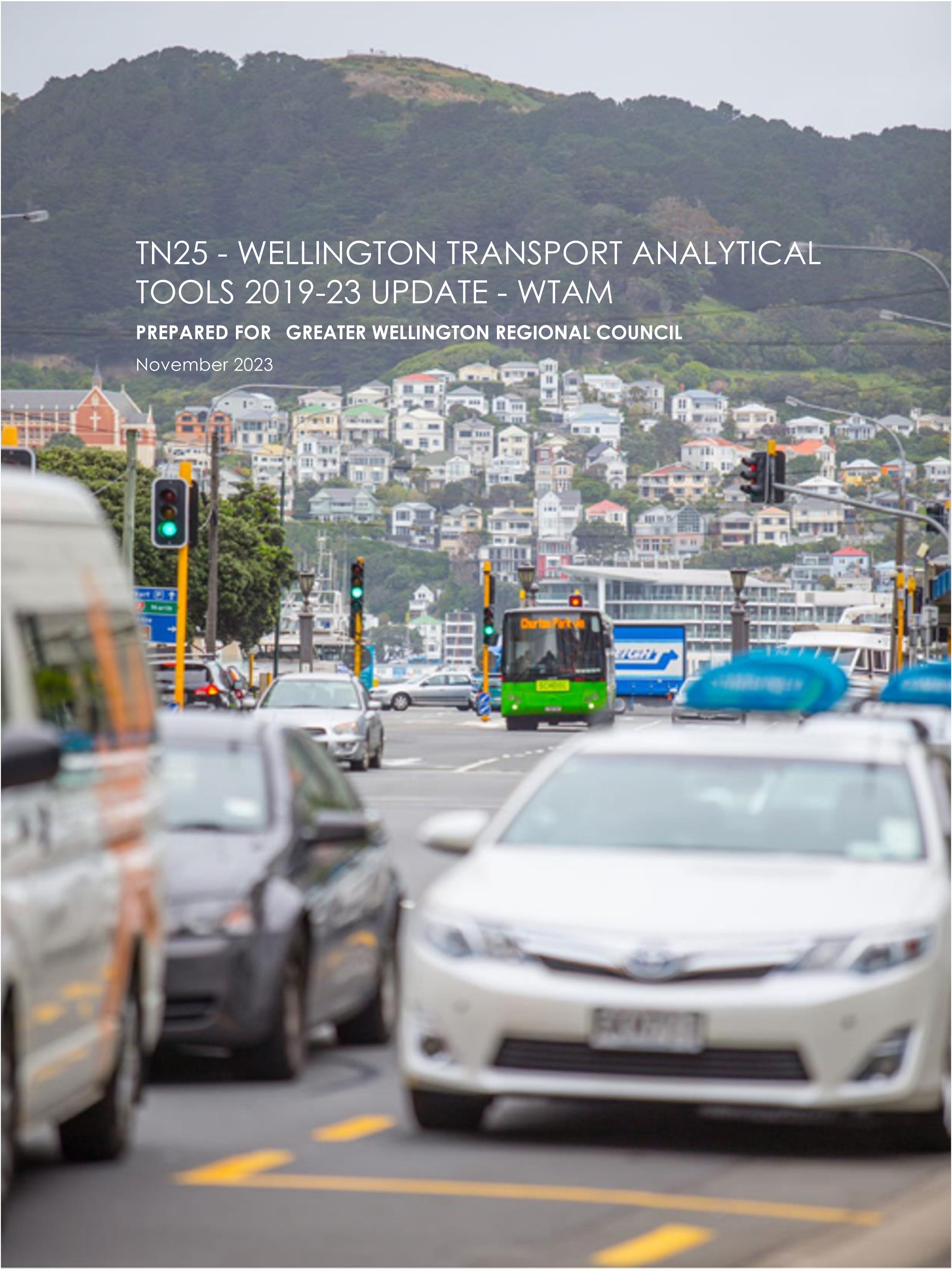
TN25 - WELLINGTON TRANSPORT ANALYTICAL TOOLS 2019-23 UPDATE - WTAM

PREPARED FOR GREATER WELLINGTON REGIONAL COUNCIL

November 2023



Stantec | JACOBS

QUALITY STATEMENT

PROJECT MANAGER		**PROJECT TECHNICAL LEAD**
Ali Siddiqui		Julie Ballantyne
PREPARED BY		
Luke Aldridge/Julie Ballantyne	....	30 / 11 / 2023
CHECKED BY		
Julie Ballantyne	....	30 / 11 / 2023
REVIEWED BY		
Luke Aldridge	....	30 / 11 / 2023
APPROVED FOR ISSUE BY		
Julie Ballantyne	....	30 / 11 / 2023

CHRISTCHURCH
Hazeldean Business Park, 2 Hazeldean Road, Addington, Christchurch 8024
PO Box 13-052, Armagh, Christchurch 8141
TEL +64 3 366 7449, FAX +64 3 366 7780

REVISION SCHEDULE

Rev No.	Date	Description	Signature or Typed Name (documentation on file)			
			Prepared by	Checked by	Reviewed by	Approved by
1	Oct 2022	Draft	LA/JEB	JEB	LA	JEB
2	Nov 2023	Final Draft (New Executive Summary and Sections 6 & 7)	LA/JEB	JEB	LA	JEB
3	Nov 2023	Final, including response to comments	LA/JEB	JEB	LA	JEB

Greater Wellington Regional Council

TN25 - Wellington Transport Analytical Tools 2019-23 update - WTAM

CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

Executive Summary

The Wellington Traffic Assignment Model (WTAM) is a new analytical tool added to the suite as part of this update. It is a traffic assignment model with base year demands derived from observed data (rather than using synthetic demand as in WTSM), with future year growth calculated based on the change forecast by WTSM.

The modelled time periods are:

- AM shoulder, 6-8am
- AM peak hour, 8-9am
- Interpeak, 9am-3pm
- PM shoulder, 3-5pm
- PM peak hour, 5-6pm

The suite of models are static in nature, and therefore trips are allocated completely to one time period.

Light and heavy vehicles are modelled separately. Vehicles are modelled as PCU's, reflecting the additional road space that buses and heavy vehicles take up.

The heavy vehicle demands were calculated synthetically in WTSM and input to the WTAM.

The light vehicle 2018 base year demand in WTAM was produced by:

- Obtaining mobile phone tracking data for person trips
- These were adjusted from sample to represent the total population by the supplier.
- We produced vehicle trips by removing walk, public transport, and car passenger trips. Walk trips were flagged by the supplier, while observed PT trips were available from electronic ticketing machine data and other sources. Car passengers were removed by applying occupancy factors.
- The AM and PM three hour peak period demands were factored to the initial hour and shoulder periods using global factors, which were found to be as good as using more refined proportions from the Household Travel Survey.
- Matrix estimation applied to improve the match to observed traffic counts.

The standard matrix estimation checks were carried out, noting that a considerable amount of pre-processing was required. Checks on the prior to post matrix estimated demands included: trip length distributions; trip end changes for origins and destinations; the magnitude of change for each origin-destination pair; and sector-to-sector demand changes.

The WTAM network detail and zoning are identical to the other models in the suite, with 819 zones in total including the externals. Intersections are represented more explicitly than in the previous version of WTSM, however, intersection delays are still relatively simplistic reflecting the strategic nature of the models.

The validation criteria are based on "category B" in the Transport Model Development Guidelines. Light and heavy vehicles are validated separately, as are each of the five time periods listed above. In addition, the full AM peak period (6-9am) and PM peak period (3-6pm) are also checked.

The validation outcomes were considered very good for a strategic model. Table 5-1 is replicated below which shows the comparison of modelled flows to traffic counts.

Table E-1: Summary of Traffic Count Validation

Period	Screenlines		Links	
	Lights	Heavies	Lights	Heavies
AM Peak Hour	Almost all achieved	Mostly not achieved, but close	Mostly not achieved, but close	Mostly not achieved. Poor RMSE and R2
AM Shoulder	Almost all achieved	Mostly achieved	Mostly not achieved, but close	Mostly achieved
AM Peak Period	All achieved	Mostly achieved	All achieved	Mostly achieved
Interpeak	Almost all achieved	Mostly achieved	Mostly achieved	Mostly achieved
PM Peak Hour	All achieved	Mostly not achieved, but close	Mostly not achieved, but close	Mostly achieved. Poor RMSE and R2
PM Shoulder	All achieved	Mostly not achieved, but close	Mostly achieved	Mostly achieved. Poor RMSE and R2
PM Peak Period	Almost all achieved	Mostly not achieved, but close	Mostly not achieved, but close	Mostly achieved. Poor RMSE and R2

At a screenline level, all criteria are met for all five modelled time periods. There is more variation at link level, but where the WTAM does not meet the criteria, it is often very close.

