Appendix J

Base 2018 Model Update Report

Eastern Busway - Base 2018 Model Update Report

Prepared for Auckland Transport (AT)
Prepared by Beca Limited

28 February 2019

Contents

Appendices

List of Abbreviations

Abbreviation	
ADTA	Auckland Dynamic Traffic Assignment (model)
AFC	Auckland Forecasting Centre
AMETI	Auckland-Manuka Eastern Transport Initiative
AT	Auckland Transport
GEH	Gesellschaft zur Erhaltung alter und gefährdeter Haustierrassen (statistic)
JDF	Junction Delay Function
MSM	Macro Strategic Model
NZTA	New Zealand Transport Agency
QLD	Queensland model (Aimsun model in Australia)
SCATS	Sydney Coordinated Adaptive Traffic System
TPF	Turn Delay Function
VDF	Volume Delay Function
EB	Eastern Busway

Table of Figures

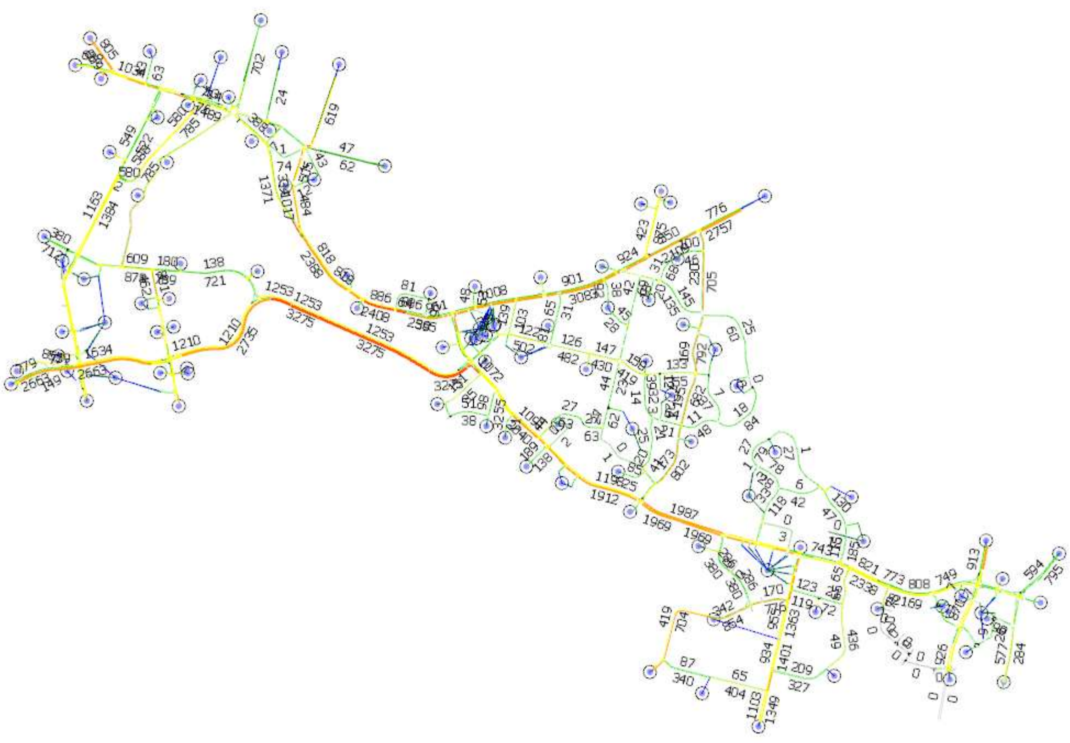


Table of Tables

Revision History

Revision Nº	Prepared By	Description	Date
1.0	**Ling Hoong**	Draft for client comments	1 March 2019

Document Acceptance

Action	Name	Signed	Date
Prepared by	**Ling Hoong**		1 March 2019
Reviewed by	**Caleb Deverell / Nyan Aung Lin**		1 March 2019
Approved by	**Andrew Murray**		1 March 2019
on behalf of	Beca Limited		

Executive Summary

This report details the update and calibration/validation of the Aimsun model for the Eastern Busway Project. The purpose of this model is to provide a consistent and common base for project developments in the East Auckland Area, primarily along Ti Rakau Drive for the EB 2 and EB3 detailed design work.

The model covers two three-hour peak periods (6.30 am – 9.30 am, and 3.30 pm – 6.30 pm). The modelled periods were chosen to capture the congestion typically experienced in the modelled area.

The model consists of macro and micro tiers with the respective assignment methods: static assignment and microscopic dynamic assignment (DTA). The macro tier provides an interim stage to calibrate the demand through demand adjustment and to generate 80% of paths for the micro DTA. Based on previous modelling of the area, an 80-to-20 split in static versus dynamic path assignment was considered appropriate. This gave better control of modelling route choice in the area and sense-checks during the model development process showed that route distribution in the model is reasonable.

Various observed data were provided by Auckland Transport (AT) for the model development. These included traffic counts, travel time, public transport timing, and signal timing.

The traffic demands come from the AMETI EMME traffic model and were processed before assigning to the Aimsun model. This demand interface process includes a minor refinement of AMETI traffic model zones and application of 2-to-3 hour expansion factors to fit the Aimsun model period. Demand adjustment as part of the validation process was done manually.

The model network was developed in line with the Auckland Dynamic Traffic Assignment Model (ADTA) network coding guideline, which sets out the recommended network coding methodology for Aimsun models in Auckland. This included a standard system of classification and labelling of different turn movement types which were important function variables in the ADTA-developed cost functions also adopted in this model for calculating junction and turn delays.

Model validation showed that the model meets the validation target criteria for Category C: Urban Area in NZTA Model Development Guidelines on individual link flows and turn flows for each hour between 7am – 9am, and 4pm – 6pm. Travel times in the model fit reasonably well with the observed.

Overall, the base year model is considered acceptably calibrated and validated for the purposes of the EB2/3 design work.

1 Introduction

1.1 Background

This report documents the calibration and validation of the Aimsun model to the year 2018.

The Eastern Busway project is focused on developing an integrated multi-modal transport system that supports population and economic growth in East Auckland and Manukau. This involves providing more and better transport choices and aims to significantly enhance the safety, quality and attractiveness of passenger transport, walking and cycling environments.

Beca Ltd (Beca) was commissioned by the Auckland Transport (AT) to update the existing microsimulation model in Aimsun software for testing scenarios relating to the Eastern Busway project. Figure 1 shows the extent of the model. The model was calibrated to 2018 observations and will be used to forecast operational performance for various future scenarios in 2026.

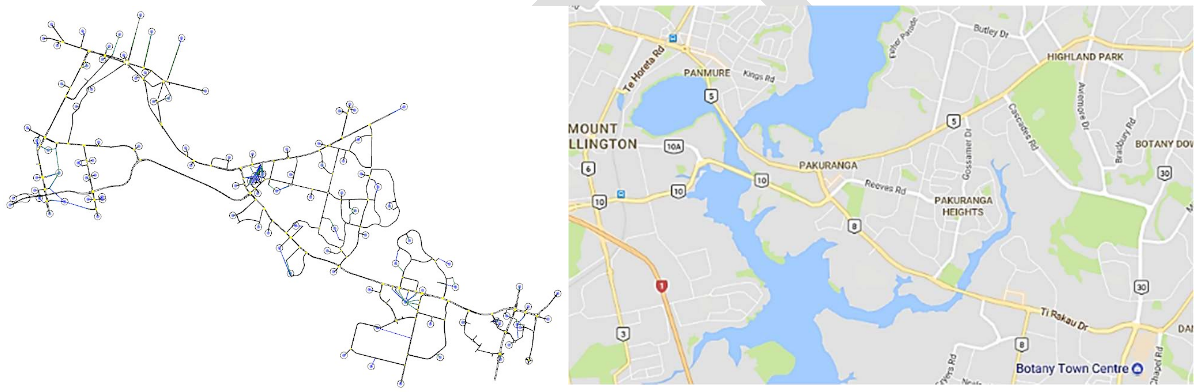


Figure 1 - Snapshot of Aimsun model network and zone structure

1.2 Report Structure

The remainder of this report is structured as follows:

Chapter 2 Describes the model's background and structure;

Chapter 3 Details the model's data inputs;

Chapter 4 Details the model's parameter inputs;

Chapter 5 Presents the calibration and validation results;

Chapter 6 Presents conclusions of this report;

2 Model Background and Structure

2.1 Background and Focus

Previously, an update of the Base model had been undertaken in 2017, focusing on the area around the Panmure Town Centre, including the Panmure roundabout, King's Roundabout and Lagoon Drive, which were of interest for the EB1 project. SCATS and manual traffic counts and observed travel time data were used to validate the model to a 2016 base year for EB1 option-testing.

This update focuses on the EB2/3 corridor which is along Ti Rakau Drive from Pakuranga Highway to Botany (Figure 2). This base year for this model update is 2018 where 2018 input demand were sourced from the AMETI traffic model and calibration/validation process used 2018 counts and travel time information.

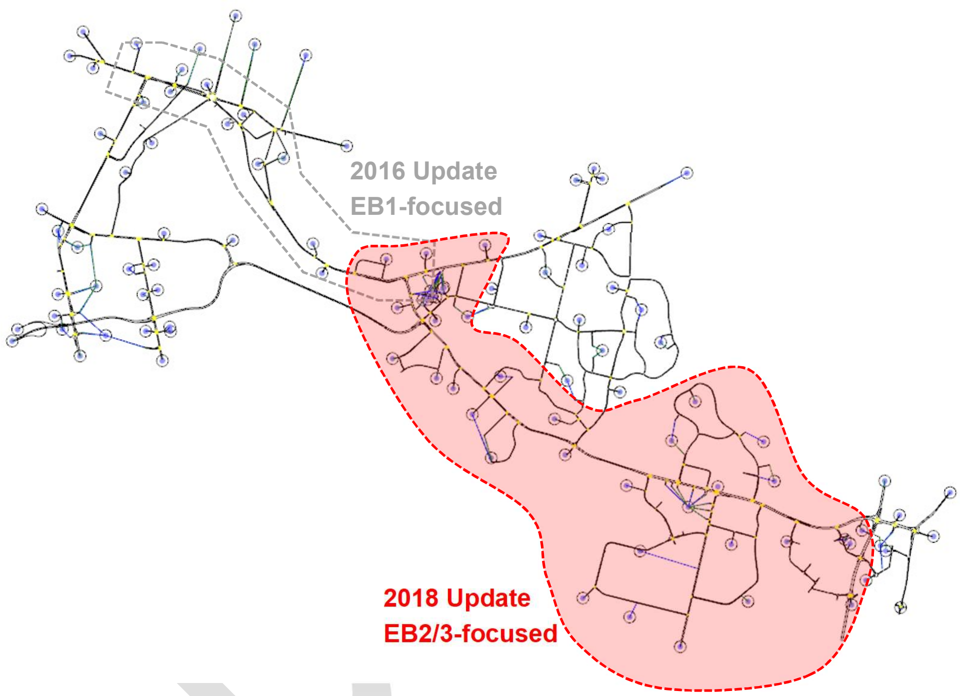


Figure 2 - Aimsun model focus areas: 2016/ EB1-focused (grey) and 2018/ EB2/3-focused (red)

2.2 Model Structure

The Aimsun model follows the hierarchical modelling structure that has been used successfully on other major projects in Auckland since the early 1990's. This involves the following three components:

- A strategic multi-modal **Demand (Macro Strategic Model, MSM)** model (an EMME model developed by AFC) that relates forecast land use (such as population and employment), to travel patterns at a strategic, region-wide level;
- A **Traffic Assignment** model (an EMME model developed by Arup) that has a more refined network representation for the wider study area. It takes the demand matrices from the Demand model and is calibrated to match traffic conditions particularly in the study area of interest. This model provides the cordon matrices for the Project Operational model.
- A **Project Operational** model (an Aimsun model and the focus of this report) that has a more refined network in a smaller project area. This model loads the vehicle trip patterns predicted by the assignment model onto the road network to test various options and investigate the traffic effects at a more detailed level.

It is the **project operational** model, developed in Aimsun that is detailed in this report.
The **demand** model was developed in EMME and is the Macro Strategic Model (MSM) developed by AFC. Also AMETI traffic assignment model was developed in EMME software.

The overall model structure is shown schematically in Figure 3 which comprises a hierarchical structure with the MSM model providing the multi-modal demand forecasts, and the EMME traffic assignment model and the Aimsun project model used for assignment and network performance modelling.

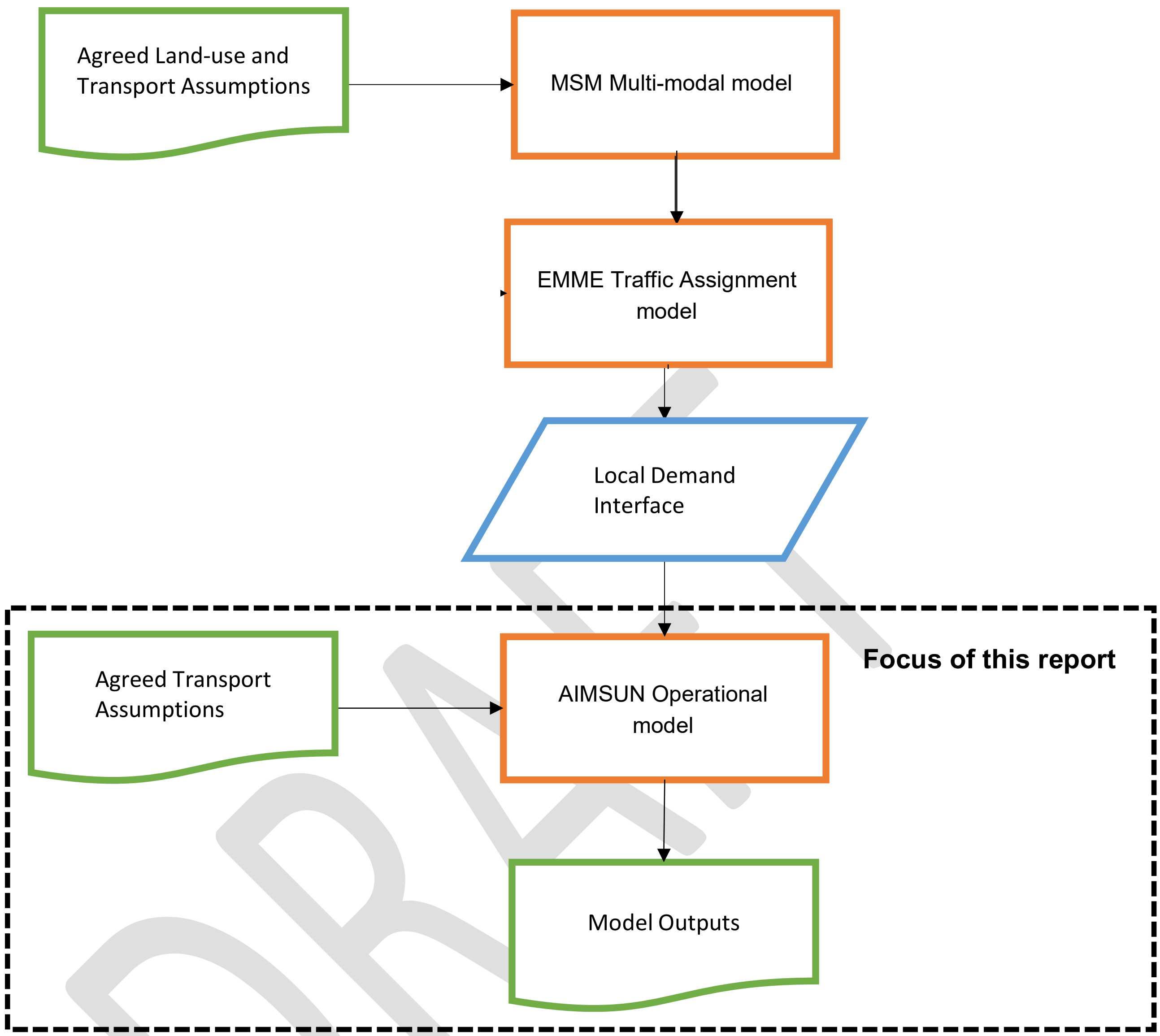


Figure 3 - Model Structure

2.2.1 MSM Demand Model

The MSM model is a traditional 4-step multi-modal model. The original model was developed for the year 2006, using the 2006 Census data and observed travel data. The model was updated in 2017/ 2018 using Census data from 2013, and validated to 2016 conditions. Separate models exist for the morning and evening commuter peaks and weekday inter-peak periods.

The model itself comprises the following key modules:

- **Trip Generation**. This is where the number of person-trips are estimated as a function of the land use data (population, employment, school roll etc.);
- **Mode Choice.** This is where the choice of preferred travel mode is determined, based on the relative attractiveness of the various modes. The key modes are car-driver, car passenger, bus passenger, train passenger and ferry passenger. A process is used to also consider 'slow' modes, such as walking and cycling;

- **Trip Distribution.** This is where the trips produced in each zone (generally by the households), are matched to a preferred destination. This distribution is predicted as a function of the relative attractiveness of each destination zone (generally related to employment), and the travel costs to reach each destination;
- **Time of Day.** This is where the proportion of daily trips occur in each peak. The proportion occurring in each peak changes in future-year models in response to the changes in travel time and costs; and
- **Trip Assignment**. This is where the resulting travel demands, in the form of origin to destination trip tables, are loaded to the road and public transport networks. An iterative process is used to firstly identify the lowest-cost route between each origin and destination, followed by an estimation of the speeds and delays on each route associated with the predicted traffic flows on the route.

The MSM model is operated by AFC and is implemented in the EMME software, which is a well-used and proven platform for this kind of analysis.

It is therefore the MSM model that predicts the overall regional traffic patterns, based on the inputs and forecasts of population and employment growth, together with the assumed level of road and public transport infrastructure.

