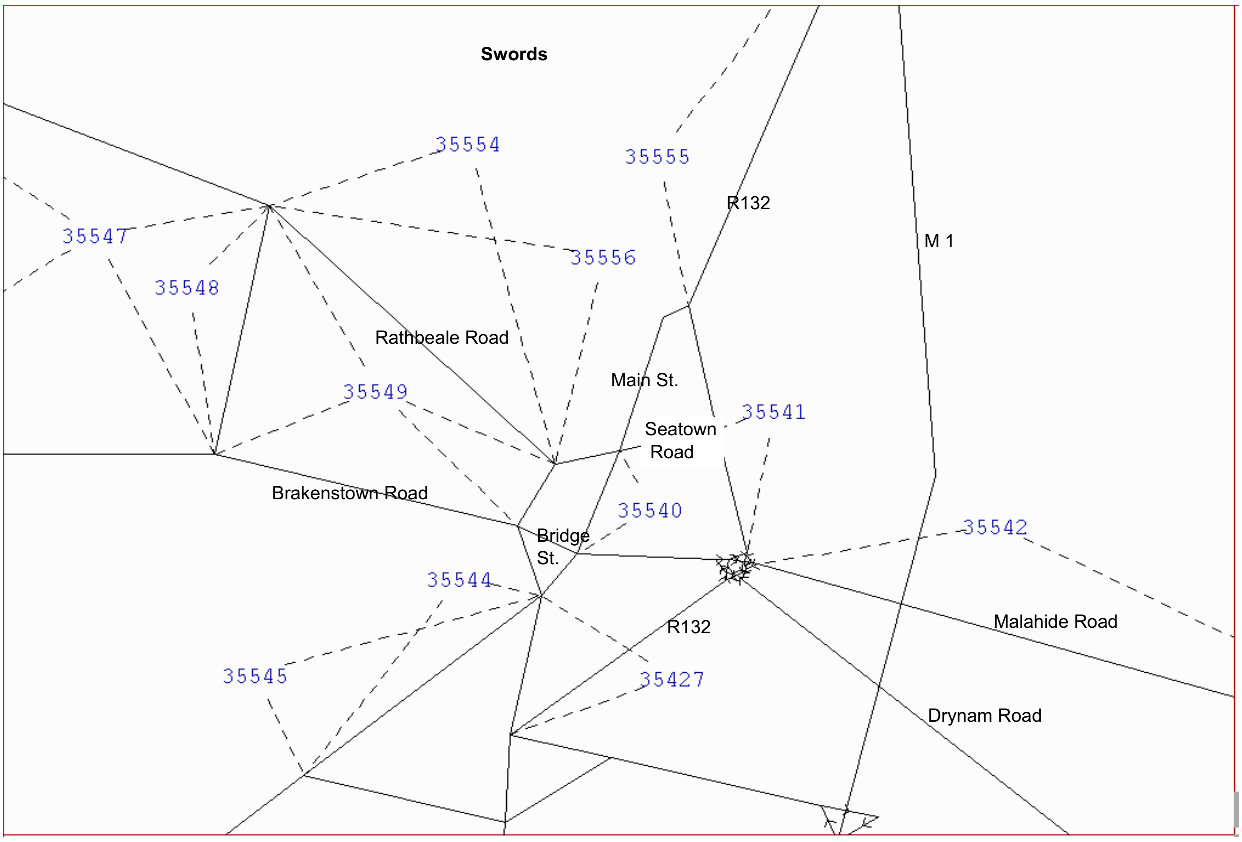


Figure 3-2 Swords / Airside Road Network (MNTM)

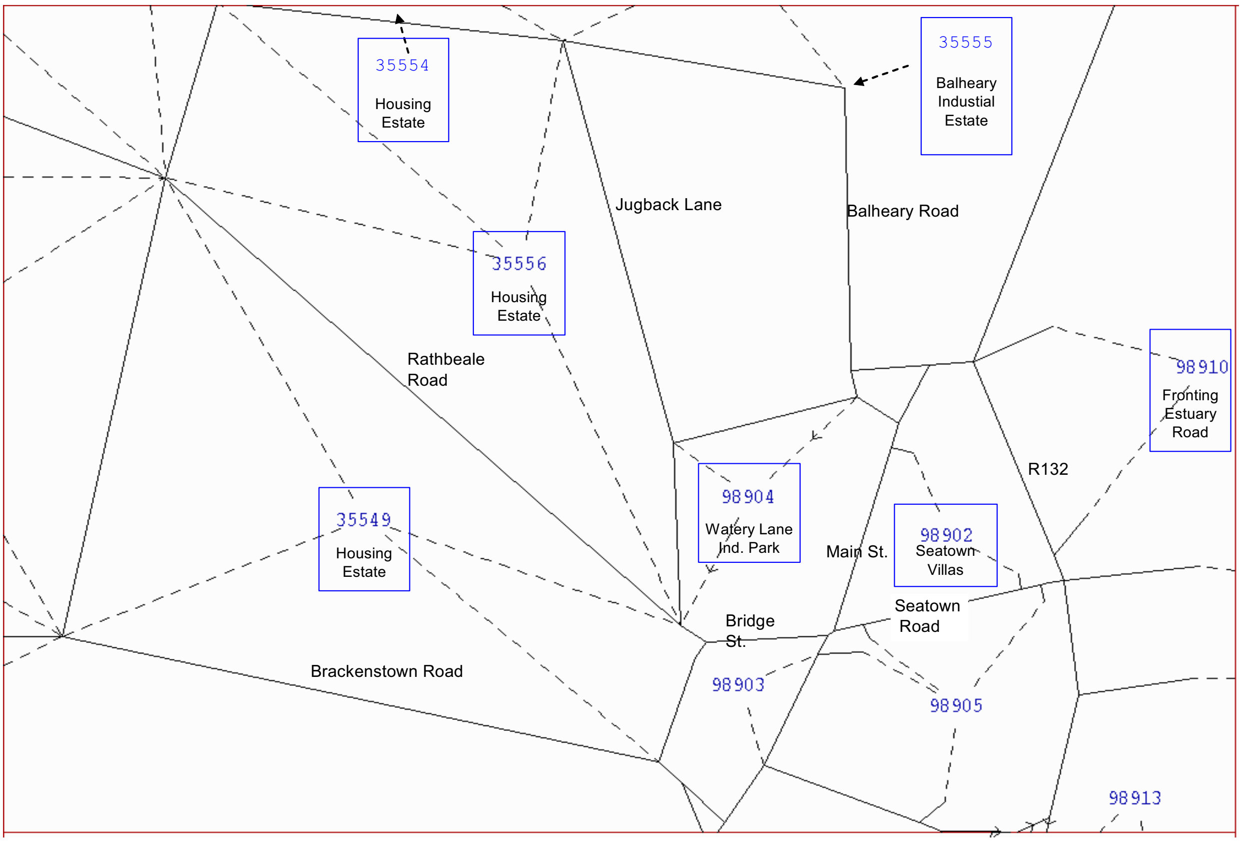


Figure 3-3 **Santry Road Network (DTOTM)**

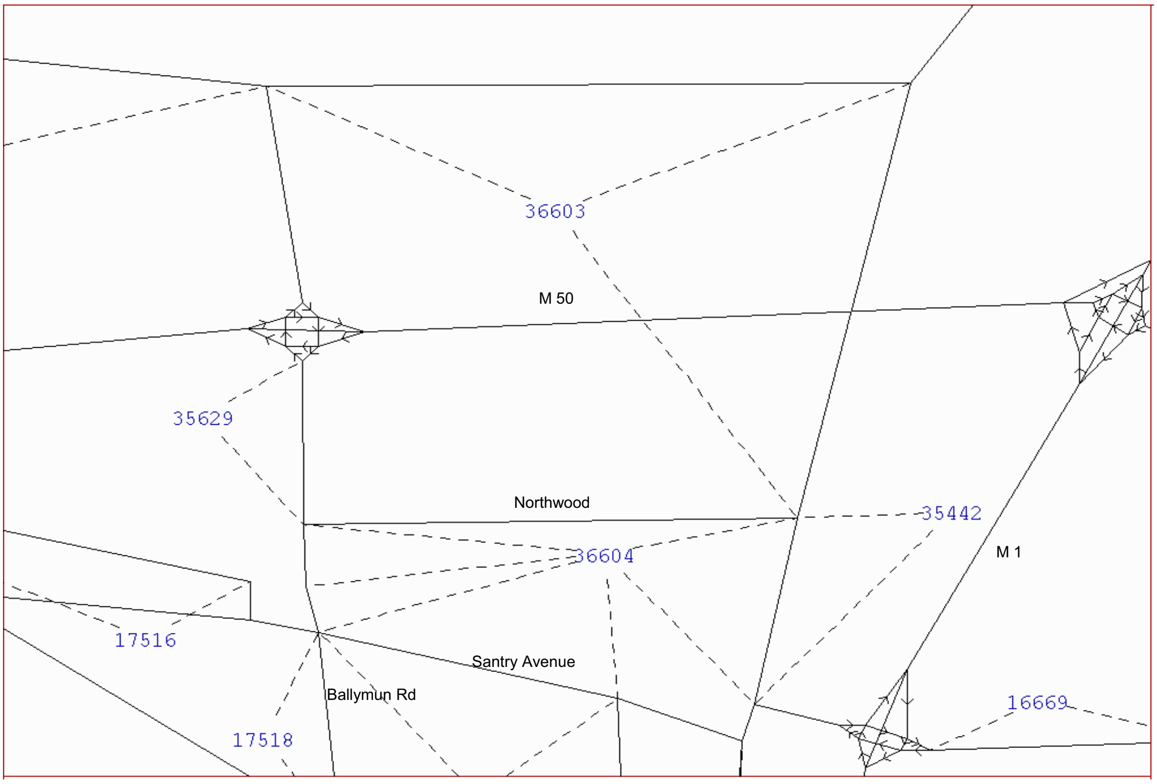


Figure 3-4 **Santry Road Network (MNTM)**

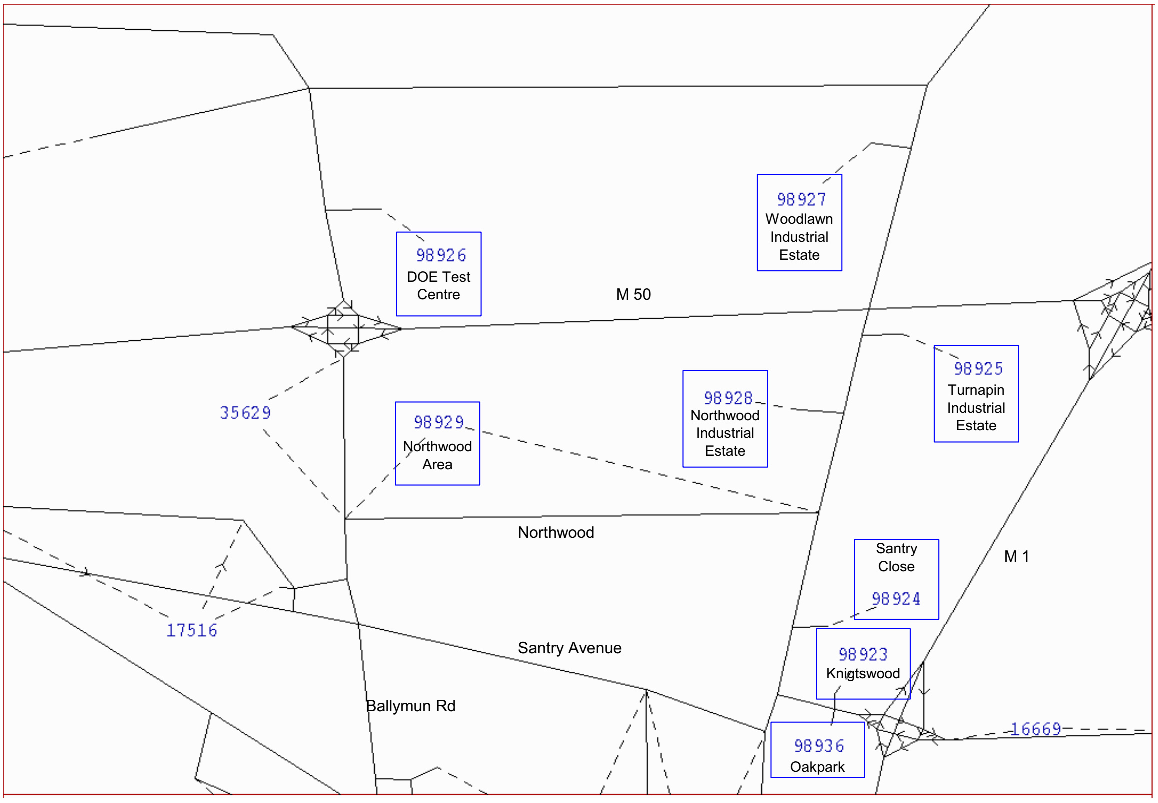


Figure 3-5 Ballymun / Glasnevin (DTOTM)

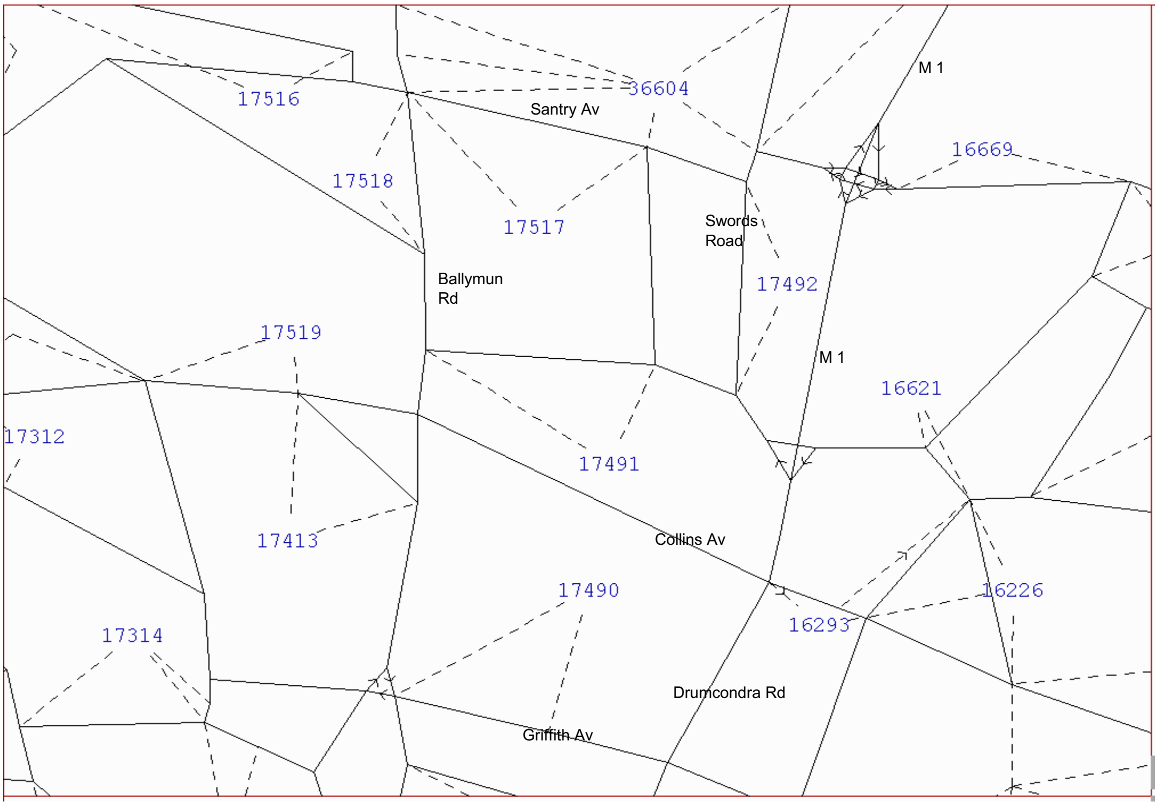


Figure 3-6 Ballymun / Glasnevin (MNTM)

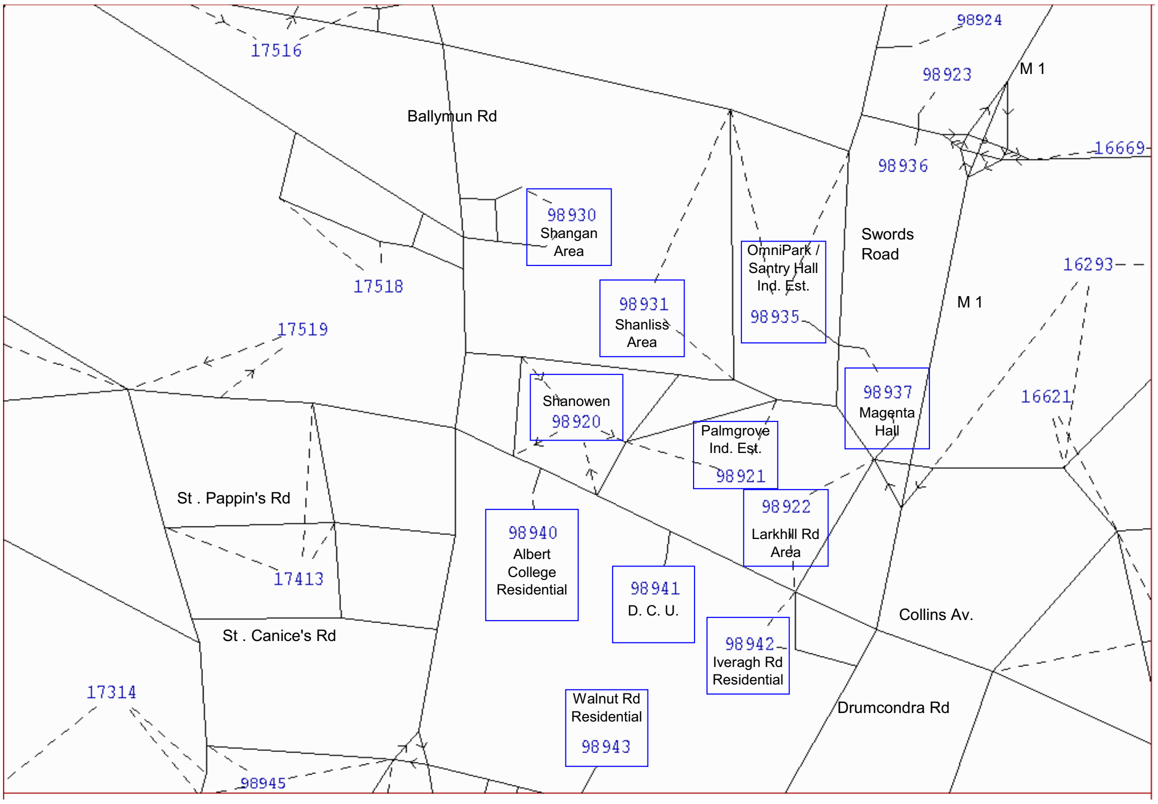


Figure 3-7 Drumcondra (DTOTM Network)

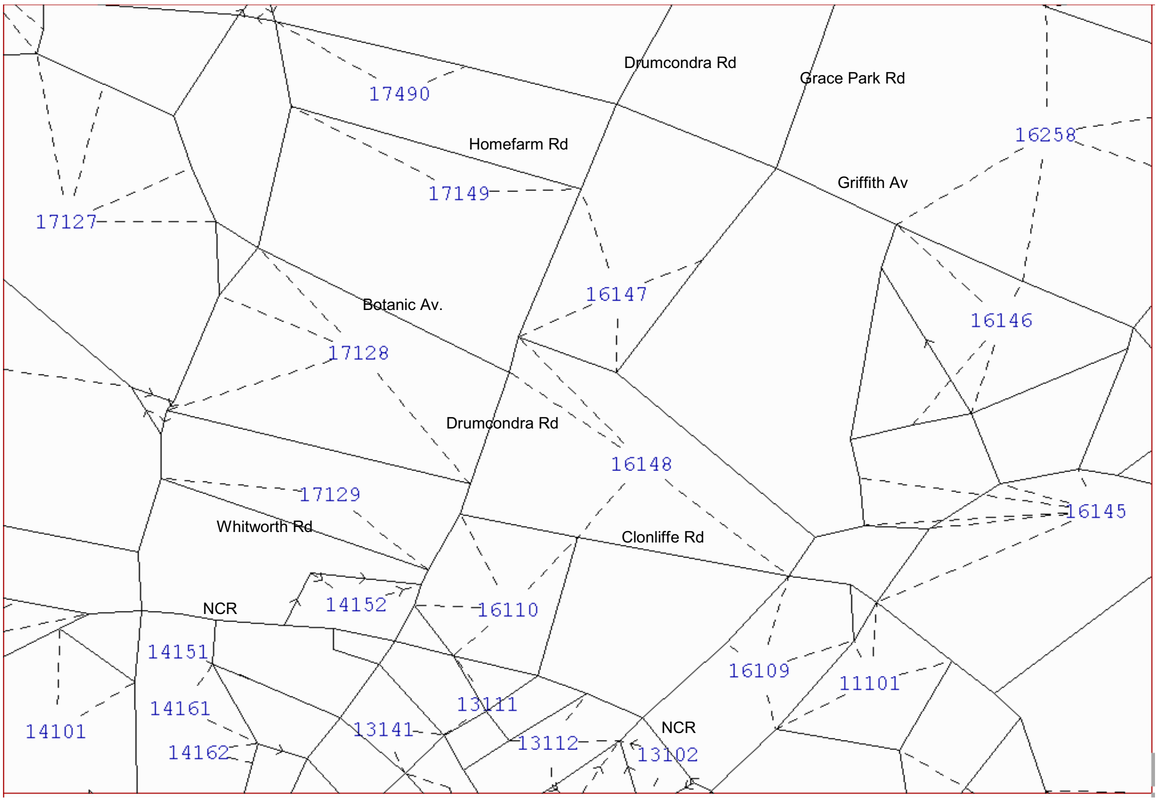
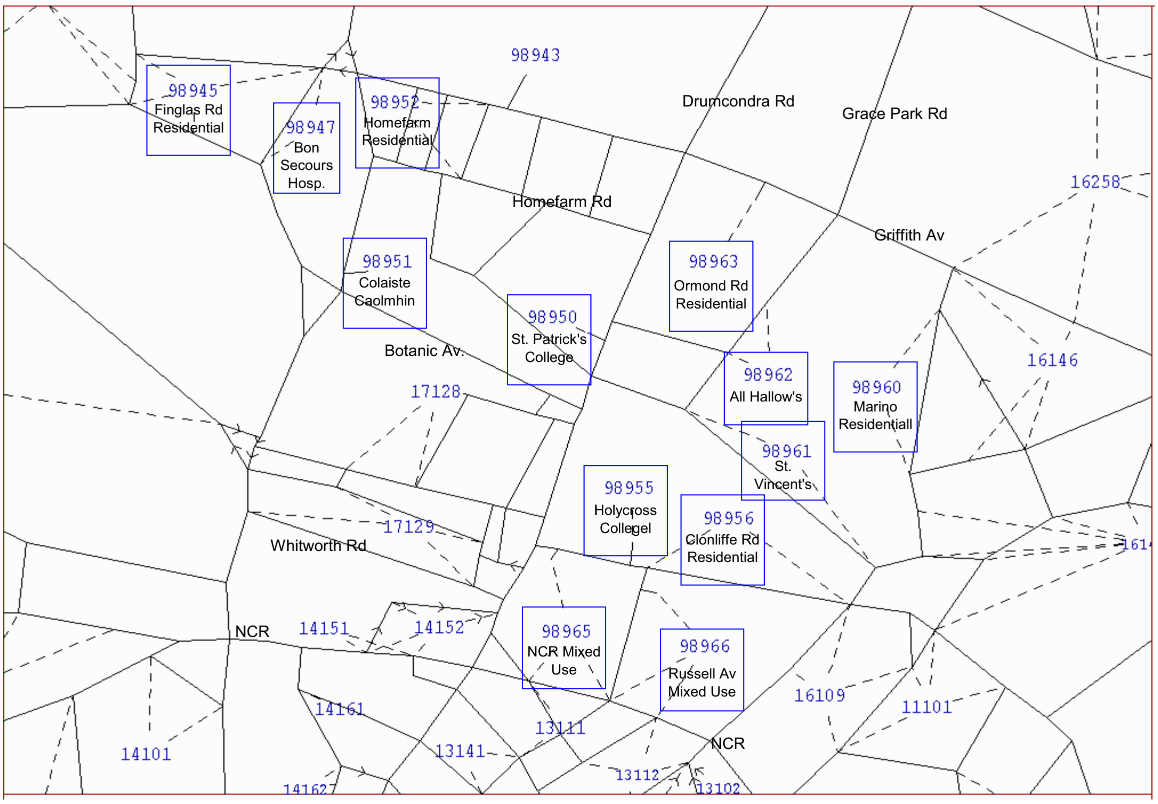


Figure 3-8 Drumcondra (MNTM)



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4 MNTM Calibration Process and Results

4.1 Calibration Process

4.1.1 Calibration is intended to improve agreement in the refined model (the MNTM) between observed and modelled traffic characteristics.

4.1.2 Generally, the components of the model that may be adjusted on the demand side are trip distribution and trip production and generation rates. This adjustment usually involves trip matrix estimation.

4.1.3 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.

4.1.4 In the case of the MNTM significant new network and matrix detail (as described in Chapter 3) requires calibration. It must be noted the MNTM is equivalent to the DTOTM in many parts of the study area, especially in the city centre. There is little scope to adjust these parts of the network as it must be assumed they are for the most part correct in the DTOTM. This implies the calibration effort for the MNTM must concentrate of the demand side, i.e., trip demand matrix adjustment.

4.1.5 Other aspects of the calibration are detailed in this chapter, such as model convergence results, which determine the stability of modelled flows with respect to successive assignment iterations.

4.1.6 Additional parameters that must be assessed when judging the integrity of any changes made to the matrices include any changes made to trip length distribution given by origin-destination patterns in the matrix. Results for trip length distribution for both prior and post calibrated trip demand are given later in this chapter.

Initial Calibration Steps

4.1.7 As an initial calibration step, all modelled junction movements with a corresponding turning count were examined to determine if the count exceeded modelled capacity. Remedial steps were then taken to permit realistic flows in the model.

4.1.8 In the study area especially a full review is then carried out in areas where detail has been added. The judgement of the modeller is employed to refine model representation of the road network, based on knowledge of the area, site visits, and mapping. Each of the following model parameters may be adjusted if there is a clear reason for doing so:

Network Adjustment Possibilities – Junctions or Roads

- Junction type (Priority, Signalised, Roundabout);
- Road lengths;
- Signal timings;
- Link free flow travel speed;
- The number of approach lanes at each junction arm;
- Traffic lane width per junction approach, and the lane discipline adopted (including prohibited turns);
- Saturation flow through junctions;
- Assumed road capacities;
- Link based flow-delay relationships; and
- Any other traffic management measures that may impact on capacity, such as bus lanes, traffic calming, parking controls and cycle-lanes.

Network Adjustment Possibilities – Traffic Zones

- Zone co-ordinates; and
- Zone loading points (connections to the network).

4.2 Trip Demand Adjustment (Matrix Estimation)

4.2.1 Adjustments are then made to the MNTM disaggregated LV and HGV matrices to introduce more short trips in and around the more detailed study area

4.2.2 Trip demand is adjusted according to count data, so that there is an improved agreement between counts and modelled flows. The matrix representing unadjusted demand is fed into a SATURN programme called ME2. This matrix is known as the prior matrix. ME2 then adjusts origin-destination patterns to produce a trip demand matrix that better replicates counts when assigned to the network. When this replication is satisfactory the matrix is said to be calibrated.

4.2.3 The prior matrix is adjusted only after all options for improving the network are exhausted. Any matrix adjustment must significantly improve the match between observed and modelled flows, and not introduce more trips into a zone than could realistically be expected. Controls are placed on zones to ensure that the trip demand generated by zones is sensible and in line with census population and employment statistics.

4.3 Matrix Adjustment Constraints

4.3.1 A key requirement in matrix estimation is that critical traffic movements do not experience any interference within the LV class. The DTO demand model derives its travel demand matrices for LVs is based on accurate household and employment information. This information establishes global trip demand characteristics for LVs, such as the pattern of long-distance commuter trips, and all other trip distributions around the GDA. As such MNTM trip demand adjustment must also be done without sacrifice to such characteristics already validated in the base DTO model.

4.3.2 The algorithm driving Me2 tends to reduce such long trips in place of chains of short trips, especially when counts are spread over a wide area.

4.3.3 Constraints are therefore placed on the adjustment process to maintain the integrity of critical movements (i.e. strategic movements) in the original matrix.

4.3.4 By restricting such long trips the matrix adjustment algorithm is forced to create or re-distribute short trips that are not normally accounted for in a strategic model such as that of the DTOTM.