Travel time validation was also considered acceptable. The model tends to be slightly faster than observed for all time periods aside from the AM shoulder.

WTSM was validated after the WTAM calibration/validation was completed, and this resulted in changes to the network which is common to both models. Using the updated network made minimal difference to the validation of WTAM, with the PM peak shoulder declining slightly but achieving similar levels of validation to the other peak periods. The tables in this report were not updated and reflect the results using the network that was current when WTAM was calibrated and validated. Instead, validation spreadsheets were provided to the peer reviewer with the results using both the original and updated networks, and demonstrating minimal change, which was accepted.

Future year demands are created using a "pivot" from WTSM forecasts, using the same approach as for the WPTM. The majority of future year demand in the WTAM comes from OD pairs where there are values in the WTAM base as well as WTSM base and future years with typical growth forecast by WTSM. There are large numbers of OD pairs where there are no trips in the WTAM base year, but trips in WTSM for the base and future years. This results in zero future year demand for WTAM for these OD pairs, which is worth monitoring over time to ensure the total growth in WTAM mirrors that forecast by WTSM. The application of this forecasting approach produces future demands in the WTAM in line with growth predicted by WTSM, albeit very slightly higher.

1. Introduction

This technical note is part of a series documenting the 2019-2023 update of components of the Wellington Regional Transportation Planning Analytical Tools. The higher-level Analytical Tools are maintained and operated by Greater Wellington Regional Council (GWRC), who are the client for this project. This project is being primarily delivered by Stantec and Jacobs, supported by GWRC transport planners.

This technical note documents the development of the new Wellington Traffic Assignment Model (WTAM).

This technical note covers the following:

- Specification, including network, zoning, validation data and criteria, and other general information
- Observed demand data, and match to traffic counts
- Adjustment of the observed demand
- Validation results
- Forecasting

2. Specification

2.1 Overview

The WTAM is a completely new model in the Wellington analytics suite, designed to closer replicate traffic counts than the strategic demand model (WTSM, Wellington Strategy Transportation Model). The WTAM achieves this by having an observed light vehicle demand matrix for the base year of 2018. In forecast mode, changes predicted by WTSM are applied to WTAM to 'pivot' the demand from 2018 to the future year. As a pivot model, the WTAM is similar to the Wellington Public Transport Model (WPTM), which also has base year demands from observed origin-destination (OD) data.

Observed light vehicle demands are introduced in Section 3 of this note, while the forecasting mechanism is described in Section 6.

The primary time periods in WTSM are:

- AM peak period, 6-9am
- Interpeak, 9am-3pm
- PM peak period, 3-6pm
- Overnight, 6pm-6am

As the two commuting periods are relatively long in duration at three hours each, these have each been split into a peak hour and a shoulder, where the shoulder is the remainder of the period. The reason for introducing the peak hour is to better reflect congestion across the period. Derivation of the peak hour and shoulder is documented in Technical Note 21: Peak Periods and Vehicle Occupancy.

The time periods to be modelled for the WTAM are:

- AM shoulder, 6-8am
- AM peak hour, 8-9am
- Interpeak, 9am-3pm
- PM shoulder, 3-5pm
- PM peak hour, 5-6pm

The overnight period is not included in the WTAM, as there are no congestion issues.

In all cases, an average hour is assigned to simplify the model setup for the junction modelling.

2.2 Treatment of Heavy Vehicles

In the WTAM, both light and heavy commercial vehicles (HCV) are assigned, while bus flows are included as a preload.

The HCV demands are produced in WTSM and are fully synthetic (i.e. calculated by trip generation and distribution equations). HCVs are therefore not "observed" in the same way as light vehicles. This was considered appropriate because HCVs are numerically small.

HCVs and buses are included as PCUs, which is described in Technical Note 28: Road Assignment.

The PCU factors adopted are reproduced below for reference.

Table 2-1: PCU Values

Vehicle Type	PCU Value
Cars	1.0
Heavy Commercial Vehicles	2.0
Buses	3.0

2.3 Transport Network and Intersection Modelling

The road network is taken directly from WTSM and includes the same level of zoning, which is the 819 zone system.

The assignment mechanism in WTAM is primarily the same as WTSM. Turning capacities are calculated by the software using a new tool called Junction Capacity Assignment Tool (JCAT). Travel times and delays are then calculated by applying volume-delay functions and turn penalty functions. The capacity and delay equations are documented in Technical Note 28: Road Assignment. Specific to WTAM, the assignment is fully multi-class (lights and heavies separately), whereas a single class process is used in WTSM (followed by a final multi-class assignment) to reduce run times. This simplification is not required in WTAM.

2.4 Validation Criteria and Data

The criteria to be used for validation of the WTAM is based on category B in the Transport Model Development Guidelines (TMDG), or 'Strategic Network' because of the large geographic coverage of the model. The validation targets are specified in Section 9 of Technical Note 17: Model Rebuild Specification. These are replicated below so that this technical note can be read independently.

Validation data, which is observed traffic counts and travel times, are documented in Technical Note 4: Data Analysis (TN4). It is noted that anomalies with the observed data have been identified and corrected over the course of the project, and so observed data in this technical note may differ from TN4.

In particular, when the data analysis was originally undertaken, the peak hour and shoulder concept had not been developed. So traffic counts and travel times were all reprocessed to extract these additional time periods. At the Port, very limited data was available to estimate the daily flows for the four main model periods. So the Port is only checked at the peak period level, and not for the peak hour or shoulder assignments.

2.4.1 Validation Criteria - Traffic Counts and Screenline

The validation targets for a category B model are listed below, noting these are based on the traffic flows being an hourly equivalent.

Table 2-2: GEH Validation Targets

GEH	% of screenlines (per direction)	% of traffic counts (per direction)
GEH <5	>75%	>80%
GEH <7.5	>85%	>85%
GEH <10	>95%	>90%
GEH <12	N/A	>95%

In addition to the GEH, the TMDG specifies the following criteria:

Screenline hourly count bands:

- >80% within 10%
- >90% within 15%

Link hourly counts bands:

- For links with volumes less 700 vph (vehicles per hour): >80% within 100vph
- For links with volumes between 700 and 2700 vph: >80% within 15%
- For links with volumes above 2700 vph: >80% within 400vph

Scatterplots of modelled vs observed for all traffic counts:

- R^2 greater than 0.9
- Slope line of best fit between 0.9 and 1.1

RMSE (root mean squared error) for all counts:

- Acceptable: less than 25%
- Requires clarification: between 25% and 35%
- Unlikely to be appropriate: greater than 35%

The R-squared value will be calculated using the method of least squares (LINEST formula in Excel), with the trendline forced through zero.

Turning movements will not be validated for a strategic-level assignment model.

Validation will be carried out separately for light vehicles, and medium and heavy vehicles combined. However light commercial vehicles will be combined with private cars as observed data does not allow separate validation.

Validation will also be carried out separately for the peak hour and shoulder periods in the AM and PM peaks although the focus will be on validation of the peak period overall. The Interpeak period will be average hour assignment and validation.

2.4.2 Validation Criteria - Private Vehicle Journey Times

Journey times for private vehicles will be compared against observed on eight different routes (in both directions), as detailed in TN4.

The TMDG specifies the following criteria:

- 85% of routes within 15% or 1 minute (if higher)
- 90% of routes within 25% or 1.5 minute (if higher)

Modelled and observed times along each route will be plotted on an XY scatter graph. Traditionally these graphs show the mean observed travel times, along with the minimum and maximum. In this case however, due to the travel time data being sourced from GPS information, minimum and maximum times reflect minimums and maximums experienced at a particular point in time. Summing minimums/maximums over a route does not result in a minimum/maximum journey time experienced in reality. The 5^{th} and 95^{th} percentiles will therefore be used as an alternative.