The MSM standard model years are 2016, 2026 and so on. To get the 2018 regional demand, a demand interpolation process was undertaken between 2016 and 2026 scenarios. The 2016 scenario is the validated MSM base year scenario. As part of this project, a 2026 scenario was developed using the today network layout and bus service patterns.

2.2.2 EMME Traffic Assignment Model

This model was originally developed by Arup in 2010 and was peer-reviewed. This peer-reviewed model was used as the traffic assignment model for the previous AMETI project. The model takes its traffic demands from the MSM model and has the same model extent as MSM but has a more refined network representation in the wider study area of interest (Manukau and Auckland City areas). A zone refinement process was undertaken as an interface between the MSM and traffic assignment models.

2.2.3 Aimsun Operational Model

The Aimsun model is only a traffic operational model in that it takes the localised traffic demands from the EMME traffic assignment model, assigns them to the road network and tests the operation of the network. Land use data is not directly used in this part of the model, and it only considers vehicle traffic i.e. it represents bus vehicles but not passengers.

2.3 Model Time Period

The Aimsun model models two peak periods:

- AM: 6.30am – 9.30am
- PM: 3.30pm – 6.30pm

The traffic counts and typical traffic conditions were evaluated to determine that these time periods are suitable to capture the peak traffic on the network and ending at a time when traffic cooldown is typically observed. Each peak consists of a 15 minute warm-up prior to the peak start time in order to generate an appropriate level of demand inside the network before the official start of the peak.

3 Model Data Inputs

3.1 Network

Most of the road network was formed from the previous version of the Aimsun model (updated for 2016 base year). Additional road network was added in around Cryers Road and Burswood Road in the South East area of the model. Further refinements or error-checking over the whole model were conducted based on ADTA network coding conventions (Ref. 160520_DTA_Template_JMAC_v2.1.3). Network parameters are detailed in Chapter 4.1.

3.2 Demand

The initial demand was from the AMETI assignment model (refer to Chapter 2.2.2) and restructured to match the zone structure in the Aimsun model.

3.2.1 Demand Expansion

The two-hour to three-hour demand expansion factor for each peak was 1.38. This has been applied to the two-hour EMME demands to create a three-hour demand as a starting point for model calibration/validation.

3.2.2 Zone Disaggregation

As discussed earlier, most of the zone refinement was undertaken between the MSM and AMETI traffic assignment models. Only a very limited zone was further refined in the demand interface process between the AMETI traffic and Aimsun models. This process was retained from the previous base model 2016. A zone to zone correlation table is provided in Appendix A.

3.2.3 Demand Release Profiles

For developing traffic release profiles, the zones in the Aimsun model were grouped into six sectors: Panmure, West, Internal, North, East and South (Figure 4). Within the Internal sector, a subset of zones was created to separately represent the region nearest the Panmure Bridge and assigned its own demand profile.

Figure 5 and Figure 6 show the sector-to-sector profiles applied in the Aimsun model. Traffic count profiles at key locations on the network were used as a guideline to develop these demand profiles.

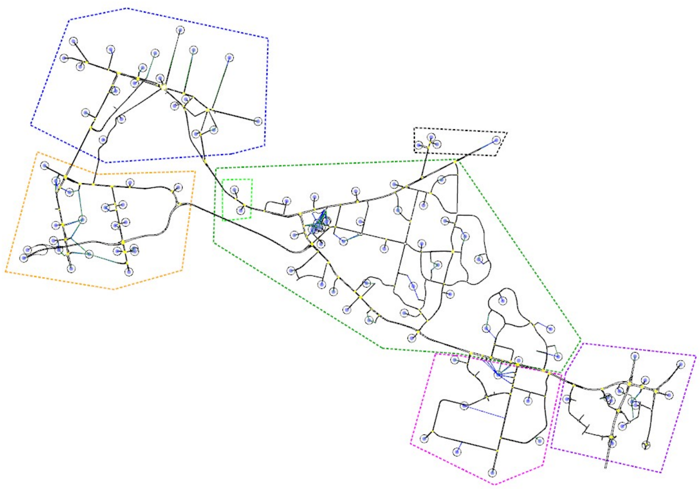


Figure 4 - Aimsun model sectors: Panmure (blue), West (yellow), Internal (dark green) with Panmure Bridge subset (light green), North (black), South (Pink), and East (purple)

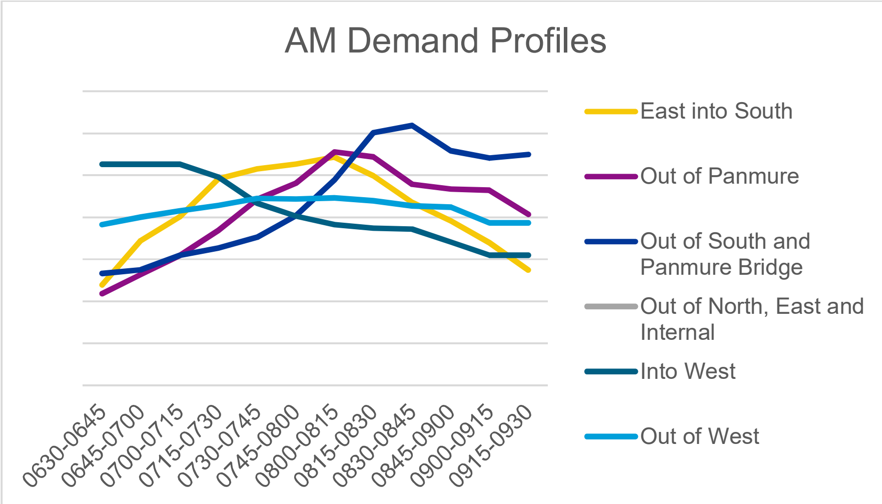


Figure 5 - AM Demand Profiles

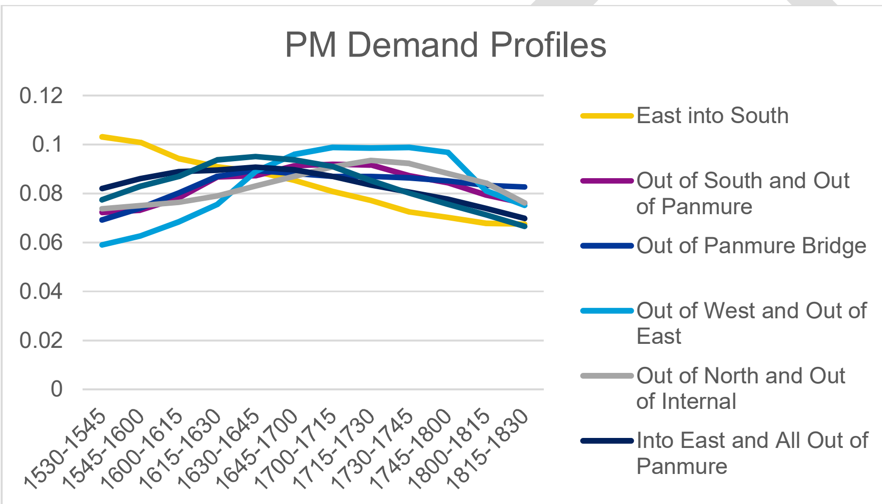


Figure 6 - PM Demand Profiles

3.3 Count Data

All count data for 2018 were provided by AFC, including SCATS detector counts and some manual counts. The locations of these counts used for link validation and turn validation (refer to Chapter 5) are shown in Figure 7 and Figure 8 respectively.

Link validation data was based on the average SCATS data of Tuesdays to Thursdays in March 2018. Turn validation data was based on the average of manual counts taken between Tuesday 12 June 2018 to Thursday 14 June 2018.

A sense-check of count continuity across the network was carried out and only counts that were consistent with adjacent counts were retained. This consisted of the majority of counts. All manual turn counts were checked for continuity with adjacent relevant SCATS counts and all were retained regardless of continuity since manual counts are considered more robust in general and these had been specifically provided by AFC for turn validation in the focus area. All counts used in validation were used as-is, without any further smoothing or processing.

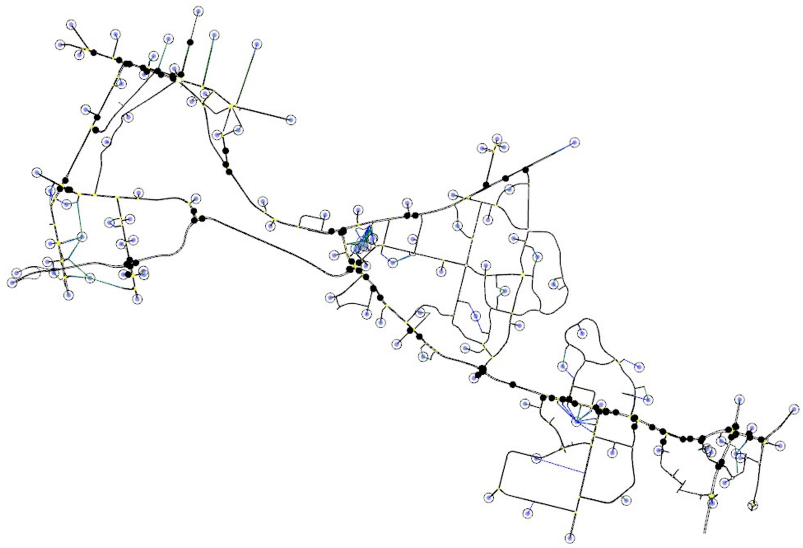


Figure 7 - Count locations used for link validation

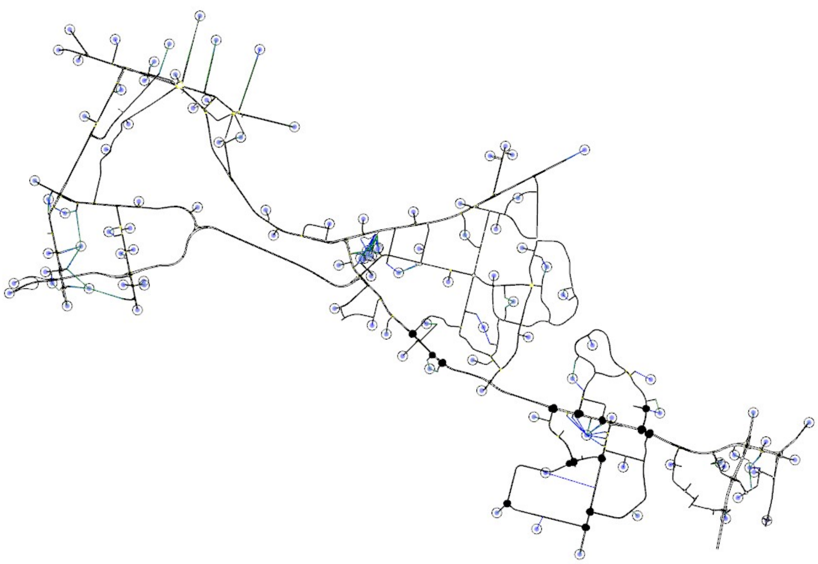


Figure 8 - Count locations used for turn validation, specifically for the model's focus area

3.4 Travel Time Data

The general traffic travel time data for key routes on the network (Figure 9) of Tuesdays to Thursdays in June 2018 was provided by AFC as summarised by Snitch GPS data. The full routes were provided in segments in order to understand the travel time and condition along the route. Following a sense-check of the travel times on Google, only the mean travel time on Ti Rakau Drive between Pakuranga Road and Pakuranga Highway was adjusted. All other travel times were accepted and retained for use in the validation.

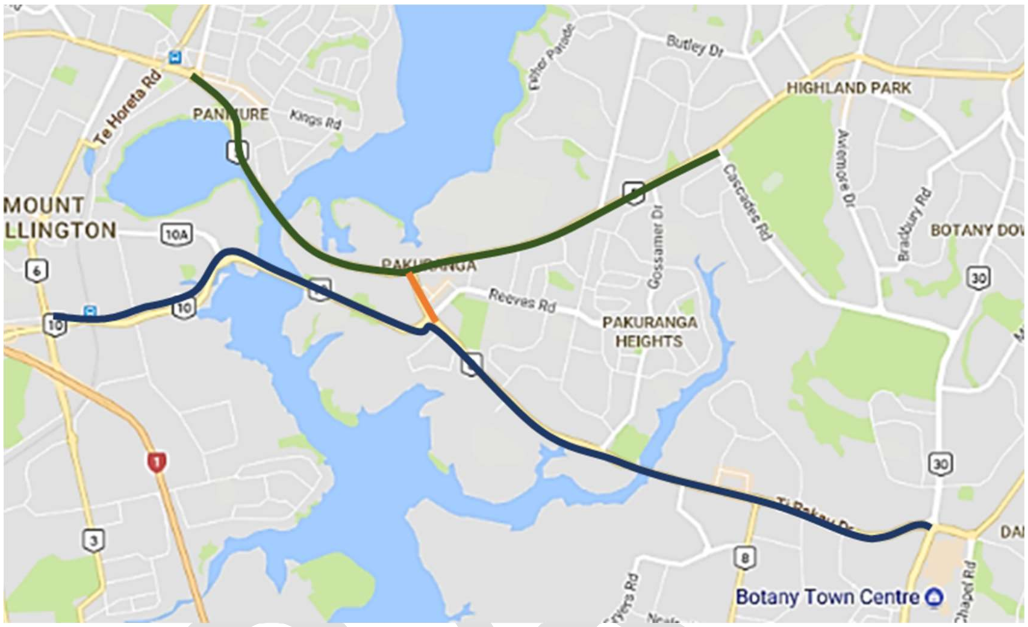


Figure 9 - Travel time routes from Snitch GPS data for reporting travel time validation in Chapter 5

3.5 Public Transport Data

All bus schedules and bus routes were obtained from the Auckland Transport (AT) website. Bus dwell time at bus stops were fixed at 30 sec mean stop time and deviation of 5. Bus travel time data was provided by AFC for March 2018 which included detailed timing of when each bus arrives and leaves each bus stop for each route. Following a sense-check of the travel times calculated from the raw data against AT's Journey Planner App, the average and maximum travel time of the routes were adjusted. The full list of bus services in the model is provided in Appendix D.

3.6 Signal Timing Data

The SCATS signal timing data of 7 March 2018 was provided by AFC for every signalised intersection within the model area. This was used to derive the signal timing coded into the model.

Average of maximum and minimum green times was used to develop the actuated control plan used in the dynamic assignment and initially used in the static assignment. During the model development process, it was noted that a fixed signal plan was more appropriate for model stability in the static assignment. Average green time from the single-day SCATS data was used as a starting point for developing the fixed control plan. Priority was placed on obtaining realistic turn delays and ensuring appropriate route choice distribution across the network rather than strict adherence to the average green times reported from that single day.

4 Model Parameter Inputs

4.1 Network Parameters

4.1.1 Road-Type Parameters

Road type distribution on the model network is summarised in Figure 10. Road type parameters were mostly retained from the ADTA model and provided in Appendix B. Adjustments were made to user-defined cost, third user-defined costs and capacity as part of the calibration process of route choice on the network. Lane-changing cooperation was also adjusted on certain road types to reflect the level of congestion as seen on Google's traffic view modes, and the travel time data.

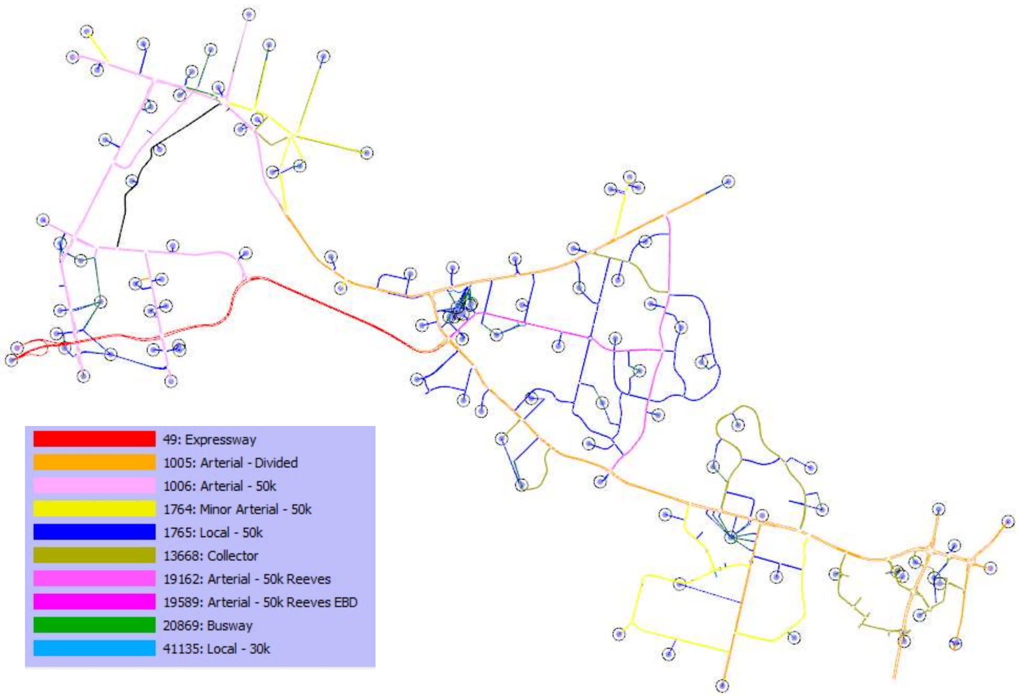


Figure 10 - Road Type Definition in the Aimsun Model

4.1.2 Attribute Overrides

The parameters of some sections and turns were controlled during assignment runs using Aimsun's attribute override functionality. This approach allows parameter values to be adjusted to a value more suitable than the default calculations at a particular section or turn. The parameter values that have been adjusted using attribute overrides are:

- Section maximum speed
- Turn capacity
- Turn look-ahead distance
- Lane-changing cooperation

The full list of these attribute overrides applied in the model is provided in Appendix E.