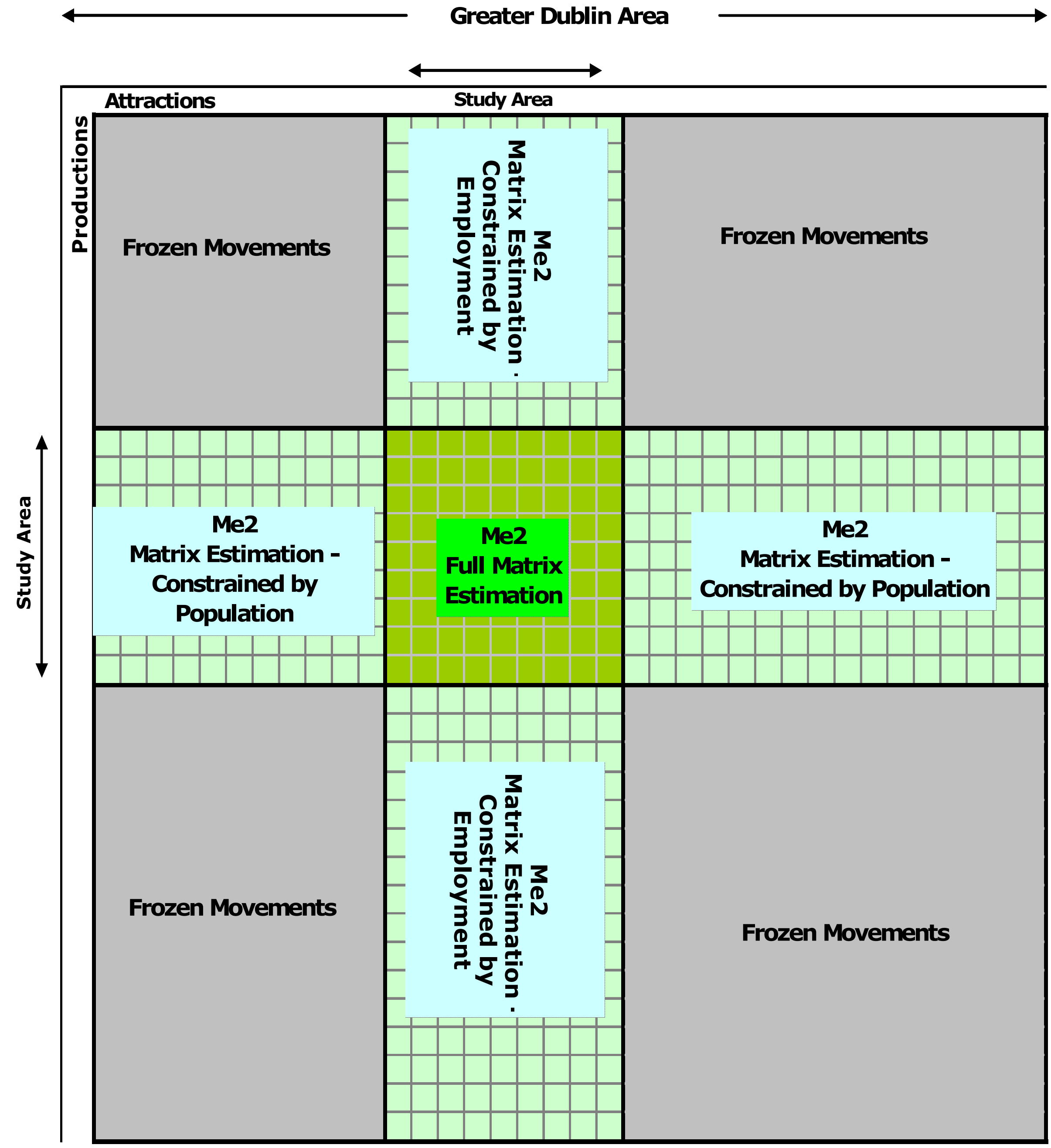
4.3.5 Accordingly, a hierarchy of constraints was devised that placed greatest emphasis on in-filling short trips within the study area. The study area itself was subdivided so that long trips within the study were not affected, such as morning commuter trips from Swords to the City Centre. Trips within Swords (or the City Centre), however, were subject to some adjustment if an improvement between observed and modelled flows resulted.

4.3.6 Furthermore, all zones within the study area were capped relative to the number of trips produced or attracted in the prior input matrix. This factor was set to 1.6 to allow ME2 (the matrix adjustment algorithm) a reasonable degree of flexibility. No zone could therefore be factored by more than 1.6. At each stage the matrix is checked for anomalous results, such as any significant bias towards adjusting certain zones / areas more than others.

4.3.7 The segmented application of constraints to the input trip matrix is shown diagrammatically in Figure 4.1 below.

4.3.8 No constraints are placed on HGV matrices for any time period. However checks remained in place to ensure there was no bias toward adjusting certain zones disproportionately. Trip distribution patterns around the network were subject to full influence by the matrix adjustment programme according to counts.

Figure 4.1 Matrix Constraint Schematic



4.4 Traffic Flow Accuracy Measure: GEH

4.4.1 The GEH statistic is a measure that considers both absolute and proportional differences in flows. Thus for high levels of flow 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:

$$\text{GEH} = \sqrt{\frac{(\text{observed} - \text{modelled})^2}{0.5 \times (\text{observed} + \text{modelled})}}$$

4.4.2 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 pcu/h may be considered a big difference if the flows are of the order of 100 pcu/h, but would be totally unimportant for flows of 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 building an extra lane or not.

4.4.3 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.

4.4.4 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.

4.4.5 There are no Irish guidelines for comparing observed and modelled flows. For the purposes of this validation exercise, however, the British Design Manual for Roads and Bridges (DMRB) Volume 12a was used as a basis for assessing the appropriateness of the highway model for traffic appraisal. The DMRB Volume 12a guidelines are a widely accepted standard in Ireland and provide extremely robust validation criteria to which certain types of highway models should adhere.

DMRB Guidance on GEH Distribution

4.4.6 DMRB sets a guideline that 85% of links should have GEH less than 5 (when measured in vehicles per hour). In addition it is commonplace to establish that 90% of assessment links have a GEH of less than 10 and that 100% of validation links have a GEH less than 20.

4.5 Link Count Calibration

4.5.1 The count locations used for matrix adjustment are listed in Appendix A. Turning movement count data at each junction was aggregated to produce link flows at each junction approach. In other cases mainline link counts were used directly, such as on the M50, M1, and at each crossing of the canal cordon entering the city. The same set of links was maintained for all iterations of the calibration process.

4.5.2 A large proportion of the study area is therefore controlled for link flows, as illustrated in Figure 4-2 and Figure 4-3 below (red indicates a counted link). In total, 219 link counts were used to calibrate each time period.

Figure 4-2 Link Counts used for Calibration – marked in red (Northern Study Area)

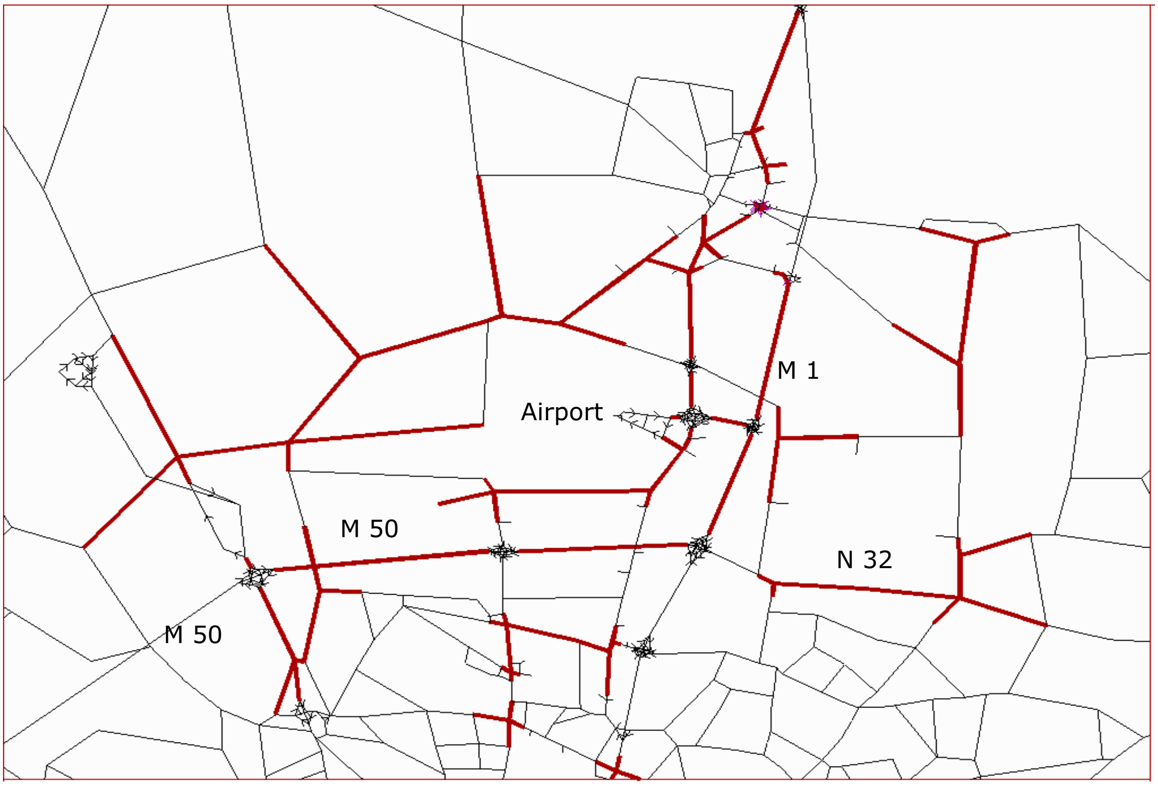
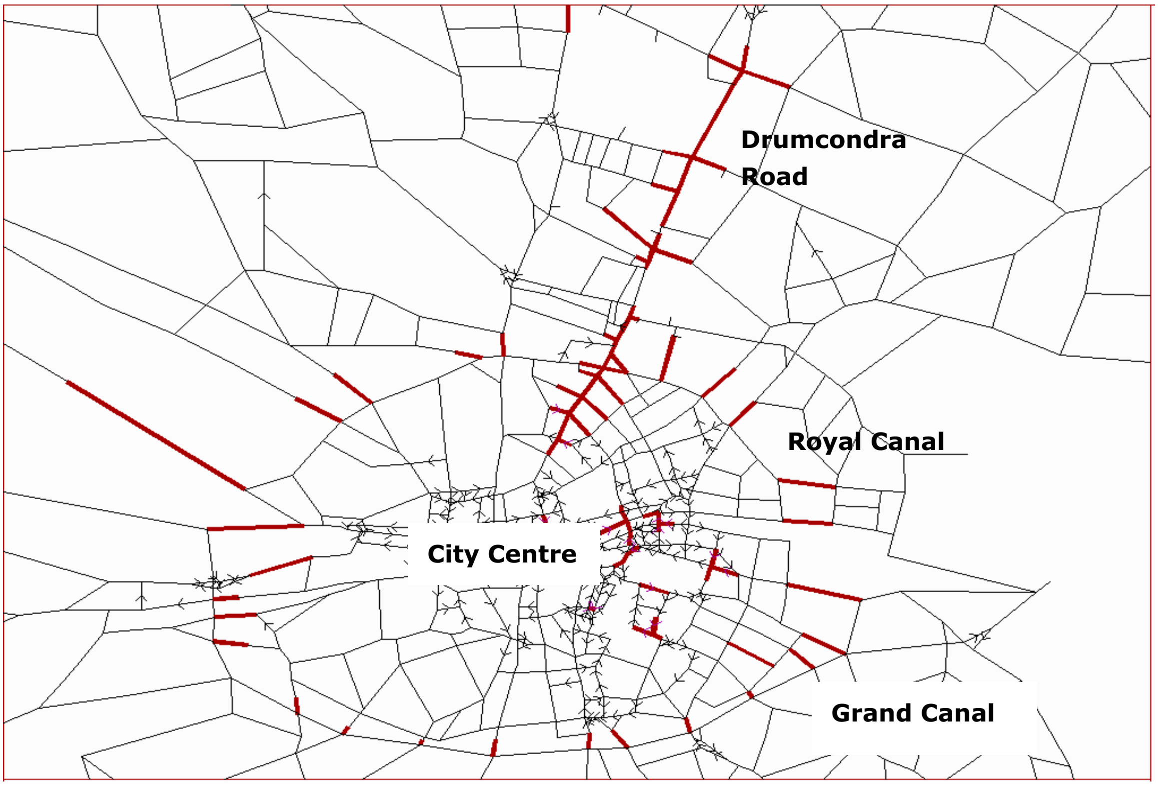


Figure 4-3 Link Counts used for Calibration – marked in red (Southern Study Area)



4.6 Model Fit to Counts (Prior to Calibration)

4.6.1 An initial test was performed to determine how well the existing demand matrices assigned to the MNTM replicated observed traffic volumes. Table 4.1 to Table 4.3 below detail model fit prior to undertaking the calibration process for each time period.

4.6.2 The percentages of total traffic at all count locations with a GEH less than 5 ranges from 32 to 39%, falling far short of DMRB guidelines in each case.

4.6.3 The remaining course of action to improve the fit between model flows and assigned volumes is therefore to perform controlled adjustments to the prior matrix using matrix estimation techniques (described above in Section 4.2).

Table 4.1 7am to 8am Count Validation (Prior to Calibration)

GEH	LV	HGV	Combined Traffic
GEH < 5	31%	41%	32%
5 < GEH < 10	24%	31%	21%
10 < GEH < 20	26%	27%	31%
GEH > 20	20%	1%	16%
Overall Average GEH	**11.59**	**7.25**	**10.82**

Table 4.2 8am to 9am Count Validation (Prior to Calibration)

GEH	LV	HGV	Combined Traffic
GEH < 5	38%	49%	35%
5 < GEH < 10	24%	30%	39%
10 < GEH < 20	37%	21%	23%
GEH > 20	1%	0%	3%
Overall Average GEH	**8.00**	**6.23**	**7.70**

Table 4.3 2pm to 3pm Count Validation (Prior to Calibration)

GEH	LV	HGV	Combined Traffic
GEH < 5	39%	42%	39%
5 < GEH < 10	29%	31%	28%
10 < GEH < 20	25%	28%	26%
GEH > 20	7%	0%	7%
Overall Average GEH	**8.26**	**8.36**	**6.81**

4.7 GEH Statistics for Calibrated MNTM

4.7.1 Table 4.4 to Table 4.6 below summarise GEH calibration results for 7-8am, 8-9am, and 2-3pm.

Table 4.4 7am to 8am Calibration Statistics

GEH	LV	HGV	Combined Traffic
GEH < 5	85%	74%	81%
5 < GEH < 10	12%	18%	14%
10 < GEH < 20	3%	7%	5%
GEH > 20	0%	0%	0%
Overall Average GEH	**2.37**	**3.39**	**3.18**

Table 4.5 8am to 9am Calibration Statistics

GEH	LV	HGV	Combined Traffic
GEH < 5	71%	79%	71%
5 < GEH < 10	22%	16%	21%
10 < GEH < 20	7%	5%	8%
GEH > 20	0%	0%	0%
Overall Average GEH	**3.56**	**2.91**	**3.68**

Table 4.6 2pm to 3pm Calibration Statistics

GEH	LV	HGV	Combined Traffic
GEH < 5	88%	75%	81%
5 < GEH < 10	9%	16%	14%
10 < GEH < 20	3%	9%	5%
GEH > 20	0%	0%	0%
Overall Average GEH	**2.16**	**3.65**	**2.88**

4.7.2 The figures demonstrate that a good calibration was achieved in each of the modelled time periods. In particular, LVs calibrate very well for the 7am to 8am and 2pm to 3pm periods, with a percent of links that are less than 5 respectively equalling 85% and 88%.

4.7.3 In no case are any GEH values above 20 present.

4.7.4 In the 8-9am time period the validation falls short of the targets suggested by DMRB guidance for both user classes and for the combined traffic measure of LV + HGV.

4.7.5 This reduction in accuracy in 8-9am is a direct result of introducing queues built up in the 7 to 8am period, i.e., a proportion of traffic present in the network is not related in any way to the input trip matrix. The following attributes of passed over queues have a restrictive effect on model calibration:

- Queues (residual traffic) are passed over without retained information on the queue composition by vehicle class. It must therefore be estimated; and
- This residual traffic is not routed onward through the network; it is represented as additional junction delay only. This characteristic means that these queues are fixed and cannot be adjusted to better fit counts.

4.7.6 However it is advantageous to pass queues from one time period to another, particularly in a congested network such as Dublin. Passing the queues from the previous hour effectively replicates congested conditions, both in terms of queuing on the network and in terms of the time taken to complete a journey. It is desirable to maintain this model feature inherited from the DTOTM despite its negative affect on the degree of flexibility available for trip demand calibration.

4.7.7 It should be noted that the origin of the DMRB advice is in respect of limited models for specific highway schemes rather than wide area all purpose models. DMRB guidance is used because it presents very useful and widely recognised standards that can be applied to any traffic model. The model prepared for Metro North is intended for much more general analysis over a wide area (indeed, the model used covers the entire GDA). The calibration acceptability measures set out by DMRB were not designed for wide area general purpose models, and must be considered within this context.

4.7.8 Calibration statistics for the HGV user class reveal a generally less close match than equivalent statistics for LVs, with around 75% of links less than GEH=5 in each time period. There are two reasons for this:

- The original input (prior to calibration) HGV matrix was synthesised by the DTO from 2002 traffic data and then factored up to account for growth to 2006. The source data for this matrix does not comprehensively cover the GDA and is not the main focus of the DTO model.
- Because the input matrix is derived from counts, only areas that had good count information in the 2002 matrix will be represented well. It is likely that the areas of interest to this project, such as around Swords, would not have such detailed counts driving the HGV trip demand matrix in that locality.

4.7.9 The results achieved for HGV in each time period, however, are considered acceptable and imply a good representation of HGV flows over the whole study area. Furthermore, HGV assignment accuracy is less import for Metro North scheme appraisal and thus a lesser validation statistic is not as critical.

4.8 Linear Regression of Counts and Modelled Flows

4.8.1 DRMB recommends a further check on flow validation: to fit a linear regression line through the origin with observed flow as the independent variable and modelled flow as the dependent variable. The slope and R^2 measure of goodness of fit for each time period and vehicle type are presented in Table 4.7 to Table 4.9.

4.8.2 DMRB guidance is that the slope of the regression line is in the range 0.9 to 1.1 and that R^2 is greater than 0.95.

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Table 4.7 7am to 8am Calibration Count Regression Analysis

	LV	HGV	Combined Traffic
Slope	0.994	0.851	0.987
R^2	0.969	0.843	0.965

Table 4.8 8am to 9am Calibration Count Regression Analysis

	LV	HGV	Combined Traffic
Slope	0.939	1.079	0.969
R^2	0.937	0.913	0.951

Table 4.9 2pm to 3pm Calibration Count Regression Analysis

	LV	HGV	Combined Traffic
Slope	0.984	0.877	0.962
R^2	0.958	0.834	0.954

4.8.3 Both slope and R^2 criteria are met in all cases for LVs except the 8 to 9am period. However, these values fall just short of the guidance in this instance and still imply a high level of correlation.

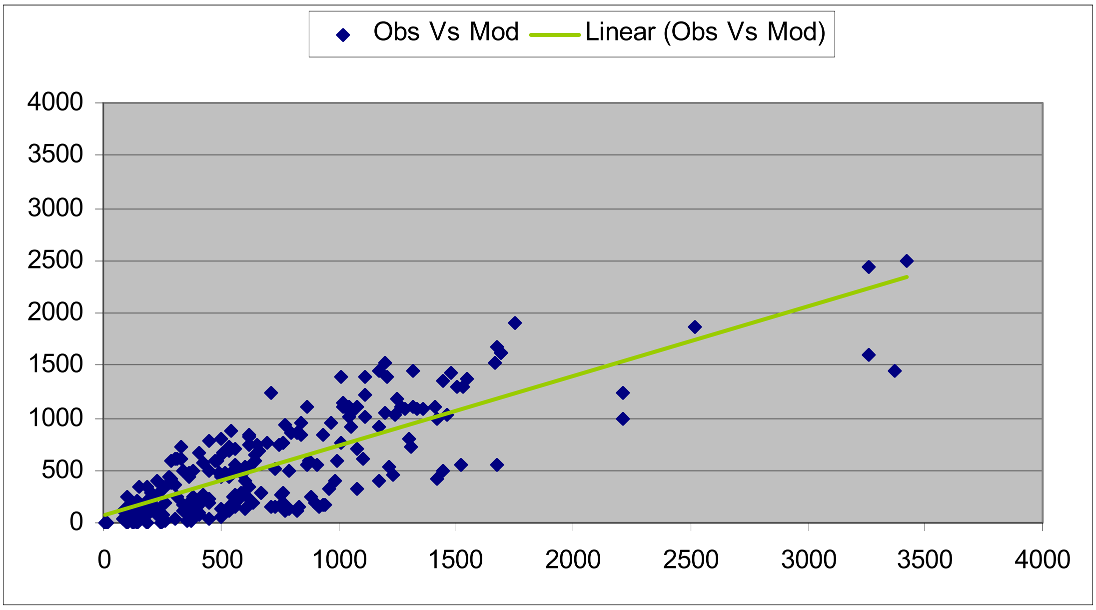
4.8.4 Results for HGV show that the fit between observed and modelled flows are reasonably well correlated but fall short of the DMRB guidance.

4.8.5 Importantly, when all road users are considered together both slope and R^2 criteria are met in each instance indicating that total flows are represented well.

4.8.6 The following charts show the correspondence between count and modelled flow data sets, with the best fit linear match plotted on each graph. The graphs are paired on each page by prior and post calibration data sets, to show how the relationship between observed and modelled flows is improved by calibration.

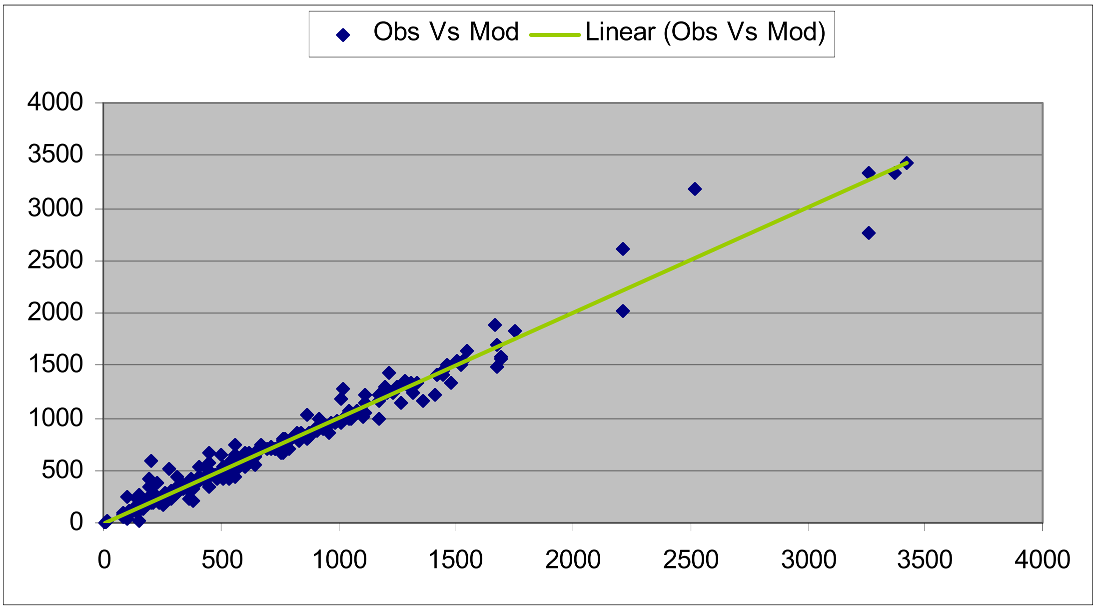
4.8.7 Figure 4.15 illustrates the fit achieved between the modelled and measured link flow for all traffic in what is the most crucial time period. The data points are distributed closely to the y = x straight line without any significant outliers. This uniformity is reflected in the R^2 value of 0.951. It is clear from the graph that the model represents flows well across a large range of volumes.