3. Observed Demand Data

3.1 Source of OD Data

The observed data was mobile phone data from Qrious. Qrious is a data analysis company through Spark and has around 40% of all mobile phones in NZ. Through an iterative process, Qrious delivered their data factored to produce OD matrices for total person trips (mode agnostic) for an average weekday for March 2018. This data was supplied by Qrious in the four main model periods, which are listed in Section 2.1, in the 819 zone system.

The nature of mobile phone location data means it is not completely accurate. Hence different dwell times, which define what constitutes a trip, were tested by Qrious. In addition, the sample had to be factored to the total in the Census. Hence this observed data is already fairly processed, but was required to get representative data.

Further processing was carried out by this project team.

To produce the light vehicle OD matrices, the total observed persons trips had walk and PT trips removed for each period and then car occupancy factors applied to convert to vehicles. Walk trips were identified by a flag provided by Qrious. PT trips from WPTM were used, and when subtracted did initially produce negative trips and hence some simplification was required to remove them.

It is acknowledged that the matrices supplied by Qrious will include some heavy vehicle trips. But these could not be identified, and the proportion of HCVs is not considered significant.

The processing carried out as part of this project is fully documented in Technical Note 24: HTS & Mobile phone data.

The observed light vehicle demand matrices from Qrious, including post-processing, are provided in Appendix A aggregated to 11 sectors shown in Figure 3-1.

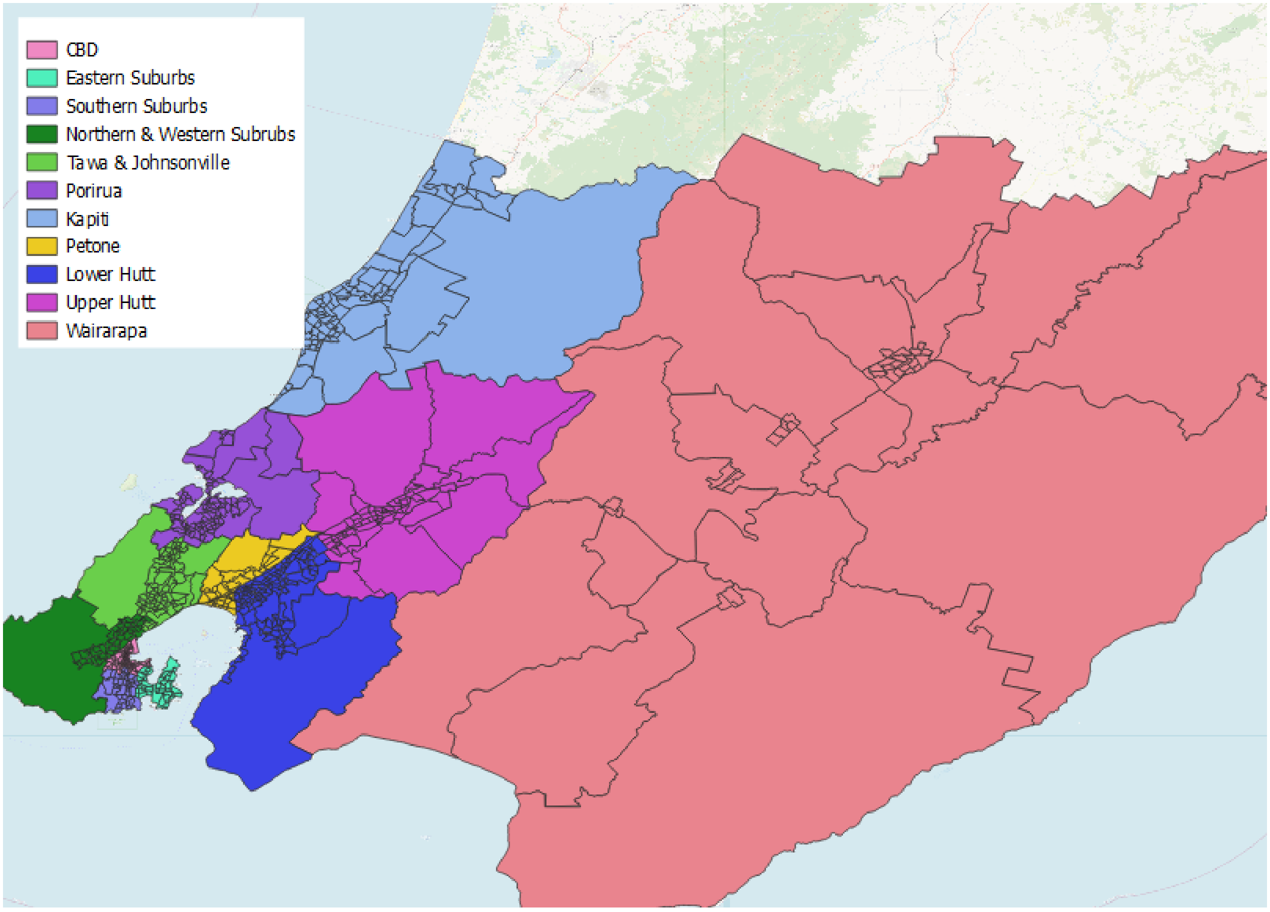


Figure 3-1: 11 Sectors

Total light vehicle trips by main peak period are tabulated below for reference.

Table 3-1: Observed Matrix Total by Main Peak Period

Period	Total Light Vehicle Trips
AM, 6-9am	201,417
Interpeak, 9am-3pm	367,850
PM, 3-6pm	229,457

3.2 Creating Observed Hour and Shoulder

The WTAM will have peak hour and shoulder assignments for the AM and PM periods. The mobile phone data was not provided for the hour and shoulder periods, primarily because this approach had not been decided when the data was ordered, and hence was not requested. Hence the AM and PM three hour periods need to be split into hour and shoulder.

Initially the HTS data that had been cleaned, processed and expanded was used. Trips were allocated to time period using the middle point of the journey time, and for car trips, proportions were calculated by dividing the peak hour by the peak period on a four sector basis. This was carried out for both AM and PM peaks, and the resulting factors are provided in Table 3-2 and Table 3-3 respectively, while the four sectors are illustrated in Figure 3-2.

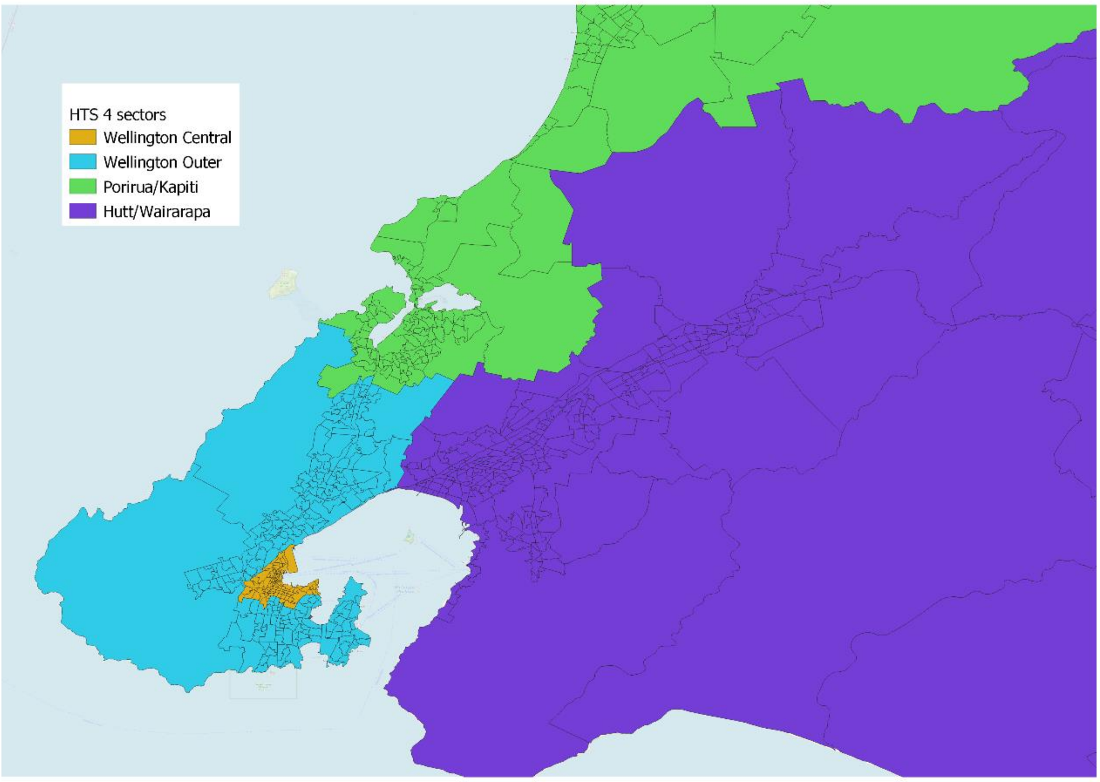


Figure 3-2: 4 Sectors for HTS Peak Hour Proportions

Table 3-2: AM Peak Hour to Peak Period Proportions, HTS

AM Peak Hour Proportions				
Sectors	**Wellington Central**	**Wellington Outer**	**Porirua/Kapiti**	**Hutt/Wairarapa**
Wellington Central	72%	68%	63%	62%
Wellington Outer	56%	55%	61%	44%
Porirua/Kapiti	39%	44%	58%	55%
Hutt/Wairarapa	51%	55%	43%	58%