4.1.3 Traffic Management

Traffic management schemes on the network were applied using Aimsun's traffic management functionality. This approach also allows certain conditions of the road to be applied when they are typically observed during the modelled period and not necessarily throughout the period. Traffic management schemes in the model applied are:

- Panmure Bridge Eastbound Lane Closure: 1 Lane Closed, 6 am – 11 am
- Panmure Bridge Westbound Lane Closure: 1 Lane Closed, 3 pm – 8 pm
- Pakuranga Highway Maximum Speed Change to 55 km/h: 7.15 am – 8.45 am
- Pakuranga Highway Maximum Speed Change to 60 km/h: 4.15 pm – 6.15 pm

Ideally the speed reduction on Pakuranga Highway should be reflected by the model response, rather than the inputs. However this behaviour is hard to replicate in the model due to the unique nature of the road. For example, there is a hidden queue extended from the Pakuranga Highway and Carbine Road intersection to the Wipuna Road in the AM peak. The local drivers reduce their speeds on the bridge accordingly as they know there is a hidden queue in the downstream at the sharp corner. This traffic management inputs were not introduced in this update, they area inherited from the previous model.

4.2 Vehicle Parameters

Vehicle parameters were determined based on comparison and sensitivity testing with those adopted in existing Aimsun models such as ADTA (AFC), and QLD (Aecom) as well as input from the NZTA Axel Classification system. List of key vehicle parameters in the model are provided in Appendix C.

4.3 Cost Calculation

All functions related to calculating the cost of travel time and travel distance in the model were adopted from the ADTA model and used in the static assignment only. The travel time component consists of 1) link travel times, represented by a Volume Delay Function (VDF) on Sections, and 2) delays associated with making a turn at an intersection, represented by a Turn Penalty Function (TPF) and Junction Delay Function (JDF). Cost function scripts used in the model are provided in Appendix G.

The travel distance component reflects perceived vehicle operating costs and helps stabilise the traffic assignment.

4.3.1 Volume Delay Function

The VDF is based on the Akçelik VDF, which is widely adopted by strategic models in New Zealand, including MSM. Its formulation is as follows:

$$t=t_0 \{1 + 0.25 r_f [z + (z^2 + 8 J_A x / (Q t_0 r_f))^{0.5}]\}$$

where:

t = average travel time per unit distance (seconds per km)

t0 = free flow travel time per unit distance (seconds per km)

J_A = Akçelik friction parameter

z = x – 1

x = q / Q = degree of saturation

q = demand flow rate (pcu/hr)

Q = capacity (pcu/hr)

rf = the ratio of flow period to minimum travel time

The distance component, which is added to the travel time cost, is as follows:

d= df x rf x L

where:

d = the distance cost

df = distance factor (0.5 for cars and 1.0 for Trucks)

rf = road type factor

L = length of the section

This function was applied to every Section in the model, including centroid connectors. Different values of free flow speed, link capacity and Akçelik friction factors were defined by road type using Section attributes (Appendix B).

4.3.2 Intersection Delays – Signalised Movements

Aimsun provides default TPFs for signalised turning movements based on their respective green time split, adopting the procedures from Chapter 18 of the Highway Capacity Manual (HCM) 2010.

This procedure requires a movement capacity as an input and in the model this was estimated based on the following formula:

$$Q = Q_s \times l \times g / C$$

where:

Q = capacity of the turning movement (pcu/hr)

Q_s = saturation flow at signal for the turning movement (pcu/hr/lane)

l = number of lanes for the turning movement

g = green time for the turning movement

C = cycle time at the signal

The saturation flow Qs estimation was adopted from the ADTA model and is based on the relationship between saturation flow and turning speed from simulation tests conducted in Aimsun (Figure 11).

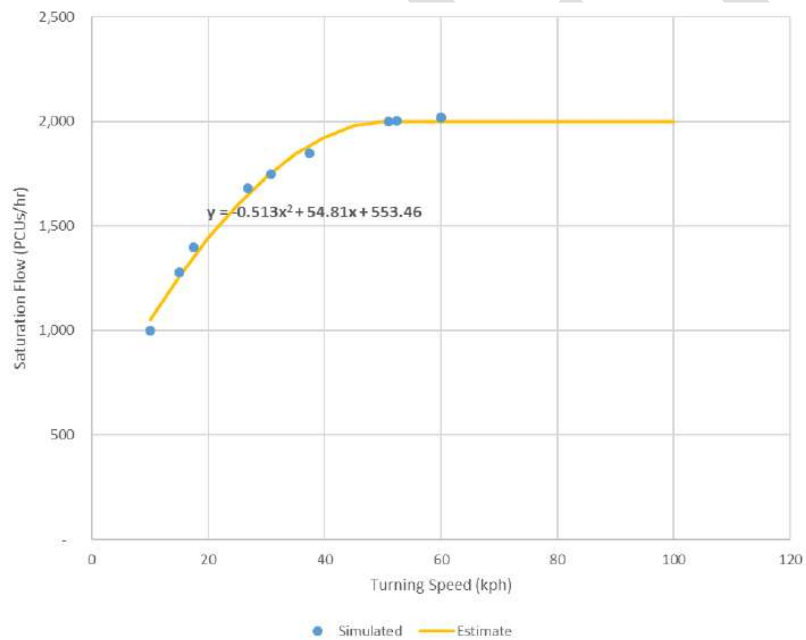


Figure 11 - Adopted Relationship between Signal Saturation Flow and Turning Speed. The line of best fit through the simulated saturation flows for turning speeds between 10 and 50 km/hr, where 10 km/hr is the minimum turning speed applied in ADTA. The saturation flow was capped at 2,000 pcu/hr/lane for turning speeds higher than 50 km/hr.

4.3.3 Intersection Delays – Priority Movements

Delays at priority-controlled intersections were represented by JDFs.

Relationships between the capacity of priority movements and the opposing flow were estimated using a linear relationship:

Q = Qs – r x fo

where:

Q = capacity of the turning movement (pcu/hr)

Q_s = saturation flow for the turning movement i.e. capacity of the turning movement at zero opposing flow (pcu/hr); intercept

r = the rate at which the capacity decreases as opposing flow increases; slope

f_o = the flow opposing this turning movement (pcu/hr)

The resulting turn capacity **Q** was applied to the Akçelik VDF formula from Chapter 4.3.1 assuming a friction factor of 1.0 to calculate the corresponding turning delay for the priority movement.

The calibrated capacity intercepts and slopes for all priority turning movement types as used in the ADTA model is provided in Appendix F.

4.4 Model Assignment Parameters

4.4.1 Assignment Methodology

Based on previous modelling, an 80-to-20 split in static versus dynamic path assignment was considered appropriate for the microscopic simulation. This gave better control of modelling route choice in the area and sense-checks during the model development process showed that route distribution in the model was reasonable and supported the use of the method.

4.4.2 Static Assignment Parameters

Table 1 shows the key parameters of the static assignment used in the Aimsun model.

Table 1 - Key Static Assignment Parameters

Static Assignment Parameters	
Assignment Engine	Frank and Wolf Assignment
Maximum Iterations	50
Relative Gap	0.1 %

4.4.3 Dynamic Assignment Parameters

All dynamic assignment parameters (Table 2 and Table 3) were determined based on comparison and sensitivity testing with those adopted in existing Aimsun models such as ADTA (AFC), and QLD (Aecom).

Table 2 - Key Dynamic Assignment Parameters

Dynamic Assignment Parameters		
Main		
Network Loading	Microscopic Simulator	
Assignment Approach	Stochastic Route Choice	
Using Warm-Up	(5% of demand, 15 min)	
Using a Saved Initial State	No	
Attributes Overrides	(refer to Appendix E)	
Performance Settings:		
Simulation Threads	4	
Route Choice Threads	4	
Behaviour		
Car Following:		
Two-Lane Car-Following Model	No	
Apply Slope Model	No	
Lane Changing:		
Distance Zone Variability	40%	
Two-Way Two-Lane Overtaking Model	No	
Queue Speeds:		
Queue Entry Speed	1 m/s	
Queue Exit Speed	1 m/s	

Table 3 - Key Dynamic Assignment Parameters continued

Dynamic Assignment Parameters					
Reaction Time					
Simulation Step	0.8 sec				
Reaction Time Settings	Fixed				
Reaction Time at Stop	1.15 sec				
Reaction Time at Traffic Light	1.35 sec				
Arrivals					
Global Arrivals	Normal				
Dynamic Traffic Assignment					
Costs:					
Cycle	5 min				
Number of Intervals	3				
Attractiveness Weight	5				
User-Defined Cost Weight	1				
Use Link Costs from Replication	None				
Group Route Choice Intervals	No				
Fixed Routes:	Following OD Routes	Following Input Path Assignment			
Car	100%	80%			
Truck	100%	100%			
Max. Paths to Use From Input Path Assignment	All				
Stochastic Route Choice:					
Model	C-Logit				
Enroute	No				
Enroute After Virtual Queue	No				
Stochastic Route Choice - Basic:					
Path Calculation	Source	Max. Number of Initial Paths to Consider			
	K-SP	1			
Max. Paths per Interval	For All Veh	3			
Stochastic Route Choice – Parameters:	Origin	Destination	Scale	Beta	Gamma
	All	All	12	0.15	1

5 Calibration and Validation Results

5.1 General Approach

Calibration and validation for the model were undertaken with reference to criteria for Category C: Urban Area in NZTA Model Development Guidelines (Criteria) on individual link flows, turn flows and travel time for each hour between 7am – 9am, and 4pm – 6pm.

Adjustments to demand and network during the calibration process were carefully considered with respect to implications on model response and forecasting.
Several sense-checks were made as part of the calibration process including checks on route-choice, turn delays in the static assignment, demand profiles, HCV counts and visual congestion on the network.

5.2 Demand Adjustment

5.2.1 Manual Adjustment

All demand adjustments for the model were done manually and summarised in Table 4 - Table 9. During the demand adjustment, care was taken to retain the demand distribution from the strategic model. Adjustments were made to resolve majority of the network issues in the first instance, before demand adjustments were made.

Table 4 – AM Post-Adjusted Sector-to-Sector Demands

	East	Internal	North	South	Panmure	West	
East	3,465	1,664	210	6,545	940	2,889	15,713
Internal	965	1,101	1,160	1,922	1,570	2,769	9,487
North	520	1,301	0	860	4,128	3,451	10,260
South	3,716	1,268	90	2,865	374	499	8,811
Panmure	493	558	982	448	4,957	5,700	13,137
West	1,177	1,001	1,039	992	3,931	8,024	16,164
	10,336	6,892	3,481	13,632	15,900	23,331	73,572

Table 7 - PM Post-Adjusted Sector-to-Sector Demands

	East	Internal	North	South	Panmure	West	
East	4,374	2,299	916	3,808	1,104	1,881	14,382
Internal	2,293	1,224	1,867	1,239	733	1,431	8,787
North	131	1,582	0	169	1,296	1,319	4,498
South	8,000	2,248	229	3,166	873	793	15,310
Panmure	928	1,671	3,528	507	4,548	4,777	15,958
West	1,867	3,065	4,493	375	5,892	7,621	23,314
	17,592	12,089	11,033	9,264	14,447	17,823	82,249

Table 5 - AM Sector-to-Sector Demand Adjustment

	East	Internal	North	South	Panmure	West	Total
East	-651	-77	-37	21	74	217	-454
Internal	-506	-68	17	-180	-154	12	-880
North	-397	-50	0	-104	-576	0	-1,128
South	-537	-192	-185	64	2	117	-731
Panmure	-99	-85	230	-417	-1,187	-433	-1,991
West	-25	-6	-3	172	-198	-276	-336
Total	-2,216	-478	22	-444	-2,040	-364	-5,520

Table 8 - PM Sector-to-Sector Demand Adjustment

	East	Internal	North	South	Panmure	West	Total
East	800	420	162	-218	420	299	1,882
Internal	-216	-21	566	-348	-131	-36	-185
North	-370	356	0	-341	99	-432	-688
South	11	378	-471	599	134	126	778
Panmure	-216	42	976	-129	-335	425	763
West	2	593	-269	-20	141	-1,035	-586
Total	11	1,768	964	-456	329	-653	1,963

Table 6 - AM Sector-to-Sector Demand Percent Adjustment

	East	Internal	North	South	Panmure	West	Total
East	-16%	-4%	-15%	0%	8%	8%	-3%
Internal	-34%	-6%	2%	-9%	-9%	0%	-8%
North	-43%	-4%	0%	-11%	-12%	0%	-10%
South	-13%	-13%	-67%	2%	1%	30%	-8%
Panmure	-17%	-13%	31%	-48%	-19%	-7%	-13%
West	-2%	-1%	0%	21%	-5%	-3%	-2%
Total	-18%	-6%	1%	-3%	-11%	-2%	-7%

Table 9 - PM Sector-to-Sector Demand Percent Adjustment

	East	Internal	North	South	Panmure	West	Total
East	22%	22%	21%	-5%	61%	19%	15%
Internal	-9%	-2%	44%	-22%	-15%	-2%	-2%
North	-74%	29%	0%	-67%	8%	-25%	-13%
South	0%	20%	-67%	23%	18%	19%	5%
Panmure	-19%	3%	38%	-20%	-7%	10%	5%
West	0%	24%	-6%	-5%	2%	-12%	-2%
Total	0%	17%	10%	-5%	2%	-4%	2%

5.2.2 Turn Delay Check

Turn delays from the static assignment were monitored to ensure that no major delays were adversely affecting path assignment and route distribution, as well as to gauge model stability.

To facilitate stability of the static assignment, a fixed signal control plan was used (whereas an actuated control plan was used in the dynamic assignment). Priority was placed on reducing turn delay and ensuring appropriate route choice distribution across the network rather than strict adherence to the maximum green times reported from the single-day SCATS data.

5.3 Static Assignment Results

5.3.1 Convergence

The static assignment for each modelled period was stable and attained the relative gap (rgap) before 50 iterations (Figure 12 and Figure 13). 80% of the path assignments from the static assignment was set to be retained during the dynamic assignment.

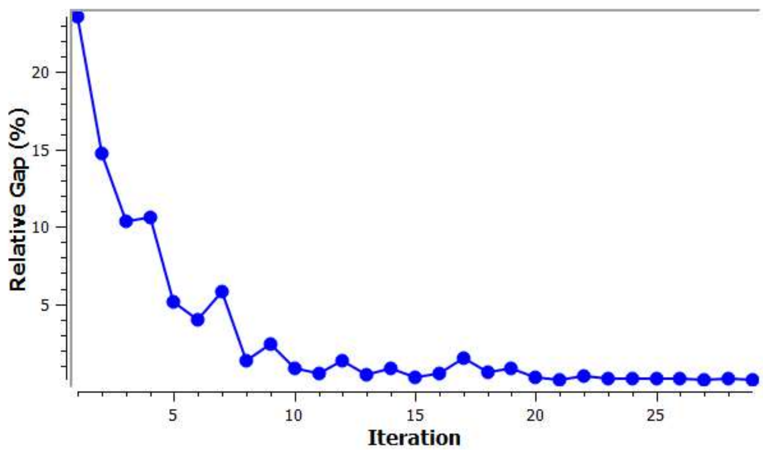


Figure 12 - AM Peak Static Assignment Convergence

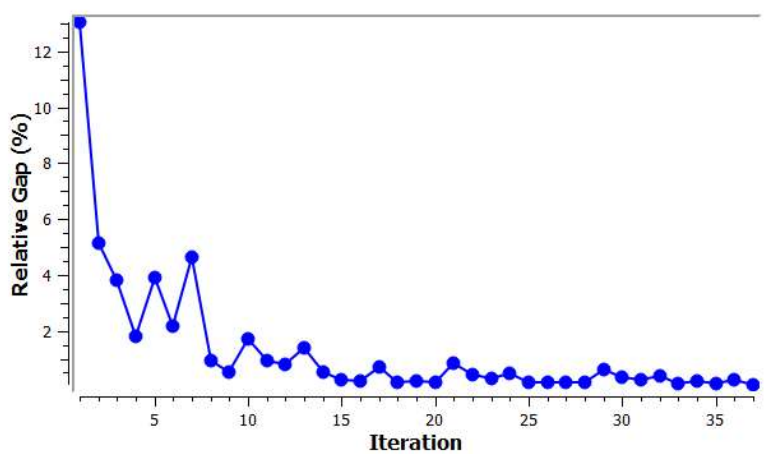


Figure 13 - PM Peak Static Assignment Convergence

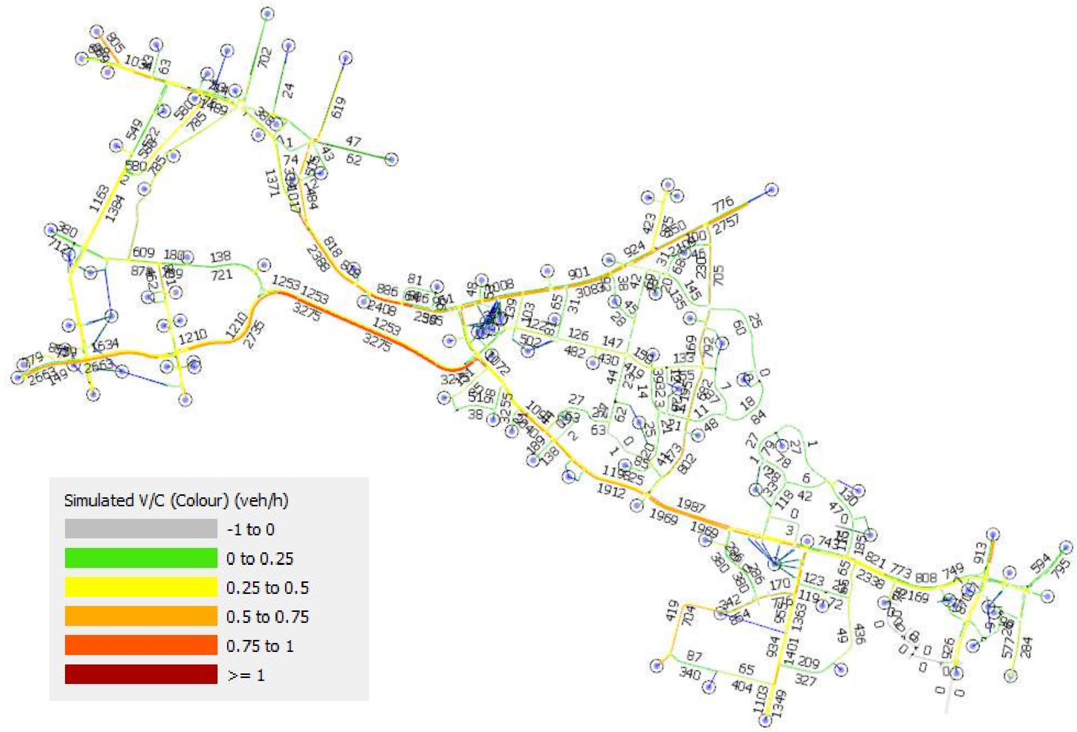


Figure 14 - AM Peak Assigned Flow in PCU/hr (6.15 am – 9.30 am)