Figure 4.4 Car 7 to 8 am – Prior Calibration



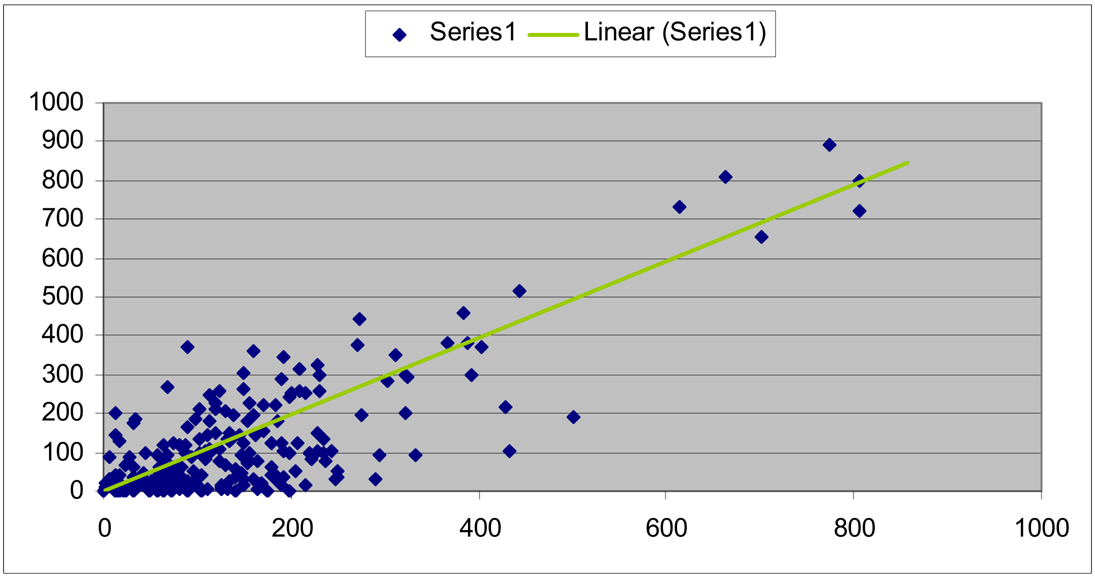
Slope = 0.664 R^2 = 0.644

Figure 4.5 Car 7 to 8 am – Post Calibration



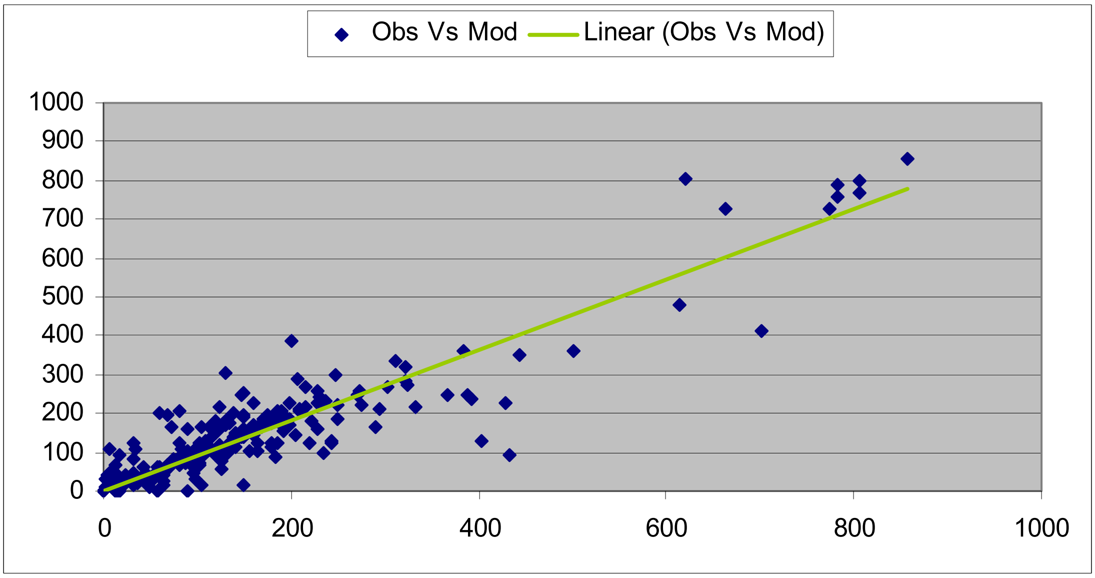
Slope = 0.991 R^2 = 0.970

Figure 4.6 HGV 7 to 8 am – Prior Calibration



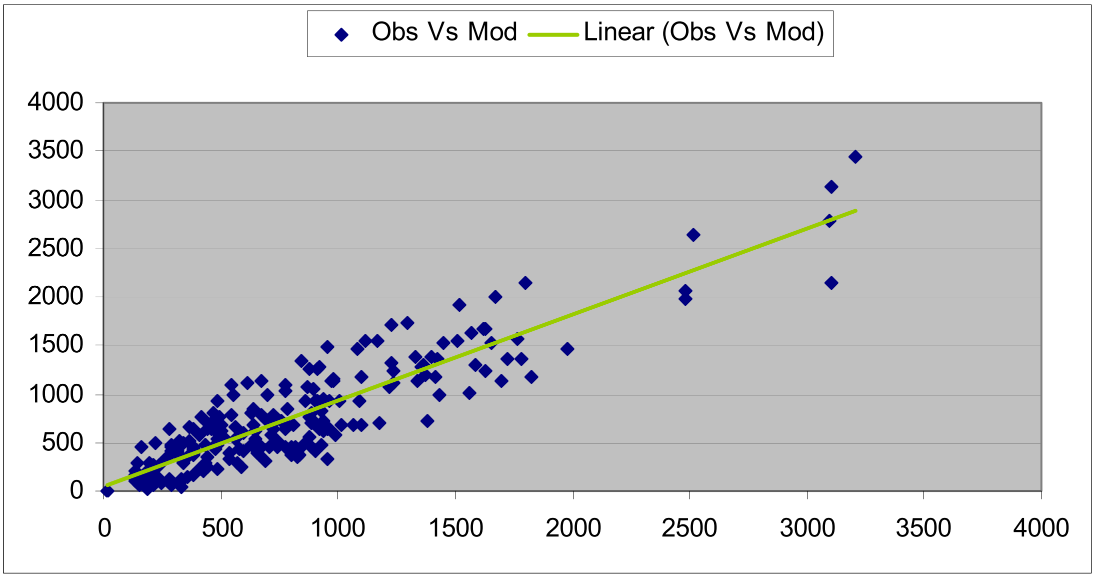
Slope = 1.086 R^2 = 0.720

Figure 4.7 HGV 7 to 8 am – Post Calibration



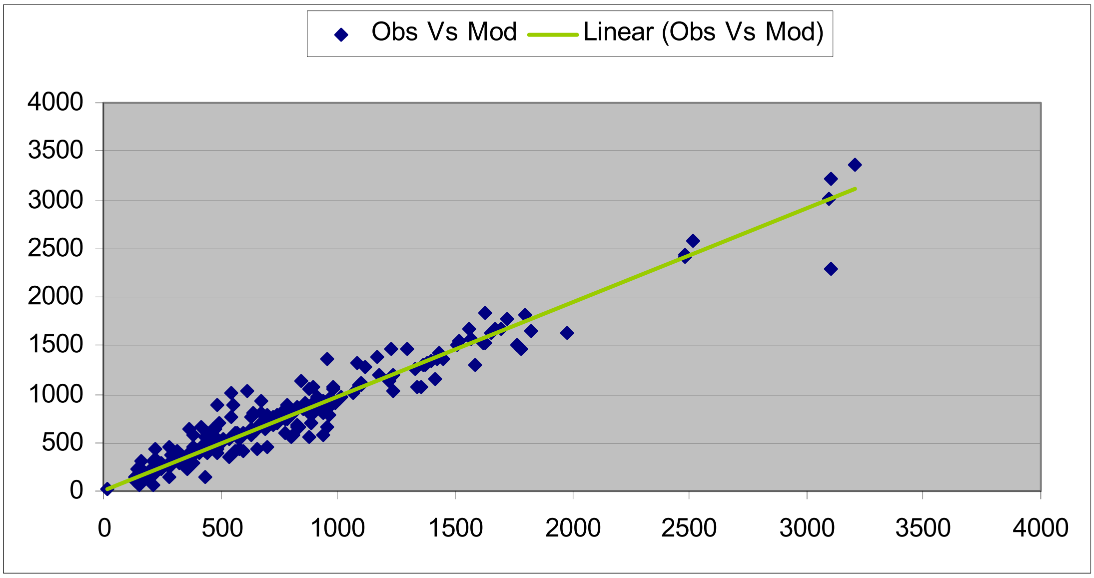
Slope = 0.862 R^2 = 0.838

Figure 4.8 Car 8am to 9am – Prior Calibration



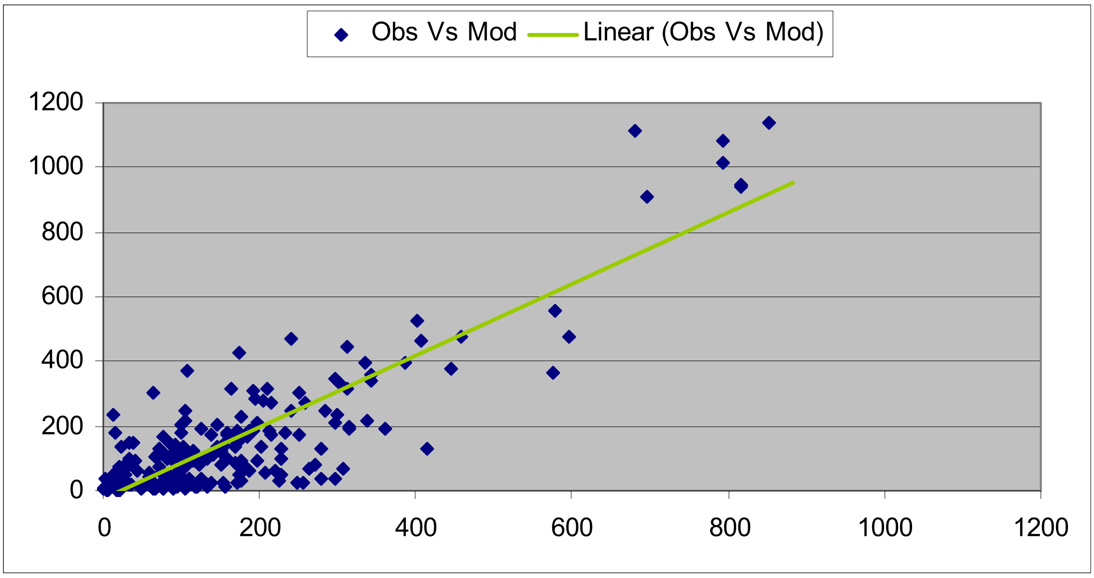
Slope = 0.881 R^2 = 0.798

Figure 4.9 Car 8to 9am – Post Calibration



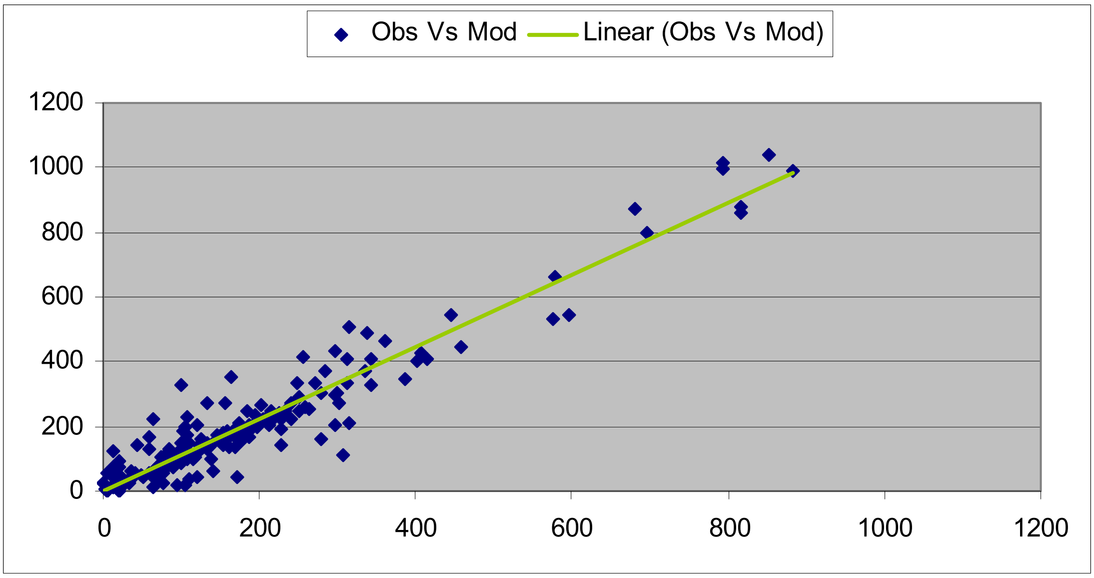
Slope = 0.936 R^2 = 0.936

Figure 4.10 HGV 8to 9am – Prior Calibration



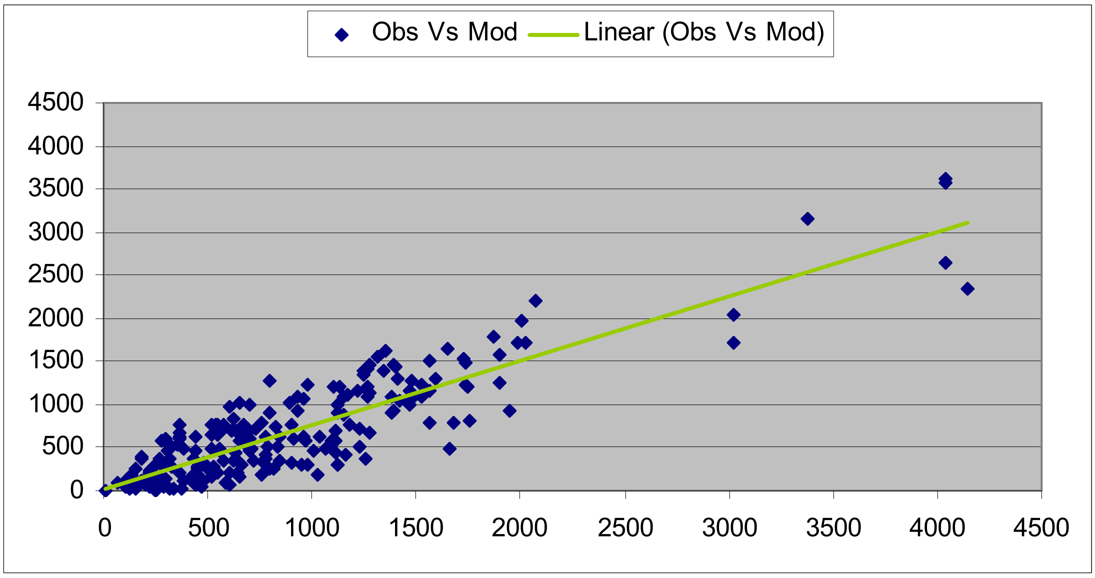
Slope = 1.106 R^2 = 0.765

Figure 4.11 HGV 8 to 9am – Post Calibration



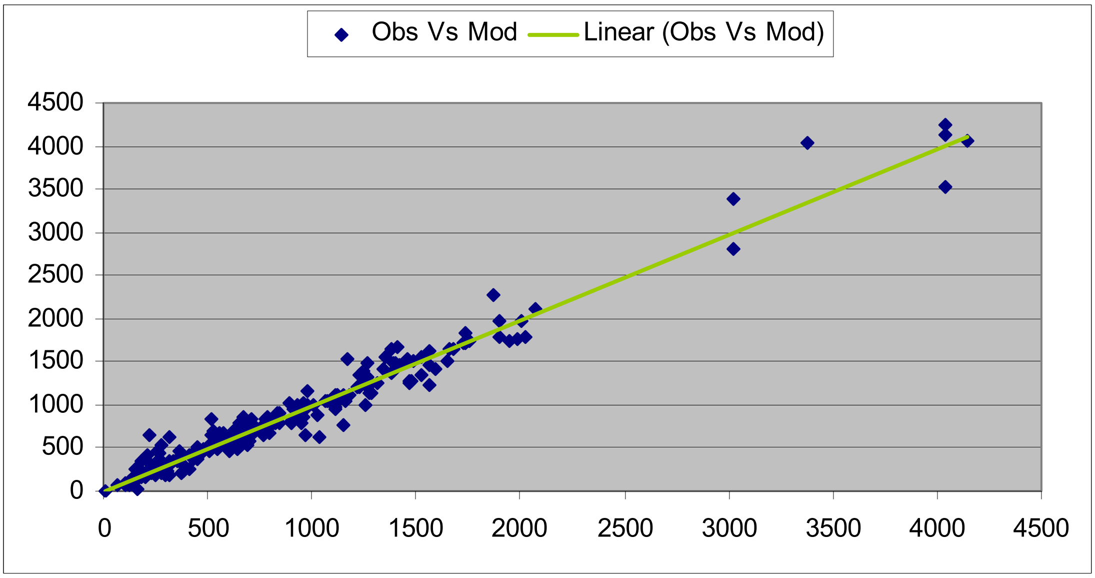
Slope = 1.102 R^2 = 0.917

Figure 4.12 Combined Traffic 7 to 8am – Prior Calibration



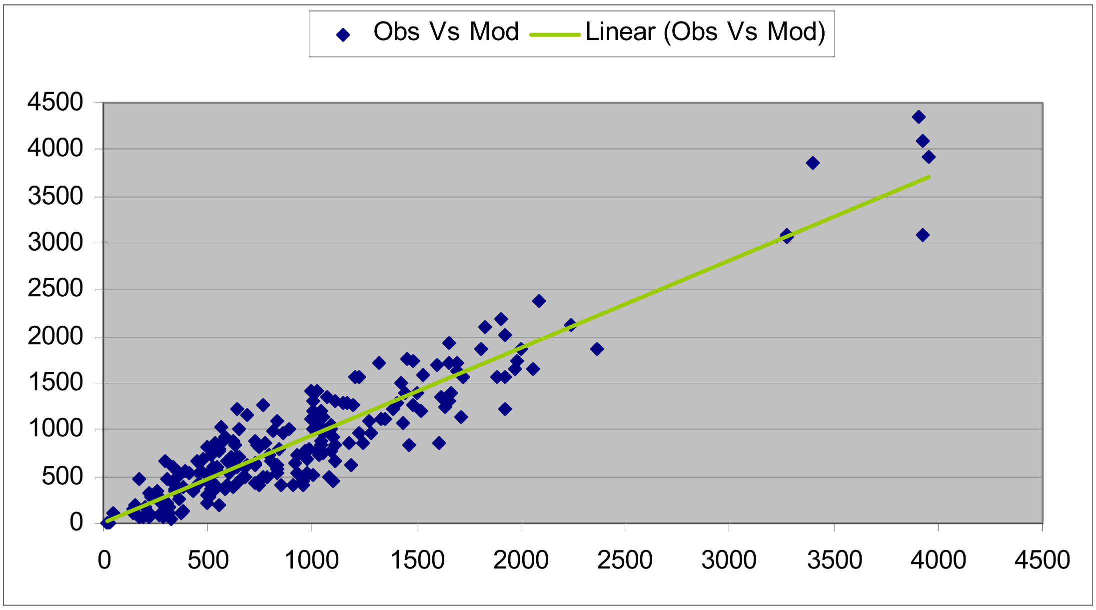
Slope = 0.745 R^2 = 0.773

Figure 4.13 Combined Traffic 7 to 8am – Post Calibration



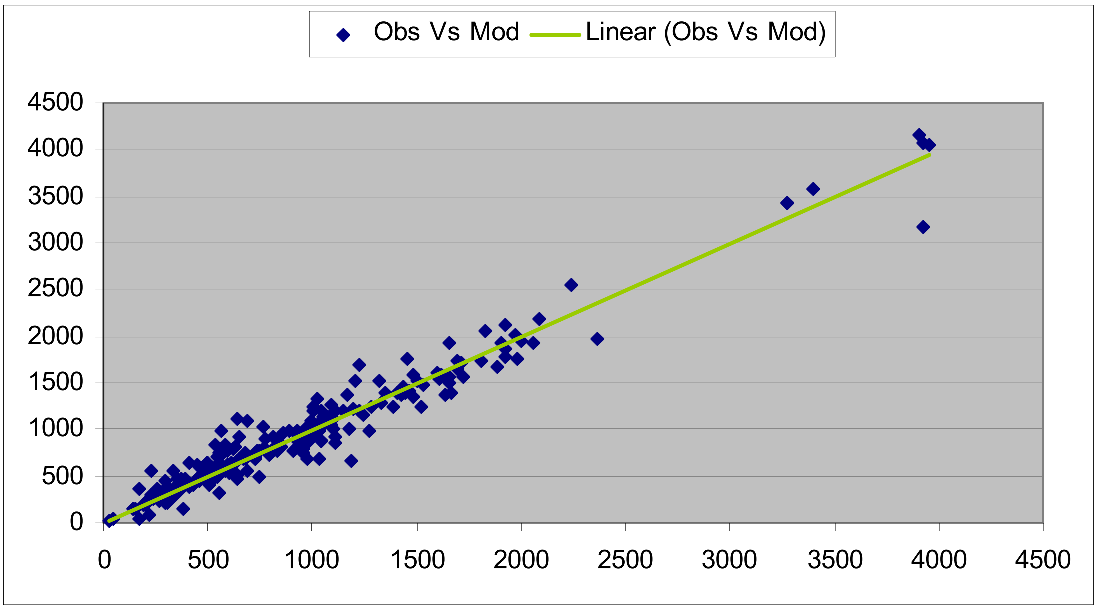
Slope = 0.990 R^2 = 0.964

Figure 4.14 Combined Traffic 8 to 9 am – Prior Calibration



Slope = 0.935 R^2 = 0.867

Figure 4.15 Combined Traffic 8 to 9am – Post Calibration



Slope = 0.973 R^2 = 0.951

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4.9 Model Convergence

4.9.1 The parameter used by Saturn to monitor the rate of convergence is the percentage of link flows which vary by less than a specified percentage between loop n and loop n-1.

4.9.2 The values used in each assignment during calibration are that 98% of links should differ by less than 5% between subsequent iterations.

4.9.3 This convergence criterion is achieved for all assignments carried out in calibrating the Metro North Highway Model.

4.10 Trip Length Distribution - Calibration Impact

4.10.1 Trip length distribution is compared below for both LV and HGV matrices for the 8am to 9am time period. The percent of trips made by car are shown on the y-axis. Distance bands are shown on the x-axis. The data shows there is little difference evident in terms of how trip distribution was adjusted by the overall matrix adjustment process.

Figure 4.16 LV Distance Distribution (8am to 9am)

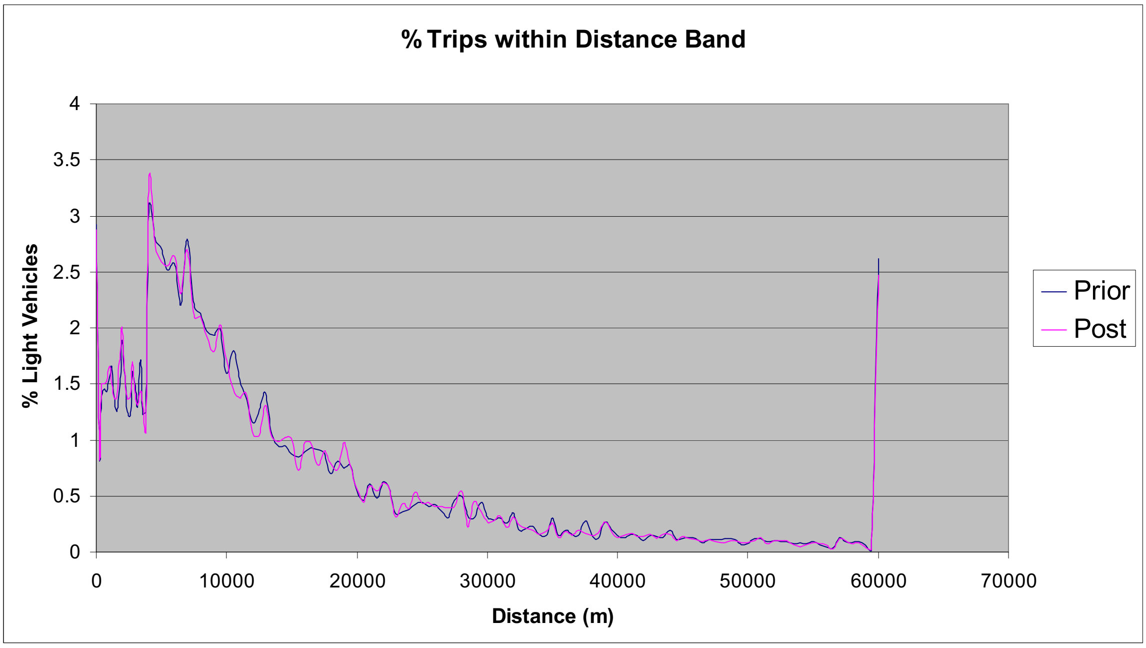
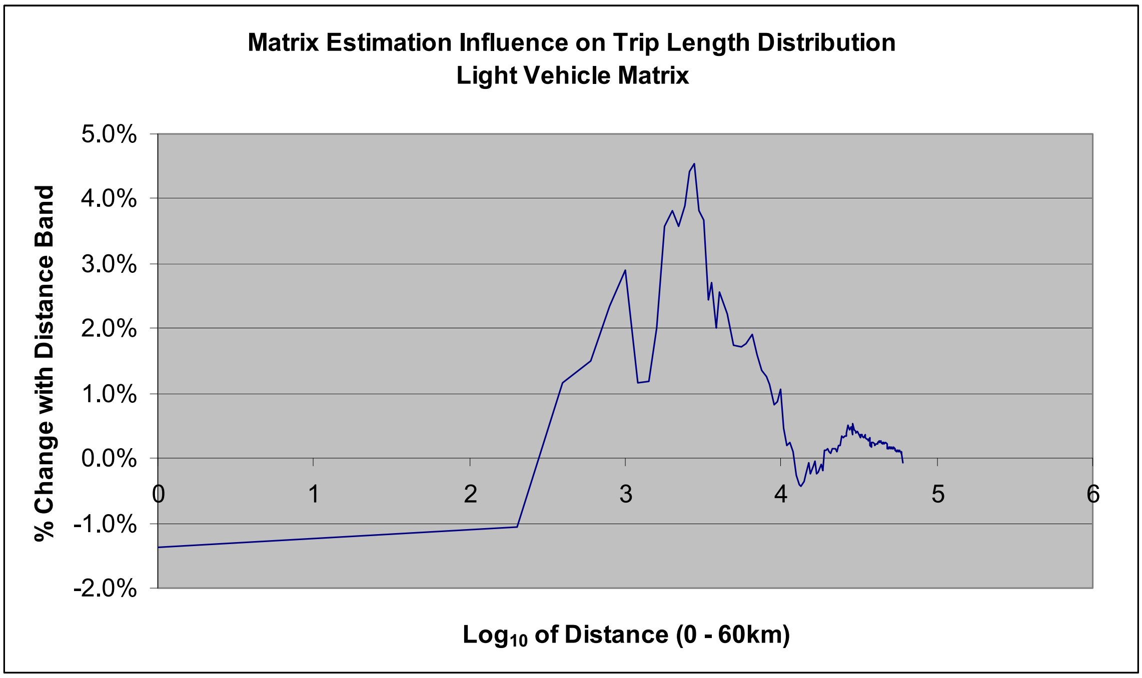


Figure 4.17 Relative Change within Distance Bands (LV 8 to 9am)



4.10.2 Figure 4.17 above shows the relative change within distance bands determined by the logarithm (base 10) of network travel distance. Up to 100m (log2) there are few measurements, and although a decrease within this range is apparent a negligible number of trips are affected. Most trips are affected between log3 and log4 (1 to 10km). Relative changes to trips peak at 4.5% in the 2.8 to 3km range and trail off rapidly thereafter. Around the log4 range (10,000m), the changes made to the matrix in the calibration process diminish to near zero percent levels.

4.10.3 Similar charts are presented below for HGV 8 to 9am and both user classes for the inter peak hour. A large proportion of HGV trips are over 60km (18%), hence the spike at this point in the chart.

Figure 4.18 HGV Distance Distribution (8am to 9am)

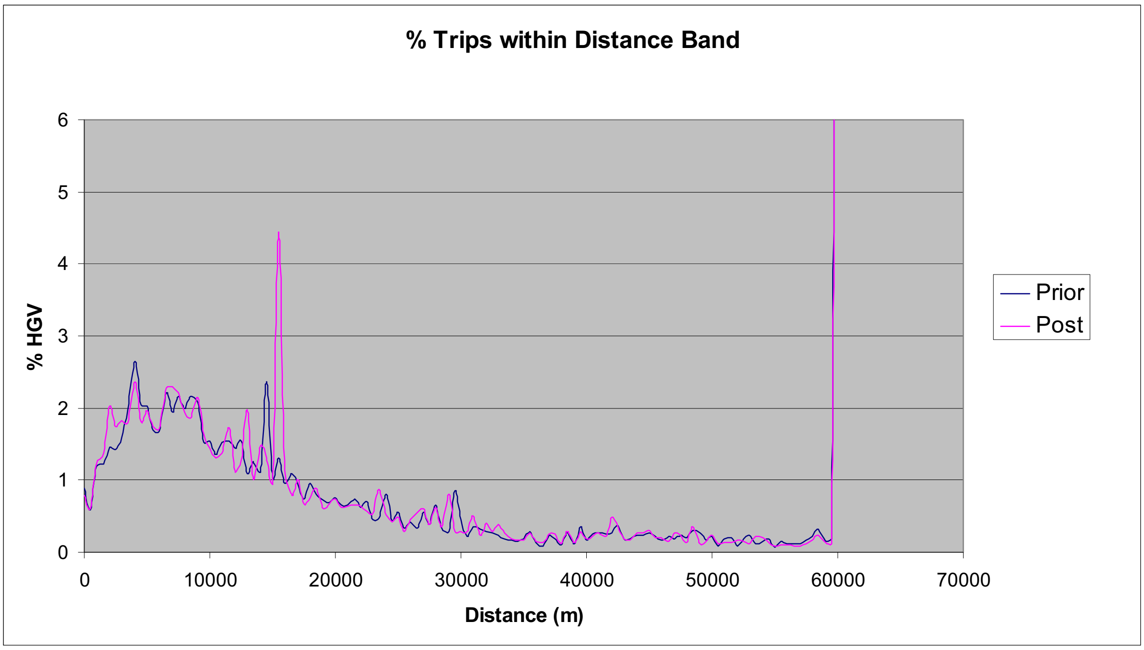
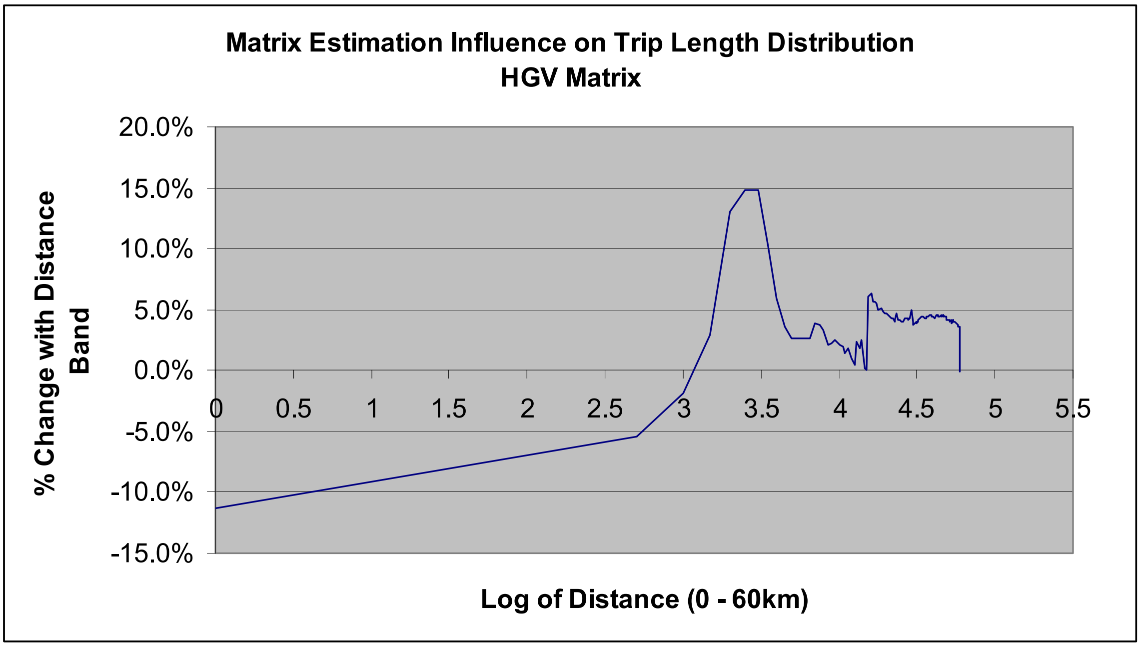


Figure 4.19 Relative Change within Distance Bands (HGV 8 to 9am)



4.10.4 The pattern of adjustment to HGV trip length in the network reveals:

- That the magnitude of most increases is much greater than that for LVs. In the 2 to 5km range (log3.3 – log3.6) trip length increases by a sustained 10%. This effect is a result of introducing longer trips through the study area where previously there were gaps in HGV travel data;
- There is a reduction in HGV trips in the 0 to 1.5km range. This seems realistic given normal goods distribution patterns around the GDA; and
- There is a distinct magnification effect on trips above 10km that is not exhibited by the LV statistics shown in Figure 4.16. Unlike adjustments applied to LV, the matrix adjustment process is unconstrained above this distance for HGVs, resulting in an increase in volumes making longer trips.