The AM peak hour proportions seem logical, ranging from 39% to 72%, the largest proportion being for trips within Wellington Central.

Table 3-3: PM Peak Hour to Peak Period Proportions, HTS

PM Peak Hour Proportions				
Sectors	**Wellington Central**	**Wellington Outer**	**Porirua/Kapiti**	**Hutt/Wairarapa**
Wellington Central	42%	45%	48%	41%
Wellington Outer	30%	33%	31%	27%
Porirua/Kapiti	26%	41%	30%	44%
Hutt/Wairarapa	31%	33%	29%	31%

The PM peak hour proportion of the period are lower than in the AM and range from 26% to 48%. This is somewhat consistent with the traffic counts, which shows around a third of trips within each hour of the three hour period.

The proportions in Table 3-2 and Table 3-3 were applied to the mobile phone AM and PM peak period matrices to produce peak hour demands. It is noted that the mobile phone period matrices were not adjusted to match observed traffic counts. This was to minimise the amount of demand adjustment/matrix estimation (i.e. avoid correcting the period, and then making further changes to the hour and shoulder). It was decided that a more robust approach was to adjust the hour and shoulder separately to match observed counts, which will automatically result in a representative peak period demand.

Applying the peak hour proportions from the HTS to the Qrious period matrices resulted in 55% of the AM period demand in the peak hour, and 33% for the PM. These hourly demands were assigned and the resulting flows ("modelled") compared to observed traffic counts. Figures showing key validation comparisons for screenlines (left) and individual links (right) are shown below for the AM peak hour, followed by the PM peak hour.

AM Peak Period Traffic Volume Comparison Summary (0800-0900)

1.0 **Flow Divisor for GEH (trips already average hour)**

TMDG Criteria Summary

Purpose Category: (Regional / Strategic Network)

Strategic Network

Evaluation Criteria		Target	Screenline Summary Light Abs.	(%)	Evaluation Criteria		Target	Individual Link Summary Light Abs.	(%)
GEH	< 5	75%	18	(28%)	GEH	< 5	80%	57	(30%)
	< 7.5	85%	5	(36%)		< 7.5	85%	16	(38%)
	< 10	95%	6	(45%)		< 10	90%	22	(50%)
	<= Max	100%	35	(100%)		< 12	95%	11	(55%)
						<= Max	100%	85	(100%)
% Difference Less Than	10%	-	17	(26%)	% Difference Less Than	10%	-	23	(12%)
	20%	-	27	(41%)		20%	-	42	(23%)
R2		-	0.95		R2		-	0.92	

Figure 3-3: HTS Proportions, AM Peak Hour Screenline Results

Summing the screenlines flows, there are 54,000 more trips in the AM peak hour than observed traffic counts, which is a 39% overestimate. It is acknowledged that summing screenlines could propagate any errors as a trip may cross multiple screenlines, but it does provide a useful metric. Applying the peak hour proportions from the HTS to the AM peak period mobile phone matrix has not produced a good fit to traffic counts considering the GEH criteria. The R-Squared value does indicate minimal scatter, and that the matrices have a relatively good correlation.

PM Peak Period Traffic Volume Comparison Summary (1700-1800)

1.0 Flow Divisor for GEH (trips already average hour)

TMDG Criteria Summary

Purpose Category: (Regional / Strategic Network)

Strategic Network

Evaluation Criteria		Target	Screenline Summary Light Abs.	(%)
GEH	< 5	75%	20	(31%)
	< 7.5	85%	8	(44%)
	< 10	95%	7	(55%)
	<= Max	100%	29	(100%)
% Difference Less Than	10%	-	17	(26%)
	20%	-	30	(45%)
R2		-	0.92	

Evaluation Criteria		Target	Individual Link Summary Light Abs.	(%)
GEH	< 5	80%	75	(39%)
	< 7.5	85%	21	(50%)
	< 10	90%	24	(63%)
	< 12	95%	12	(69%)
	<= Max	100%	59	(100%)
% Difference Less Than	10%	-	41	(22%)
	20%	-	70	(38%)
R2		-	0.87	

Figure 3-4: HTS Proportions, PM Peak Hour Screenline Results

PM peak hour proportions from the HTS, applied to period Qrious data, produce a peak hour that had a slightly better match to observed traffic counts than the AM peak, but it is still nowhere near acceptable in terms of GEH criteria. Again, the R-squared value is strong indicating a good correlation.

It became clear that the Qrious observed matrices would need a reasonable amount of adjustment to replicate traffic counts, and that matrix estimation would be needed. A more controlled manual factoring approach was considered, but discarded – the errors were not consistent, and the Qrious demands were not close enough to observed traffic counts.

Given the mismatch between Qrious "observed" demands and traffic counts which means matrix estimation will be needed, and that the HTS sample size is very small, using a flat global factor to produce the hour from the period was assessed. A factor of 40% was used for the AM peak hour and 33% for the PM.

For the AM peak hour, a flat factor of 40% produced total trips (sum of trips crossing screenlines) closer to traffic counts than using proportions from the HTS, which is shown in Table 3-4. Key validation statistics are provided in Figure 3-5.

Table 3-4: AM Peak Hour Screenline Total by Method

AM Peak Hour Total Screenlines		
Traffic Counts	HTS Factor	Flat Factor
138,807	192,807	153,851

AM Peak Period Traffic Volume Comparison Summary (0800-0900)

1.0 Flow Divisor for GEH (trips already average hour)

TMDG Criteria Summary

Purpose Category: (Regional / Strategic Network)

Strategic Network

Evaluation Criteria		Target	Screenline Summary Light Abs.	(%)
GEH	< 5	75%	16	(25%)
	< 7.5	85%	12	(44%)
	< 10	95%	12	(63%)
	<= Max	100%	24	(100%)
% Difference Less Than	10%	-	12	(18%)
	20%	-	33	(50%)
R2		-	0.94	

Evaluation Criteria		Target	Individual Link Summary Light Abs.	(%)
GEH	< 5	80%	70	(37%)
	< 7.5	85%	33	(54%)
	< 10	90%	26	(68%)
	< 12	95%	14	(75%)
	<= Max	100%	48	(100%)
% Difference Less Than	10%	-	42	(23%)
	20%	-	64	(35%)
R2		-	0.92	

Figure 3-5: AM Flat Factor (40%) Peak Hour Screenline Results

Considering links rather than screenlines, for the AM peak hour, applying a network-wide global factor produces a better match to traffic counts rather than using peak hour proportions from the HTS.

The same analysis is provided below for the PM peak, where the flat factor was 33%.