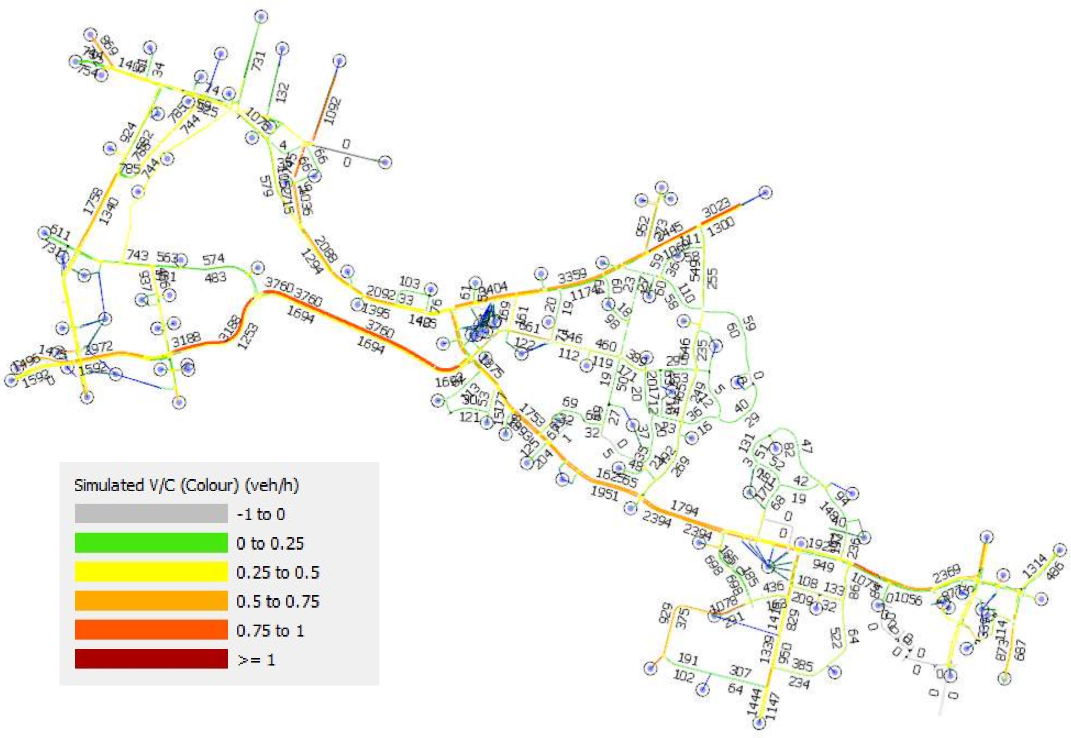


Figure 15 - PM Peak Assigned Flow in PCU/hr (3.15 pm – 6.30 pm)

5.4 Validation Results

5.4.1 Link Counts Validation

Results for individual link counts (Table 10 and Figure 16) network-wide show that the model satisfies the validation criteria for GEH, R^2 and RMSE.

Table 10 - Summary of Individual Link Counts Validation Results across Network

	AM (%)		PM (%)		NZTA Guideline
	7am - 8am	8am - 9am	4pm - 5pm	5pm - 6pm	Category C
GEH <5	85	85	91	87	>80%
GEH <7.5	94	95	98	99	>85%
GEH <10	99	98	99	100	>90%
R^2	0.98	0.98	0.99	0.99	>0.95
RMSE	12	13	10	9	<20%

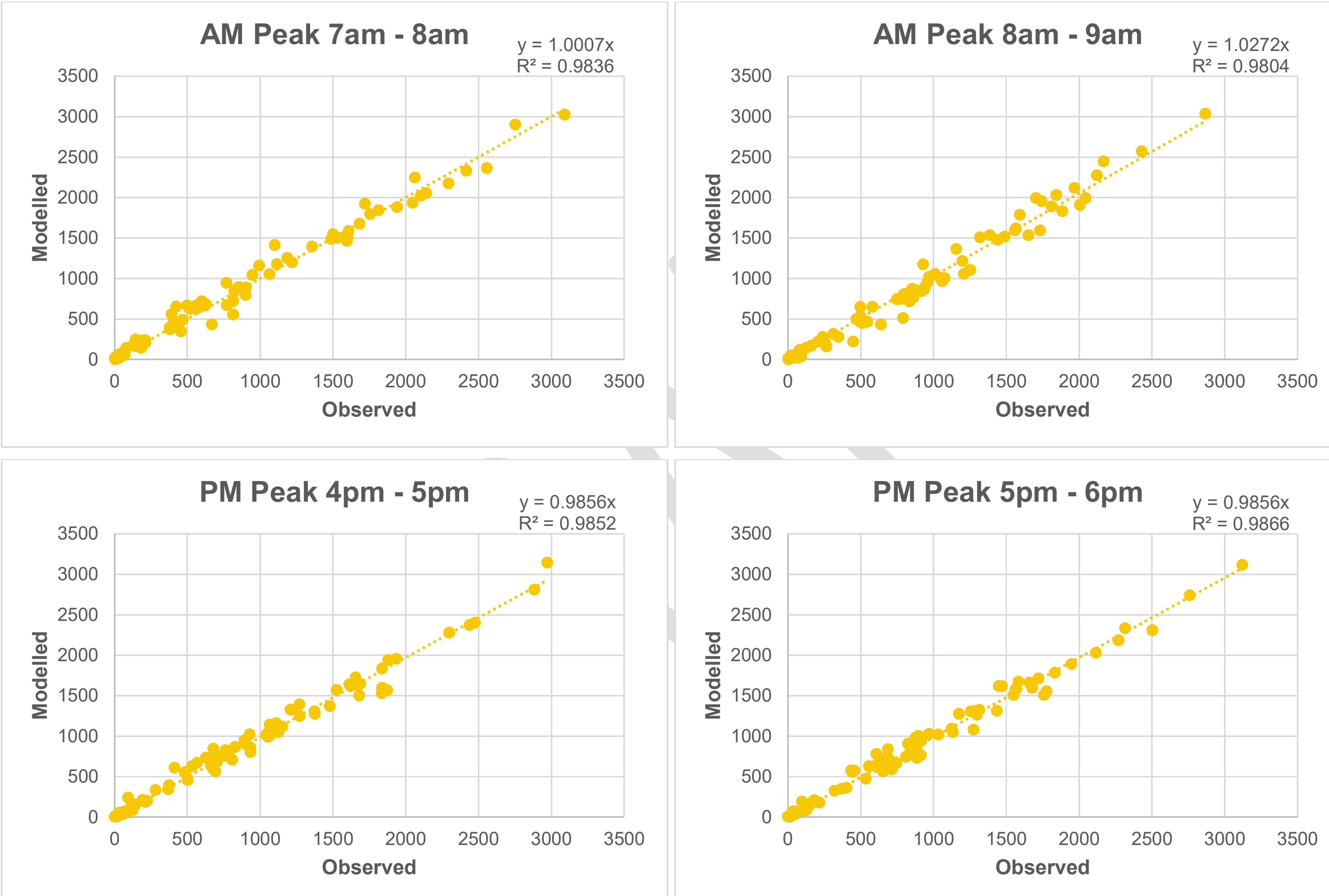


Figure 16 - Link Counts Validation Scatter Plots

5.4.2 Turn Counts Validation

Results for individual turn counts (Table 11) in the focus area show that the model satisfies the validation criteria for GEH, R^2 and RMSE. Where the modelled counts did not meet the GEH <5 criteria, the manual counts at that turn were either found to be unreasonable when cross-checked with adjacent counts or there was lack of information on reliability and therefore given less priority for validation.

Table 11 - Summary of Individual Turn Counts Validation Results in Focused Area

	AM (%)		PM (%)		NZTA Guideline
	7am - 8am	8am - 9am	4pm - 5pm	5pm - 6pm	Category C
GEH <5	84	85	78	84	>80%
GEH <7.5	93	91	94	94	>85%
GEH <10	96	98	99	100	>90%
R^2	0.99	0.98	0.99	0.99	>0.95
RMSE	19	19	19	14	<20%

5.5 Flow Profile Validation

Flow profiles at key locations across the network (Figure 17) were monitored. Overall, the modelled flow profiles follow the observed profiles reasonably well (Figure 18 and Figure 19).

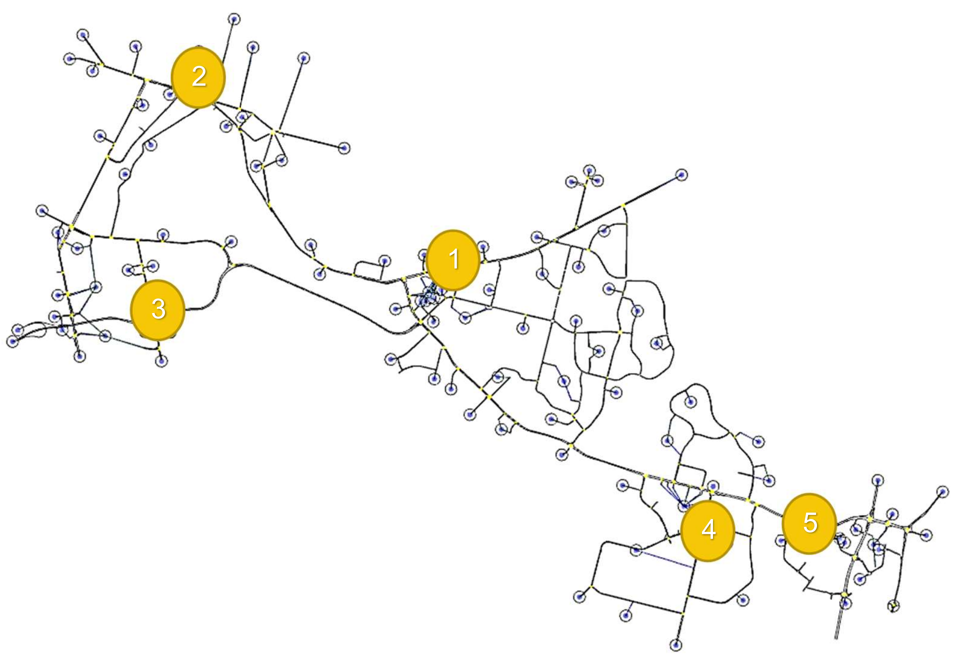
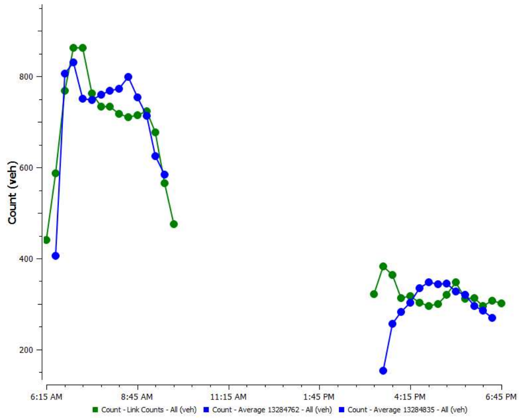


Figure 17 - Profile Validation Locations

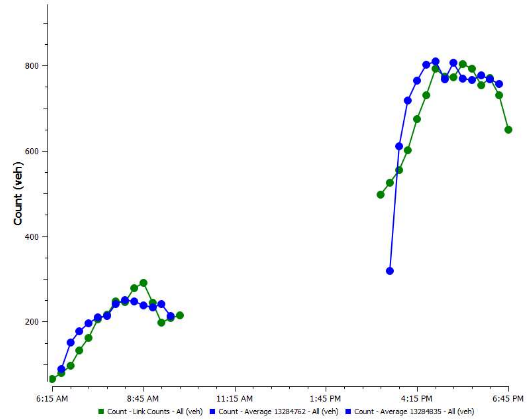
1 – Pakuranga Road / Lewis Road

Westbound



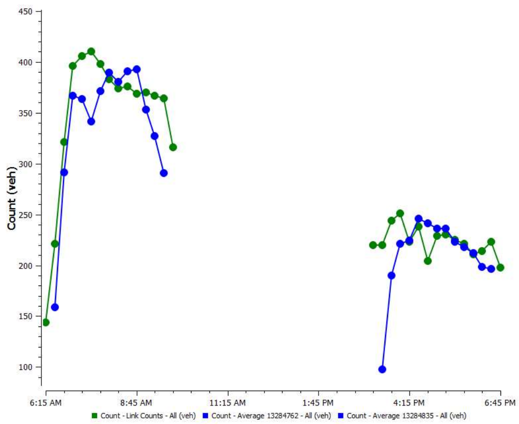
1 – Pakuranga Road / Lewis Road

Eastbound



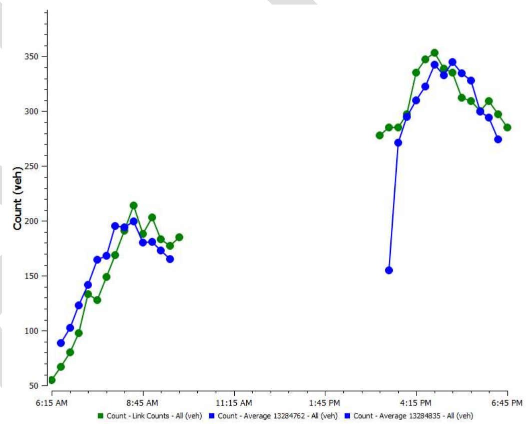
2 – Panmure Roundabout, Mount Wellington Approach

Westbound



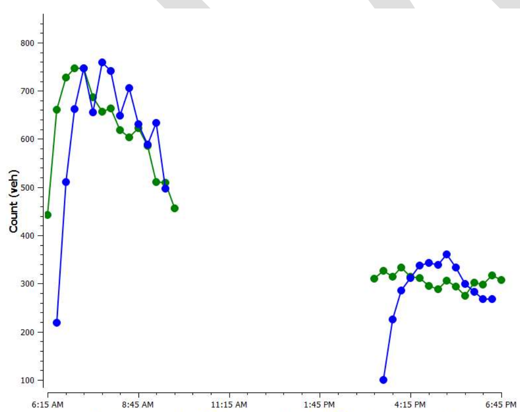
2 – Panmure Roundabout, Mount Wellington Approach

Eastbound



3 –South-Eastern Highway / Carbine Road

Westbound



3 – South-Eastern Highway / Carbine Road

Eastbound

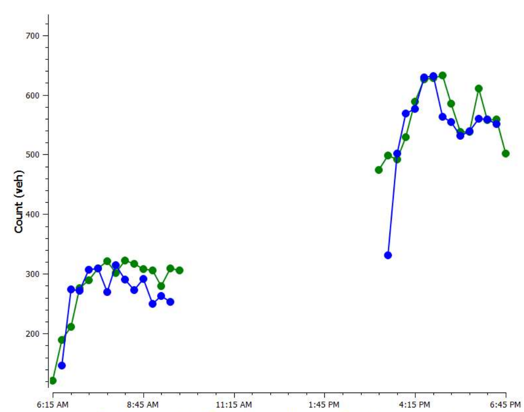
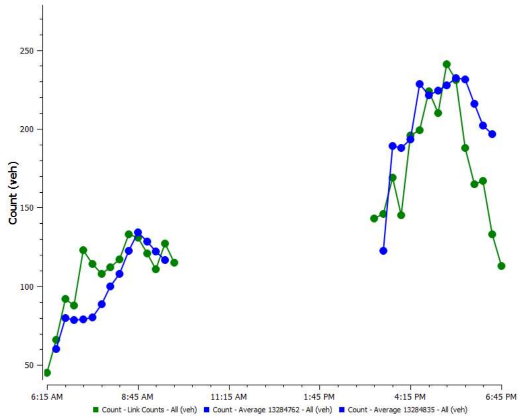


Figure 18 - Flow Profile Validation (modelled in blue, observed in green)

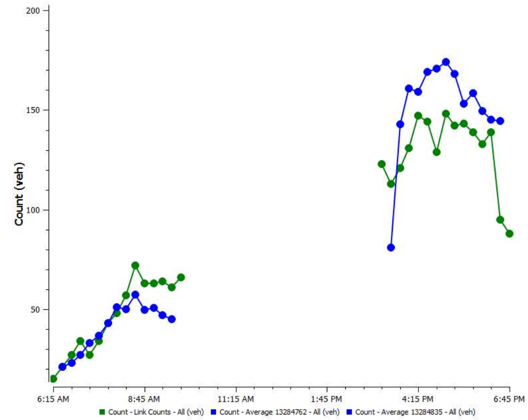
4 –Ti Rakau Drive / Harris Road

Harris Road Westbound



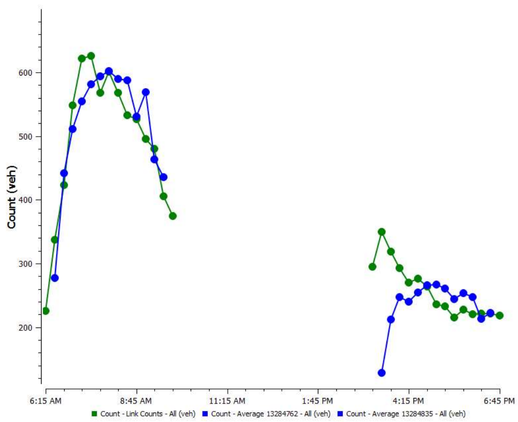
4 –Ti Rakau Drive / Harris Road

Harris Road Eastbound



5 – Ti Rakau Drive / Huntington Drive

Westbound



5 – Ti Rakau Drive / Huntington Drive

Eastbound

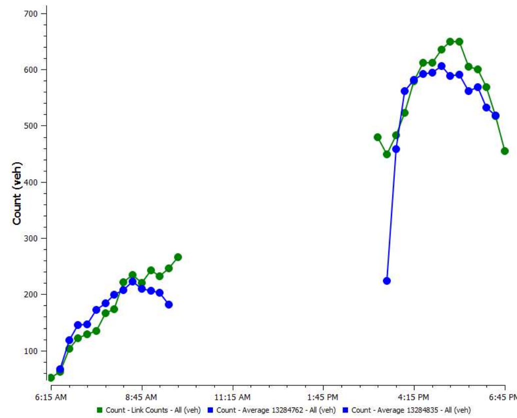


Figure 19 - Flow Profile Validation (modelled in blue, observed in green) continued

5.6 HCV Count Validation

A sense-check of the modelled proportion of vehicles assigned as NZTA Axel Class 4 and above (medium and heavy vehicles) was made at key locations across the network. Estimates of car to HCV proportions were made based on available tube count data and judgement. Overall, the modelled proportions match the estimates reasonably well (Figure 20).