Figure 4.20 LV Distance Distribution (2 to 3pm)

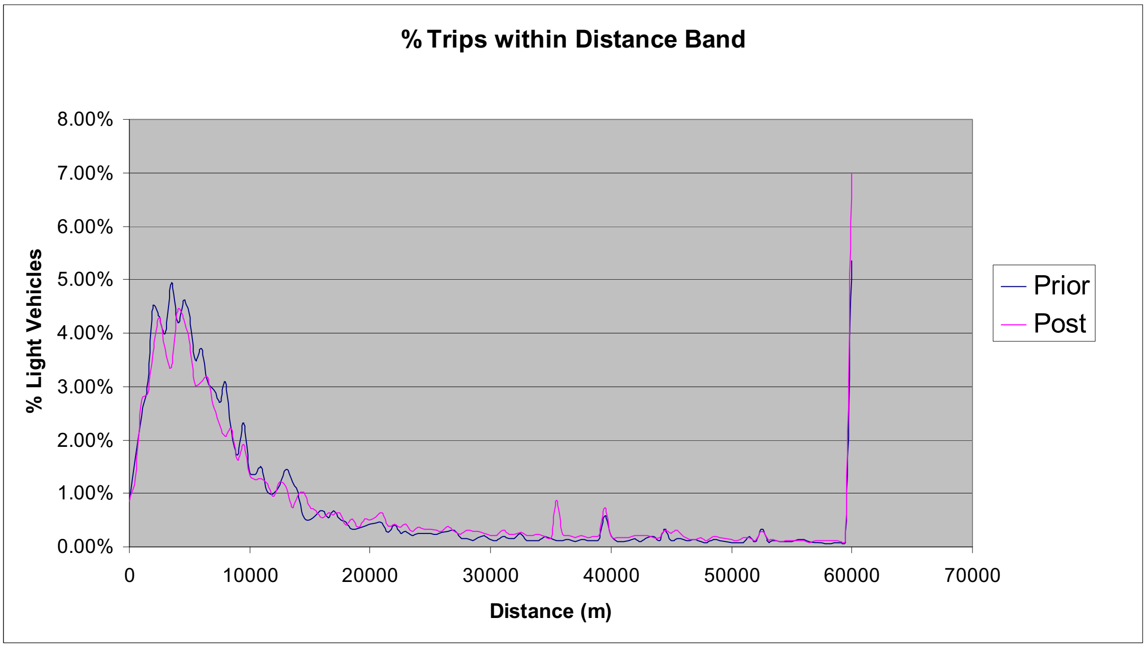


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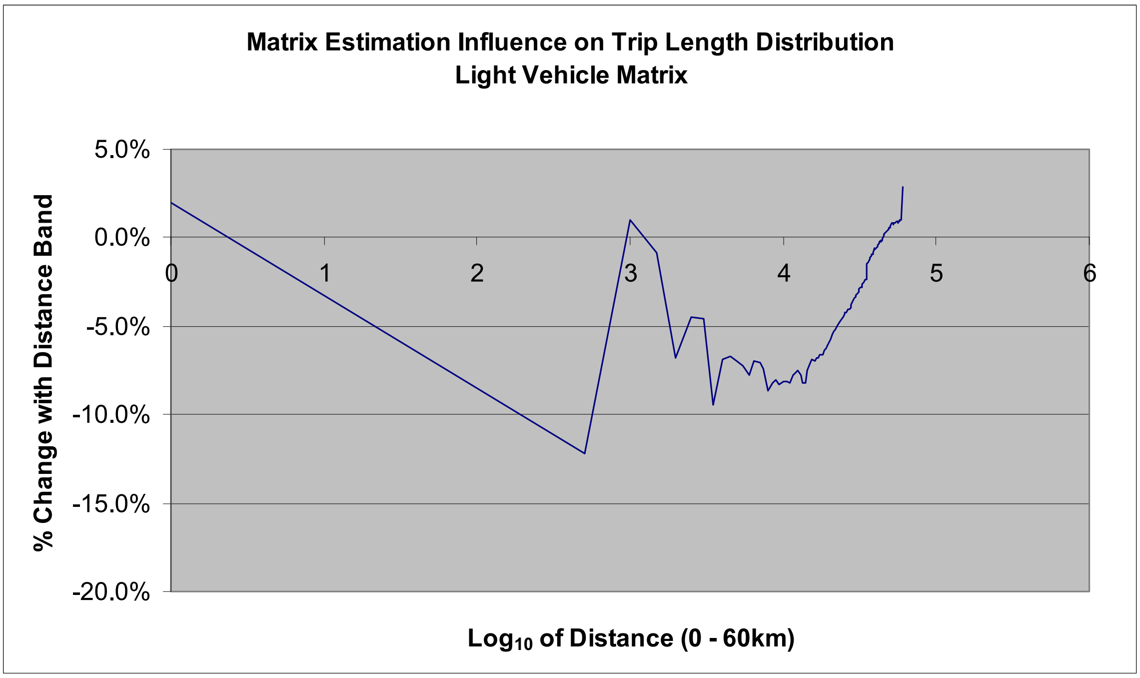
Figure 4.21 Change within Distance Bands (LV 2 to 3pm)



4.10.5 In the 2pm to 3pm period, LV trips are more likely to occupy distance bands below 10km than the morning peak period. In the inter peak hour less commuting occurs than in the morning peak; therefore average trip length is likely to be less.

4.10.6 Figure 4.21 illustrates well what is happening to trip distribution above 1km (log 3). At less than this value on the x-axis there are too few measurements to draw conclusions from the chart. However, most trip lengths are reduced between 1km and 4.5km (log3 to log4.6).

4.10.7 Considering that the inter peak period validates very well, such changes in trip length are probably necessary to accommodate a better model fit to counts.

4.10.8 Figure 4.22 and Figure 4.23 below show similar distributions for inter-peak HGVs. There is considerable smoothening of distance bands resulting from matrix adjustment. In addition, the number of HGVs travelling between 1km and 4.5km is reduced. Since overall traffic conditions are represented well by the model, there is no reason to conclude that change to the matrix is unsound.

Figure 4.22 HGV Distance Distribution (2 to 3pm)

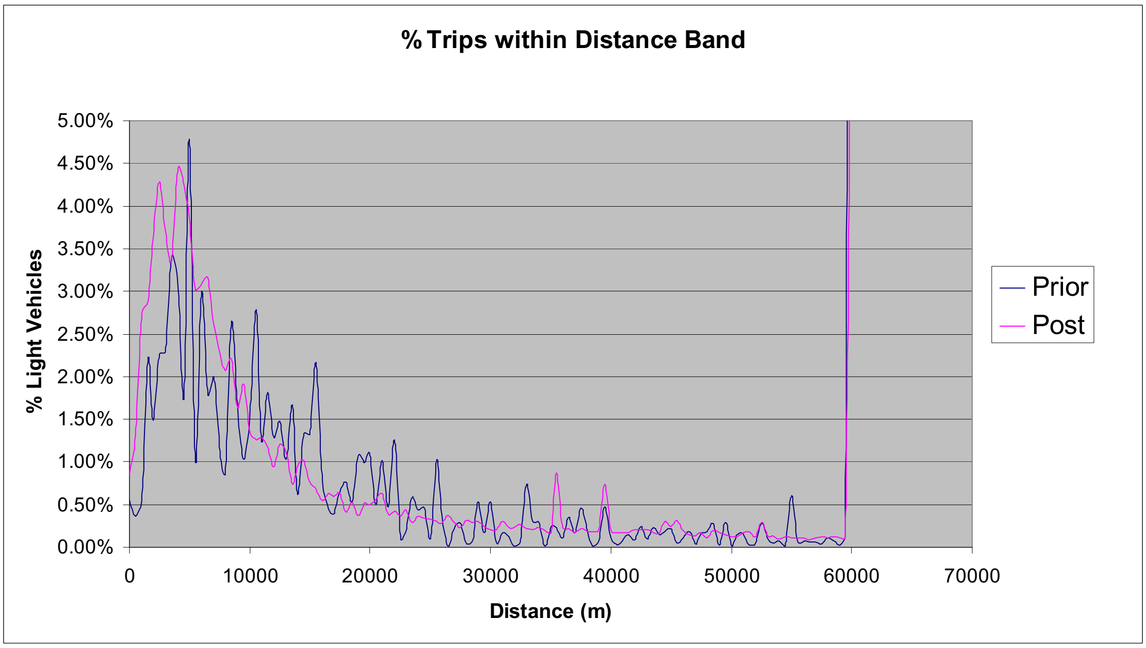
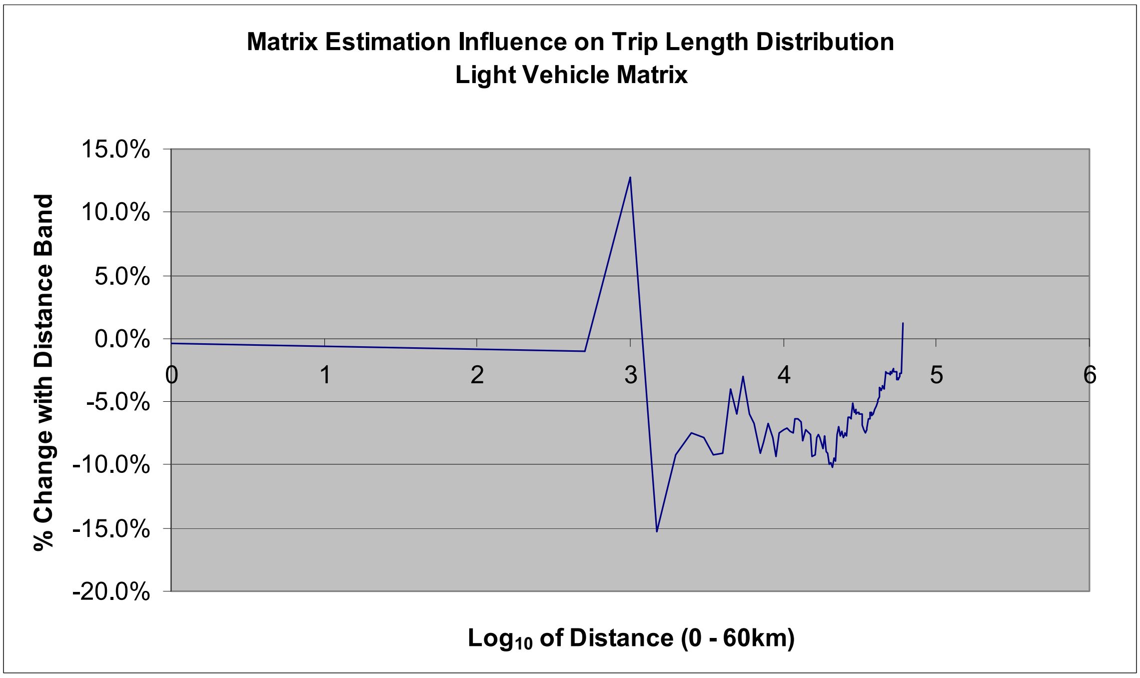


Figure 4.23 Change within Distance Bands (LV 2 to 3pm)



5 MNTM Validation

5.1 Introduction

5.1.1 This section sets out additional comparative measures by which the robustness of the calibrated model may be judged. The following model performance characteristics are detailed:

- Comparison of modelled traffic flows to an independent set of count data (individual counts not used directly in the calibration process);
- Metro alignment validation – this is a comparison of modelled traffic flows to counts taken at junctions located beside the proposed Metro stop locations;
- Comparison of modelled journey times to observed journey times;
- Distribution of trip lengths over the full model area;
- Individual zone and matrix trip end totals; and
- Model Convergence Statistics.

5.2 Independent Turning Count Validation

5.2.1 Modelled flows were compared with independent turning counts at 40 surveyed junctions. These junctions were chosen to provide a wide geographical spread of validation locations around the modelled area of interest.

5.2.2 DMRB presents additional guidelines for traffic flow validation, these are:

- flows within 100 for links with flow less than 700 vehicles per hour;
- flows within 15% for links with flow between 700 and 2,700 vehicles per hour; and
- flows within 400 for links with flow over 2,700 vehicles per hour.

5.2.3 The results in Table 5.1 below were obtained when testing all individual turning counts throughout the model under the three criteria set out above.

Table 5.1 Turning Count Validation– % Links Satisfying Alternative DMRB Criteria

DMRB Condition	LV	HGV	Combined Traffic
7am to 8am	85%	94%	78%
8am to 9am	80%	97%	75%
2pm to 3pm	77%	93%	77%

5.2.4 Both 8am to 9am and 2pm to 3pm periods fall short of meeting these additional DRMB criteria.

5.2.5 However, as mentioned previously these guidelines are when validating against turning volumes, the follow excerpt from the DMRB guidelines on turning flow accuracy should be considered.

"This [reduction in accuracy] is to be expected, however, since the magnitude of turning movements at junctions can vary widely. The accuracy of modelled turning flows, in percentage terms, will generally be much less than that of the modelled link flows. In this case, a lesser degree of apparent agreement between modelled and observed flows does not necessarily imply a poorer model fit"

5.3 Metro Alignment Validation

5.3.1 A further validation check is presented in Table 5.2 below. This table illustrates the accuracy of the model at different parts of the network, specifically along the Metro North alignment and at junctions in close proximity to the location of proposed Metro North stations. The accuracy of the model in these areas is important as it is to be used to assess the impact of station construction on the network.

5.3.2 The table details how well the model validates using the same set of DMRB criteria applied in the calibration (percent of measurements with GEH < 5).

5.3.3 The GEH figure for each junction shown below is an average of each GEH value at all of the approaches to the junction.

5.3.4 The results in Table 5.2 demonstrate an excellent agreement between observed and modelled flows in the AM for both user classes. In the inter-peak period the HGV assignment produces a number of GEH values above 5. However all GEH values are below 7. The inter-peak HGV assignment is considered acceptable as the proportion of traffic that is made of HGV flow is relatively small (<5%). Furthermore, a GEH of between 5 and 7 on a link does not indicate significant traffic flow problem at that point in model.

Table 5.2 Metro Alignment Count Validation

Metro North Station	Nearest Traffic Observation	AM Peak 8 - 9		Interpeak	
		LV GEH	HGV GEH	LV GEH	HGV GEH
Lissenhall	Estuary Road / R132	4.6	0.5	2.2	2.7
Seatown	Seatown Road / R132	1.2	0.7	0.3	3.9
Swords	R132 / Malahide Road Roundabout	2.1	1.1	3.8	2.2
Nevinstown	R132 / Dublin Road	3.8	0.0	1.1	6.4
Airside	R132 / Dublin Road	1.5	0.0	4.1	6.5
Airport	Airport Roundabout	0.7	3.2	1.8	4.7
Metro Park	Collinstown Cross	1.0	2.9	2.4	4.2
Santry Demense	Ballymun Road / Balbutcher Lane	1.4	3.4	2.8	3.2
Ballymun	Ballymun Road / Shangan Road	1.4	4.6	2.7	6.4
DCU	Ballymun Road / Collins Avenue	1.4	3.6	2.9	6.5
Griffith Avenue	Bantry Road / Griffith Avenue	4.9	1.2	1.9	2.6
Drumcondra	Drumcondra Road / Clonliffe Road	4.2	2.8	1.4	3.3
Mater	Eccles Street	1.9	1.2	2.0	5.3
Parnell Square	Granby Row	4.4	1.2	2.4	3.4
O'Connell Bridge	O'Connell Street	3.1	6.2	2.3	6.7
St. Stephen's Green	Stephen Street Lower	1.0	0.6	0.9	1.8
	% Junctions with GEH < 5.0	**100%**	**94%**	**100%**	**63%**
	% Junctions with GEH < 10.0	**100%**	**100%**	**100%**	**100%**

5.4 Journey Time Validation

5.4.1 Travel time surveys were commissioned by the DTO for several radial routes into the city centre and other orbital routes in 2004. This survey information was obtained by MVA for the morning peak hour 8am to 9am and the inter-peak hour of 2pm to 3pm. A full list of junctions for each route is listed in Appendix D.

5.4.2 Table 5.3 below summarises the routes used for the journey time validation. These routes were selected based on their proximity to the study area. Route 5 passes through Swords and Route 4 passes directly through Ballymun; both routes therefore pass though key parts of the study area.

Table 5.3 Summary of Journey Time Survey Routes

Route Number	Description
Route 4	Lissenhall to O'Connell Bridge via Swords R132 and Drumcondra Road
Route 5	M50 / R108 Junction to City Centre via Ballymun
Route 6	Kilshane Cross (N2) to City Centre via Finglas

5.4.3 Table 5.4 and Table 5.5 below summarise total observed and modelled travel times for 6 routes for the AM peak hour and inter-peak hour, respectively.

Table 5.4 AM Observed Vs Modelled Journey Times

Route	Observed Time	Modelled Time	Percentage Difference
Route4 8to9	3800	4300	12%
Route5 8to9	2900	2700	-7%
Route6 8to9	3400	2800	-18%
Routes Combined	**10100**	**9800**	**-3%**

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Table 5.5 Inter-peak Observed Vs Modelled Journey Times

Route	Observed Time	Modelled Time	Percentage Difference
Route4 8to9	1900	2200	14%
Route5 8to9	1550	1850	19%
Route6 8to9	1600	1500	-7%
Routes Combined	**5050**	**5550**	**10%**

5.4.4 The DMRB guidelines advise that modelled journey times should be within 15% of the observed time. This criterion is satisfied in the AM peak for both routes passing through the area of interest (routes 4 and 5). Route 6, however, falls short of this condition: the modelled time is 18% quicker than the observed time. The area of network route 6 passes through, however, is largely outside of the study area. There is likely to be significant variance in flows in this area of the model, due to its sensitivity to Dublin Port Tunnel works and associated delays. These delays are manifested in traffic counts taken more recently and used in the model calibration process; the travel time surveys would not reflect the conditions in this area necessary to reproduce model flows that replicate counts.

5.4.5 Figure 5.1 to Figure 5.6 below plot time elapsed to each junction on each route surveyed and for AM and inter-peak hours. The charts demonstrate a clear correlation between observed and modelled delay in every case.