Table 3-5: PM Peak Hour Screenline Total by Method

PM Peak Hour Total Screenlines		
Traffic Counts	HTS Factor	Flat Factor
148,051	140,451	139,641

PM Peak Period Traffic Volume Comparison Summary (1700-1800)

1.0 Flow Divisor for GEH (trips already average hour)

TMDG Criteria Summary

Purpose Category: (Regional / Strategic Network)

Strategic Network

Evaluation Criteria		Target	Screenline Summary Light Abs.	(%)
GEH	< 5	75%	25	(39%)
	< 7.5	85%	8	(52%)
	< 10	95%	9	(66%)
	<= Max	100%	22	(100%)
% Difference Less Than	10%	-	23	(35%)
	20%	-	38	(58%)
R2		-	0.95	

Evaluation Criteria		Target	Individual Link Summary Light Abs.	(%)
GEH	< 5	80%	73	(38%)
	< 7.5	85%	29	(53%)
	< 10	90%	25	(66%)
	< 12	95%	17	(75%)
	<= Max	100%	47	(100%)
% Difference Less Than	10%	-	39	(21%)
	20%	-	78	(42%)
R2		-	0.91	

Figure 3-6: PM Flat Factor (33%) Peak Hour Screenline Results

The screenlines improve using the flat factor to calculate the peak hour, with a very slight improvement in for individual links.

A flat factor was therefore adopted to produce the initial peak hour and shoulder matrices from the peak period. This is because of the small sample in the HTS, the improved replication of traffic counts from using a flat factor, and the simplicity of the adopted approach.

4. Demand Adjustment

4.1 Approach

Because of the poor match to observed traffic counts on links and screenlines (in terms of GEH values), matrix estimation was required for all five periods (AM peak hour, AM shoulder, interpeak, PM peak hour, and PM shoulder).

The matrices assigned and then matrix estimated are produced from the three hour commuting periods (AM and PM) and six hour interpeak by applying the following factors to produce a one hour demand.

- AM Peak Hour, **40%** of AM period 6-9am
- AM Shoulder, **60%** of AM period 6-9am. This is then halved to produce an average hour
- Interpeak, **16%** of Interpeak period 9am-3pm to produce an average hour
- PM Peak Hour, **33%** of PM period 3-6pm
- PM Shoulder, **67%** of PM period 3-6pm. This is then halved to produce an average hour

EMME has a multiclass traffic demand adjustment tool that performs matrix estimation. This has the option of using screenlines or links to adjust to. The preference was to adjust to screenlines, which should result in less change to the matrix. However, estimating to screenlines did not bring the demands sufficiently into line. Hence matrix estimation to link flows has been undertaken.

Prior to matrix estimation, the row and columns for zones 2261 (SH1 external) and 2271 (SH2 external) were manually factored to match the observed traffic counts.

4.2 Changes in Demand

In this section, the comparisons between the demand matrices before and after estimation are summarised. The following tabulations are provided:

- Trip length distribution

- Trip ends, origins and destinations
- Change in individual origin-destination pairs
- Sector-to-sector demand changes, checked at period level.

Sector-to-sector demand changes are only checked at the peak period level because the peak hour and shoulder initial ("raw") demands have been produced by applying a flat global factor and so the comparison is not robust. The same issue applies for the trip end and OD changes, but these are reported to demonstrate the demands have not been significantly altered.

4.2.1 AM Peak Hour

The trip length distribution is provided below for the raw (demands from Qrious, processed, and globally factored to approximately an hour) compared with the matrix output from the estimation ("adjusted"). Distance is in kilometres, with the vertical access showing percentage of trips – this applies to all trip length distribution graphs.

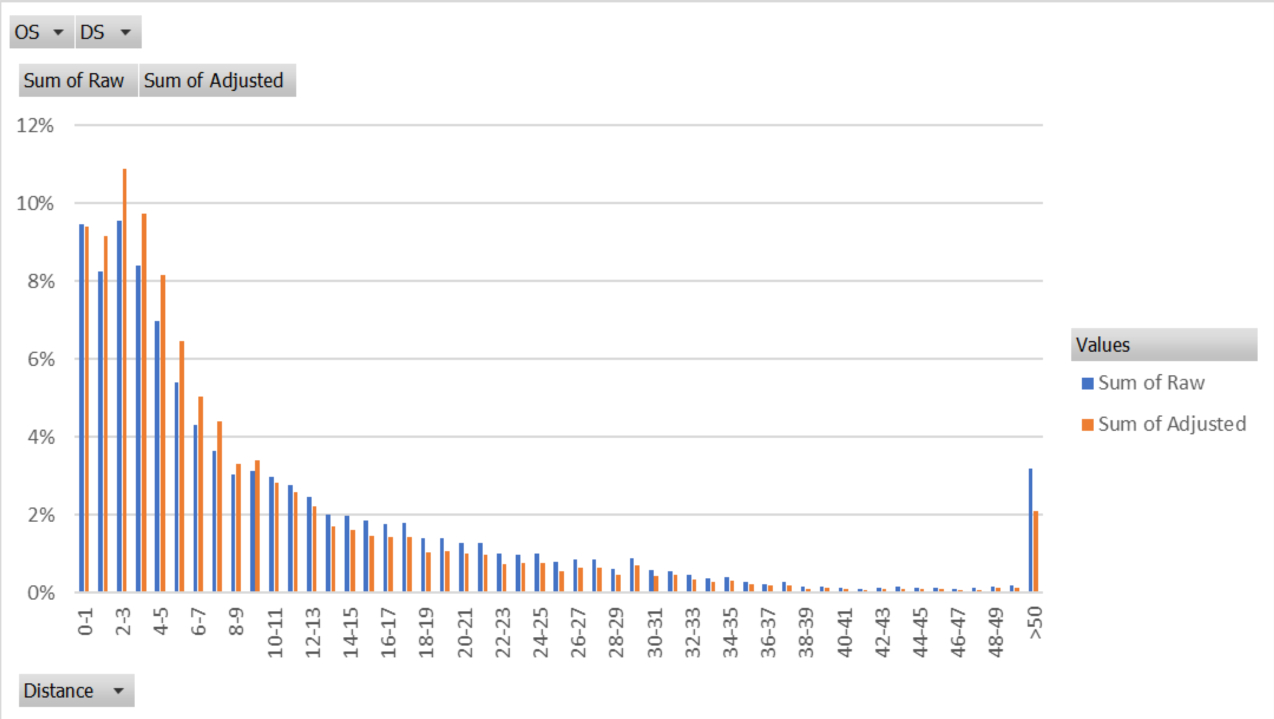


Figure 4-1: AM Peak Hour, Trip Length Distribution

Figure 4-1 demonstrates that the matrix estimation has not changed the shape of the demands. In general, trips from 1-8km in length have increased slightly. There is also a reduction in longer trips (>50km), part of which will be associated with factoring the externals at SH1 and SH2 to match the traffic counts. The reduction in longer trips is small (1% of total demand).

The difference in origins and destinations for the raw and adjusted demands is shown below as a frequency count of the changes.

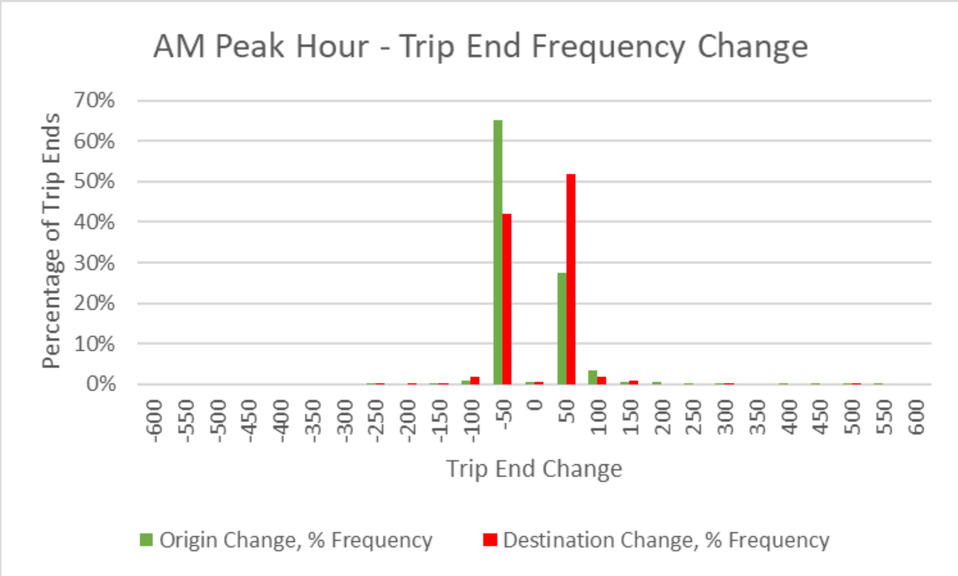


Figure 4-2: AM Peak Hour, Trip End Change Frequency Count

Figure 4-2 demonstrates that no zone has changed significantly in terms of total origins or destinations. The majority of zones are changing by +/- 50 trips.