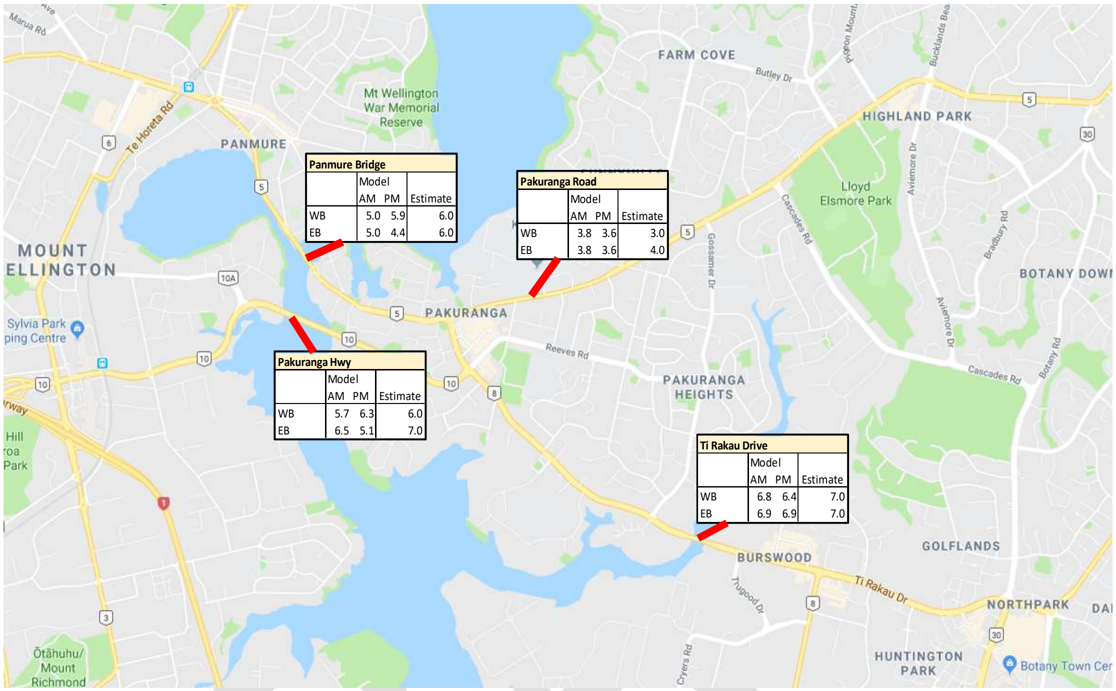


Figure 20 - Comparison of HCV percentage at key locations on the network

As described, the HCV includes MCV counts and we understand the survey at intersections only include pure HCV and hence this data was not used in this validation.

5.7 Travel Time Validation

Journey time versus distance graphs show that the modelled travel times were generally a good fit to the observed travel time (Figure 22 - **Error! Reference source not found.**). Signals at the modelled intersections were actuated based on minimum and maximum green times provided from the SCATS data of 7 March 2018. Adjustments were made up to five seconds above and below the maximum green time where required to calibrate travel times. Despite these adjustments, it is noted that:

- For the AM peak, modelled travel time from Edgewater Drive to Pakuranga Highway on Ti Rakau Drive is slightly low in the second hour. Overall 92% of the routes meet the Criteria for the AM peak.
- For the PM peak, modelled travel time from Jellicoe Road to Ti Rakau Drive is slightly low in the second hour. Overall 92% of the routes meet the Criteria for the PM peak.

Nevertheless, all modelled travel times (routes summarised in Figure 21) were within the 15th and 85th percentile of observed travel time. Therefore, the model is considered acceptably validated for travel time.

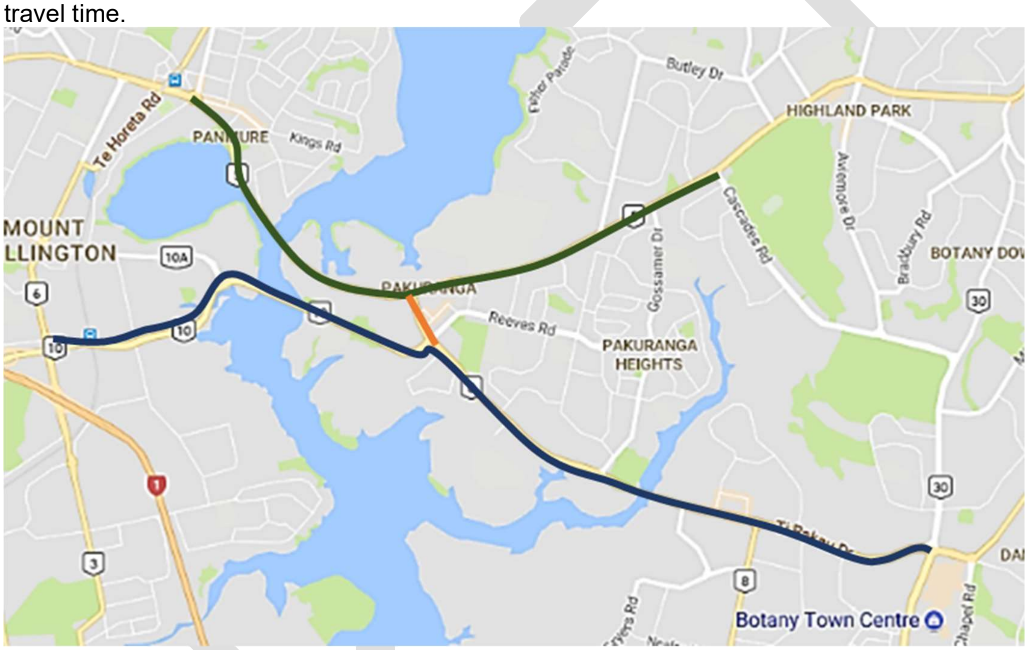


Figure 21 - Travel time routes (traffic) from Snitch GPS data for reporting travel time validation in Chapter 5

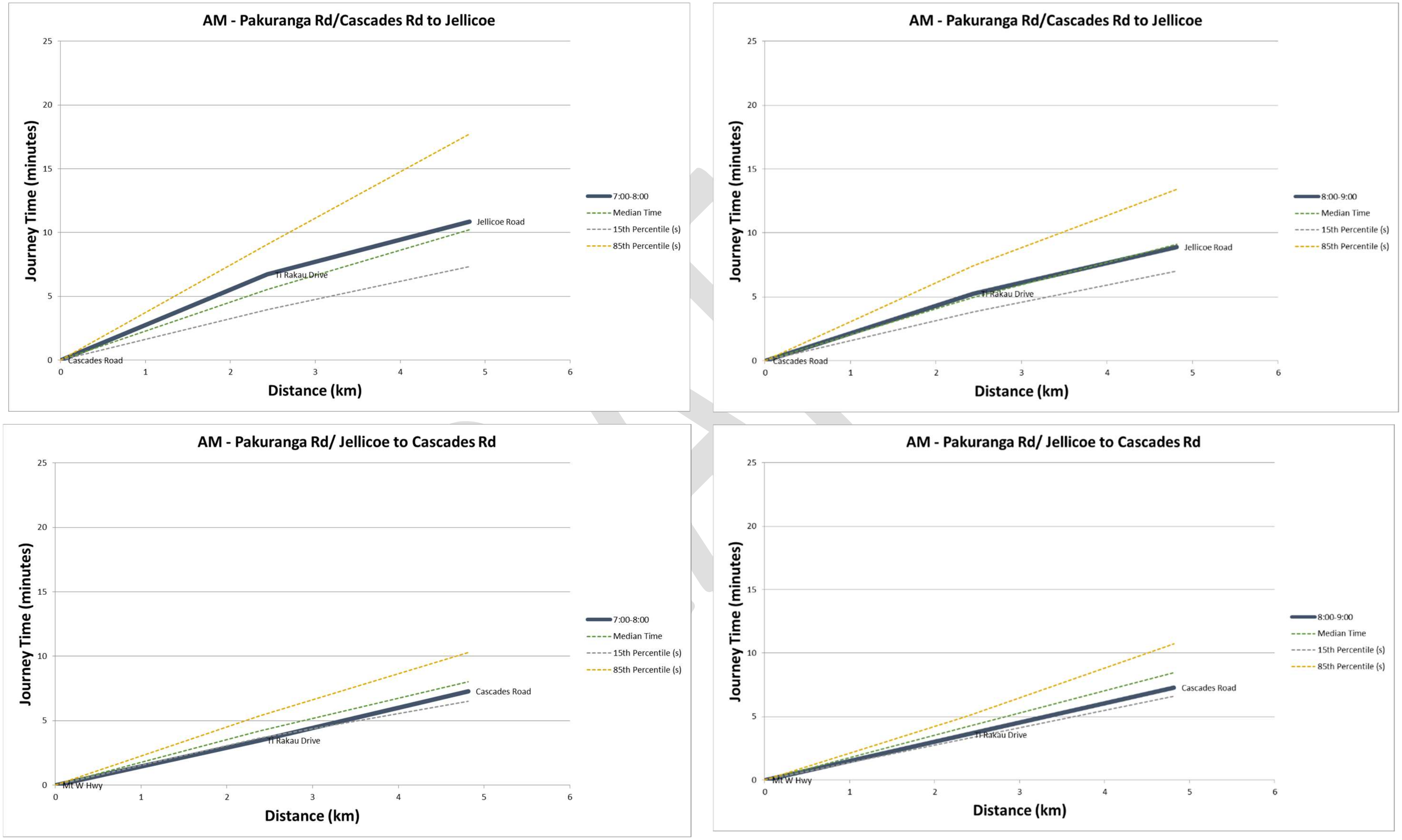


Figure 22 - Travel Time Validation Graphs: AM Pakuranga Road/ Cascades Road to Mount Wellington Highway

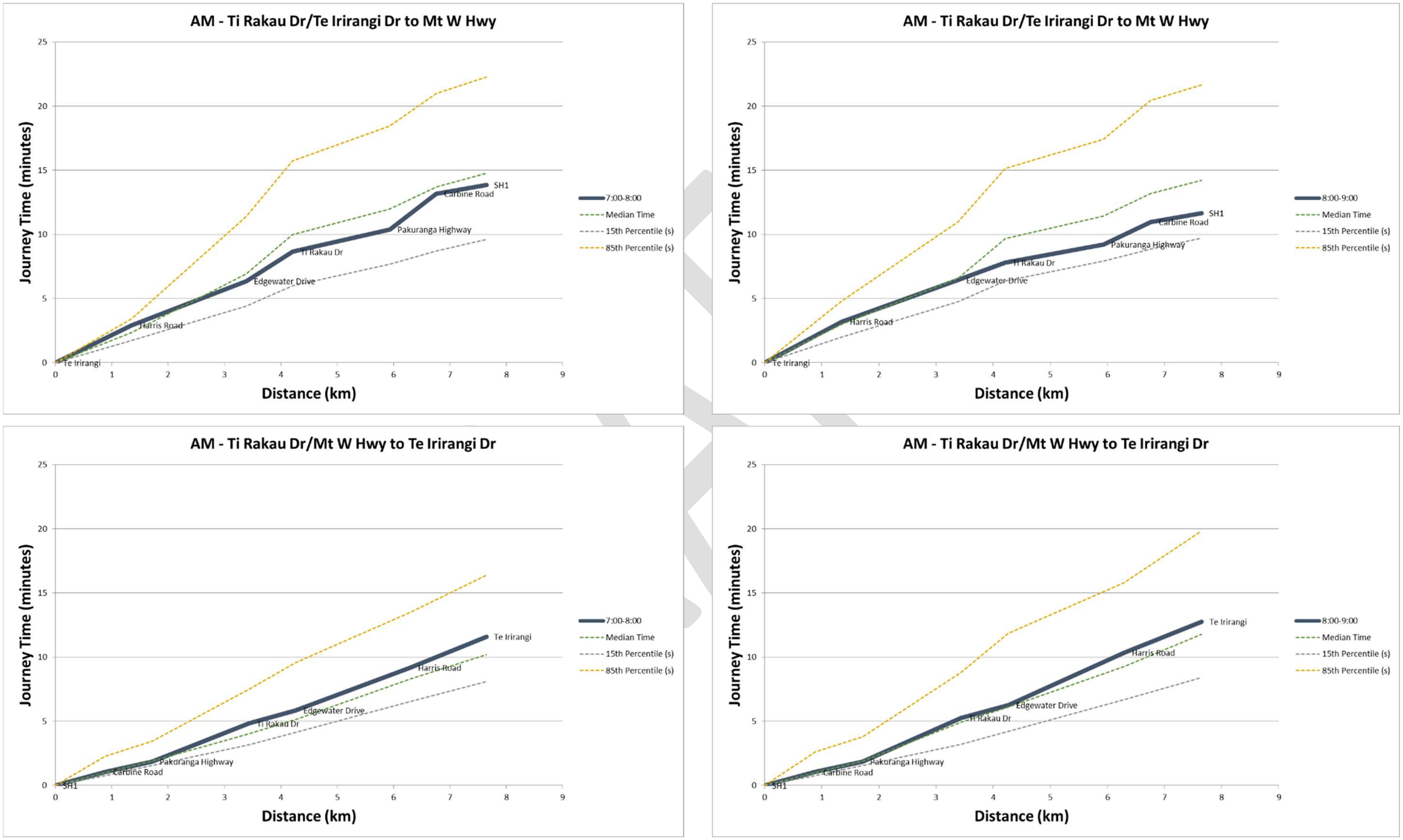


Figure 23 - Travel Time Validation Graphs: AM Ti Rakau Drive/ Te Irirangi Drive to Mount Wellington Highway

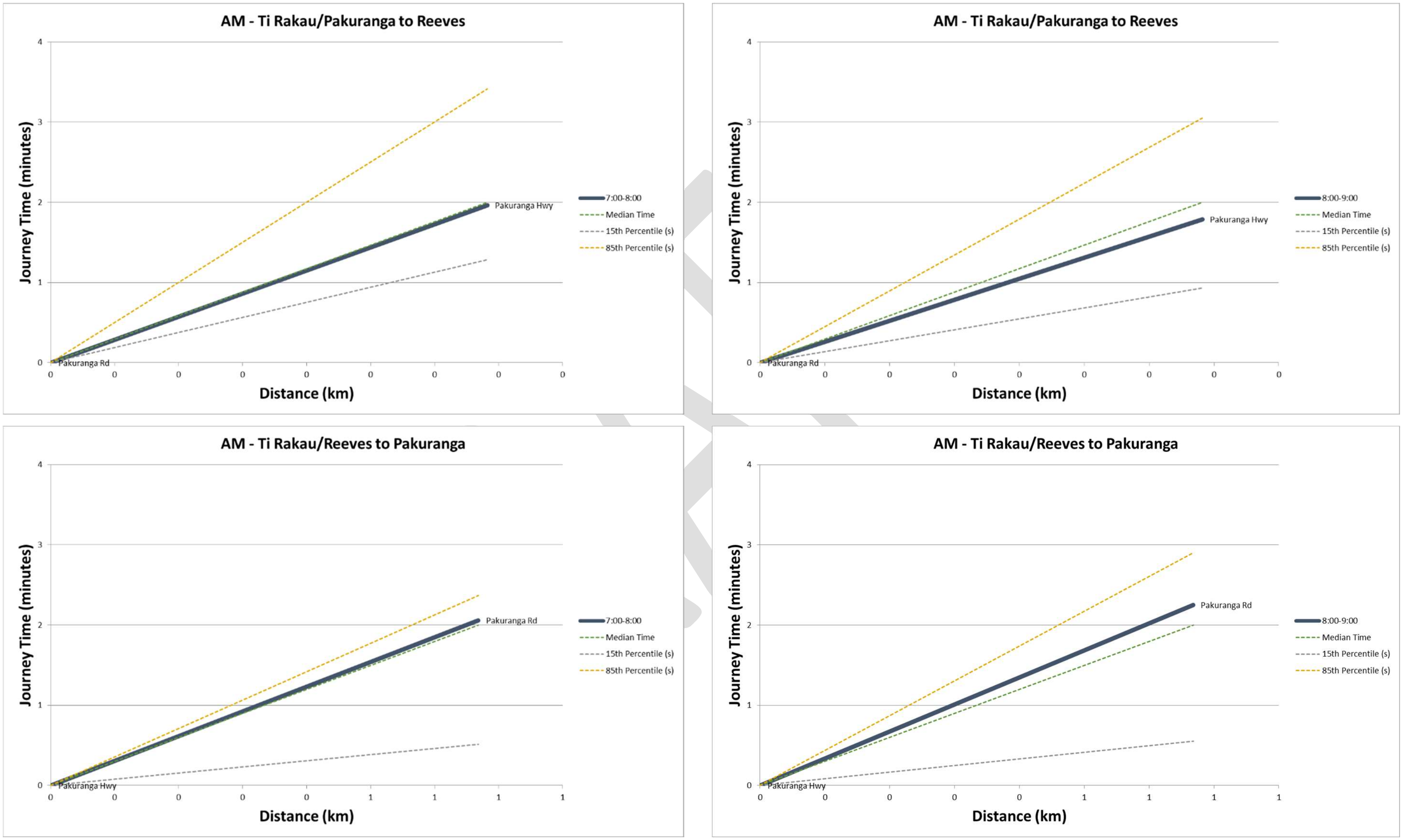


Figure 24 - Travel Time Validation Graphs: AM Ti Rakau Drive/ Pakuranga Road to Reeves Road