Figure 5.1 Swords to City Centre Modelled Vs Observed AM Journey Time

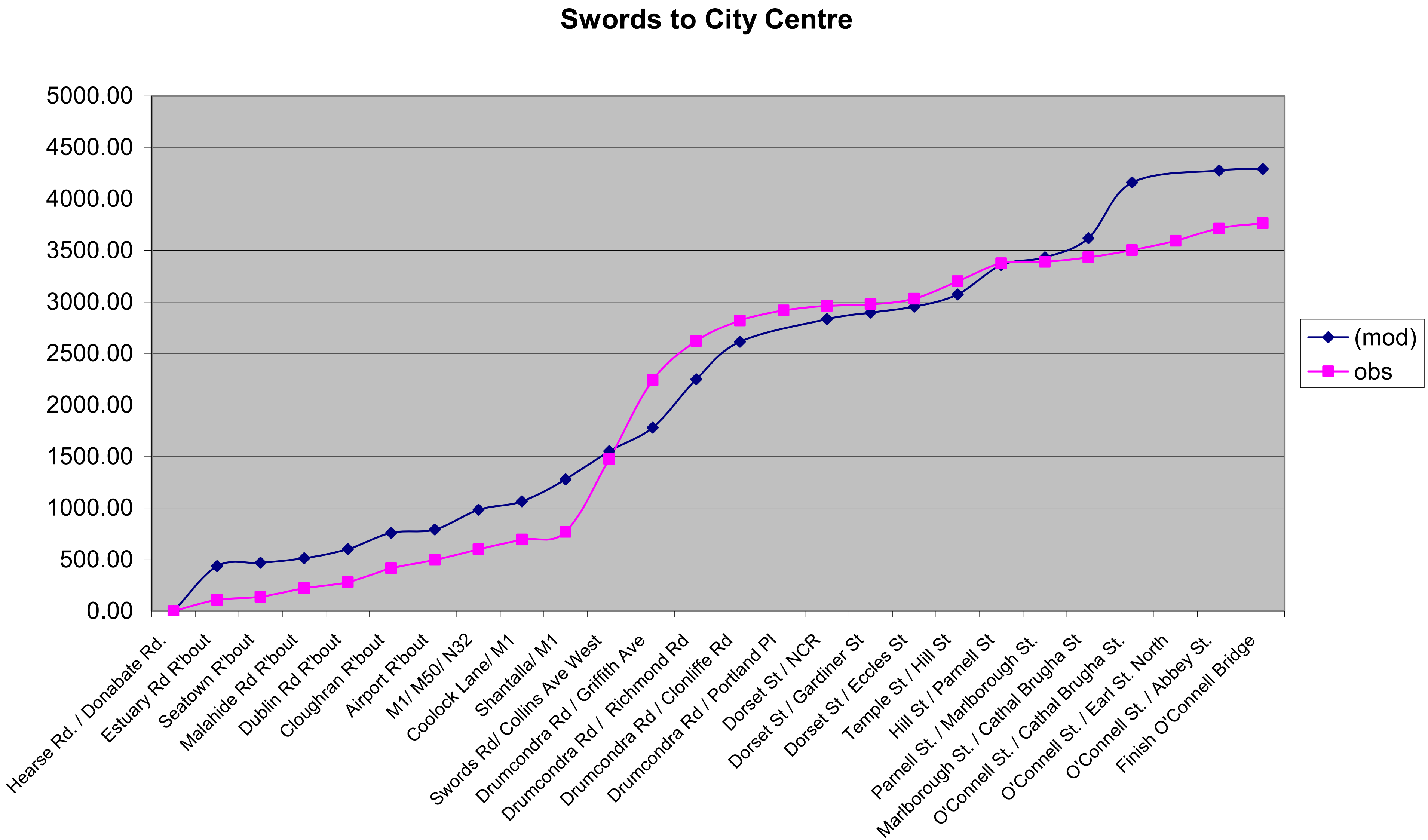


Figure 5.2 **Ballymun to City Centre Modelled Vs Observed AM Journey Time**

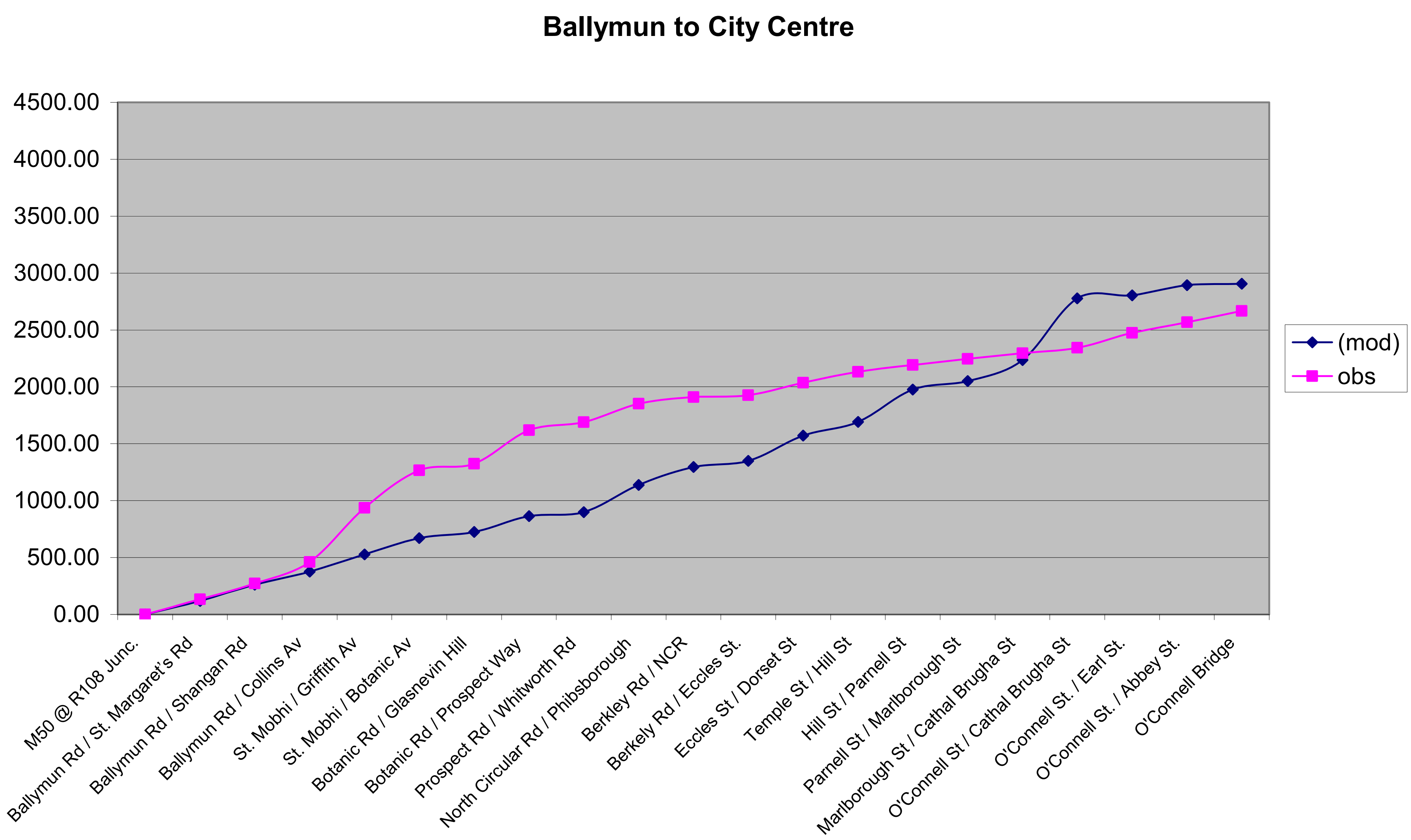


Figure 5.1 Finglas to City Centre Modelled Vs Observed AM Journey Time

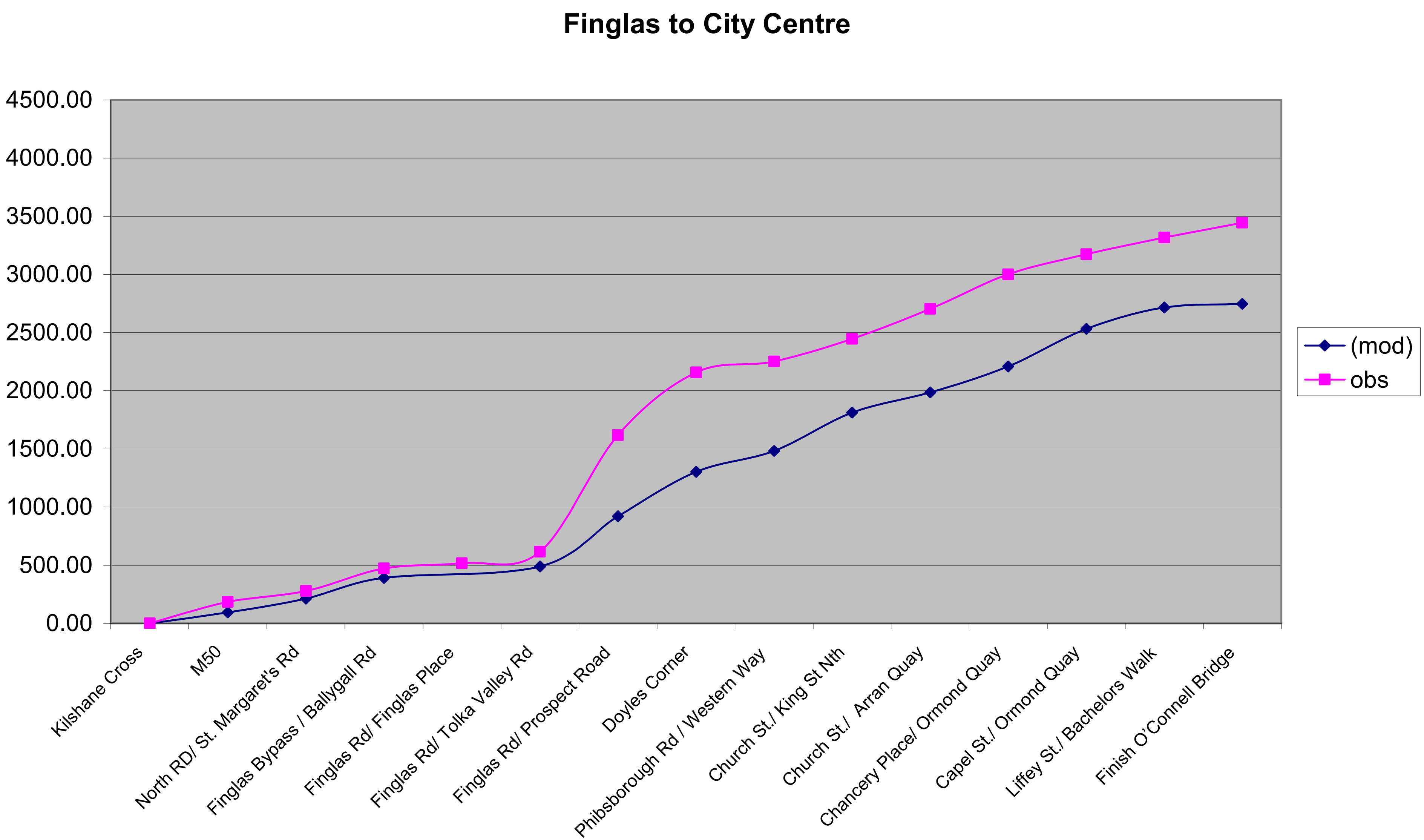


Figure 5.4 Swords to City Centre Modelled Vs Observed Inter-peak Journey Time

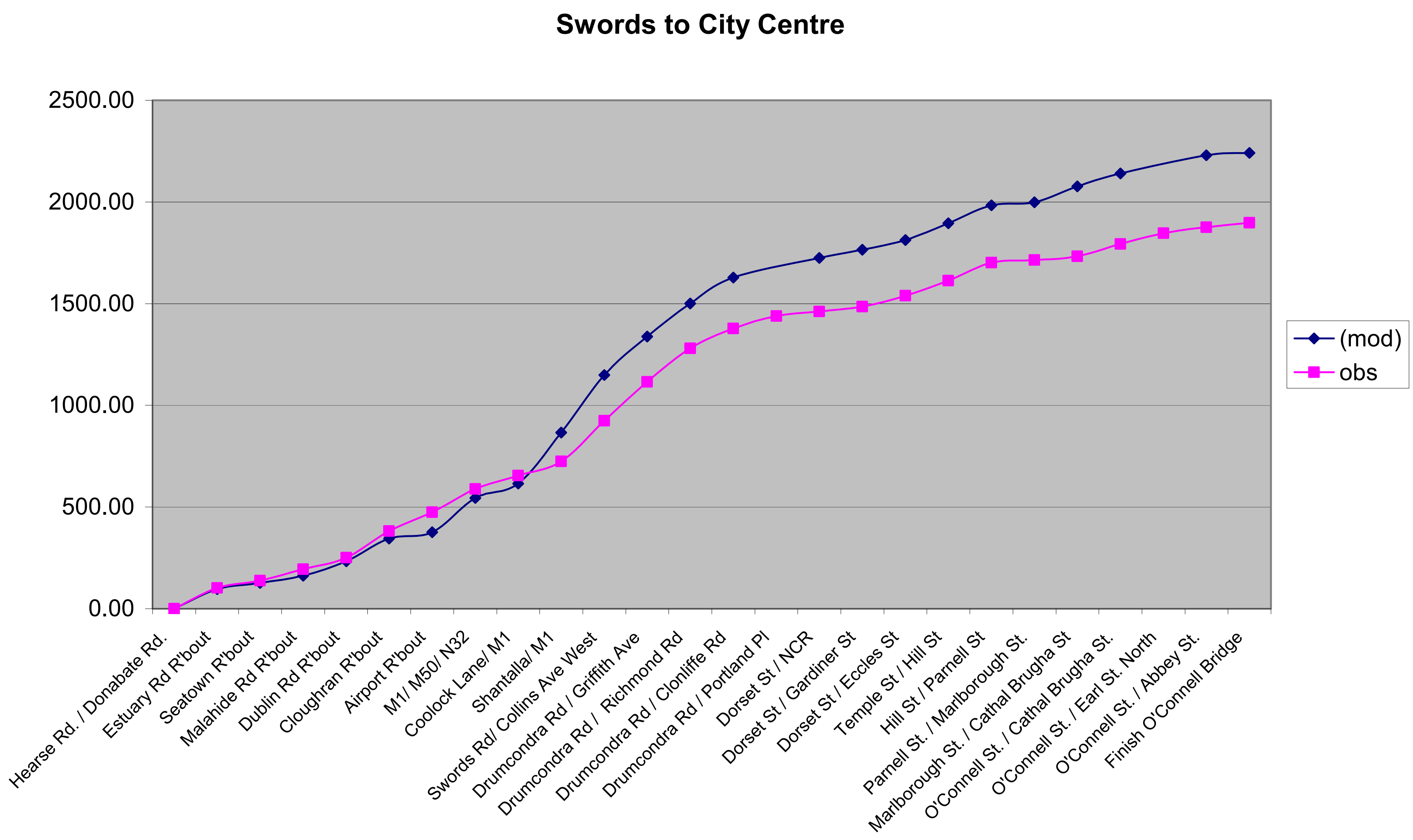


Figure 5.2 Ballymun to City Centre Modelled Vs Observed Inter-peak Journey Time

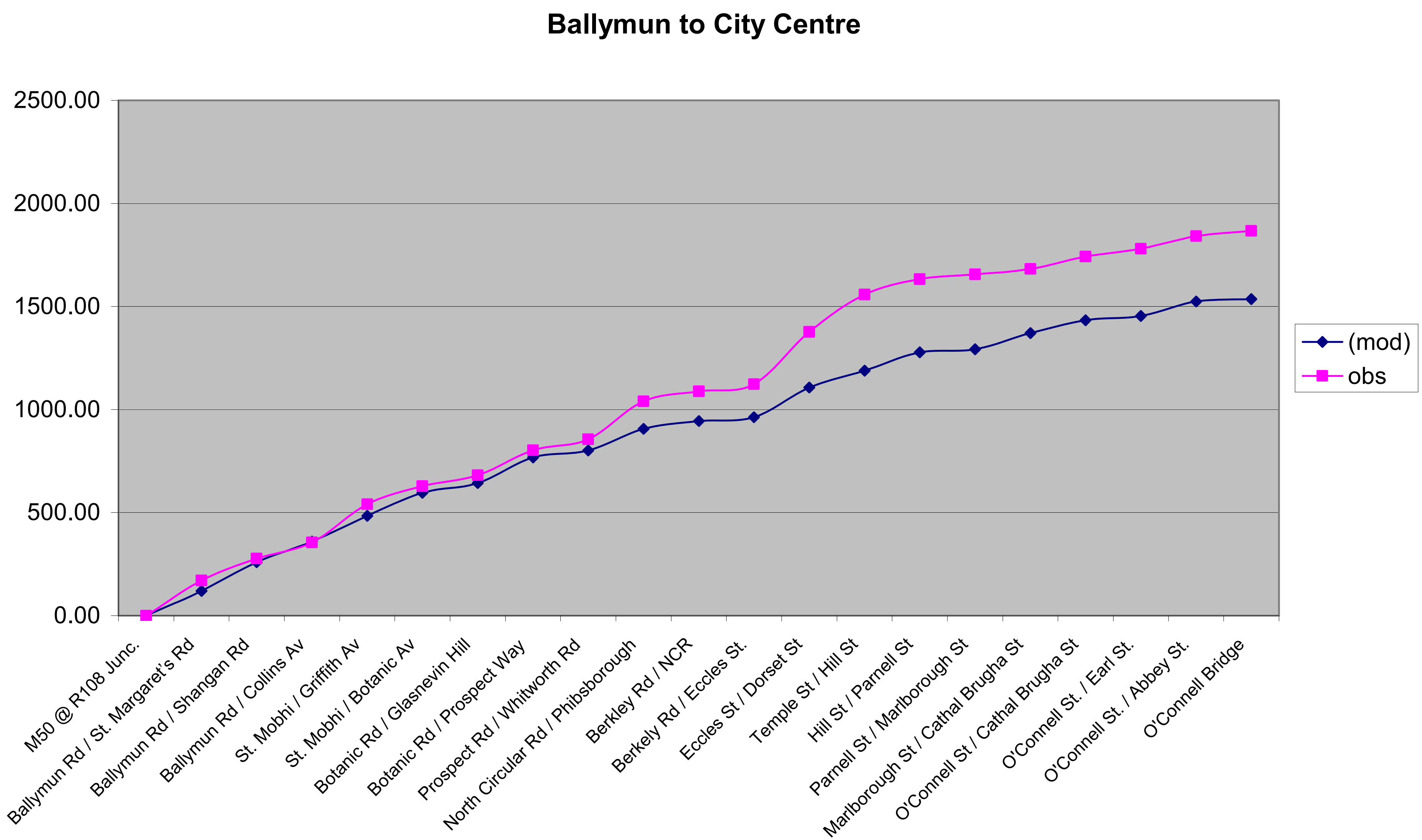
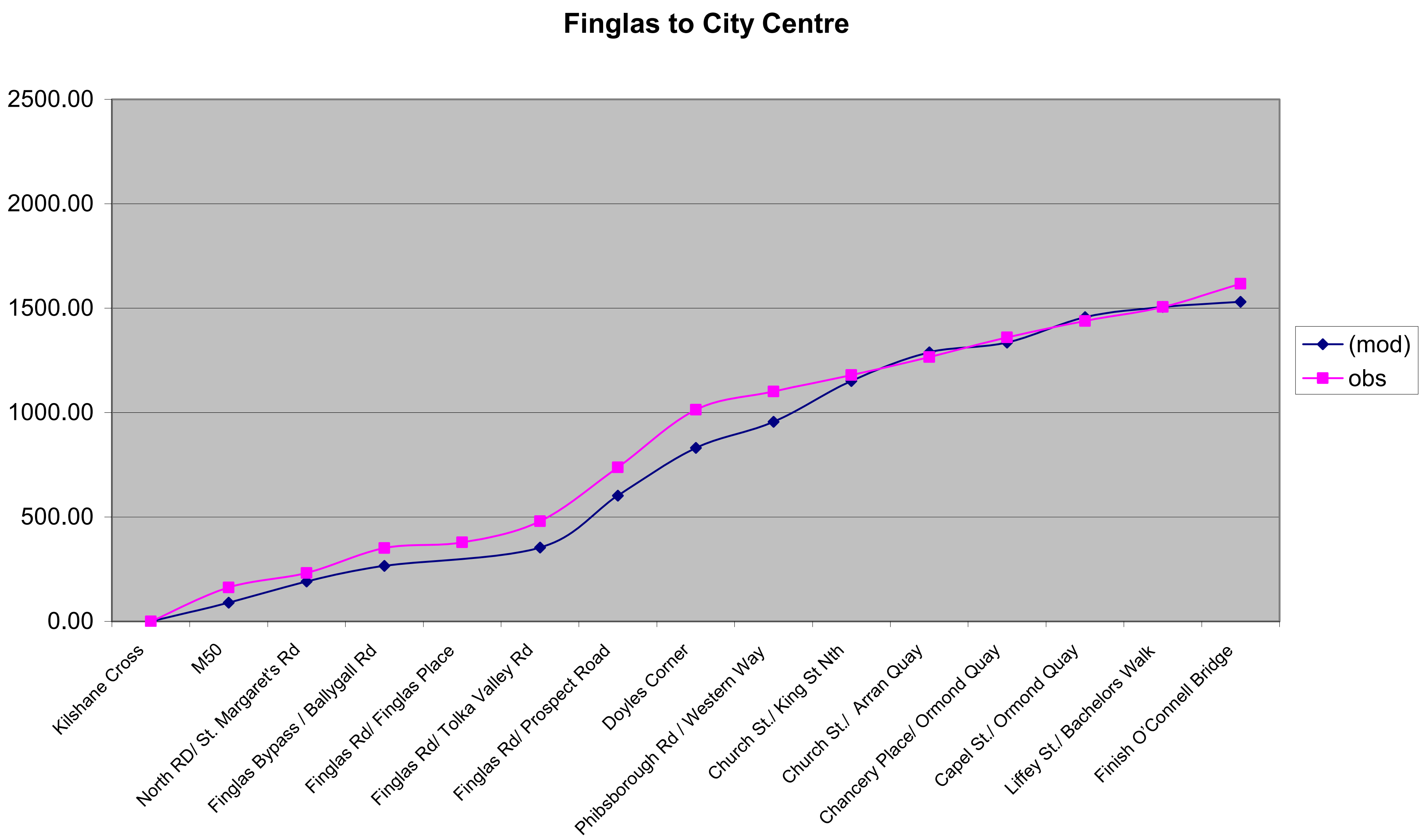


Figure 5.3 Finglas to City Centre Modelled Vs Observed Inter-peak Journey Time



6 Conclusions

6.1 Introduction

6.1.1 This report documents the development, calibration, and validation of the Metro North Traffic Model (MNTM) for a base year of 2006. The area of model refinement covers the full alignment of the Metro North route. The full model covers the Greater Dublin Area.

6.1.2 Both 1-hour time periods in the AM from 7am to 9am were calibrated and validated, as was a single 1-hour period from 2pm to 3pm. Only the 8am to 9am period will be used for morning peak forecasting.

6.1.3 Traffic flow calibration and validation indicates that the correlation between modelled and observed flows is good for a large multi-use model representing a major urban area.

6.1.4 Traffic flow validation considering an independent count set, over 200 turn counts in each time period, indicate a greater variation in modelled and observed flows. However regression analysis indicates that there is no strong bias in the modelled flows.

6.1.5 We consider that the highway assignment model is fit for purpose. It represents base year traffic conditions well, as demonstrated statistically in Chapters 4 and 5. It provides a robust basis for assessing impacts on the road network related to Metro North construction and during its operation, for the following reasons:

- The model realistically represents journey times;
- The study area is covered by a large number of counts for both calibration and validation;
- The Metro North alignment validation demonstrates an excellent match between observed and modelled flows at junctions in close proximity to proposed Metro stations; and
- Regression analysis indicates a high correlation between modelled and observed flows and no strong biases.

6.1.6 Approval was also sought from the Dublin Transportation Office regarding the use of their model as a basis for the MNTM and the validation results achieved. A letter from the DTO is included in Appendix F that endorses the development process and validation results of MNTM.

Appendices

Appendix A – Count Locations

Location	Area	Date	Source
Collinstown Cross	Airport South	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
Swords Road / Corballis Road South / Long Term Car Park Access	Airport South	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
Swords Road / Long Term Car Park Access	Airport South	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
Airport Roundabut	Airport	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
Cloghran Roundabout	Airport North	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
Clonshaugh Road / Baskin Lane	Stockhole	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
N32 / Clonshaugh Road east junction	Clonshaugh	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
N32 / Malahide Road / Grange Road	Balgriffin	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
Malahide Road / Balgriffin Road	Balgriffin	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
Malahide Road / Feltrim Road	Malahide	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
Forest Road / Naul Road	Swords South	14th March 2006	Dublin Airport – Terminal 2 Study / Arup

Location	Area	Date	Source
R108 / Naul Road	Swords South West	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
Kingstown Cross Roads	St. Margaret's	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
R108 / R122 north junction	St. Margaret's	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
Kilshane Cross	Kilshane	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
R104 / R122	Poppintree	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
R106 / R107	Malahide	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
Pinnockhill Roundabout	Swords	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
R132 / Airside	Swords	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
Drinan Interchange west roundabout	Swords	14th March 2006	Dublin Airport – Terminal 2 Study / Arup
Pearse St Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Grand Canal St Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Mount St Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Hubband Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring

Location	Area	Date	Source
Baggott St Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Leeson St Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Charlemont St Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Portobello Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Harolds Cross Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Clogher Rd Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Dolphins Barn Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Herberton Rd Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
South Circular Rd	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Old Kilmainham	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Kilmainham Lane	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
St. Johns Road	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Conyngham Rd	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Pheonix Park Main Rd	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Pheonix Park Back Rd	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Blackhorse Avenue	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Old Cabra Rd	Canal Cordon	Nov 2005 (2 day	DTO Road User

Location	Area	Date	Source
		average)	Monitoring
Annamoe Rd	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Charleville Rd	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
New Cabra Rd	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Phibsborough Rd	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Royal Canal Bank	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Drumcondra Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Jones Road Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Summerhill Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
North Strand Rd Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Sheriff St Upper Bridge	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
North Wall Quay	Canal Cordon	Nov 2005 (2 day average)	DTO Road User Monitoring
Estuary Road / R132	Swords	3rd October 2006	RPA
Seatown Road / R132	Swords	3rd October 2006	RPA
R132 / Malahide Rd Roundabout	Swords	3rd October 2006	RPA
R132 / Dublin Rd	Swords	3rd October 2006	RPA
R132 / Airside	Swords	3rd October 2006	RPA
R108 / Collinstown Rd	Airport South	3rd October 2006	RPA
Ballymun Rd / Balbutcher Lane	Ballymun	3rd October 2006	RPA

Location	Area	Date	Source
Ballymun Rd/ Collins Av	Glasnevin	3rd October 2006	RPA
Bantry Rd / Griffith Av	Drumcondra	3rd October 2006	RPA
Drumcondra Rd / Clonliffe Rd	Drumcondra	3rd October 2006	RPA
Granby Row	Swords Road	September 2005	QBN Project Office
North Frederick Street	Swords Road	September 2005	QBN Project Office
Eccles Street	Swords Road	September 2005	QBN Project Office
Gardiner Street Upper	Swords Road	September 2005	QBN Project Office
North Circular Road	Swords Road	September 2005	QBN Project Office
Belvidere Road	Swords Road	September 2005	QBN Project Office
Whitworth Road	Swords Road	September 2005	QBN Project Office
Clonliffe Road	Swords Road	September 2005	QBN Project Office
Botanic Avenue	Swords Road	September 2005	QBN Project Office
Richmond Road	Swords Road	September 2005	QBN Project Office
Home Farm Road	Swords Road	September 2005	QBN Project Office
Griffith Avenue	Swords Road	September 2005	QBN Project Office
Seven Oaks	Swords Road	September 2005	QBN Project Office
Collins Avenue West	Swords Road	September 2005	QBN Project Office
M1 North of Airport Interchange		2006 Average Weekday	National Roads Authority
M50 between N2 and R108		2006 Average Weekday	National Roads Authority
M50 between N3 and N2		2006 Average Weekday	National Roads Authority
N2 between M50 and Auburn Avenue		2006 Average Weekday	National Roads Authority
O'Connell Street / Abbey Street	City Centre	February 2005	RPA

Location	Area	Date	Source
Dawson Street / Duke Street / Dawson Lane	City Centre	February 2005	RPA
William St Sth / Stephen St Lwr / Mercer St / King St Sth	City Centre	February 2005	RPA
Dame St / Parliament St / Lord Edward St	City Centre	February 2005	RPA
Capel Street / Ormond Quay Upper	City Centre	February 2005	RPA
Capel Street / Marys Street / Abbey Street Lower	City Centre	February 2005	RPA
College Street / Westmorland Street	City Centre	February 2005	RPA
Beresford Memorial Road / Eden Quay / Customs House Quay	City Centre	February 2005	RPA
College Green	City Centre	February 2005	RPA
Butt Bridge / Burgh Quay / George's Quay / Tara St	City Centre	February 2005	RPA
Dawson Street / Saint Stephens Street	City Centre	February 2005	RPA
Kildare Street / Saint Stephens Street	City Centre	February 2005	RPA
O'Connell Bridge / Aston Quay / Westmorland Street / D'Olier Street / Burgh Quay	City Centre	February 2005	RPA
O'Connell Street / Bachelors Walk / O'Connell Bridge / Eden Quay	City Centre	February 2005	RPA
Lombard Strett East / Pearse Street / Westland Row	City Centre	February 2005	RPA
Leinster Street South / Kildare Street / Clare Street	City Centre	February 2005	RPA

Appendix B – Surveyed Junctions

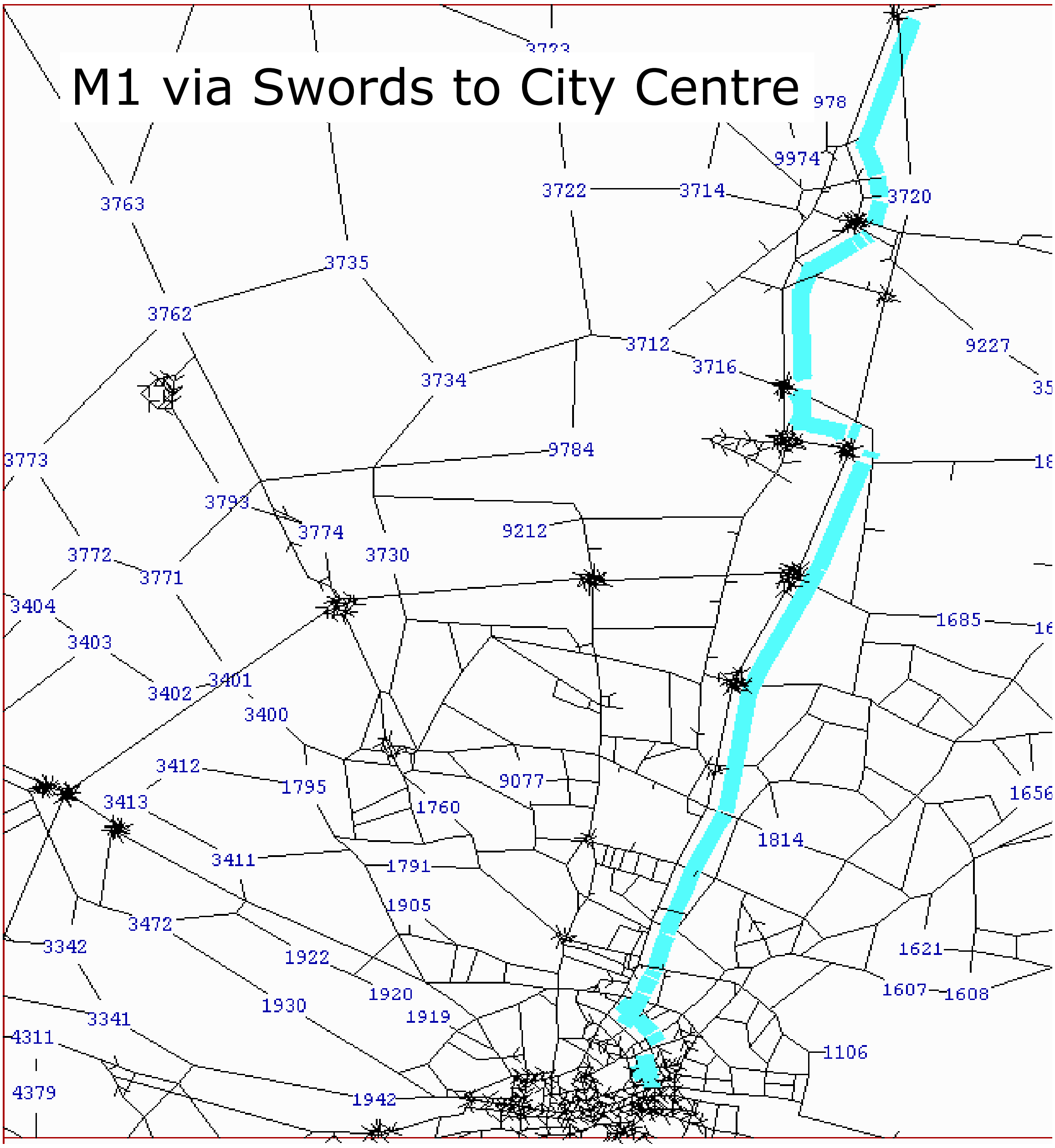
Junction Name	Junction Type	Location	Comments
Larkhill Rd / Collins Av	Priority	Whitehall	Right turn ban from Collins Av. Eastbound 7-10am
Whitworth Rd / St. Patrick's Rd	Priority	Drumcondra	
Whitworth Rd / St. Brigid's Rd	Priority	Drumcondra	
Whitworth Rd / St. Columbus Rd Lwr	Priority	Drumcondra	
Botanic Rd / Lindsay Rd	Priority	Drumcondra	
Botanic Rd / Iona Rd	Priority	Drumcondra	
Drumcondra Rd / St. Anne's Rd	Priority	Drumcondra	
Drumcondra Rd / Clonliffe Rd	Signalised	Drumcondra	
Drumcondra Rd / St Alphonsus Rd	Priority	Drumcondra	Southbound Bus Lane on Drumcondra Rd
Drumcondra Rd / Dargle Rd	Priority	Drumcondra	Banned right turn from Drumcondra Rd Soutbound
Drumcondra Rd / Carlingford Rd	Priority	Drumcondra	Banned right turn from Drumcondra Rd Soutbound
Drumcondra Rd / Hollybank Rd	Priority	Drumcondra	
Clonliffe Rd / Jone's Rd	Signalised	Drumcondra	
Drumcondra Rd / Homefarm Rd	Signalised	Drumcondra	Bus lane southbound. Bus lane on northbound junction exit
Drumcondra Rd / Church Av	Priority	Drumcondra	HGV Ban Church Av

Junction Name	Junction Type	Location	Comments
Drumcondra Rd / Richmond Rd	Signalised	Drumcondra	No left turn from Millmont Av. No right turn from Richmond Rd. HGV ban Millmont Av
Botanic Av / Glendalough Rd	Priority	Drumcondra	
Drumcondra Rd / Ormond Rd	Priority	Drumcondra	Bus lanes on both Drumcondra Rd approaches
Drumcondra Rd / Clonturk Park	Priority	Drumcondra	Bus lanes on both Drumcondra Rd approaches
Drumcondra Rd / Botanic Av	Signalised	Drumcondra	
Ballymun Rd / Gateway Av	Priority	Ballymun	Left out only
Ballymun Rd / Temple Gardens	Signalised	Ballymun	
Ballymun Rd / Shanliss Rd	Priority	Ballymun	Southbound left turn banned AM
Ballymun Rd / Cresent Av	Priority	Ballymun	Left out only
Ballymun Rd / Shangan Rd	Signals	Ballymun	
Balbutcher Lane Corner	Priority	Ballymun	
Balbutcher Lane / Ballymun Rd	Priority	Ballymun	Left out only
Balbutcher Lane / Sillogue Rd	Priority	Ballymun	
DCU Entrance on Collins Av	Signalised	Whitehall	
Ballymun Rd / Griffith Av	Signalised	Drumcondra	
Griffith Av / Mobhi Rd	Signalised	Drumcondra	
Griffith Av / Ballygall Rd	Signalised	Drumcondra	

Junction Name	Junction Type	Location	Comments
Finglas Rd Old / Ballygall Rd	Signalised	Glasnevin	
Rathbeale Rd / Watery Lane	Priority	Swords	
Rathbeale Rd / Outlands	Signalised	Swords	
Jugback Lane / Water Lane	Priority	Swords	
Seatown Rd / R132	Priority	Swords	2 lanes + bus lane Southbound.
Seatown Rd / Mantua Park	Priority	Swords	Car Park access to south
Seatown Rd / Seatown Terrace	Priority	Swords	
Seatown Rd / Seatown Villas	Priority	Swords	
Watery Lane / Balheary Rd	Signalised	Swords	
Scotchstone Bridge / North St	Priority	Swords	
Scotchstone Bridge / Watery Lane	Priority	Swords	
North St / Seatown Villas	Priority	Swords	
Main St / Bridge St	Signalised	Swords	
Main St / Seatown Rd	Priority	Swords	
Church Rd / Main St South	Priority	Swords	
Malahide Rd / Longlands	Priority	Swords	
Main St / Malahide Rd	Signalised	Swords	
Dublin St @ 33B Bus Terminus	Signalised	Swords	

Junction Name	Junction Type	Location	Comments
Church Road Fork	Priority	Swords	
Bridge St / Church Rd	Split Priority	Swords	Local access only
Jugback Lane / Watery Lane	Priority	Swords	
Balheary Road North	Priority	Swords	Serves new residential development
Seatown West / Estuary Road	Priority	Swords	

Appendix C – Journey Time Survey Routes

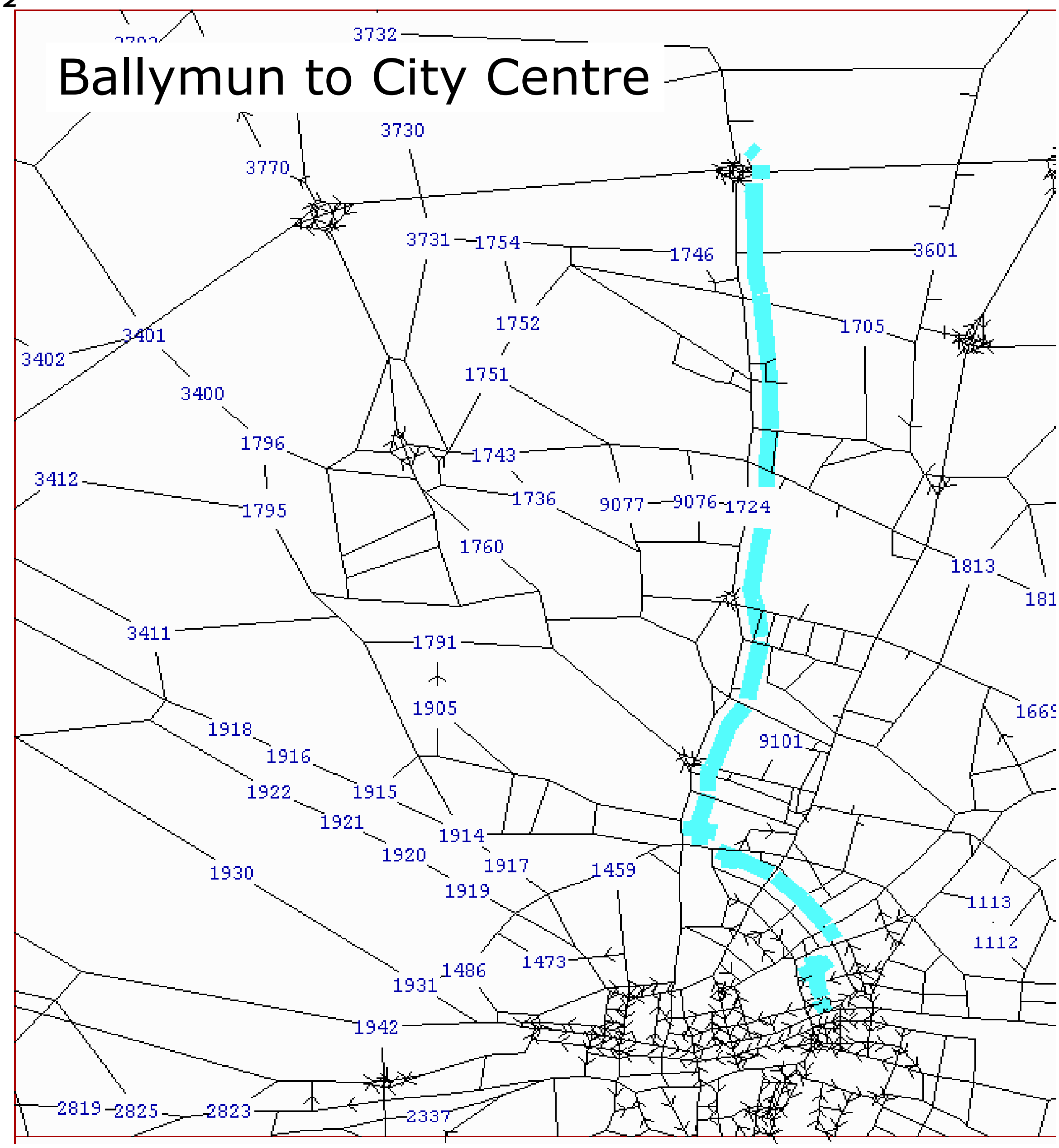


1 Swords to City Centre Junctions

Junction	Journey Time Beginning 8am	Journey Time Beginning 2pm
Start on approach to Hearse Rd. / Donabate Rd.	00:00:00	00:00:00
Estuary Rd Roundabout	00:01:48	00:01:42
N1 Roundabout @ Industrial Estate - Seatown Roundabout	00:02:19	00:02:18
Malahide Rd Roundabout	00:03:43	00:03:14
Dublin Rd Roundabout	00:04:40	00:04:11
Cloughran Roundabout	00:06:55	00:06:22
Airport Roundabout	00:08:16	00:07:55
M1/ M50/ N32	00:10:00	00:09:49
Coolock Lane/ M1	00:11:33	00:10:55
Shantalla/ M1	00:12:49	00:12:04
Swords Rd/ Collins Ave West	00:24:37	00:15:24
Drumcondra Rd Upr./ Griffith Ave	00:37:20	00:18:35
Drumcondra Rd Upr./ Richmond Rd	00:43:41	00:21:20
Drumcondra Rd Upr./ Clonliffe Rd	00:47:00	00:22:58
Drumcondra Rd/ Portland Place	00:48:38	00:23:59
Upper Dorset St./ North Circular Rd	00:49:23	00:24:21
Upper Dorset St./ Gardiner Street Upper	00:49:39	00:24:46
Dorset Street / Eccles Street	00:50:32	00:25:39
Temple Street / Hill Street	00:53:20	00:26:53
Hill Street / Parnell Street	00:56:14	00:28:21
Parnell St. / Marlborough St.	00:56:29	00:28:34
Marlborough St. / Cathal Brugha Street	00:57:12	00:28:53