Table 4-1: Trip End Absolute and % Differences, AM Peak Hour

		% Difference								% of total
Absolute Difference	**0**	**25%**	**50%**	**75%**	**100%**	**125%**	**150%**	**175%**	**200%**	
	1	53	-	-	-	1	-	-	-	6.7%
	2	64	-	2	-	-	-	-	-	8.1%
	3	52	1	1	-	-	-	-	-	6.7%
	4	54	4	1	1	-	-	-	-	7.4%
	5	39	-	-	-	-	-	-	-	4.8%
	10	157	13	7	-	-	-	-	-	21.8%
	15	87	13	-	1	-	-	-	-	12.5%
	20	42	15	1	1	-	-	-	-	7.3%
	25	24	6	2	-	1	-	-	-	4.1%
	30	26	11	5	-	-	-	-	-	5.2%
	35	14	9	1	-	-	-	-	-	3.0%
	40	11	10	2	1	-	-	-	-	3.0%
	45	5	6	1	-	-	-	-	-	1.5%
	50	3	1	2	3	-	1	-	-	1.2%
	100	7	8	8	7	2	1	1	-	4.2%
	200	2	2	2	4	1	2	-	-	1.6%
	201	-	-	-	-	-	-	-	-	0.0%
	550	1	-	2	-	1	3	1	1	1.1%
% of total		79.0%	12.2%	4.6%	2.2%	0.7%	0.9%	0.2%	0.1%	

Table 4-1 shows that six zones have high percentage differences (>100%) and high absolute differences (>200). All of these are in the CBD where there were larger matrix adjustments required to meet screenline targets. The AM peak hour shows the most significant changes in terms of total and percentage and hence has been reported. Other periods are not reported as they show lesser change.

The difference in individual OD cells for the raw and adjusted demands is shown below as a frequency count of the changes.

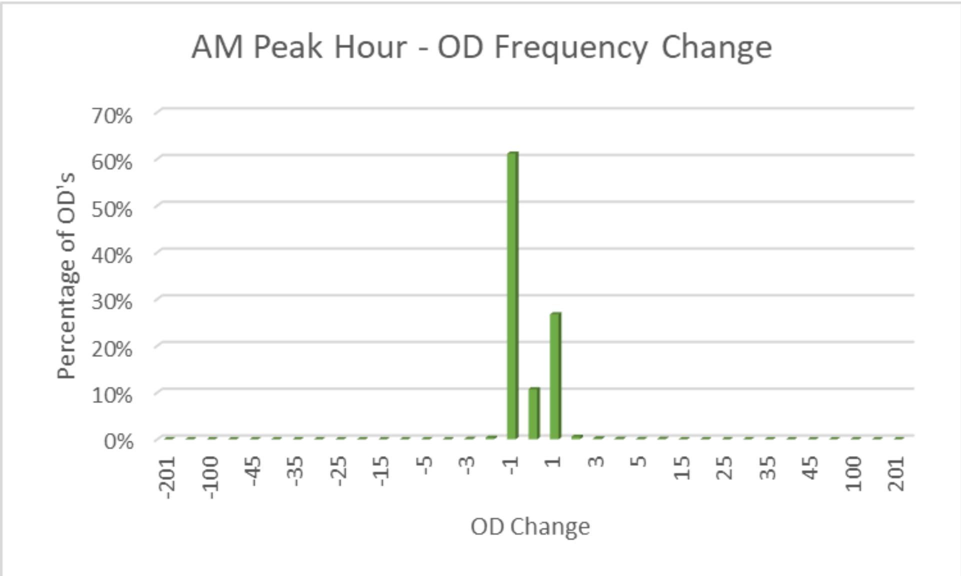


Figure 4-3: AM Peak Hour, OD Change Frequency Count

Figure 4-3 shows individual OD cells are not changing significantly, with cell values changing by +/-1.

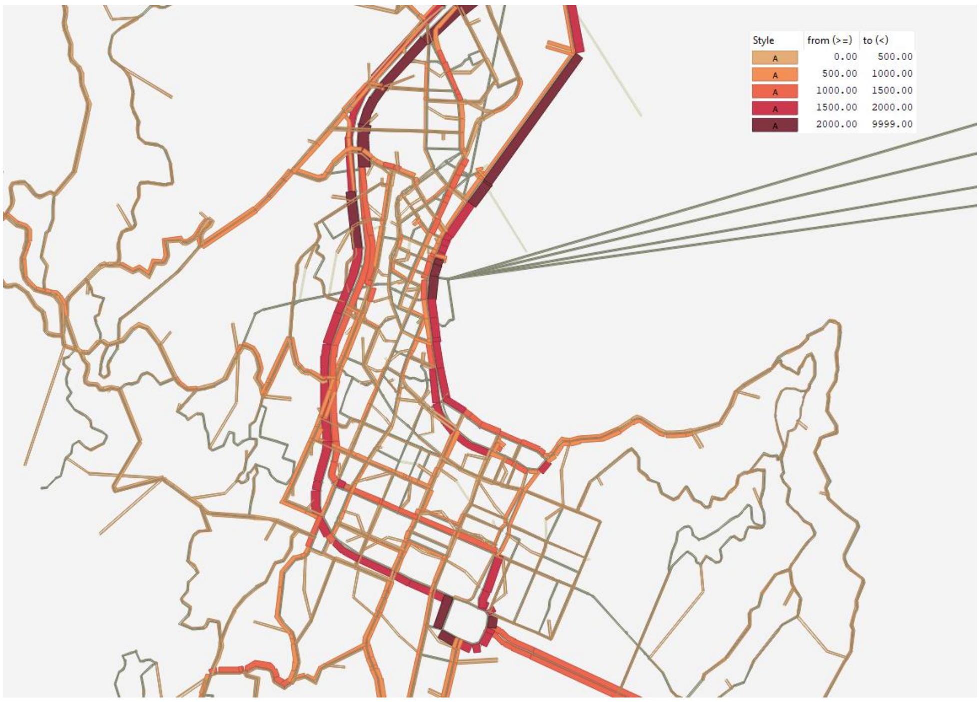


Figure 4-4: AM Peak Hour Light Vehicle Volumes (Wellington CBD)

Figure 4-4 shows the flow of vehicles in the AM peak hour as a thematic map. This shows that there isn't any unusual traffic flows, and high traffic levels are where they are expected. Select link analysis has been undertaken at key points in the network for the AM peak hour. This shows that there are no issues with traffic routeing through the selected roads based on judgement and local knowledge. The select link plots of light vehicle trips for the AM and PM peak hours are provided in Appendix E.

4.2.2 AM Shoulder Period

The trip length distribution is provided below for the raw (demands from Qrious, processed, and globally factored to approximately an hour) compared with the matrix output from the estimation ("adjusted").