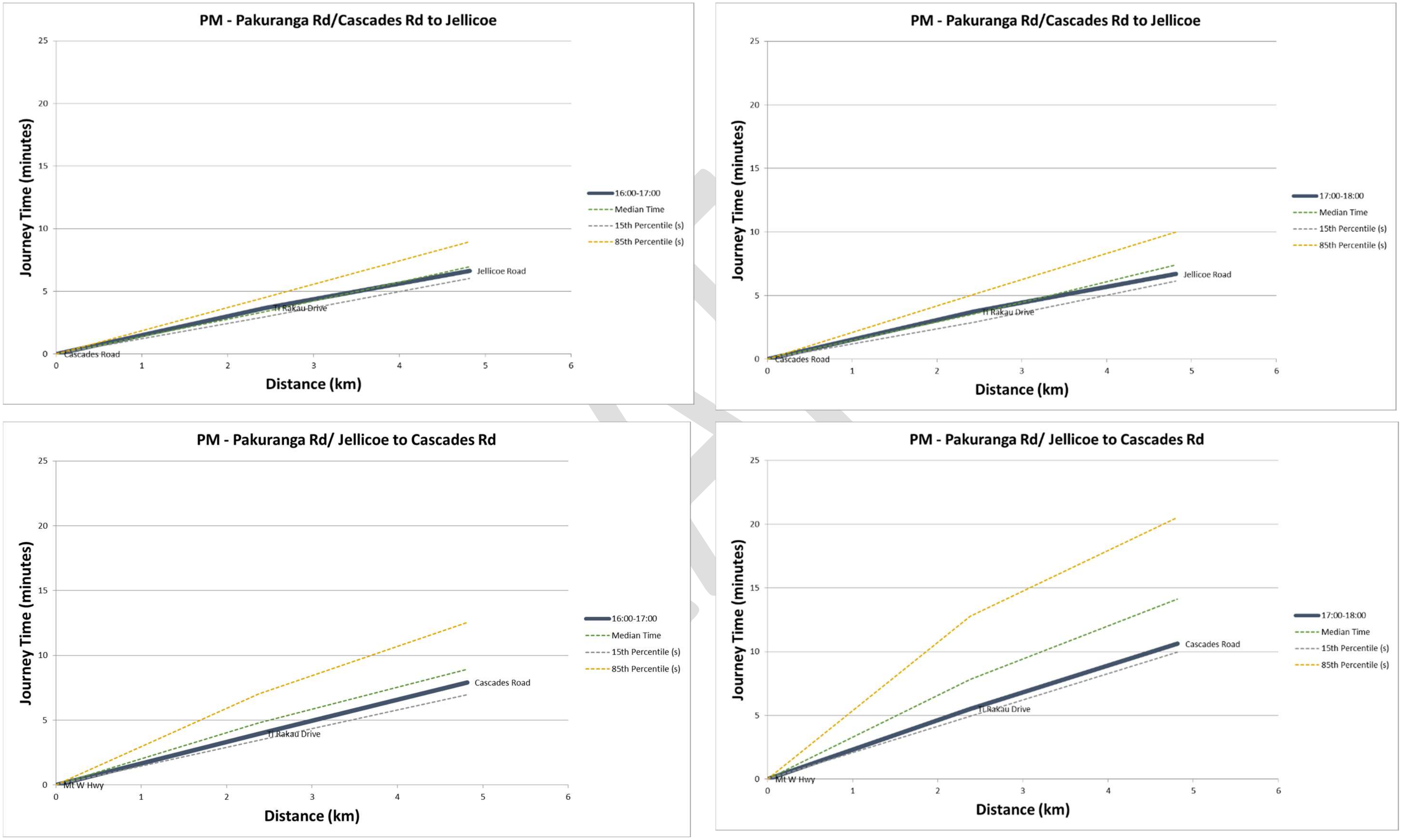


Figure 25 - Travel Time Validation Graphs: PM Pakuranga Road/ Cascades Road to Mount Wellington Highway

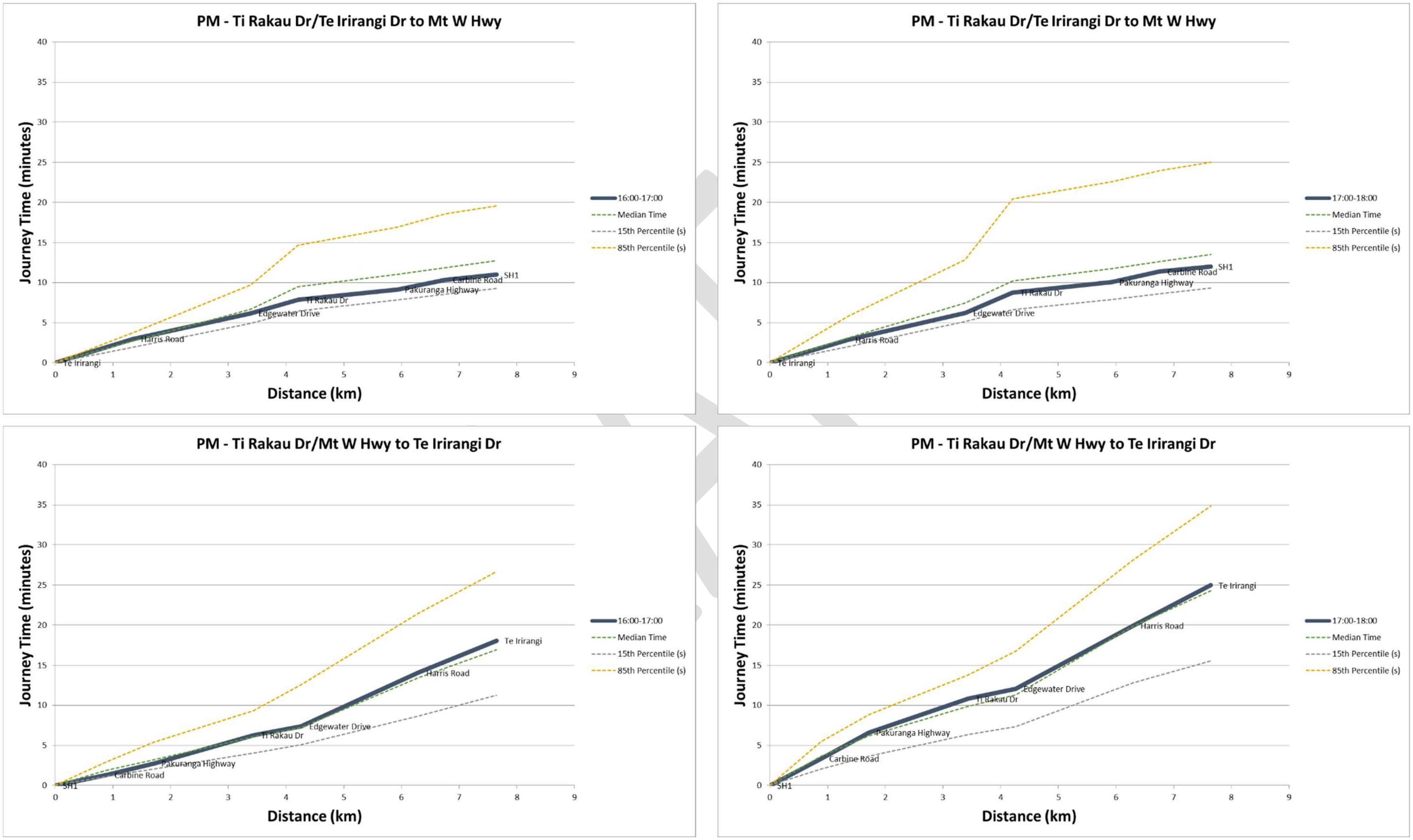


Figure 26 - Travel Time Validation Graphs: PM Ti Rakau Drive/ Te Irirangi Drive to Mount Wellington Highway

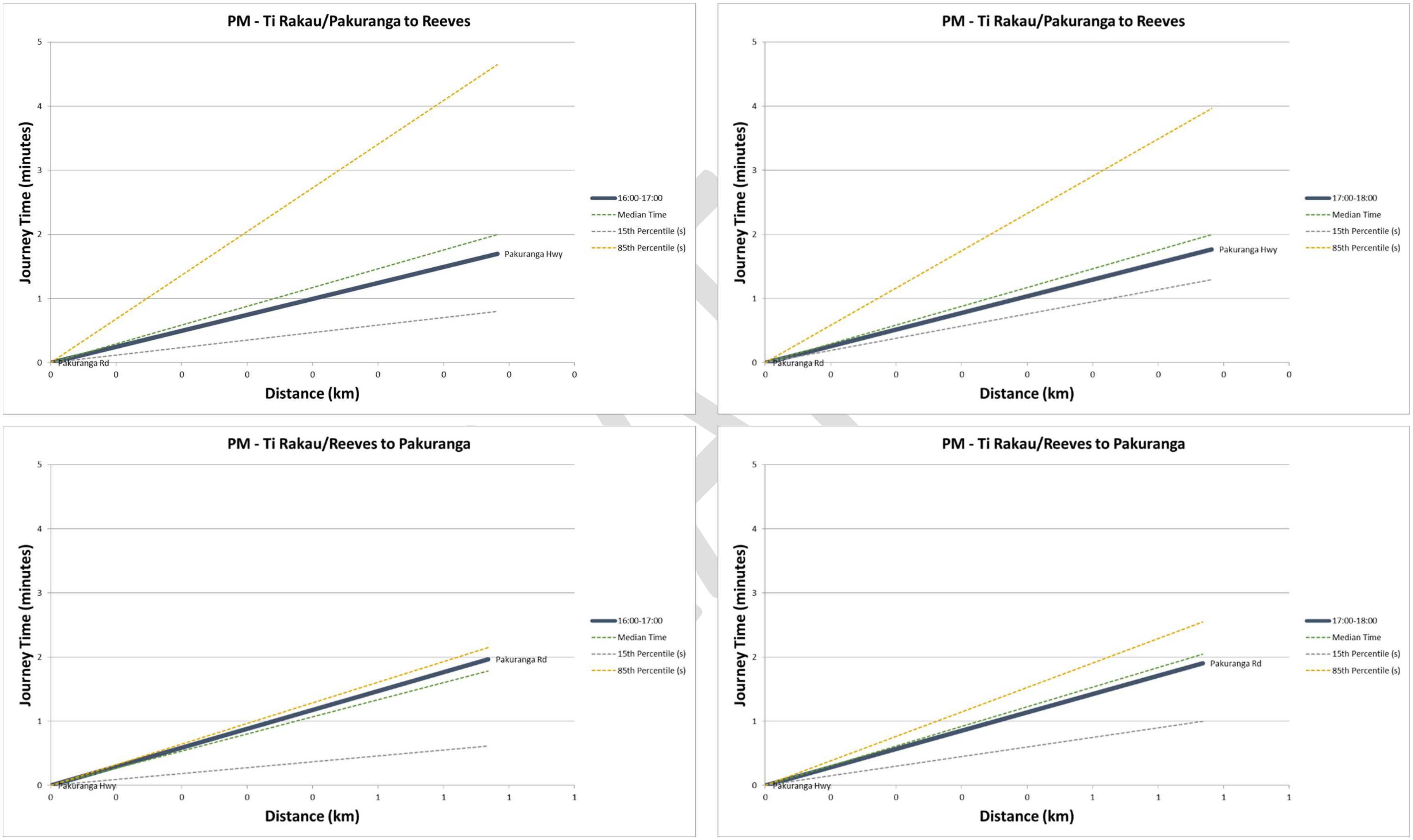


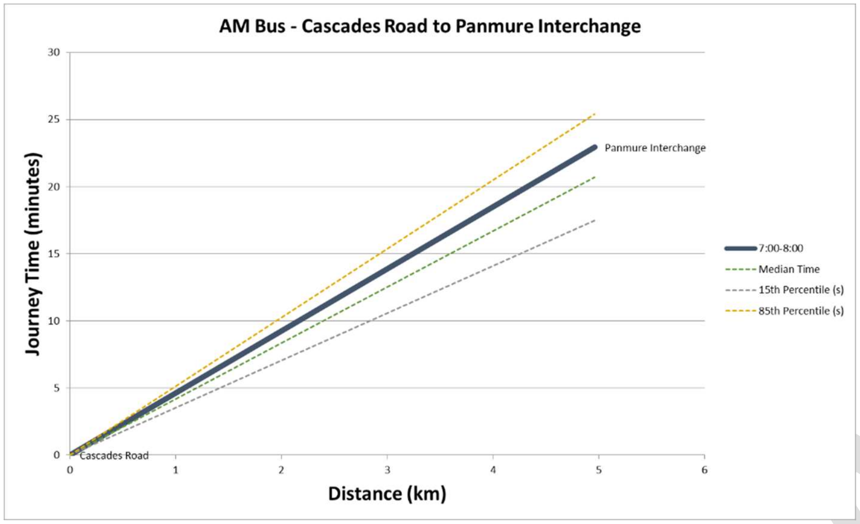
Figure 27 - Travel Time Validation Graphs: PM Ti Rakau Drive/ Pakuranga Road to Reeves Road

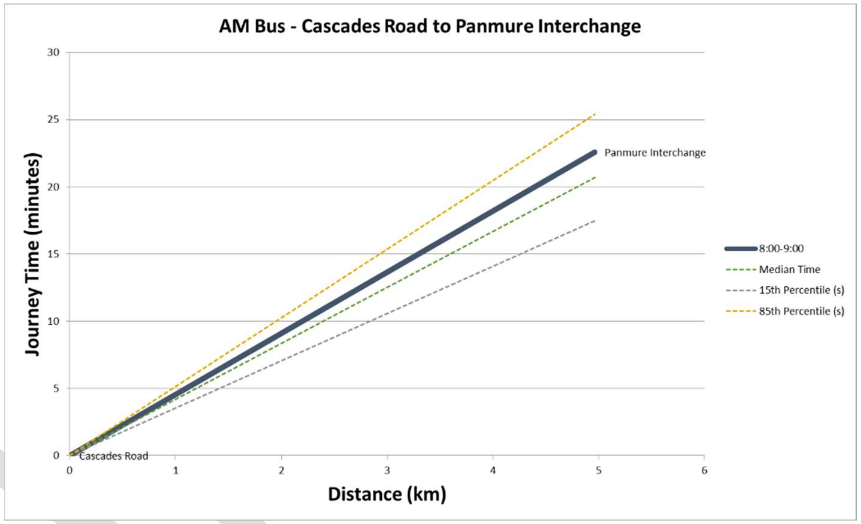
Bus travel time for key corridors in the model also fit reasonably well with observed (Figure 28 - Figure 29). The routes are:

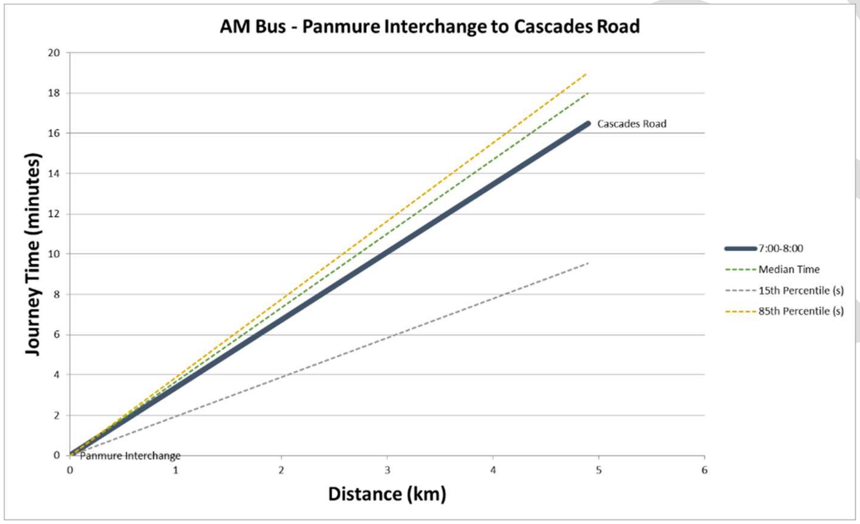
- Bus Route 70 – between Botany Town Centre and Panmure Interchange.
- Bus Route 72 – between Cascades Road and Panmure Interchange.