Junction	Journey Time Beginning 8am	Journey Time Beginning 2pm
O'Connell St. / Cathal Brugha St.	00:58:22	00:29:53
O'Connell St. / Earl St. North	00:59:54	00:30:46
O'Connell St. / Abbey St.	01:01:54	00:31:16
Finish Turning onto O'Connell St.	01:02:45	00:31:38

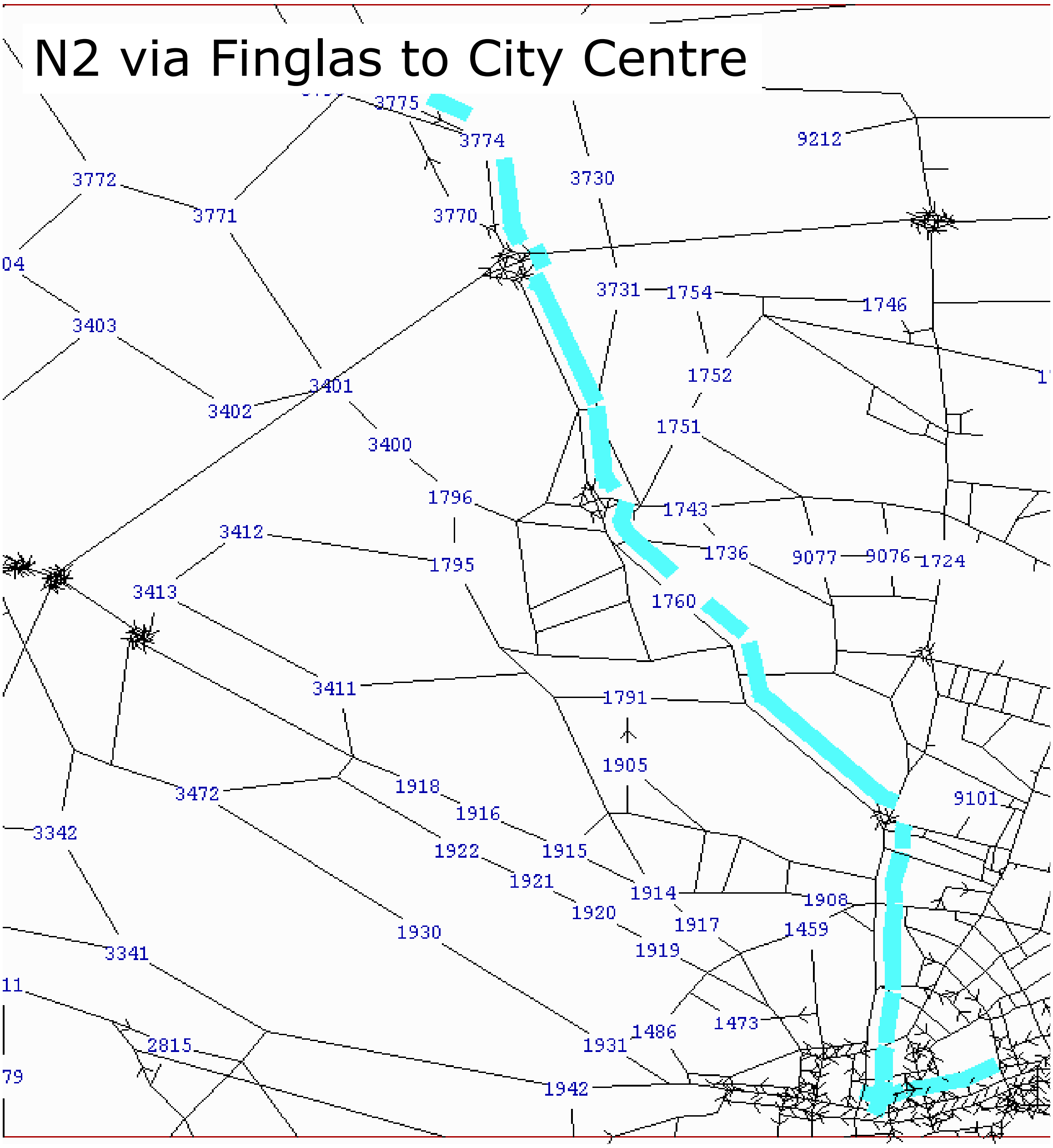
2



2 Ballymun to City Centre Junctions

Junction	Journey Time Beginning 8am	Journey Time Beginning 2pm
Start on approach to Ballymun Junction of M50 & R108	00:00:00	00:00:00
Ballymun Rd/ St. Margaret’s Rd	00:02:12	00:02:51
Ballymun Rd/ Shangan Rd Roundabout	00:04:31	00:04:37
Ballymun Rd/ Collins Ave Extension	00:07:40	00:05:55
St. Mobhi/ Griffith Ave	00:15:36	00:09:01
St. Mobhi/ Botanic Ave	00:21:06	00:10:28
Botanic Rd/ Glasnevin Hill Rd	00:22:05	00:11:22
Botanic Rd/ Prospect Way	00:27:00	00:13:23
Prospect Rd/ Whitworth Rd	00:28:09	00:14:16
North Circular Rd/ Phibsborough - Doyles Corner	00:30:52	00:17:20
Berkley Rd/ NCR	00:31:49	00:18:09
Berkely Rd / Eccles St.	00:32:07	00:18:43
Eccles St. / Dorset St.	00:33:56	00:22:57
Temple St. / Hill St.	00:35:31	00:25:58
Hill St. / Parnell St.	00:36:31	00:27:13
Parnell St. / Marlborough St.	00:37:26	00:27:36
Marlborough St. / Cathal Brugha St.	00:38:15	00:28:02
O'Connell St. / Cathal Brugha St.	00:39:03	00:29:02
O'Connell St. / Earl St. North	00:41:15	00:29:41
O'Connell St. / Abbey Street	00:42:48	00:30:42
Finish turning onto O'Connell St.	00:44:27	00:31:07

3 N2 via Finglas to City Centre

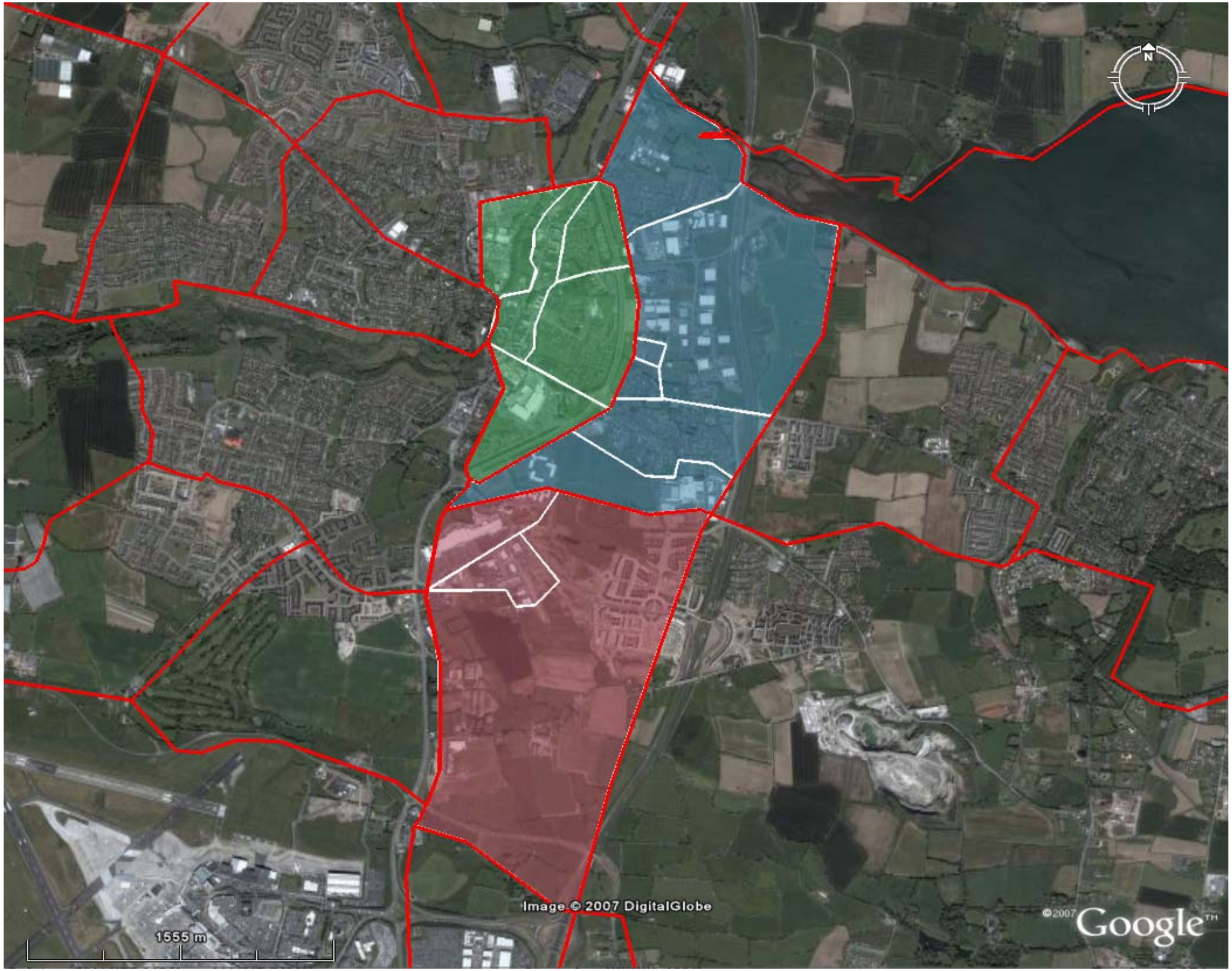


3 Finglas to City Centre Junctions

Junction	Journey Time Beginning 8am	Journey Time Beginning 2pm
Kilshane Cross	00:00:00	00:00:00
M50	00:03:05	00:02:42
North RD/ St. Margaret's Rd	00:04:39	00:03:52
Finglas Bypass / Ballygall Rd	00:07:52	00:05:51
Finglas Rd/ Finglas Place	00:08:37	00:06:18
Finglas Rd/ Tolka Valley Rd	00:10:16	00:08:00
Finglas Rd/ Prospect Road	00:26:58	00:12:17
Phibsborough Rd/ North Circular Rd - Doyles Corner	00:35:58	00:16:54
Phibsborough Rd/ Western Way	00:37:33	00:18:21
Church St./ King St Nth	00:40:47	00:19:40
Church St./ Arran Quay	00:45:05	00:21:06
Chancery Place/ Ormond Quay	00:50:00	00:22:40
Capel St./ Ormond Quay	00:52:55	00:23:59
Liffey St./ Bachelors Walk	00:55:18	00:25:06
Finish turning onto O'Connell Bridge	00:57:24	00:26:57

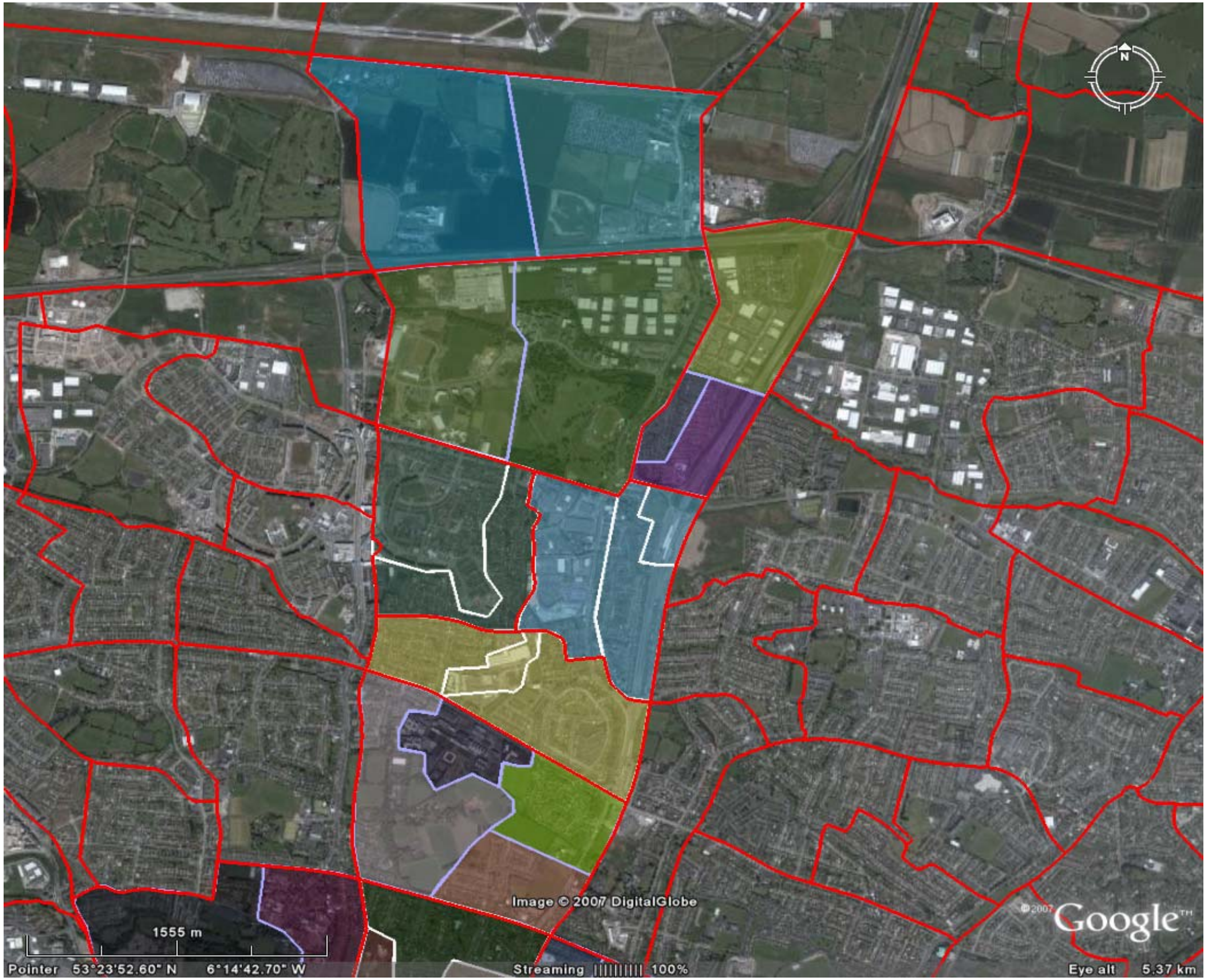
Appendix D – Disaggregated Zone Boundaries

MVA Zone Boundaries



DTO zones are outlined in red

MVA Zone Boundaries



DTO zones are outlined in red

MVA Zone Boundaries

DTO zones are outlined in red

Appendix E – HGV Zone Disaggregation Factors

DTO Zone	MNTM Zone	AM Disagg Factor		Inter-peak Disagg		New Zone Description
		Trips Out	Trips In	Trips Out	Trips In	
35540	98901	0.50	0.60	0.50	0.60	Swords Pavillion Shopping Centre
	98902	0.00	0.00	0.00	0.00	Seatown Villas
	98903	0.00	0.20	0.00	0.20	Along Main Street
	98904	0.50	0.20	0.50	0.20	Watery Lane Industrial Estate
	98905	0.00	0.00	0.00	0.00	Between Seatown & Malahide Roads
35541	98910	0.80	0.30	0.80	0.30	Fronting Seatown Rd / Estuary Rd
	98911	0.10	0.30	0.10	0.30	Seatown Roundabout Access
	98912	0.00	0.00	0.00	0.00	Fronting Swords Bypass Southbound Side
	98913	0.00	0.00	0.00	0.00	Ashley Avenue Area
	98914	0.00	0.00	0.00	0.00	Foxwood
	98915	0.10	0.40	0.10	0.40	Feltrim Industrial Park
35427	98916	0.00	0.00	0.00	0.00	Airside Business Park North
	98917	1.00	1.00	1.00	1.00	Airside Business Park South
	98918	0.00	0.00	0.00	0.00	Feltrim Hall Area
17491	98920	0.00	0.00	0.00	0.00	Shanowen Residential Area
	98921	1.00	1.00	1.00	1.00	Palmgrove Industrial Estate
	98922	0.00	0.00	0.00	0.00	Larkhill Road area
17517	98930	0.50	0.50	0.50	0.50	Shangan Area
	98931	0.50	0.50	0.50	0.50	Shanliss Area
17492	98935	0.00	1.00	0.00	1.00	Omni Shopping Centre

DTO Zone	MNTM Zone	AM Disagg Factor		Inter-peak Disagg		New Zone Description
		Trips Out	Trips In	Trips Out	Trips In	
	98936	0.20	0.00	0.20	0.00	Oakpark Avenue
	98937	0.80	0.00	0.80	0.00	Magenta Hall
17490	98940	0.20	0.00	0.20	0.00	Albert College Roads
	98941	0.00	1.00	0.00	1.00	Dublin City University
	98942	0.40	0.00	0.40	0.00	Iveragh Road
	98943	0.40	0.00	0.40	0.00	Walnut Roads
35442	98923	0.00	0.00	0.00	0.00	Knights Wood
	98924	0.00	0.00	0.00	0.00	Santry Close
	98925	1.00	1.00	1.00	1.00	Turnapin Residential / Industrial Estate
36603	98926	0.20	0.20	0.20	0.20	DOE Test Centre
	98927	0.80	0.80	0.80	0.80	Along Swords Road
36604	98929	0.75	0.75	0.75	0.75	Northwood Area
	98928	0.25	0.25	0.25	0.25	Lymewood Mews and Commercial Area
16147	98960	0.65	0.00	0.65	0.00	Marino Area Residential
	98961	0.00	0.55	0.00	0.55	St. Vincent's Hospital
	98962	0.15	0.45	0.15	0.45	All Hallow's School and Surrounding Schools
	98963	0.20	0.00	0.20	0.00	Ormond Road
16110	98965	0.50	0.50	0.50	0.50	West of Russell Av
	98966	0.50	0.50	0.50	0.50	East of Russel Av
17127	98945	1.00	0.00	1.00	0.00	Fronting Finglas Road Old
	98947	0.00	1.00	0.00	1.00	Enterprise Ireland / Bon Secours Hos.
17149	98950	1.00	1.00	1.00	1.00	St. Patrick's College

DTO Zone	MNTM Zone	AM Disagg Factor		Inter-peak Disagg		New Zone Description
		Trips Out	Trips In	Trips Out	Trips In	
	98951	0.00	0.00	0.00	0.00	Colaiste Caolmhin
	98952	0.00	0.00	0.00	0.00	Residential Streets Fronting Homefarm Road
16148	98955	0.00	0.00	0.00	0.00	Holycross College
	98956	0.00	0.00	0.00	0.00	Residential Streets Fronting Clonliffe Road

Appendix F - DTO Validation Approval Letter

dto Dublin Transportation Office

Certificate of valid use of DTO Model

Project: Metro North
Consultant: MVA Consultancy
Client: Railway Procurement Agency
Date of modelling work: June 2006 to April 2007

This certificate refers to modelling work using the DTO's strategic multi-modal transport model, undertaken by MVA Consultancy on behalf of the Railway Procurement Agency for the above project between the stated dates. The modelling work involved the calibration and validation of a highway model for the area affected by the scheme. This represents the first phase of modelling analysis aimed at quantifying the highway impacts of the scheme, and the outputs from this process will form an essential input into the Environmental Impact Statement for Metro North.

To facilitate the development of a highway model for the area affected by Metro North, the DTO made available to MVA Consultancy both the 3-hour am peak and the afternoon off-peak models for the 2006 base year. From the base year strategic model, MVA Consultancy identified the area affected by the proposed scheme and inserted significant additional network and zonal data in this area of the model to make it sufficiently detailed to test the net highway impacts of the scheme. Following this, MVA consultancy calibrated the highway model using matrix estimation techniques to match modelled flows to observed traffic counts. Following this calibration process, they also used independent traffic counts to validate the newly created highway model.

Having examined the outputs from this process and the accompanying model validation report, the DTO are now in a position to confirm that the modelling work undertaken by MVA Consultancy on this project represents a valid use of the DTO model. Furthermore, the DTO fully endorse the approach taken by MVA Consultancy in using the DTO strategic model as the basis for developing a more detailed highway model for the area affected by Metro North. Also, given the very large size of affected area, the level of calibration and validation achieved was very good and in accordance with what could realistically be expected. Hence, the newly validated highway model is a robust and valid tool for testing the highway impacts of Metro North.

The next phase of the modelling work on this project will be to develop forecast year scenarios and to use the newly created highway model to test the highway impacts of the Metro North scheme in these forecast years. To enable this process, the DTO will make available to MVA Consultancy outputs from its strategic model for these forecast years. The DTO can confirm that this is an appropriate use of the DTO model, and is the correct methodology by which to test and quantify the highway impacts of the scheme.

Certified by: Date: 12/June/2007

Frank McCabe,
Technical Director, Research & Analysis

Appendix G – Calibration Links (GEH Stats)

Car 7 to 8 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
3533	3644	3259	2763	-496	-15%	9.0
9901	2172	451	348	-103	-23%	5.1
9137	1333	280	513	233	83%	11.7
9989	3728	207	596	389	188%	19.4
9211	3651	340	343	3	1%	0.1
1361	1301	447	672	225	50%	9.5
1726	1725	1118	1056	-62	-6%	1.9
1101	1306	103	249	146	142%	11.0
9104	1852	903	898	-5	-1%	0.2
9089	1856	150	15	-135	-90%	14.8
3602	3603	607	612	5	1%	0.2
9216	3517	317	447	130	41%	6.6
9028	9780	99	44	-55	-56%	6.5
1301	1302	1103	1004	-99	-9%	3.1
2911	2092	367	224	-143	-39%	8.3
1392	1391	761	670	-91	-12%	3.4
9052	1728	383	390	7	2%	0.4
9113	1857	867	1032	165	19%	5.3
1391	1390	769	677	-92	-12%	3.4
1745	1725	562	563	1	0%	0.0
3716	3712	382	369	-13	-3%	0.7
3780	3781	151	274	123	82%	8.5
1301	2001	1022	1284	262	26%	7.7
1788	1776	267	196	-71	-27%	4.7
3614	3552	558	750	192	34%	7.5
2008	2018	199	415	216	108%	12.3
2155	2154	1479	1336	-143	-10%	3.8
1667	1682	792	713	-79	-10%	2.9
2102	9900	764	666	-98	-13%	3.7
1409	1393	363	298	-65	-18%	3.6
1389	1390	537	425	-112	-21%	5.1
3604	3603	1358	1154	-204	-15%	5.7
2861	2364	602	526	-76	-13%	3.2
9217	3517	558	431	-127	-23%	5.7
9060	1702	403	417	14	4%	0.7
3535	3551	2212	2020	-192	-9%	4.2
1724	1725	411	418	7	2%	0.3
9038	1703	732	711	-21	-3%	0.8
3786	3787	1218	1421	203	17%	5.6
1346	1393	356	353	-3	-1%	0.1
9052	1727	548	576	28	5%	1.2
1301	1361	450	578	128	29%	5.7
1853	1852	1204	1302	98	8%	2.8
1705	1728	376	424	48	13%	2.4
3611	3604	1411	1218	-193	-14%	5.3
1131	1319	1056	991	-65	-6%	2.0
9212	3651	19	19	0	0%	0.0
2011	2001	729	699	-30	-4%	1.1
9029	3651	638	564	-74	-12%	3.0
1367	1391	7	1	-6	-82%	2.8
3516	3517	253	169	-84	-33%	5.8
3560	3705	1422	1407	-15	-1%	0.4
9780	3702	498	643	145	29%	6.1
3754	3642	3372	3333	-39	-1%	0.7

Car 7 to 8 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
3515	1682	1015	956	-59	-6%	1.9
3622	3603	171	138	-33	-19%	2.6
3782	3783	959	865	-94	-10%	3.1
2103	2085	1119	1227	108	10%	3.2
9063	1858	236	191	-45	-19%	3.1
1411	1410	1693	1559	-134	-8%	3.3
1362	1361	607	672	65	11%	2.6
1813	1858	492	465	-27	-5%	1.2
1410	1394	1266	1141	-125	-10%	3.6
1847	1846	1673	1486	-187	-11%	4.7
9123	1856	828	850	22	3%	0.8
9967	3705	89	51	-38	-43%	4.6
1390	1391	601	579	-22	-4%	0.9
1103	1309	384	316	-68	-18%	3.7
2013	2012	874	828	-46	-5%	1.6
1799	1329	1444	1452	8	1%	0.2
3785	3786	717	697	-20	-3%	0.8
9784	3733	316	289	-27	-9%	1.6
1373	1301	1510	1542	32	2%	0.8
1851	1411	1690	1578	-112	-7%	2.8
1394	1410	794	788	-6	-1%	0.2
1407	1391	161	136	-25	-15%	2.0
2158	2157	502	481	-21	-4%	0.9
3783	3785	996	966	-30	-3%	1.0
1917	1469	618	581	-37	-6%	1.5
9132	1857	258	208	-50	-20%	3.3
1372	1390	183	179	-4	-2%	0.3
1919	1471	718	724	6	1%	0.2
9093	1854	261	271	10	4%	0.6
9094	1854	941	940	-1	0%	0.0
1359	1392	139	119	-20	-14%	1.7
2711	2059	648	621	-27	-4%	1.1
1392	1393	675	747	72	11%	2.7
1930	1931	623	658	35	6%	1.4
1804	1855	144	219	75	52%	5.6
2014	2013	874	849	-25	-3%	0.9
1393	1392	908	869	-39	-4%	1.3
3621	3612	482	428	-54	-11%	2.5
2172	1303	1286	1356	70	5%	1.9
9135	1852	197	333	136	69%	8.4
9141	9782	289	295	6	2%	0.3
1755	3731	198	232	34	17%	2.3
3712	3721	406	529	123	30%	5.7
1302	1303	1173	987	-186	-16%	5.7
1703	1702	1462	1505	43	3%	1.1
1850	1848	417	414	-3	-1%	0.1
3631	3613	1533	1541	8	1%	0.2
2961	2134	537	562	25	5%	1.1
2151	2012	1332	1325	-7	-1%	0.2
9031	3602	263	281	18	7%	1.1
9104	1851	1202	1235	33	3%	0.9
3781	3783	233	223	-10	-4%	0.6
2981	2147	512	527	15	3%	0.7
2931	2112	1320	1307	-13	-1%	0.4