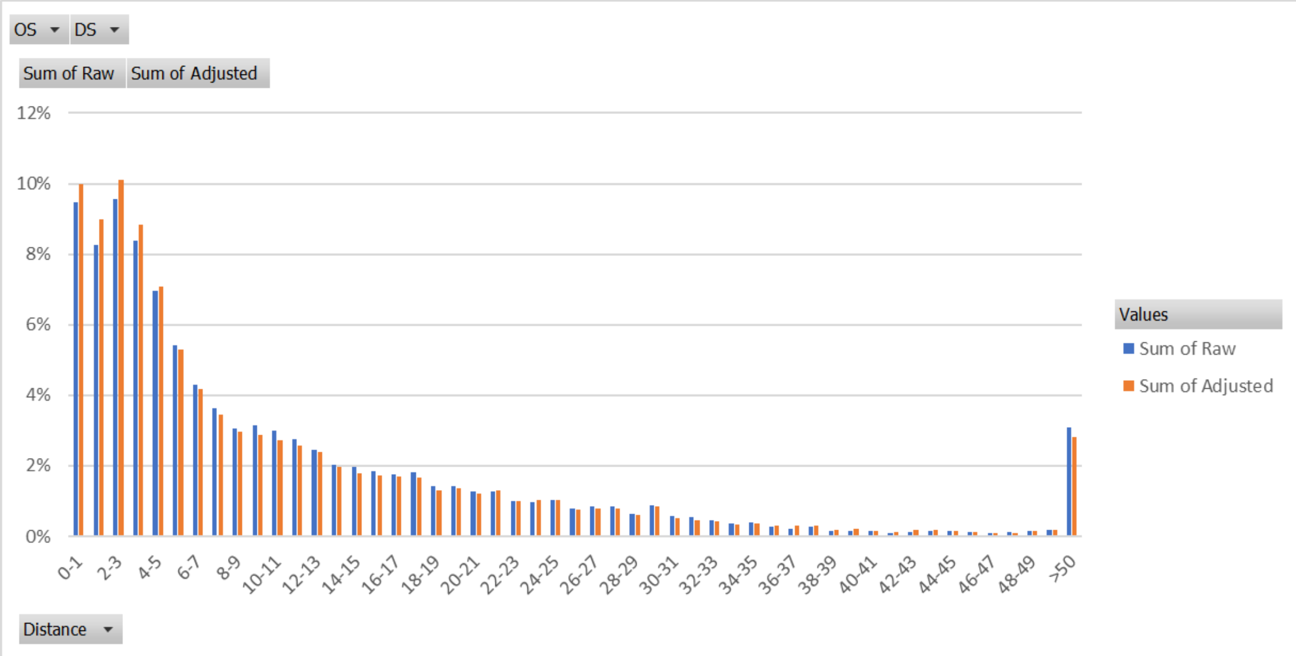


Figure 4-5: AM Shoulder, Trip Length Distribution

While the percentage of shorter trips has increased, it is not by much and considered acceptable.

The difference in origins and destinations for the raw and adjusted demands is shown below as a frequency count of the changes. It is noted that this is for the average hour.

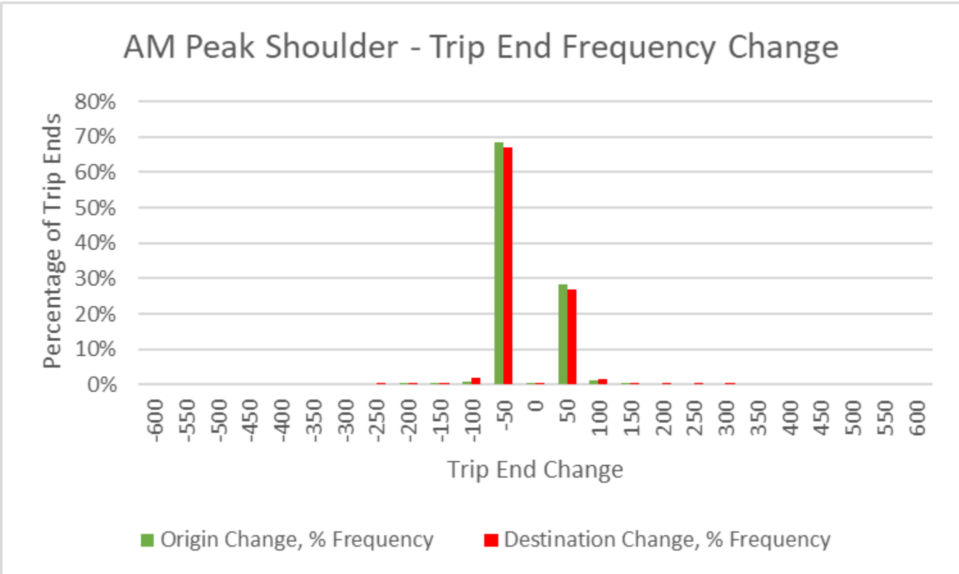


Figure 4-6: AM Shoulder, Trip End Change Frequency Count

As for the AM peak hour, the origin and destination totals have not changed significantly, with most changing by +/-50 trips (average hour).

The difference in individual OD cells for the raw and adjusted average hour demands is shown below as a frequency count of the changes.

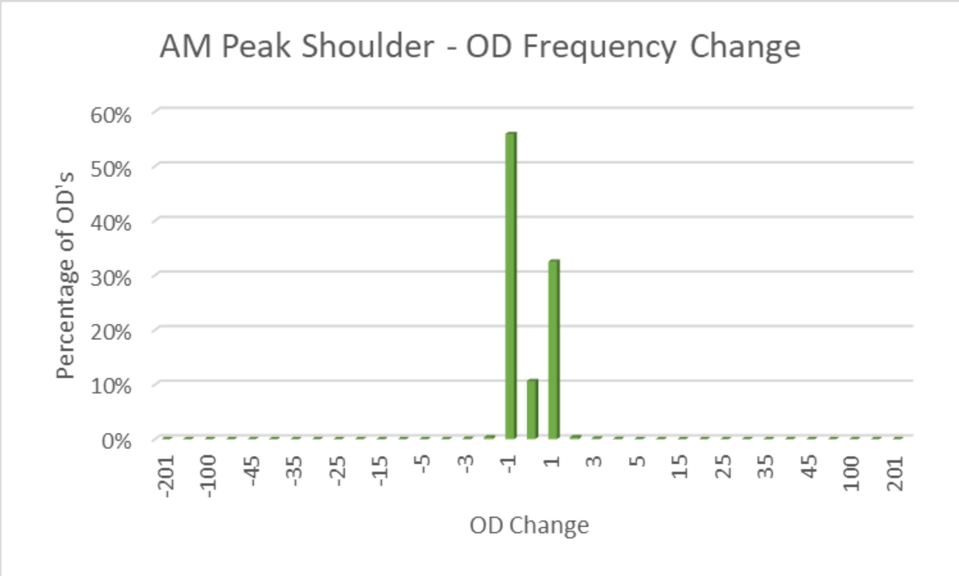


Figure 4-7: AM Shoulder, OD Change Frequency Count

Again, most cells change by +/-1 trip for the average hour demand.

4.2.3 AM Peak Period

The adjusted matrices (AM peak hour, AM shoulder, AM peak period) are provided in Appendix B aggregated to 11 sectors.

The difference between the adjusted and raw for the AM peak period is provided below. This is three hours in duration. The percentage difference is provided in Table 4-3.

Table 4-2: Peak Period, Difference, Adjusted minus Raw Demands

Adjusted Demands, 3 hours												
	CBD	Eastern suburbs	Kapiti	Lower Hutt	North & Western suburbs	Petone	Porirua	Southern suburbs	Tawa & Johnsonville	Upper Hutt	Wairarapa	Grand Total
CBD	3,034	1,238	-44	190	838	174	41	1,014	682	81	-17	7,231
Eastern suburbs	-138	1,321	-264	-34	-50	11	-37	386	77	-4	-32	1,236
Kapiti	-205	208	-298	75	-43	-44	-177	-26	-143	-16	-13	-683
Lower Hutt	-472	-183	25	-611	-428	202	116	-93	-485	-321	-63	-2,312
North & Western suburbs	-1,319	-298	-62	-232	-50	-129	-152	-449	76	-43	-19	-2,676
Petone	-16	-58	-37	-215	-233	-10	-71	9	-256	-10	-29	-925
Porirua	-106	-26	-261	144	-118	-68	689	-134	-592	38	-27	-459
Southern suburbs	-293	405	-45	-43	-60	8	-46	203	127	-2	-13	242
Tawa & Johnsonville	-917	-120	-108	-277	122	-130	351	-336	434	-40	-36	-1,059
Upper Hutt	-225	-44	-8	-1,468	-195	648	170	12	-199	-235	-101	-1,646
Wairarapa	99	8	-67	-103	-19	23	-8	15	-14	-152	-781	-1,000
Grand Total	-558	2,447	-1,166	-2,575	-237	686	878	603	-294	-702	-1,132	-2,051