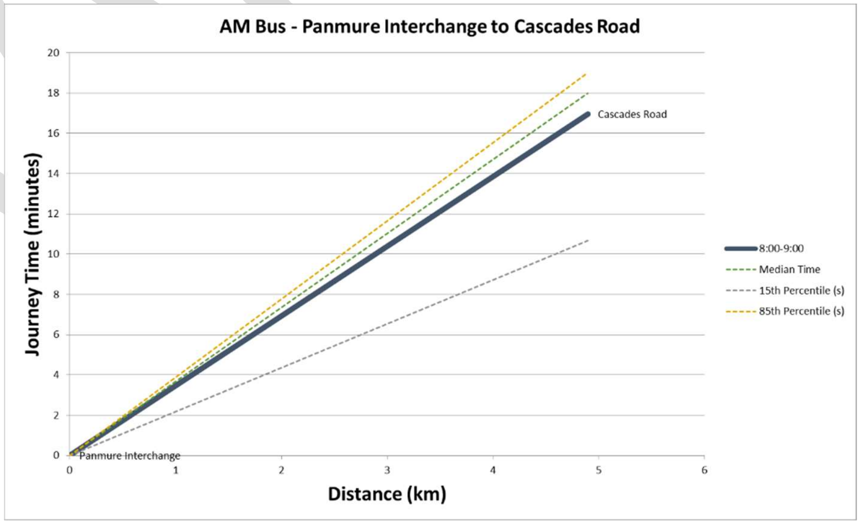
From the bus journey time graphs, it is noted that

- For the AM peak, modelled travel time from the Botany to Panmure Town Centre is low in the first hour. Overall 88% of the routes meet the Criteria for the AM peak.
- For the PM peak, modelled travel time between the Botany and Panmure from Jellicoe Road to Ti Rakau Drive is high in the second hour. The additional travel time is occurring in the Panmure area and does not impact on the focus area. For the future year, the bus travel time along this route will be monitored to ensure it does not increase unrealistically. Overall 75% of the routes meet the Criteria for the PM peak which is below the target 85%.


AM Bus - Cascades Road to Panmure Interchange
Journey Time (minutes)
Distance (km)
Panmure Interchange
Cascades Road
7:00-8:00
Median Time
15th Percentile (s)
85th Percentile (s)


AM Bus - Cascades Road to Panmure Interchange
Journey Time (minutes)
Distance (km)
Panmure Interchange
Cascades Road
8:00-9:00
Median Time
15th Percentile (s)
85th Percentile (s)


AM Bus - Panmure Interchange to Cascades Road
Journey Time (minutes)
Distance (km)
Cascades Road
Panmure Interchange
7:00-8:00
Median Time
15th Percentile (s)
85th Percentile (s)


AM Bus - Panmure Interchange to Cascades Road
Journey Time (minutes)
Distance (km)
Cascades Road
Panmure Interchange
8:00-9:00
Median Time
15th Percentile (s)
85th Percentile (s)

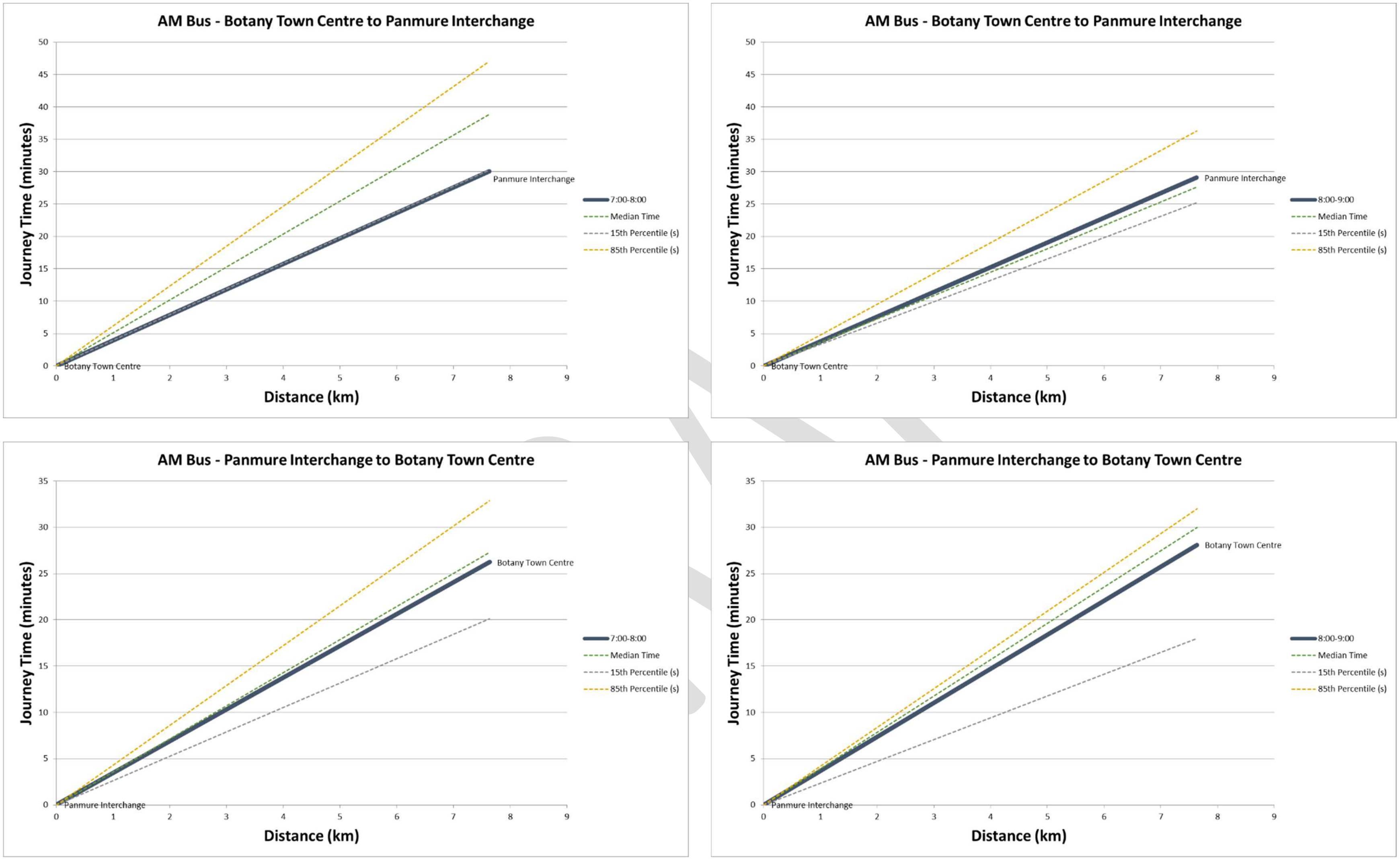
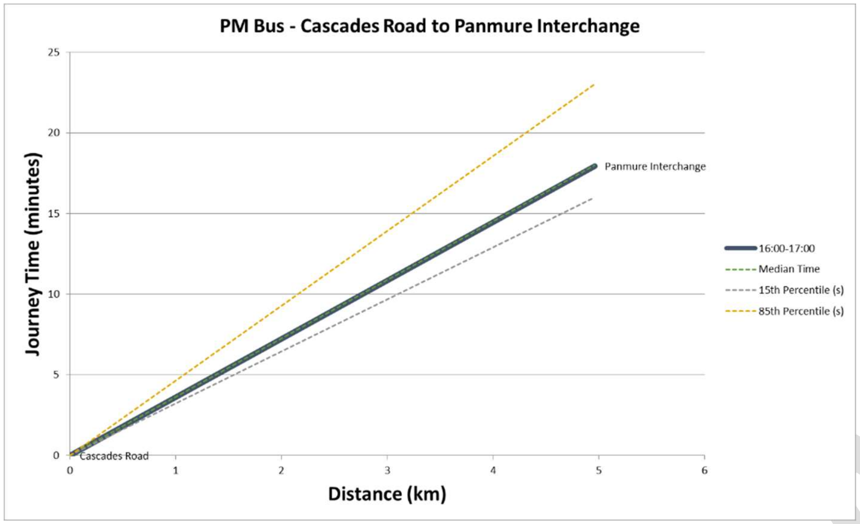
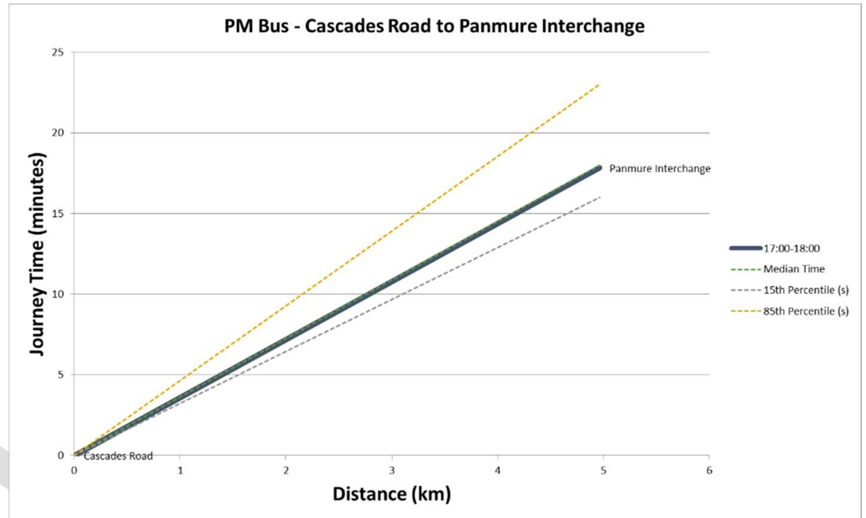
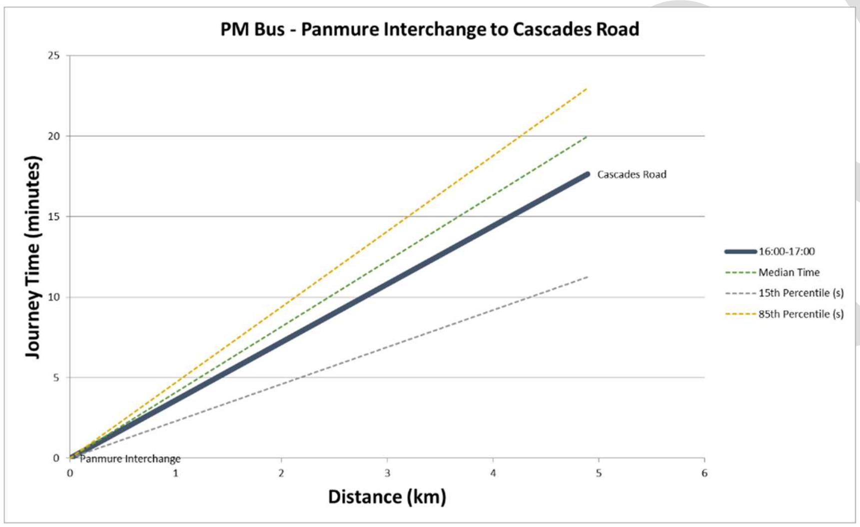
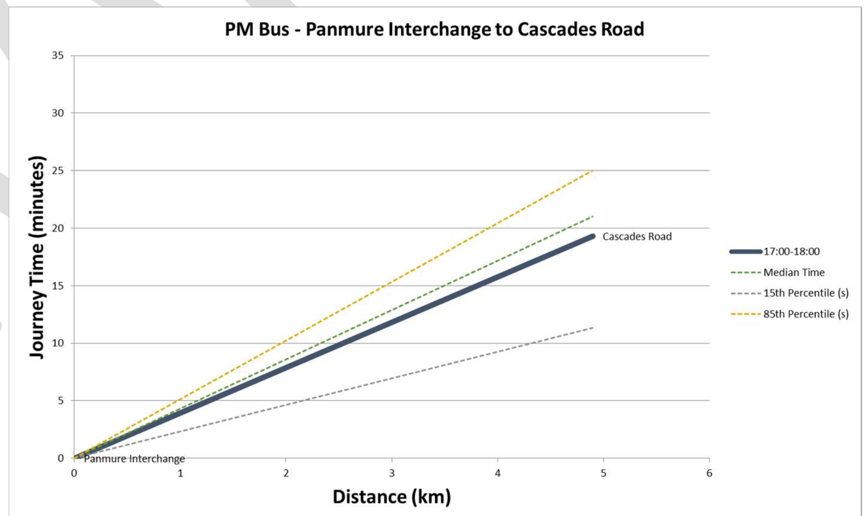


Figure 28 – Travel Time Validation: AM Bus


PM Bus - Cascades Road to Panmure Interchange
Journey Time (minutes)
Distance (km)
Panmure Interchange
Cascades Road
16:00-17:00
Median Time
15th Percentile (s)
85th Percentile (s)


PM Bus - Cascades Road to Panmure Interchange
Journey Time (minutes)
Distance (km)
Panmure Interchange
Cascades Road
17:00-18:00
Median Time
15th Percentile (s)
85th Percentile (s)


PM Bus - Panmure Interchange to Cascades Road
Journey Time (minutes)
Distance (km)
Cascades Road
Panmure Interchange
16:00-17:00
Median Time
15th Percentile (s)
85th Percentile (s)


PM Bus - Panmure Interchange to Cascades Road
Journey Time (minutes)
Distance (km)
Cascades Road
Panmure Interchange
17:00-18:00
Median Time
15th Percentile (s)
85th Percentile (s)

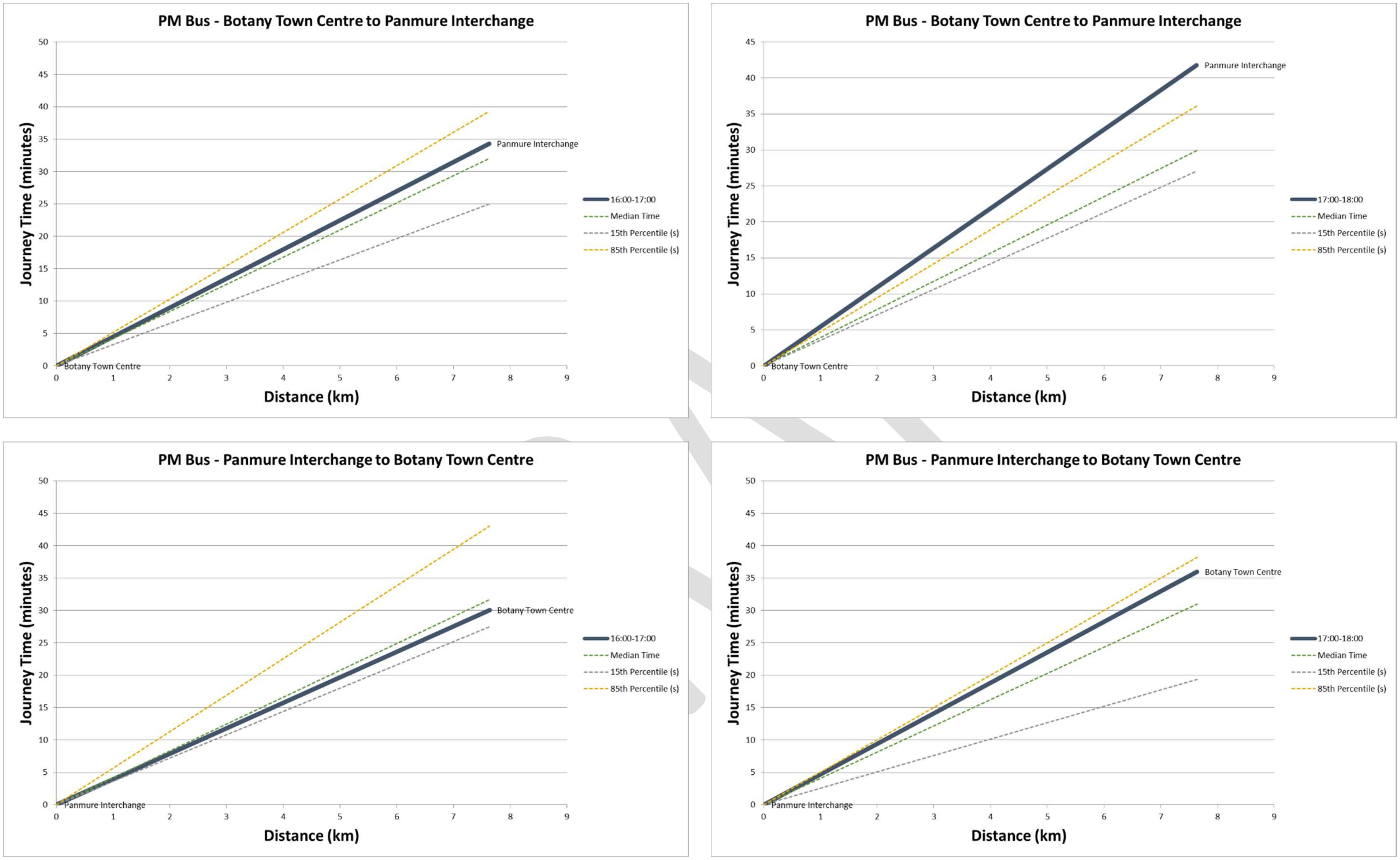


Figure 29 - Travel Time Validation: PM Bus

5.8 Traffic Congestion Check

Traffic count and travel time data are the principle measures of the model performance. Traffic congestion on the network was monitored as an additional sense-check of model performance.

Side-by-side comparison to Google's live traffic view-mode for Thursday 21 February 2019 show that the model represents congestion on the network reasonably well (Figure 30 and Figure 31). In the AM peak, less congestion was seen on Ti Rakau Drive Northbound in the model compared to observed, and this was reflected in the faster travel time for that segment. However, also in the AM, although less congestion was seen on Pakuranga Highway Westbound in the model compared to observed, this was not reflected in the travel time validation. In the PM peak, less congestion was seen on Ti Rakau Eastbound in the model, however this was not reflected in the travel time validation.