Car 7 to 8 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
3702	9780	1253	1295	42	3%	1.2
9139	9782	113	104	-9	-8%	0.9
9781	3702	231	243	12	5%	0.8
1384	1383	563	655	92	16%	3.7
3735	3734	216	292	76	35%	4.8
1854	1855	939	941	2	0%	0.1
9982	3702	1307	1334	27	2%	0.8
9010	3706	212	203	-10	-4%	0.7
9968	3706	1527	1503	-24	-2%	0.6
9061	1703	1111	1144	33	3%	1.0
3726	3553	3424	3437	13	0%	0.2
1411	1851	916	998	82	9%	2.7
1382	1377	1749	1824	75	4%	1.8
3771	3761	412	396	-16	-4%	0.8
9088	1857	293	222	-71	-24%	4.4
9126	1848	340	324	-16	-5%	0.9
3635	9780	452	443	-9	-2%	0.4
1334	1394	310	275	-35	-11%	2.0
2148	2154	447	498	51	11%	2.4
9227	3516	553	497	-56	-10%	2.4
3734	3733	1049	1073	24	2%	0.7
3710	3702	330	328	-3	-1%	0.1
2313	2306	773	777	4	0%	0.1
3517	3516	643	556	-87	-14%	3.6
9139	3712	328	330	2	1%	0.1
9067	1725	534	520	-14	-3%	0.6
1705	1702	341	366	25	7%	1.3
1685	1846	939	898	-41	-4%	1.4
3708	3705	622	603	-19	-3%	0.7
1856	1857	772	795	23	3%	0.8
2951	2124	537	558	21	4%	0.9
1334	1410	125	140	15	12%	1.3
9050	1727	84	91	7	9%	0.8
3751	1776	1045	982	-63	-6%	2.0
1383	1382	656	688	32	5%	1.2
3788	3787	370	395	25	7%	1.3
2350	2354	425	425	0	0%	0.0
2851	2352	587	555	-32	-6%	1.4
9783	3721	361	350	-11	-3%	0.6
2104	2103	1210	1240	30	2%	0.8
3761	3733	421	414	-7	-2%	0.4
1776	3751	830	778	-52	-6%	1.8
1942	1941	770	808	38	5%	1.4
1855	1854	1080	1062	-18	-2%	0.6
9006	9780	523	508	-15	-3%	0.7
3553	3726	1236	1236	0	0%	0.0
1754	3731	81	68	-13	-16%	1.5
2065	2066	113	112	-1	-1%	0.1
3613	3631	562	550	-12	-2%	0.5
3768	3753	749	708	-41	-6%	1.5
3733	3761	498	486	-12	-2%	0.6
3642	3754	2515	3176	661	26%	12.4
2171	2001	867	791	-76	-9%	2.6
3721	3712	498	483	-15	-3%	0.7

Car 7 to 8 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
1391	1392	669	710	41	6%	1.5
1729	1728	826	820	-6	-1%	0.2
1394	1393	1319	1247	-72	-5%	2.0
2871	2447	622	603	-19	-3%	0.8
3775	3761	192	418	226	118%	13.0
3604	3611	145	129	-16	-11%	1.4
9130	3515	988	960	-28	-3%	0.9
3603	3602	1422	1419	-3	0%	0.1
1685	1682	1080	1052	-28	-3%	0.9
3612	3621	1177	1168	-9	-1%	0.3
3651	3602	588	556	-32	-6%	1.4
2338	2337	695	708	13	2%	0.5
3794	3761	506	482	-24	-5%	1.1
1413	1394	309	284	-25	-8%	1.4
3552	3614	1548	1637	89	6%	2.2
1908	1431	560	544	-16	-3%	0.7
2012	2013	1242	1273	31	3%	0.9
3753	3768	568	510	-58	-10%	2.5
1393	1394	882	852	-30	-3%	1.0
2166	2154	668	695	27	4%	1.1
3787	3781	1299	1297	-2	0%	0.0
3511	3515	303	326	23	8%	1.3
2162	2172	1666	1879	213	13%	5.1
1395	1382	1679	1694	15	1%	0.4
9964	3706	479	466	-13	-3%	0.6
9128	1848	101	90	-11	-10%	1.1
1681	1682	615	617	2	0%	0.1
9091	1855	183	220	37	20%	2.6
3602	3651	553	578	25	4%	1.0
2082	2101	1173	1224	51	4%	1.5
3644	3533	2212	2611	399	18%	8.1
1829	1846	213	199	-14	-7%	1.0
9968	3705	425	412	-13	-3%	0.6
3722	3721	1081	1059	-22	-2%	0.7
3733	3734	377	388	11	3%	0.6
9006	9782	128	115	-13	-10%	1.2
2891	2890	1025	987	-38	-4%	1.2
9113	1858	766	776	10	1%	0.4
2074	2066	162	158	-4	-2%	0.3
3551	3535	3259	3330	71	2%	1.2
3730	3731	804	793	-11	-1%	0.4
3784	3785	200	195	-5	-2%	0.3
1417	1392	292	309	17	6%	1.0
1682	3515	535	541	6	1%	0.2
9045	1727	149	152	3	2%	0.3
1755	1776	623	608	-15	-2%	0.6
3732	3733	230	237	7	3%	0.5
9099	1851	508	424	-84	-17%	3.9
3703	3786	1447	1415	-32	-2%	0.8
1773	1776	757	750	-7	-1%	0.3
9783	3734	845	866	21	3%	0.7
1429	1428	1014	1180	166	16%	5.0
1849	3516	368	373	5	1%	0.3
9963	3706	248	248	0	0%	0.0

Car 7 to 8 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
9053	1727	231	383	152	66%	8.7
9118	1855	971	959	-12	-1%	0.4
1859	1858	1054	1047	-7	-1%	0.2
1857	1856	840	832	-8	-1%	0.3
3726	3728	382	218	-164	-43%	9.5

HGV 7 to 8 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
1942	1941	123	217	94	76%	7.2
2151	2012	198	226	28	14%	1.9
2102	9900	141	144	3	2%	0.2
1773	1776	90	160	70	78%	6.3
9093	1854	6	106	100	1671%	13.4
3622	3603	126	57	-69	-55%	7.2
2012	2013	174	195	21	12%	1.5
9137	1333	32	125	93	291%	10.5
1703	1702	276	223	-53	-19%	3.4
1301	2001	150	253	103	69%	7.3
1301	1361	90	1	-89	-99%	13.1
9088	1857	18	18	0	1%	0.0
2861	2364	432	93	-339	-78%	20.9
1362	1361	105	168	63	60%	5.4
1729	1728	138	203	65	47%	5.0
3551	3535	783	790	7	1%	0.3
3794	3761	69	196	127	184%	11.0
9038	1703	291	167	-124	-43%	8.2
2008	2018	57	52	-5	-9%	0.7
1372	1390	63	27	-36	-57%	5.4
2981	2147	149	15	-134	-90%	14.7
1799	1329	120	178	58	49%	4.8
9113	1857	114	133	19	16%	1.7
2082	2101	216	268	52	24%	3.3
1373	1301	393	239	-154	-39%	8.7
9052	1727	150	159	9	6%	0.7
1853	1852	147	245	98	67%	7.0
1361	1301	72	168	96	133%	8.7
9060	1702	147	140	-7	-5%	0.6
1394	1393	249	224	-25	-10%	1.6
3631	3613	198	186	-12	-6%	0.8
3751	1776	273	259	-14	-5%	0.8
1726	1725	132	187	55	42%	4.4
9783	3734	81	122	41	50%	4.0
1788	1776	105	17	-88	-84%	11.3
3517	3516	54	30	-24	-44%	3.7
1395	1382	324	272	-52	-16%	3.0
1383	1382	165	101	-64	-39%	5.6
9031	3602	249	183	-66	-26%	4.5
9091	1855	3	9	6	204%	2.5
1851	1411	333	215	-118	-35%	7.1
1390	1391	120	93	-27	-23%	2.7
3604	3611	144	138	-6	-4%	0.5
9901	2172	702	412	-290	-41%	12.3
1410	1394	204	145	-59	-29%	4.5
1393	1392	189	171	-19	-10%	1.4
9063	1858	42	27	-15	-35%	2.5
3775	3761	90	104	14	15%	1.4
1392	1391	186	121	-65	-35%	5.2
9967	3705	15	14	-1	-4%	0.2
1394	1410	210	208	-2	-1%	0.1
9061	1703	159	168	9	6%	0.7
9784	3733	12	41	29	242%	5.6
1334	1394	207	290	83	40%	5.3

HGV 7 to 8 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
1389	1390	102	65	-37	-36%	4.0
9963	3706	90	90	0	0%	0.0
1411	1410	294	213	-81	-28%	5.1
9099	1851	180	113	-67	-37%	5.5
3535	3551	806	797	-9	-1%	0.3
9781	3702	12	44	32	265%	6.0
9045	1727	57	1	-56	-99%	10.5
9050	1727	18	0	-18	-100%	6.0
9104	1852	210	210	0	0%	0.0
2313	2306	500	361	-139	-28%	6.7
9135	1852	18	95	77	427%	10.2
3621	3612	63	47	-16	-25%	2.1
1393	1394	228	227	-1	-1%	0.1
9006	9782	12	1	-11	-90%	4.2
9010	3706	15	17	2	13%	0.5
3726	3553	620	803	183	30%	6.9
1409	1393	18	4	-14	-78%	4.2
3734	3733	219	124	-95	-43%	7.3
9104	1851	180	125	-55	-30%	4.4
9139	9782	12	18	6	52%	1.6
3721	3712	87	78	-9	-10%	1.0
9067	1725	96	45	-51	-54%	6.1
9123	1856	153	150	-3	-2%	0.2
1705	1702	93	67	-26	-28%	2.9
1804	1855	6	45	39	658%	7.8
1392	1393	156	154	-2	-1%	0.2
1745	1725	99	33	-66	-67%	8.2
1384	1383	111	102	-9	-8%	0.8
2104	2103	129	169	40	31%	3.3
3516	3517	63	17	-46	-73%	7.2
9783	3721	105	86	-19	-18%	2.0
2103	2085	126	167	41	33%	3.4
1411	1851	312	336	24	8%	1.3
1302	1303	387	246	-141	-36%	7.9
1919	1471	83	106	23	28%	2.4
2158	2157	99	108	9	9%	0.9
9141	9782	12	18	6	50%	1.5
1346	1393	87	74	-13	-15%	1.4
2951	2124	80	67	-13	-16%	1.5
3552	3614	189	189	0	0%	0.0
1413	1394	126	79	-47	-37%	4.7
2166	2154	66	51	-15	-23%	2.0
2931	2112	74	73	-1	-1%	0.1
2350	2354	14	30	16	115%	3.4
3603	3602	321	321	0	0%	0.0
9053	1727	42	60	18	44%	2.6
3786	3787	159	225	66	41%	4.7
1391	1390	135	121	-14	-10%	1.2
3735	3734	3	30	27	915%	6.7
2871	2447	35	110	75	215%	8.8
3722	3721	96	62	-34	-35%	3.8
1391	1392	120	152	32	27%	2.7
1705	1728	75	80	5	6%	0.5
9216	3517	48	9	-39	-82%	7.4

HGV 7 to 8 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
1103	1309	134	175	41	31%	3.3
1855	1854	141	147	6	4%	0.5
3702	9780	150	190	40	26%	3.0
3602	3651	228	258	30	13%	1.9
1685	1846	216	218	2	1%	0.2
9089	1856	15	0	-15	-100%	5.5
9094	1854	180	176	-4	-2%	0.3
3730	3731	123	92	-31	-25%	3.0
1857	1856	129	108	-21	-16%	1.9
2338	2337	102	123	21	21%	2.0
1908	1431	132	100	-32	-24%	2.9
9227	3516	69	58	-11	-16%	1.4
1776	3751	429	229	-200	-47%	11.0
3710	3702	33	38	5	16%	0.9
1847	1846	270	247	-23	-9%	1.4
3560	3705	237	233	-4	-2%	0.3
2891	2890	80	77	-3	-3%	0.3
2074	2066	21	14	-7	-33%	1.7
9139	3712	36	19	-17	-47%	3.2
9130	3515	87	85	-2	-2%	0.2
9132	1857	192	152	-40	-21%	3.0
3782	3783	198	171	-28	-14%	2.0
2013	2012	243	125	-118	-49%	8.7
3716	3712	93	89	-4	-5%	0.5
9982	3702	150	198	48	32%	3.6
1917	1469	140	114	-26	-18%	2.3
1131	1319	66	63	-3	-4%	0.3
1407	1391	57	62	5	9%	0.6
1417	1392	24	41	17	72%	3.0
3787	3781	189	204	15	8%	1.1
2148	2154	81	205	124	153%	10.4
2162	2172	201	386	185	92%	10.8
2014	2013	243	128	-115	-47%	8.4
1359	1392	12	8	-4	-37%	1.4
1101	1306	443	350	-93	-21%	4.7
3780	3781	33	80	47	143%	6.3
1685	1682	192	196	4	2%	0.3
3602	3603	168	167	-1	-1%	0.1
2961	2134	41	30	-11	-26%	1.8
1667	1682	123	120	-3	-2%	0.2
9029	3651	156	105	-51	-33%	4.4
3651	3602	183	90	-93	-51%	8.0
3733	3761	183	188	5	3%	0.4
1681	1682	162	167	5	3%	0.4
1829	1846	6	19	13	213%	3.6
3733	3734	69	66	-3	-4%	0.4
3511	3515	60	59	-1	-1%	0.1
3732	3733	135	113	-22	-17%	2.0
9217	3517	51	37	-14	-28%	2.2
3768	3753	384	359	-25	-6%	1.3
1724	1725	72	70	-2	-3%	0.2
1754	3731	165	121	-44	-26%	3.7
9780	3702	159	143	-16	-10%	1.3
9968	3706	231	242	11	5%	0.7

HGV 7 to 8 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
3604	3603	171	188	17	10%	1.3
1813	1858	60	200	140	233%	12.3
9006	9780	33	16	-17	-52%	3.5
3553	3726	664	728	64	10%	2.4
1850	1848	30	42	12	40%	2.0
2011	2001	228	160	-68	-30%	4.9
3761	3733	108	129	21	20%	2.0
9052	1728	60	61	1	1%	0.1
3515	1682	111	105	-6	-6%	0.6
2065	2066	24	30	6	25%	1.2
3712	3721	114	109	-5	-5%	0.5
9113	1858	303	270	-33	-11%	1.9
3785	3786	102	98	-4	-4%	0.4
2155	2154	171	179	8	4%	0.6
9964	3706	156	159	3	2%	0.2
1682	3515	108	109	1	1%	0.1
1849	3516	84	85	1	1%	0.1
3784	3785	24	23	-1	-5%	0.3
3708	3705	75	84	9	12%	1.0
1755	1776	222	181	-41	-18%	2.9
2172	1303	129	304	175	136%	11.9
9968	3705	153	155	2	2%	0.2
2851	2352	63	39	-24	-38%	3.3
3771	3761	114	167	53	46%	4.5
1429	1428	248	298	50	20%	3.0
1854	1855	180	177	-3	-2%	0.3
2711	2059	39	33	-6	-15%	0.9
1367	1391	0	0	0	#DIV/0!	0.1
3753	3768	404	129	-275	-68%	16.9
9028	9780	21	21	0	-1%	0.0
1930	1931	5	40	35	706%	7.4
3635	9780	150	141	-9	-6%	0.7
3788	3787	69	66	-3	-4%	0.3
3703	3786	231	227	-4	-2%	0.3
9126	1848	12	12	0	2%	0.1
1755	3731	27	30	3	10%	0.5
9211	3651	75	80	5	7%	0.6
9212	3651	45	45	0	0%	0.0
3783	3785	234	233	-1	0%	0.0
2911	2092	14	15	1	5%	0.2
3781	3783	78	83	5	7%	0.6
1334	1410	99	111	12	12%	1.2
3754	3642	775	724	-51	-7%	1.8
3642	3754	858	854	-4	0%	0.1
3644	3533	806	767	-39	-5%	1.4
3533	3644	783	759	-24	-3%	0.9
3614	3552	114	112	-2	-2%	0.2
3613	3631	192	171	-21	-11%	1.6
3612	3621	102	71	-31	-31%	3.4
3611	3604	186	207	21	11%	1.5
1382	1377	321	283	-38	-12%	2.2
1301	1302	366	245	-121	-33%	6.9
2171	2001	615	480	-135	-22%	5.7
3726	3728	33	48	15	46%	2.4

HGV 7 to 8 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
9989	3728	12	65	53	444%	8.6
9118	1855	138	141	3	2%	0.2
1856	1857	144	145	1	1%	0.1
1859	1858	234	100	-134	-57%	10.4
1856	1857	192	207	15	8%	1.1

Car 8 to 9 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
9113	1857	542	1004	462	85%	16.6
3533	3644	3107	2287	-820	-26%	15.8
1857	1856	485	893	408	84%	15.5
1919	1471	610	1025	415	68%	14.5
1302	1303	935	574	-361	-39%	13.2
9901	2172	436	140	-296	-68%	17.4
3771	3761	365	642	277	76%	12.3
2861	2364	879	558	-321	-37%	12.0
2981	2147	557	896	339	61%	12.6
9989	3728	221	435	214	97%	11.8
2082	2101	958	1360	402	42%	11.8
3761	3733	415	655	240	58%	10.4
9217	3517	657	423	-234	-36%	10.1
2711	2059	956	657	-299	-31%	10.5
9089	1856	150	53	-97	-65%	9.7
9967	3705	209	70	-139	-67%	11.8
3622	3603	279	136	-143	-51%	9.9
3735	3734	164	304	140	85%	9.1
1429	1428	846	1129	283	33%	9.0
2011	2001	772	591	-181	-23%	6.9
9141	9782	279	447	168	60%	8.8
2014	2013	889	691	-198	-22%	7.0
2158	2157	674	929	255	38%	9.0
3511	3515	492	702	210	43%	8.6
2151	2012	1359	1072	-287	-21%	8.2
3786	3787	1976	1629	-347	-18%	8.2
2013	2012	889	703	-186	-21%	6.6
2148	2154	541	352	-189	-35%	8.9
1799	1329	1780	1468	-312	-18%	7.7
3712	3721	474	647	173	37%	7.3
2338	2337	542	761	219	40%	8.6
2172	1303	1170	1387	217	19%	6.1
2102	9900	882	1060	178	20%	5.7
1103	1309	580	427	-153	-26%	6.8
3732	3733	358	233	-125	-35%	7.2
2104	2103	1589	1301	-288	-18%	7.6
9029	3651	798	565	-233	-29%	8.9
2313	2306	700	453	-247	-35%	10.3
1362	1361	596	406	-190	-32%	8.5
1410	1394	1339	1081	-258	-19%	7.4
1853	1852	1084	1314	230	21%	6.6
9137	1333	388	577	189	49%	8.6
3768	3753	638	802	164	26%	6.1
9099	1851	565	412	-153	-27%	6.9
1372	1390	191	118	-73	-38%	5.9
3602	3651	472	638	166	35%	7.0
2171	2001	809	573	-236	-29%	9.0
1393	1392	961	774	-187	-20%	6.4
1411	1410	1768	1500	-268	-15%	6.6
3710	3702	466	613	147	32%	6.3
2012	2013	1236	1028	-208	-17%	6.2
3775	3761	224	336	112	50%	6.7
3733	3761	447	600	153	34%	6.7
2911	2092	461	580	119	26%	5.2

Car 8 to 9 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
3612	3621	1227	1458	231	19%	6.3
1788	1776	386	283	-103	-27%	5.6
1394	1393	1415	1153	-262	-19%	7.3
1392	1391	824	652	-172	-21%	6.3
1373	1301	1114	1275	161	14%	4.7
1391	1390	838	660	-178	-21%	6.5
9104	1852	941	794	-147	-16%	5.0
3708	3705	830	675	-155	-19%	5.6
1395	1382	1295	1454	159	12%	4.3
9216	3517	438	548	110	25%	4.9
1101	1306	146	221	75	51%	5.5
1930	1931	634	766	132	21%	5.0
1855	1854	899	1065	166	18%	5.3
9781	3702	318	415	97	30%	5.0
1755	3731	213	308	95	45%	5.9
3703	3786	1627	1830	203	13%	4.9
9118	1855	672	800	128	19%	4.7
9010	3706	289	369	80	28%	4.4
1917	1469	458	545	87	19%	3.9
1681	1682	954	850	-104	-11%	3.5
1850	1848	477	557	80	17%	3.5
1334	1410	202	144	-58	-29%	4.4
1301	1302	696	787	91	13%	3.3
1393	1394	988	910	-78	-8%	2.5
1384	1383	388	458	70	18%	3.4
1390	1391	591	553	-38	-7%	1.6
1847	1846	1821	1647	-174	-10%	4.2
3614	3552	884	784	-100	-11%	3.5
1383	1382	633	576	-57	-9%	2.3
9104	1851	1220	1129	-91	-7%	2.7
1854	1855	1066	1012	-54	-5%	1.7
1361	1301	487	400	-87	-18%	4.1
1389	1390	486	465	-21	-4%	0.9
2155	2154	1621	1535	-86	-5%	2.2
3553	3726	1564	1670	106	7%	2.6
2871	2447	787	879	92	12%	3.2
9982	3702	1626	1518	-108	-7%	2.7
9053	1727	383	400	17	4%	0.8
3613	3631	741	692	-49	-7%	1.8
2065	2066	182	181	-1	0%	0.1
1301	2001	916	951	35	4%	1.1
3734	3733	981	1063	82	8%	2.6
9031	3602	409	401	-8	-2%	0.4
3722	3721	1003	952	-51	-5%	1.6
9028	9780	173	204	31	18%	2.2
1705	1728	359	322	-37	-10%	2.0
2891	2890	985	1041	56	6%	1.8
2074	2066	291	296	5	2%	0.3
3635	9780	688	647	-41	-6%	1.6
3726	3553	3211	3371	160	5%	2.8
3726	3728	382	431	49	13%	2.4
3631	3613	1446	1368	-78	-5%	2.1
1131	1319	859	916	57	7%	1.9
1685	1846	910	977	67	7%	2.2

Car 8 to 9 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
3602	3603	775	849	74	9%	2.6
1382	1377	1514	1545	31	2%	0.8
3644	3533	2481	2425	-56	-2%	1.1
2162	2172	1800	1818	18	1%	0.4
1413	1394	338	304	-34	-10%	1.9
3781	3783	323	292	-31	-10%	1.8
3702	9780	1424	1355	-69	-5%	1.9
2103	2085	1367	1299	-68	-5%	1.9
3642	3754	2518	2587	69	3%	1.4
3780	3781	215	187	-28	-13%	2.0
1754	3731	133	101	-32	-24%	3.0
1724	1725	830	867	37	4%	1.3
1367	1391	20	19	-1	-3%	0.1
9060	1702	652	629	-23	-4%	0.9
3733	3734	443	473	30	7%	1.4
3611	3604	1333	1267	-66	-5%	1.8
9968	3706	1720	1766	46	3%	1.1
3604	3603	1231	1177	-54	-4%	1.6
3716	3712	476	441	-35	-7%	1.6
1685	1682	1179	1187	8	1%	0.2
3535	3551	2481	2411	-70	-3%	1.4
3782	3783	1380	1321	-59	-4%	1.6
3603	3602	1396	1350	-46	-3%	1.2
1942	1941	755	775	20	3%	0.7
1411	1851	1100	1083	-17	-2%	0.5
1394	1410	854	848	-6	-1%	0.2
9038	1703	578	546	-32	-6%	1.4
9088	1857	369	389	20	5%	1.0
1745	1725	879	842	-37	-4%	1.2
2166	2154	773	743	-30	-4%	1.1
9094	1854	1019	977	-42	-4%	1.3
9006	9782	140	135	-5	-3%	0.4
1334	1394	332	379	47	14%	2.5
3754	3642	3099	3017	-82	-3%	1.5
1703	1702	1369	1303	-66	-5%	1.8
9783	3721	416	437	21	5%	1.0
3551	3535	3104	3214	110	4%	2.0
1409	1393	222	224	2	1%	0.1
1407	1391	191	168	-23	-12%	1.7
1682	3515	664	682	18	3%	0.7
2851	2352	717	694	-23	-3%	0.9
1773	1776	926	904	-22	-2%	0.7
3517	3516	648	614	-34	-5%	1.3
3730	3731	871	854	-17	-2%	0.6
1667	1682	922	882	-40	-4%	1.3
1359	1392	178	180	2	1%	0.1
9052	1728	434	452	18	4%	0.9
1346	1393	342	326	-16	-5%	0.9
3552	3614	1668	1672	4	0%	0.1
9123	1856	822	816	-6	-1%	0.2
2350	2354	509	535	26	5%	1.1
9050	1727	136	141	5	4%	0.5
9063	1858	287	272	-15	-5%	0.9
1813	1858	640	625	-15	-2%	0.6

Car 8 to 9 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
3516	3517	427	467	40	9%	1.9
1726	1725	923	907	-16	-2%	0.5
9968	3705	801	790	-11	-1%	0.4
9093	1854	250	279	29	12%	1.8
1755	1776	726	687	-39	-5%	1.5
3515	1682	1104	1122	18	2%	0.5
3784	3785	196	214	18	9%	1.3
3753	3768	568	599	31	6%	1.3
9113	1858	738	706	-32	-4%	1.2
9227	3516	565	596	31	5%	1.3
1392	1393	739	783	44	6%	1.6
1729	1728	970	942	-28	-3%	0.9
2961	2134	728	757	29	4%	1.1
9052	1727	903	825	-78	-9%	2.7
1804	1855	214	225	11	5%	0.7
2931	2112	1568	1574	6	0%	0.2
9139	3712	344	338	-6	-2%	0.3
9067	1725	502	502	0	0%	0.0
1301	1361	490	439	-51	-10%	2.4
9091	1855	240	244	4	1%	0.2
9211	3651	393	382	-11	-3%	0.6
9061	1703	1238	1205	-33	-3%	1.0
9139	9782	244	228	-16	-7%	1.1
9964	3706	926	923	-3	0%	0.1
3651	3602	788	745	-43	-5%	1.5
9126	1848	438	412	-26	-6%	1.3
3787	3781	1655	1630	-25	-2%	0.6
3604	3611	332	331	-1	0%	0.1
9780	3702	900	935	35	4%	1.2
1391	1392	672	698	26	4%	1.0
1856	1857	777	806	29	4%	1.0
1908	1431	505	522	17	3%	0.7
9132	1857	412	413	1	0%	0.0
1829	1846	286	277	-9	-3%	0.5
3794	3761	488	475	-13	-3%	0.6
2951	2124	714	705	-9	-1%	0.3
9128	1848	134	136	2	1%	0.2
1417	1392	333	329	-4	-1%	0.2
3721	3712	598	602	4	1%	0.2
1849	3516	540	533	-7	-1%	0.3
3783	3785	1434	1414	-20	-1%	0.5
9045	1727	230	205	-25	-11%	1.7
9130	3515	967	957	-10	-1%	0.3
3788	3787	276	266	-10	-4%	0.6
9783	3734	934	920	-14	-2%	0.5
2008	2018	293	284	-9	-3%	0.5
1851	1411	1511	1497	-14	-1%	0.4
3621	3612	739	775	36	5%	1.3
3560	3705	1701	1675	-26	-2%	0.6
3785	3786	704	706	2	0%	0.1
3751	1776	1095	1098	3	0%	0.1
9784	3733	323	339	16	5%	0.9
1776	3751	888	871	-17	-2%	0.6
9006	9780	632	635	3	0%	0.1

Car 8 to 9 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
9135	1852	332	316	-16	-5%	0.9
1705	1702	443	384	-59	-13%	2.9
9212	3651	16	16	0	0%	0.0
9963	3706	386	386	0	0%	0.0

HGV 8 to 9 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
1361	1301	156	272	116	75%	7.9
1373	1301	339	487	148	44%	7.3
1302	1303	342	409	67	20%	3.5
2172	1303	315	209	-106	-34%	6.5
1101	1306	446	546	100	22%	4.5
1103	1309	99	327	228	230%	15.6
1131	1319	36	60	24	66%	3.4
1799	1329	104	196	92	88%	7.5
9137	1333	21	73	52	249%	7.6
1301	1361	117	107	-10	-8%	0.9
1362	1361	132	274	142	108%	10.0
1383	1382	102	185	83	81%	6.9
1395	1382	360	467	107	30%	5.2
1384	1383	60	170	110	183%	10.3
1851	1411	183	248	65	36%	4.4
1429	1428	174	197	23	13%	1.7
1908	1431	111	112	1	1%	0.1
1917	1469	95	107	12	12%	1.2
1919	1471	75	75	0	0%	0.0
1667	1682	114	102	-12	-11%	1.2
1681	1682	150	152	2	1%	0.1
1685	1682	174	209	35	20%	2.5
3515	1682	96	110	14	14%	1.4
1703	1702	252	289	37	15%	2.2
1705	1702	93	99	6	7%	0.6
9060	1702	177	152	-25	-14%	2.0
9038	1703	207	220	13	6%	0.9
9061	1703	174	197	23	13%	1.7
1724	1725	96	116	20	21%	1.9
1726	1725	72	78	6	9%	0.7
1745	1725	111	35	-76	-69%	8.9
9067	1725	102	130	28	27%	2.6
9045	1727	63	14	-49	-78%	8.0
9053	1727	90	111	21	23%	2.0
9050	1727	18	17	-1	-4%	0.2
9052	1727	141	60	-81	-58%	8.1
1705	1728	96	117	21	22%	2.1
1729	1728	99	150	51	51%	4.6
9052	1728	108	122	14	13%	1.3
1755	1776	198	196	-2	-1%	0.2
1773	1776	163	353	190	117%	11.8
1788	1776	171	40	-131	-76%	12.7
3751	1776	408	430	22	5%	1.1
1685	1846	147	163	16	11%	1.3
1829	1846	6	15	9	152%	2.8
1847	1846	240	273	33	14%	2.1
1850	1848	18	77	59	329%	8.6
9126	1848	21	90	69	330%	9.3
9128	1848	12	12	0	-2%	0.1
1942	1941	104	198	94	91%	7.7
1301	2001	255	411	156	61%	8.6
2011	2001	201	264	63	31%	4.1
2013	2012	153	181	28	18%	2.2
2151	2012	297	432	135	46%	7.1