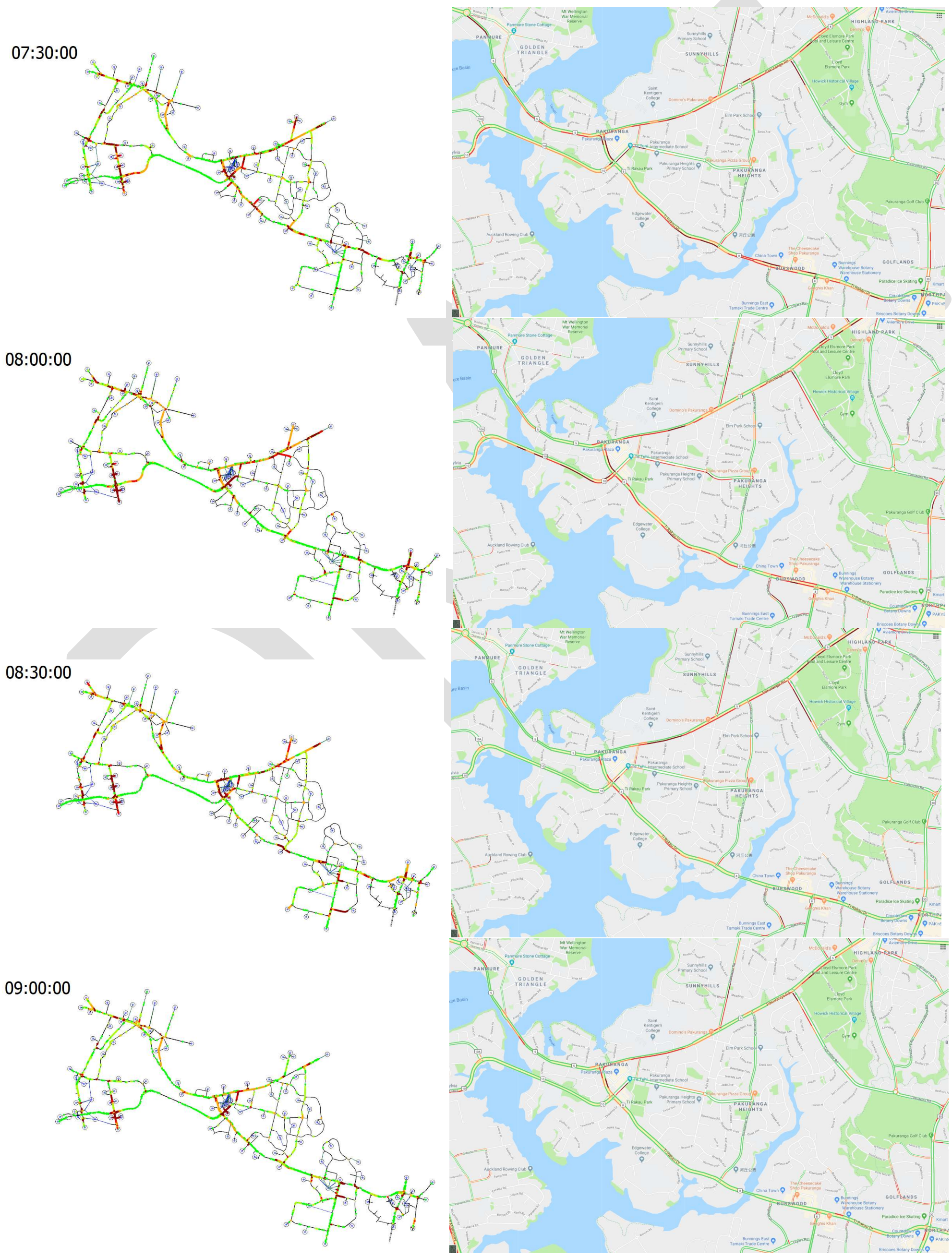


Figure 30 – AM Modelled Congestion versus Observed

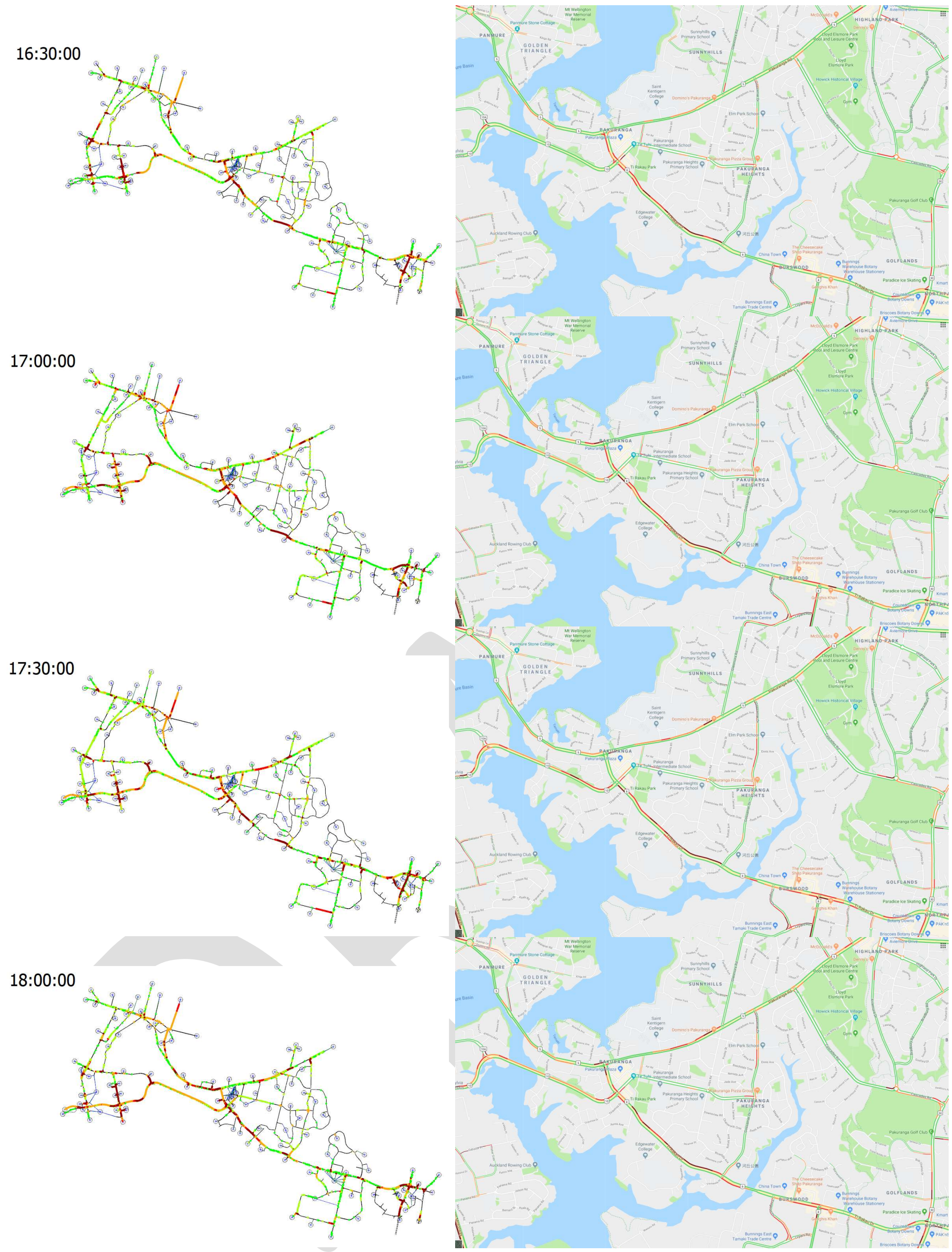


Figure 31 - PM Modelled Congestion versus Observed

This comparison is useful to understand the location of the congestion however the exact definition of congestion in Google's traffic is unknown. Hence it is used as an indication.

5.9 Route Choice Sense Check

Route choice in the model could not be directly calibrated and/or validated because there was no available data. However, sense-checks were made in the **static** model (which contributes 80% of the route choice) using previous experiences and observed traffic count-split information at intersections. Overall, route distribution in the model appears reasonable (Figure 32 - Figure 34).

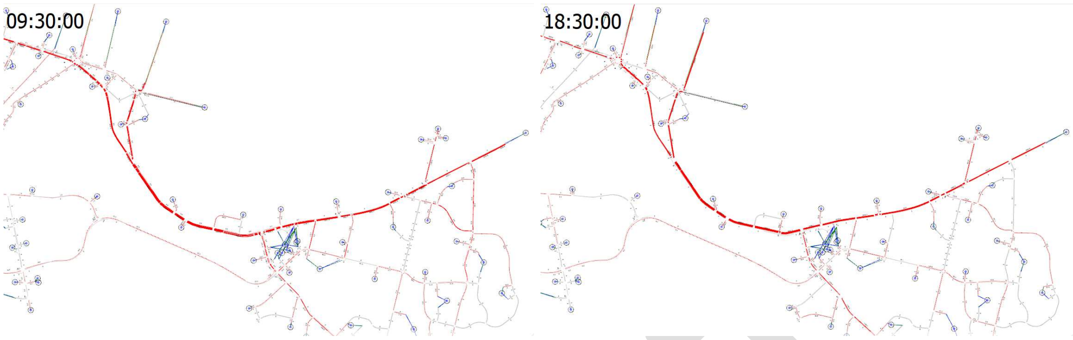


Figure 32 - Route Choice Split: AM Panmure Bridge Westbound (left) and PM Panmure Bridge Eastbound (right)

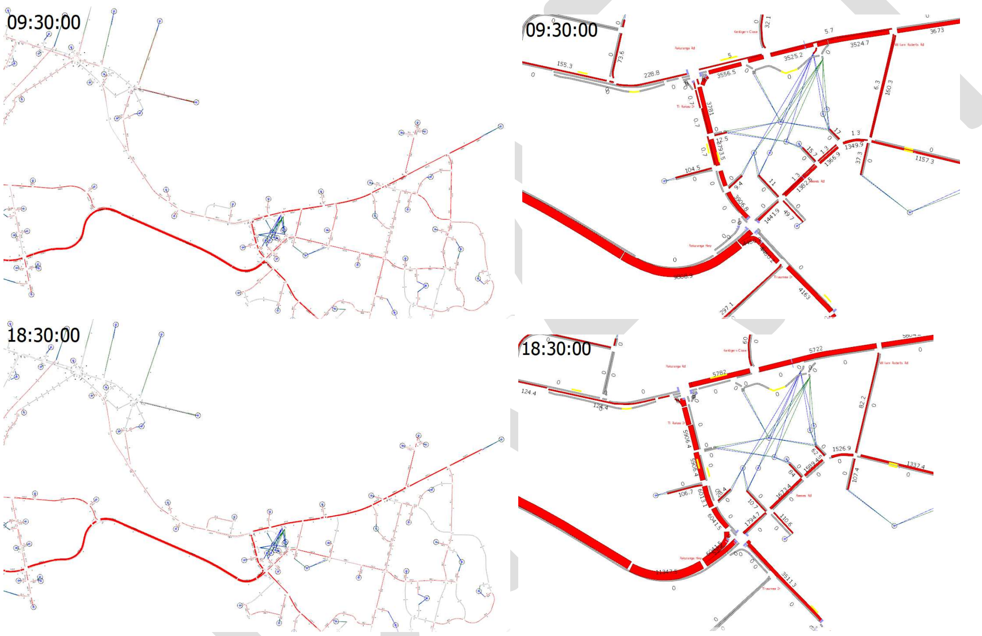


Figure 33 - Route Choice Split: AM Pakuranga Highway Westbound (above) and PM Pakuranga Highway Eastbound (below)

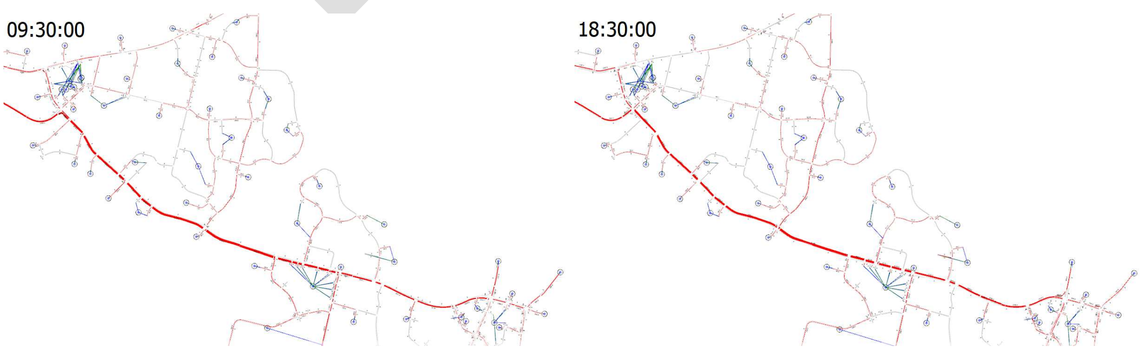


Figure 34 - Route Choice Split: AM Pakuranga Highway Westbound (above) and PM Pakuranga Highway Eastbound (below)

5.10 Model Stability

Model stability was monitored and found to be within acceptable thresholds of a coefficient of variance (COV) <5% across the modelled periods, except in the AM past 9am (Figure 35). However, since the demand and the total travel time are fulling at approximately the same profile, this is not an issue.

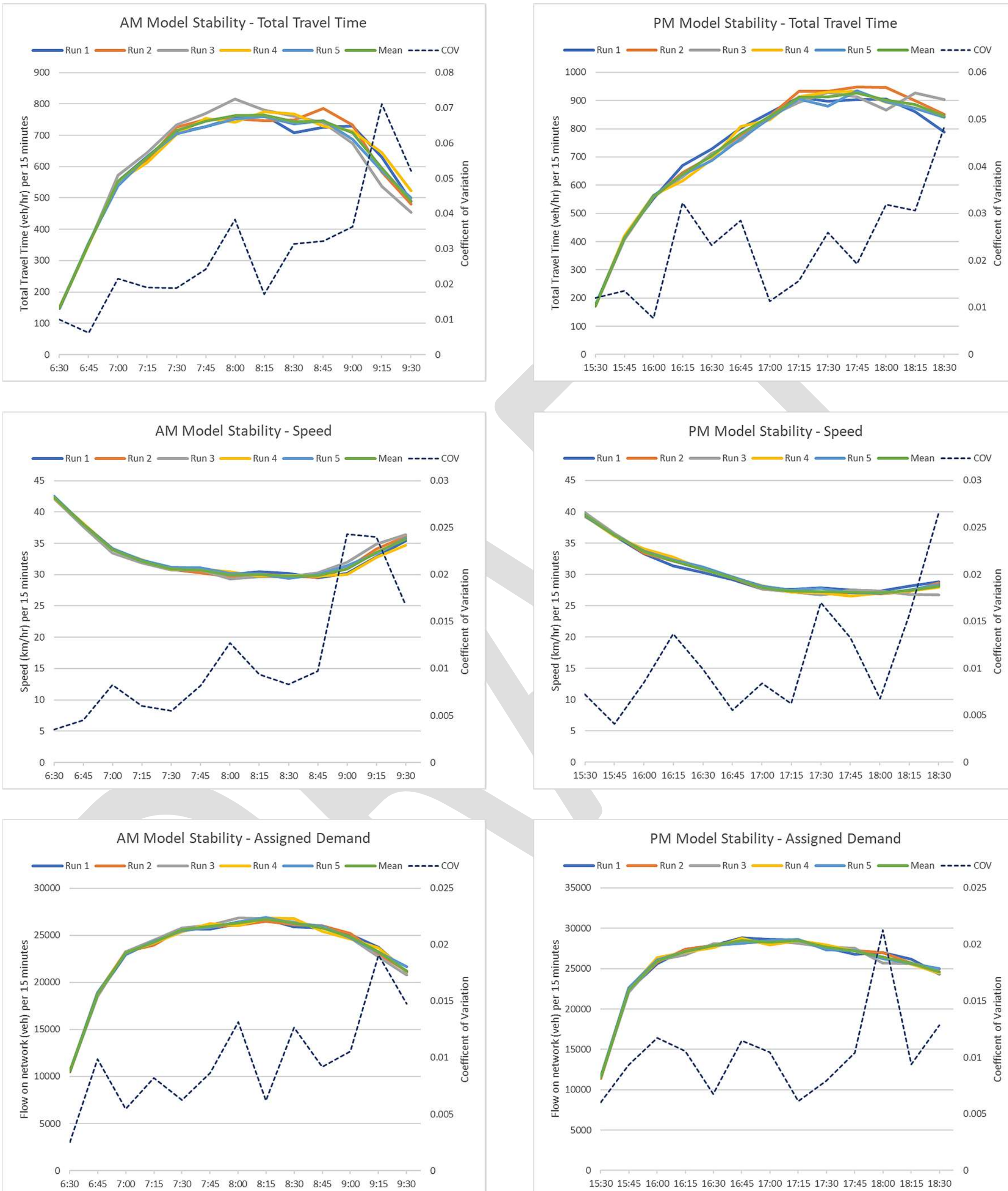


Figure 35 - Model Stability: Total Travel Time, Speed and Flow Plots

6 Conclusion

This report details the update and calibration/validation of the Aimsun model for the Eastern Busway Project. The purpose of this model is to provide a consistent and common base for project developments in the East Auckland Area, primarily along Ti Rakau Drive for the EB 2 and EB3 detailed design work.

The model covers two three-hour peak periods (6.30 am – 9.30 am, and 3.30 pm – 6.30 pm). The modelled periods were chosen to capture the congestion typically experienced in the modelled area.

The model consists of macro and micro tiers with the respective assignment methods: static assignment and microscopic dynamic assignment (DTA). The macro tier provides an interim stage to calibrate the demand through demand adjustment and to generate 80% of paths for the micro DTA. Based on previous modelling of the area, an 80-to-20 split in static versus dynamic path assignment was considered appropriate. This gave better control of modelling route choice in the area and sense-checks during the model development process showed that route distribution in the model is reasonable.

Various observed data were provided by Auckland Transport (AT) for the model development. These included traffic counts, travel time, public transport timing, and signal timing.

The traffic demands come from the AMETI EMME traffic model and were processed before assigning to the Aimsun model. This demand interface process includes a minor refinement of AMETI traffic model zones and application of 2-to-3 hour expansion factors to fit the Aimsun model period. Demand adjustment as part of the validation process was done manually.

The model network was developed in line with the Auckland Dynamic Traffic Assignment Model (ADTA) network coding guideline, which sets out the recommended network coding methodology for Aimsun models in Auckland. This included a standard system of classification and labelling of different turn movement types which were important function variables in the ADTA-developed cost functions also adopted in this model for calculating junction and turn delays.

Model validation showed that the model meets the validation target criteria for Category C: Urban Area in NZTA Model Development Guidelines on individual link flows and turn flows for each hour between 7am – 9am, and 4pm – 6pm. Travel times in the model fit reasonably well with the observed.

Overall, the base year model is considered acceptably calibrated and validated for the purposes of the EB2/3 design work.