HGV 8 to 9 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
2012	2013	249	332	83	33%	4.9
2014	2013	153	181	28	18%	2.1
2008	2018	69	71	2	4%	0.3
2014	2013	153	181	28	18%	2.1
2008	2018	69	71	2	4%	0.3
2711	2059	24	28	4	16%	0.7
2065	2066	21	20	-1	-4%	0.2
2074	2066	27	28	1	3%	0.2
2103	2085	81	90	9	11%	1.0
2911	2092	15	16	1	9%	0.3
2082	2101	270	335	65	24%	3.7
2102	9900	228	141	-87	-38%	6.4
2104	2103	81	89	8	10%	0.9
2931	2112	29	29	0	1%	0.1
2951	2124	78	25	-53	-68%	7.3
2961	2134	17	21	4	24%	0.9
2981	2147	95	18	-77	-81%	10.2
2148	2154	96	126	30	31%	2.8
2155	2154	189	197	8	4%	0.5
2166	2154	60	128	68	113%	7.0
2158	2157	93	106	13	14%	1.3
2162	2172	285	369	84	29%	4.6
9901	2172	597	544	-53	-9%	2.2
2313	2306	414	411	-3	-1%	0.1
2338	2337	26	40	14	54%	2.4
2851	2352	89	73	-16	-18%	1.8
2350	2354	18	25	7	38%	1.5
2861	2364	308	113	-195	-63%	13.5
2871	2447	23	44	21	92%	3.7
2891	2890	17	15	-2	-9%	0.4
1682	3515	102	110	8	8%	0.8
3511	3515	60	54	-6	-10%	0.8
9130	3515	123	141	18	14%	1.5
1849	3516	84	82	-2	-3%	0.2
3517	3516	78	94	16	21%	1.7
9227	3516	84	85	1	1%	0.1
3516	3517	69	61	-8	-12%	1.0
9216	3517	78	57	-21	-27%	2.5
9217	3517	90	76	-14	-15%	1.5
3551	3535	817	858	41	5%	1.4
3535	3551	794	1014	220	28%	7.3
3726	3553	697	796	99	14%	3.6
3603	3602	300	302	2	1%	0.1
3651	3602	174	179	5	3%	0.3
9031	3602	279	158	-121	-43%	8.2
3602	3603	225	243	18	8%	1.2
3604	3603	192	196	4	2%	0.3
3622	3603	105	20	-85	-81%	10.7
3604	3611	44	142	98	223%	10.2
3621	3612	99	87	-12	-13%	1.3
3631	3613	213	204	-9	-4%	0.6
3552	3614	234	246	12	5%	0.8
3602	3651	159	185	26	17%	2.0
9029	3651	156	176	20	13%	1.5

HGV 8 to 9 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
9211	3651	126	129	3	2%	0.3
9212	3651	33	33	0	0%	0.0
3710	3702	36	38	2	6%	0.4
9780	3702	183	192	9	5%	0.6
9781	3702	39	47	8	21%	1.3
9982	3702	303	271	-32	-11%	1.9
3560	3705	228	194	-34	-15%	2.4
3708	3705	132	127	-5	-3%	0.4
9967	3705	12	13	1	7%	0.2
9968	3705	180	183	3	1%	0.2
9010	3706	15	20	5	36%	1.3
9963	3706	132	147	15	11%	1.3
9964	3706	177	193	16	9%	1.2
9968	3706	252	249	-3	-1%	0.2
3716	3712	66	60	-6	-9%	0.7
3721	3712	72	80	8	12%	1.0
9139	3712	21	21	0	-1%	0.1
3712	3721	69	62	-7	-10%	0.8
3722	3721	93	93	0	0%	0.0
9783	3721	114	112	-2	-2%	0.2
3553	3726	681	873	192	28%	6.9
3726	3728	15	51	36	240%	6.3
9989	3728	12	126	114	949%	13.7
1754	3731	150	164	14	9%	1.1
1755	3731	42	56	14	32%	1.9
3730	3731	159	160	1	1%	0.1
3732	3733	147	173	26	17%	2.0
3734	3733	168	134	-34	-20%	2.8
3761	3733	168	188	20	12%	1.5
9784	3733	18	41	23	130%	4.3
3733	3734	78	90	12	15%	1.3
3735	3734	6	54	48	793%	8.7
9783	3734	84	100	16	19%	1.7
1776	3751	575	534	-41	-7%	1.7
3768	3753	401	402	1	0%	0.0
3733	3761	177	198	21	12%	1.6
3771	3761	171	197	26	15%	1.9
3775	3761	108	230	122	113%	9.4
3794	3761	63	223	160	254%	13.4
3753	3768	458	445	-13	-3%	0.6
3780	3781	51	41	-10	-20%	1.5
3787	3781	342	328	-14	-4%	0.8
3781	3783	90	95	5	6%	0.6
3782	3783	228	225	-3	-1%	0.2
3783	3785	279	300	21	8%	1.2
3784	3785	27	27	0	0%	0.0
3703	3786	297	298	1	0%	0.1
3785	3786	129	135	6	5%	0.6
3786	3787	387	344	-43	-11%	2.3
3788	3787	66	39	-27	-41%	3.7
3635	9780	168	167	-1	-1%	0.1
3702	9780	297	205	-92	-31%	5.8
9006	9780	48	47	-1	-1%	0.1
9028	9780	33	27	-6	-19%	1.2

HGV 8 to 9 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
9006	9782	6	7	1	21%	0.5
9139	9782	21	22	1	3%	0.1
9141	9782	15	14	-1	-10%	0.4
1372	1390	135	136	1	1%	0.1
1389	1390	102	102	0	0%	0.0
1391	1390	75	107	32	43%	3.4
1367	1391	6	2	-4	-75%	2.3
1390	1391	138	142	4	3%	0.3
1392	1391	138	101	-37	-27%	3.4
1407	1391	120	46	-74	-62%	8.2
1359	1392	12	11	-1	-8%	0.3
1391	1392	159	178	19	12%	1.5
1393	1392	153	143	-10	-7%	0.8
1417	1392	12	21	9	78%	2.3
1346	1393	96	114	18	18%	1.7
1392	1393	177	179	2	1%	0.1
1394	1393	219	228	9	4%	0.6
1409	1393	0	23	23	#DIV/0!	6.8
1334	1394	162	137	-25	-15%	2.1
1393	1394	258	258	0	0%	0.0
1410	1394	186	168	-18	-9%	1.3
1413	1394	90	112	22	24%	2.2
1334	1410	111	119	8	7%	0.7
1394	1410	195	238	43	22%	2.9
1411	1410	216	248	32	15%	2.1
1411	1851	336	370	34	10%	1.8
9099	1851	78	108	30	39%	3.1
9104	1851	111	146	35	32%	3.1
1853	1852	120	203	83	70%	6.6
9104	1852	240	221	-19	-8%	1.3
9135	1852	33	37	4	11%	0.6
1855	1854	108	174	66	61%	5.6
9093	1854	12	41	29	245%	5.7
9094	1854	204	222	18	9%	1.2
1804	1855	12	73	61	508%	9.3
1854	1855	216	225	9	4%	0.6
9091	1855	3	6	3	106%	1.5
1857	1856	81	100	19	23%	2.0
9089	1856	21	1	-20	-97%	6.2
9123	1856	210	209	-1	-1%	0.1
9088	1857	24	26	2	7%	0.3
9113	1857	96	116	20	21%	2.0
9132	1857	186	204	18	9%	1.3
1813	1858	84	132	48	58%	4.7
9063	1858	66	44	-22	-33%	3.0
9113	1858	312	337	25	8%	1.4
3754	3642	853	1037	184	22%	6.0
3642	3754	883	988	105	12%	3.4
3644	3533	794	999	205	26%	6.8
3533	3644	817	876	59	7%	2.0
3614	3552	126	161	35	28%	3.0
3613	3631	264	253	-11	-4%	0.7
3612	3621	90	73	-17	-19%	1.9
3611	3604	198	205	7	3%	0.5

HGV 8 to 9 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
1382	1377	315	510	195	62%	9.6
1301	1302	312	407	95	30%	5.0
2171	2001	579	661	82	14%	3.3
9118	1855	108	101	-7	-6%	0.7
1856	1857	192	207	15	8%	1.1

Combined Traffic 7 to 8 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
1942	1941	893	1025	132	15%	4.3
2151	2012	1530	1551	21	1%	0.5
2102	9900	905	809	-96	-11%	3.3
1773	1776	847	910	63	7%	2.1
9093	1854	267	377	110	41%	6.1
3622	3603	297	195	-102	-34%	6.5
2012	2013	1416	1468	52	4%	1.4
9137	1333	312	638	326	104%	14.9
1703	1702	1738	1727	-11	-1%	0.3
1301	2001	1172	1537	365	31%	9.9
1301	1361	540	580	40	7%	1.7
9088	1857	311	240	-71	-23%	4.3
2861	2364	1034	620	-414	-40%	14.4
1362	1361	712	839	127	18%	4.6
1729	1728	964	1023	59	6%	1.9
3551	3535	4042	4121	79	2%	1.2
3794	3761	575	677	102	18%	4.1
9038	1703	1023	878	-145	-14%	4.7
2008	2018	256	466	210	82%	11.1
1372	1390	246	206	-40	-16%	2.7
2981	2147	661	543	-118	-18%	4.8
1799	1329	1564	1631	67	4%	1.7
9113	1857	981	1165	184	19%	5.6
2082	2101	1389	1492	103	7%	2.7
1373	1301	1903	1781	-122	-6%	2.8
9052	1727	698	735	37	5%	1.4
1853	1852	1351	1547	196	14%	5.1
1361	1301	519	839	320	62%	12.3
9060	1702	550	557	7	1%	0.3
1394	1393	1568	1471	-97	-6%	2.5
3631	3613	1731	1728	-3	0%	0.1
3751	1776	1318	1242	-76	-6%	2.1
1726	1725	1250	1244	-6	-1%	0.2
9783	3734	926	988	62	7%	2.0
1788	1776	372	213	-159	-43%	9.3
3517	3516	697	586	-111	-16%	4.4
1395	1382	2003	1966	-37	-2%	0.8
1383	1382	821	788	-33	-4%	1.2
9031	3602	512	464	-48	-9%	2.2
9091	1855	186	229	43	23%	3.0
1851	1411	2023	1793	-230	-11%	5.3
1390	1391	721	672	-49	-7%	1.9
3604	3611	289	267	-22	-8%	1.3
9901	2172	1153	760	-393	-34%	12.7
1410	1394	1470	1286	-184	-13%	5.0
1393	1392	1097	1039	-58	-5%	1.8
9063	1858	278	218	-60	-22%	3.8
3775	3761	282	522	240	85%	12.0
1392	1391	947	791	-156	-16%	5.3
9967	3705	104	65	-39	-38%	4.2
1394	1410	1004	996	-8	-1%	0.3
9061	1703	1270	1312	42	3%	1.2
9784	3733	328	330	2	1%	0.1
1334	1394	517	565	48	9%	2.1

Combined Traffic 7 to 8 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
1389	1390	639	491	-148	-23%	6.2
9963	3706	338	338	0	0%	0.0
1411	1410	1987	1772	-215	-11%	5.0
9099	1851	688	537	-151	-22%	6.1
3535	3551	3018	2817	-201	-7%	3.7
9781	3702	243	287	44	18%	2.7
9045	1727	206	153	-53	-26%	4.0
9050	1727	102	91	-11	-10%	1.1
9104	1852	1113	1107	-6	0%	0.2
2313	2306	1273	1138	-135	-11%	3.9
9135	1852	215	428	213	99%	11.9
3621	3612	545	476	-69	-13%	3.1
1393	1394	1110	1079	-31	-3%	0.9
9006	9782	140	116	-24	-17%	2.1
9010	3706	227	219	-8	-3%	0.5
3726	3553	4044	4240	196	5%	3.1
1409	1393	381	302	-79	-21%	4.3
3734	3733	1268	1197	-71	-6%	2.0
9104	1851	1382	1360	-22	-2%	0.6
9139	9782	125	122	-3	-2%	0.3
3721	3712	585	561	-24	-4%	1.0
9067	1725	630	565	-65	-10%	2.7
9123	1856	981	1001	20	2%	0.6
1705	1702	434	433	-1	0%	0.1
1804	1855	150	265	115	77%	8.0
1392	1393	831	901	70	8%	2.4
1745	1725	661	596	-65	-10%	2.6
1384	1383	674	757	83	12%	3.1
2104	2103	1339	1409	70	5%	1.9
3516	3517	316	187	-130	-41%	8.2
9783	3721	466	435	-31	-7%	1.4
2103	2085	1245	1394	149	12%	4.1
1411	1851	1228	1334	106	9%	3.0
1302	1303	1560	1233	-327	-21%	8.8
1919	1471	801	830	29	4%	1.0
2158	2157	601	589	-12	-2%	0.5
9141	9782	301	313	12	4%	0.7
1346	1393	443	427	-16	-4%	0.7
2951	2124	617	626	9	1%	0.3
3552	3614	1737	1826	89	5%	2.1
1413	1394	435	363	-72	-17%	3.6
2166	2154	734	746	12	2%	0.4
2931	2112	1394	1380	-14	-1%	0.4
2350	2354	439	456	17	4%	0.8
3603	3602	1743	1740	-3	0%	0.1
9053	1727	273	444	171	62%	9.0
3786	3787	1377	1646	269	20%	6.9
1391	1390	904	798	-106	-12%	3.6
3735	3734	219	323	104	47%	6.3
2871	2447	657	713	56	9%	2.1
3722	3721	1177	1121	-56	-5%	1.6
1391	1392	789	862	73	9%	2.5
1705	1728	451	503	52	12%	2.4
9216	3517	365	456	91	25%	4.5

Combined Traffic 7 to 8 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
1103	1309	518	491	-27	-5%	1.2
1855	1854	1221	1209	-12	-1%	0.3
3702	9780	1403	1484	81	6%	2.1
3602	3651	781	836	55	7%	1.9
1685	1846	1155	1116	-39	-3%	1.2
9089	1856	165	16	-150	-91%	15.7
9094	1854	1121	1116	-5	0%	0.1
3730	3731	927	885	-42	-5%	1.4
1857	1856	969	940	-29	-3%	0.9
2338	2337	797	831	34	4%	1.2
1908	1431	692	645	-47	-7%	1.8
9227	3516	622	555	-67	-11%	2.8
1776	3751	1259	1007	-252	-20%	7.5
3710	3702	363	366	3	1%	0.1
1847	1846	1943	1733	-210	-11%	4.9
3560	3705	1659	1640	-19	-1%	0.5
2891	2890	1105	1064	-41	-4%	1.2
2074	2066	183	172	-11	-6%	0.8
9139	3712	364	349	-15	-4%	0.8
9130	3515	1075	1046	-29	-3%	0.9
9132	1857	450	360	-90	-20%	4.5
3782	3783	1157	1035	-122	-11%	3.7
2013	2012	1117	953	-164	-15%	5.1
3716	3712	475	458	-17	-4%	0.8
9982	3702	1457	1532	75	5%	1.9
1917	1469	758	695	-63	-8%	2.3
1131	1319	1122	1054	-68	-6%	2.1
1407	1391	218	198	-20	-9%	1.4
1417	1392	316	350	34	11%	1.9
3787	3781	1488	1502	14	1%	0.4
2148	2154	528	703	175	33%	7.1
2162	2172	1867	2264	397	21%	8.7
2014	2013	1117	977	-140	-13%	4.3
1359	1392	151	127	-24	-16%	2.1
1101	1306	546	600	54	10%	2.3
3780	3781	184	355	171	93%	10.4
1685	1682	1272	1248	-24	-2%	0.7
3602	3603	775	779	4	1%	0.1
2961	2134	578	593	15	3%	0.6
1667	1682	915	833	-82	-9%	2.8
9029	3651	794	669	-125	-16%	4.6
3651	3602	771	645	-126	-16%	4.7
3733	3761	681	674	-7	-1%	0.3
1681	1682	777	783	6	1%	0.2
1829	1846	219	218	-1	-1%	0.1
3733	3734	446	454	8	2%	0.4
3511	3515	363	385	22	6%	1.1
3732	3733	365	350	-15	-4%	0.8
9217	3517	609	468	-141	-23%	6.1
3768	3753	1133	1067	-66	-6%	2.0
1724	1725	483	488	5	1%	0.2
1754	3731	246	189	-57	-23%	3.8
9780	3702	657	786	129	20%	4.8
9968	3706	1758	1744	-14	-1%	0.3

Combined Traffic 7 to 8 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
3604	3603	1529	1342	-187	-12%	4.9
1813	1858	552	665	113	21%	4.6
9006	9780	556	524	-32	-6%	1.4
3553	3726	1900	1964	64	3%	1.4
1850	1848	447	456	9	2%	0.4
2011	2001	957	859	-98	-10%	3.2
3761	3733	529	543	14	3%	0.6
9052	1728	443	451	8	2%	0.4
3515	1682	1126	1060	-66	-6%	2.0
2065	2066	137	142	5	3%	0.4
3712	3721	520	638	118	23%	4.9
9113	1858	1069	1047	-22	-2%	0.7
3785	3786	819	794	-25	-3%	0.9
2155	2154	1650	1515	-135	-8%	3.4
9964	3706	635	625	-10	-2%	0.4
1682	3515	643	650	7	1%	0.3
1849	3516	452	458	6	1%	0.3
3784	3785	224	218	-6	-3%	0.4
3708	3705	697	688	-9	-1%	0.4
1755	1776	845	789	-56	-7%	2.0
2172	1303	1415	1660	245	17%	6.2
9968	3705	578	567	-11	-2%	0.5
2851	2352	650	594	-56	-9%	2.3
3771	3761	526	563	37	7%	1.6
1429	1428	1262	1478	216	17%	5.8
1854	1855	1119	1117	-2	0%	0.1
2711	2059	687	655	-32	-5%	1.3
1367	1391	7	1	-6	-82%	2.8
3753	3768	972	639	-333	-34%	11.7
9028	9780	120	65	-55	-46%	5.8
1930	1931	628	698	70	11%	2.7
3635	9780	602	584	-18	-3%	0.7
3788	3787	439	461	22	5%	1.0
3703	3786	1678	1642	-36	-2%	0.9
9126	1848	352	337	-15	-4%	0.8
1755	3731	225	262	37	16%	2.3
9211	3651	415	423	8	2%	0.4
9212	3651	64	64	0	0%	0.0
3783	3785	1230	1199	-31	-2%	0.9
2911	2092	381	239	-142	-37%	8.1
3781	3783	311	307	-4	-1%	0.2
1334	1410	224	251	27	12%	1.7
3754	3642	4147	4057	-90	-2%	1.4
3642	3754	3373	4030	657	19%	10.8
3644	3533	3018	3378	360	12%	6.4
3533	3644	4042	3522	-520	-13%	8.5
3614	3552	672	862	190	28%	6.8
3613	3631	754	720	-34	-4%	1.2
3612	3621	1279	1239	-40	-3%	1.1
3611	3604	1597	1425	-172	-11%	4.4
1382	1377	2070	2107	37	2%	0.8
1301	1302	1469	1249	-220	-15%	6.0
2171	2001	1482	1271	-211	-14%	5.7
3726	3728	415	266	-149	-36%	8.1

Combined Traffic 7 to 8 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
9989	3728	219	661	442	202%	21.1
9118	1855	1109	1100	-9	-1%	0.3
1856	1857	916	940	24	3%	0.8
1859	1858	1288	1147	-141	-11%	4.1
1856	1857	192	207	15	8%	1.1

Combined Traffic 8 to 9 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
9113	1857	638	1120	482	76%	16.3
3533	3644	3924	3163	-761	-19%	12.8
1857	1856	566	993	427	75%	15.3
1919	1471	685	1100	415	61%	13.9
1302	1303	1277	982	-295	-23%	8.8
9901	2172	1033	684	-349	-34%	11.9
3771	3761	536	838	302	56%	11.5
2861	2364	1187	671	-516	-43%	16.9
2981	2147	652	914	262	40%	9.4
9989	3728	233	561	328	141%	16.5
2082	2101	1228	1695	467	38%	12.2
3761	3733	583	843	260	45%	9.7
9217	3517	747	499	-248	-33%	9.9
2711	2059	980	684	-296	-30%	10.2
9089	1856	171	53	-118	-69%	11.1
9967	3705	221	82	-139	-63%	11.3
3622	3603	384	156	-228	-59%	13.9
3735	3734	170	357	187	110%	11.5
1429	1428	1020	1326	306	30%	8.9
2011	2001	973	855	-118	-12%	3.9
9141	9782	294	460	166	56%	8.6
2014	2013	1042	872	-170	-16%	5.5
2158	2157	767	1035	268	35%	8.9
3511	3515	552	756	204	37%	8.0
2151	2012	1656	1505	-151	-9%	3.8
3786	3787	2363	1973	-390	-17%	8.4
2013	2012	1042	884	-158	-15%	5.1
2148	2154	637	478	-159	-25%	6.7
1799	1329	1884	1664	-220	-12%	5.2
3712	3721	543	709	166	31%	6.6
2338	2337	568	801	233	41%	8.9
2172	1303	1485	1596	111	7%	2.8
2102	9900	1110	1202	92	8%	2.7
1103	1309	679	754	75	11%	2.8
3732	3733	505	406	-99	-20%	4.6
2104	2103	1670	1390	-280	-17%	7.2
9029	3651	954	740	-214	-22%	7.4
2313	2306	1114	864	-250	-22%	8.0
1362	1361	728	680	-48	-7%	1.8
1410	1394	1525	1249	-276	-18%	7.4
1853	1852	1204	1517	313	26%	8.5
9137	1333	409	650	241	59%	10.5
3768	3753	1039	1204	165	16%	4.9
9099	1851	643	521	-122	-19%	5.1
1372	1390	326	254	-72	-22%	4.2
3602	3651	631	823	192	30%	7.1
2171	2001	1388	1234	-154	-11%	4.2
1393	1392	1114	917	-197	-18%	6.2
1411	1410	1984	1747	-237	-12%	5.5
3710	3702	502	651	149	30%	6.2
2012	2013	1485	1360	-125	-8%	3.3
3775	3761	332	566	234	70%	11.0
3733	3761	624	799	175	28%	6.5
2911	2092	476	596	120	25%	5.2

Combined Traffic 8 to 9 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
3612	3621	1317	1531	214	16%	5.7
1788	1776	557	323	-234	-42%	11.1
1394	1393	1634	1381	-253	-15%	6.5
1392	1391	962	753	-209	-22%	7.1
1373	1301	1453	1761	308	21%	7.7
1391	1390	913	767	-146	-16%	5.1
9104	1852	1181	1015	-166	-14%	5.0
3708	3705	962	803	-159	-17%	5.4
1395	1382	1655	1921	266	16%	6.3
9216	3517	516	605	89	17%	3.8
1101	1306	592	766	174	29%	6.7
1855	1854	1007	1239	232	23%	6.9
9781	3702	357	462	105	29%	5.2
1755	3731	255	364	109	43%	6.2
3703	3786	1924	2129	205	11%	4.5
9118	1855	780	901	121	16%	4.2
9010	3706	304	390	86	28%	4.6
1917	1469	553	652	99	18%	4.0
1681	1682	1104	1001	-103	-9%	3.2
1850	1848	495	634	139	28%	5.9
1334	1410	313	262	-51	-16%	3.0
1301	1302	1008	1193	185	18%	5.6
1393	1394	1246	1167	-79	-6%	2.3
1384	1383	448	628	180	40%	7.8
1390	1391	729	695	-34	-5%	1.3
1847	1846	2061	1919	-142	-7%	3.2
3614	3552	1010	946	-64	-6%	2.1
1383	1382	735	761	26	4%	0.9
9104	1851	1331	1276	-55	-4%	1.5
1854	1855	1282	1237	-45	-3%	1.3
1361	1301	643	672	29	5%	1.1
1389	1390	588	568	-20	-3%	0.8
2155	2154	1810	1732	-78	-4%	1.9
3553	3726	2245	2543	298	13%	6.1
2871	2447	810	924	114	14%	3.9
9982	3702	1929	1789	-140	-7%	3.3
9053	1727	473	510	37	8%	1.7
3613	3631	1005	945	-60	-6%	1.9
2065	2066	203	201	-2	-1%	0.1
1301	2001	1171	1362	191	16%	5.4
3734	3733	1149	1197	48	4%	1.4
9031	3602	688	559	-129	-19%	5.2
3722	3721	1096	1045	-51	-5%	1.6
9028	9780	206	230	24	12%	1.7
1705	1728	455	440	-15	-3%	0.7
2891	2890	1002	1057	55	5%	1.7
2074	2066	318	324	6	2%	0.3
3635	9780	856	814	-42	-5%	1.4
3726	3553	3908	4166	258	7%	4.1
3726	3728	397	482	85	21%	4.0
3631	3613	1659	1573	-86	-5%	2.2
1131	1319	895	976	81	9%	2.7
1685	1846	1057	1141	84	8%	2.5
3602	3603	1000	1091	91	9%	2.8

Combined Traffic 8 to 9 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
1382	1377	1829	2055	226	12%	5.1
3644	3533	3275	3424	149	5%	2.6
2162	2172	2085	2187	102	5%	2.2
1413	1394	428	416	-12	-3%	0.6
3781	3783	413	388	-25	-6%	1.3
3702	9780	1721	1560	-161	-9%	4.0
2103	2085	1448	1389	-59	-4%	1.6
3642	3754	3401	3575	174	5%	2.9
3780	3781	266	227	-39	-15%	2.5
1754	3731	283	264	-19	-7%	1.1
1724	1725	926	983	57	6%	1.8
1367	1391	26	21	-5	-19%	1.0
9060	1702	829	781	-48	-6%	1.7
3733	3734	521	563	42	8%	1.8
3611	3604	1531	1472	-59	-4%	1.5
9968	3706	1972	2015	43	2%	1.0
3604	3603	1423	1373	-50	-4%	1.3
3716	3712	542	502	-40	-7%	1.8
1685	1682	1353	1396	43	3%	1.2
3535	3551	3275	3426	151	5%	2.6
3782	3783	1608	1546	-62	-4%	1.6
3603	3602	1696	1652	-44	-3%	1.1
1942	1941	859	973	114	13%	3.8
1411	1851	1436	1453	17	1%	0.4
1394	1410	1049	1086	37	4%	1.1
9038	1703	785	766	-19	-2%	0.7
9088	1857	393	414	21	5%	1.1
1745	1725	990	877	-113	-11%	3.7
2166	2154	833	871	38	5%	1.3
9094	1854	1223	1199	-24	-2%	0.7
9006	9782	146	143	-3	-2%	0.3
1334	1394	494	516	22	4%	1.0
3754	3642	3952	4053	101	3%	1.6
1703	1702	1621	1592	-29	-2%	0.7
9783	3721	530	549	19	4%	0.8
3551	3535	3921	4072	151	4%	2.4
1409	1393	222	247	25	11%	1.6
1407	1391	311	214	-97	-31%	6.0
1682	3515	766	793	27	4%	1.0
2851	2352	806	766	-40	-5%	1.4
1773	1776	1089	1257	168	15%	4.9
3517	3516	726	708	-18	-2%	0.7
3730	3731	1030	1014	-16	-2%	0.5
1667	1682	1036	984	-52	-5%	1.6
1359	1392	190	191	1	0%	0.0
9052	1728	542	574	32	6%	1.4
1346	1393	438	440	2	0%	0.1
3552	3614	1902	1918	16	1%	0.4
9123	1856	1032	1024	-8	-1%	0.2
2350	2354	527	560	33	6%	1.4
9050	1727	154	159	5	3%	0.4
9063	1858	353	316	-37	-10%	2.0
1813	1858	724	757	33	5%	1.2
3516	3517	496	527	31	6%	1.4

Combined Traffic 8 to 9 am

A-Node	B-Node	Count (C)	Modelled Flow (M)	Difference (M-C)	Difference (M-C)%	GEH
1705	1702	536	484	-52	-10%	2.3
9212	3651	49	49	0	0%	0.0
9963	3706	518	533	15	3%	0.7
9963	3706	386	386	0	0%	0.0

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Certificate of valid use of DTO Model

Project:	Metro North
Consultant:	MVA Consultancy
Client:	Railway Procurement Agency
Date of modelling work:	January 2009

This certificate refers to modelling work using the DTO's strategic multi-modal transport model, undertaken by MVA Consultancy on behalf of the Railway Procurement Agency on the above project in January 2009. The purpose of the modelling analysis was to test the net impacts of the Metro North construction works prior to full implementation of the scheme. The modelling results will be an input into the production of an Environmental Impact Statement for the construction phase of Metro North.

The modelling analysis undertaken by MVA on this project is based on three runs of the DTO model as follows:

1996	Base year
2009	Pre construction phase of Metro North
2011	Construction phase of Metro North

The analysis was based on runs of the DTO's multi-modal model covering the AM peak period 07:00 to 10:00 and the afternoon off-peak 14:00 to 15:00.

In undertaking this analysis, MVA have used a cordon of the DTO model covering the area impacted by Metro North construction works and by the traffic management arrangements to be put in place during this scheme construction phase. Using this cordon, they calibrated their own Metro North traffic model for the 2006 base year. The forecast year runs for 2009 and 2011 using this model take full account of the agreed land use inputs into the DTO model for these years.

The DTO can now confirm that the modelling analysis undertaken by MVA consultancy on this project is based on valid runs of the DTO model. The process of using a cordon of the DTO model is a standard modelling technique. It is required to create a local model of sufficient detail to test the net impacts of the construction phase of Metro North.

Certified by:

F. McCabe.

Frank McCabe,
Technical Director

Date:

23/02/2009

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