Table 4-3: AM Peak Period, Percentage Difference, Adjusted vs Raw Demands

Adjusted Demands, 3 hours												
	CBD	Eastern suburbs	Kapiti	Lower Hutt	North & Western suburbs	Petone	Porirua	Southern suburbs	Tawa & Johnsonville	Upper Hutt	Wairarapa	Grand Total
CBD	47%	122%	-26%	30%	84%	48%	12%	86%	115%	46%	-31%	60%
Eastern suburbs	-4%	31%	-49%	-11%	-15%	6%	-25%	30%	29%	-6%	-66%	12%
Kapiti	-17%	134%	-2%	22%	-38%	-18%	-17%	-27%	-28%	-7%	-24%	-3%
Lower Hutt	-12%	-38%	13%	-3%	-83%	4%	15%	-21%	-55%	-16%	-55%	-7%
North & Western suburbs	-21%	-52%	-63%	-38%	-1%	-33%	-44%	-46%	7%	-35%	-71%	-17%
Petone	-1%	-24%	-34%	-6%	-82%	0%	-22%	3%	-45%	-2%	-56%	-8%
Porirua	-6%	-9%	-41%	18%	-38%	-14%	6%	-37%	-17%	7%	-51%	-2%
Southern suburbs	-7%	33%	-50%	-9%	-12%	4%	-20%	5%	35%	-2%	-60%	2%
Tawa & Johnsonville	-16%	-21%	-36%	-24%	8%	-15%	13%	-45%	5%	-14%	-64%	-5%
Upper Hutt	-12%	-29%	-4%	-43%	-83%	50%	29%	6%	-44%	-2%	-46%	-8%
Wairarapa	45%	28%	-52%	-52%	-75%	26%	-19%	62%	-44%	-45%	-4%	-4%
Grand Total	-2%	27%	-6%	-9%	-2%	5%	5%	6%	-2%	-4%	-5%	-1%

While the overall percentage change is minor, there are some relatively high changes on a sector basis.

Points of note include:

- There is a notable percentage change to the Eastern suburbs (+27%), with very large percentage increases from the CBD (+122%) and Kapiti (+134%) indicating the "observed" mobile phone matrices were too low for this destination. The increased CBD and Kapiti trips total 1400, which is not excessive.
- There is a large percentage increase in trips originating in the CBD (+60%), which is also numerically large (+7200 trips over the three hour period). The majority of the change, and the largest change for any sector pair is an additional 3000 trips within the CBD. This is examined in more detail below.
- Trips within the Eastern suburbs have also been increased by 31%, which is numerically of note representing 1321 trips across the three hour peak period.
- Trips from the Northern and Western suburbs to the CBD have reduced (-1319, -21%).

Tests were undertaken limiting the changes introduced by the matrix estimation, so that the percentage and numeric differences reduced (adjusted vs raw). However, this resulted in poor validation results in terms of GEH criteria. It was therefore decided that since the observed matrices have been expanded and processed by Qrious, and then further processed by this project team, that a better project outcome was to allow the demand matrices to change and deliver a model with improved validation to observed traffic counts.

Raw and adjusted CBD-related trips are shown below, including an estimate from WTSM. The WTSM demands come from the 2018 interim version of WTSM (two hour, 7-9am), factored to produce approximate three hour demands. It is noted that the 2018 interim version of WTSM did not validate sufficiently and hence was not adopted.

Table 4-4: AM Peak Period, CBD Comparison

	Raw, 3hr	Adjusted, 3hr	3hr WTSM
CBD-CBD	6,473	9,507	13,780
CBD, origins	12,007	19,238	23,547
CBD, destinations	36,725	36,167	41,912

The matrix estimation added just over 3000 trips within the CBD. Given the Qrious matrices have about half the trips in WTSM, this increase would seem appropriate. Similarly, trip originating in the CBD were increased by the matrix estimation, and this seems an appropriate magnitude compared to WTSM. The matrix estimation made minimal changes to trips in the peak direction, destined for the CBD. Based on this comparison, the changes to CBD trips introduced by matrix estimation seem plausible and appropriate.

4.2.4 Interpeak Period

The trip length distribution is provided below for the raw (demands from Qrious, processed, and globally factored to approximately an hour) compared with the matrix output from the estimation ("adjusted").

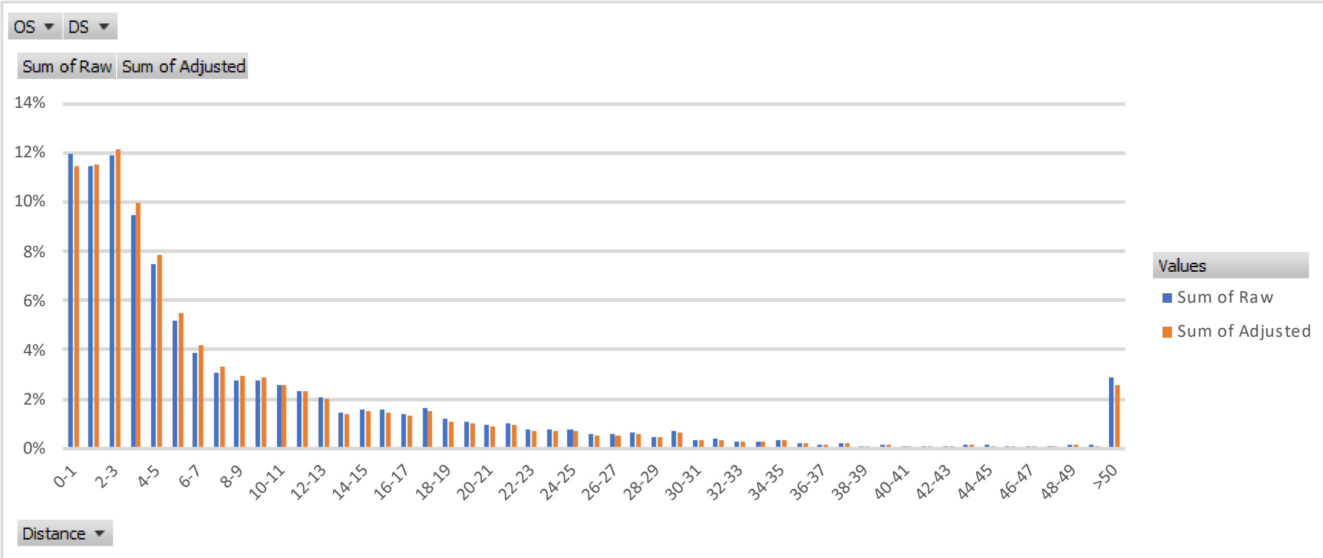


Figure 4-8: Interpeak, Trip Length Distribution

This demonstrates minimal change to the shape of the matrix has been made through matrix estimation.

The difference in origins and destinations for the raw and adjusted demands (average hour) is shown below as a frequency count of the changes.

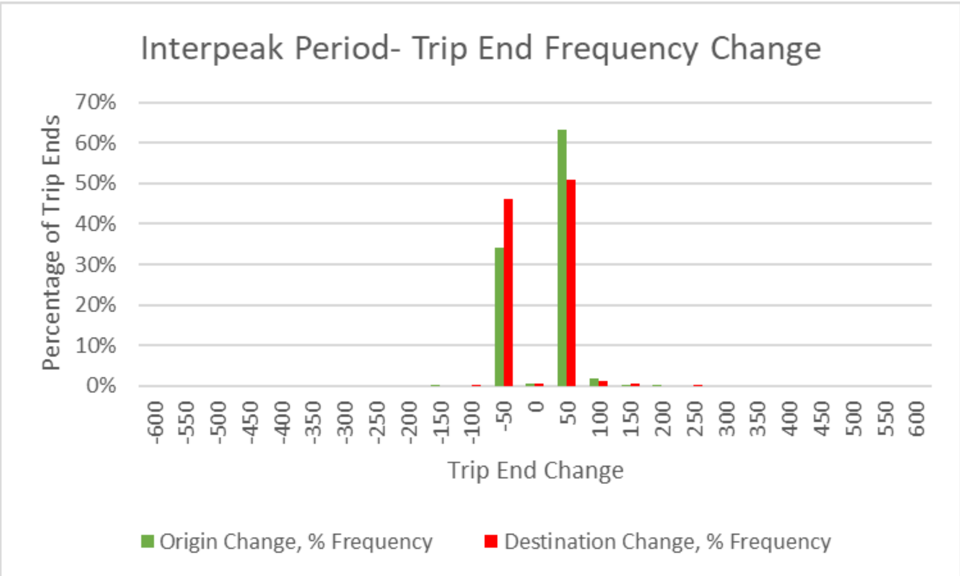


Figure 4-9: Interpeak, Trip End Change Frequency Count

Again, for the average hour, origin and destination totals have not changed significantly, with the majority changing by +/-50 trips.

The difference in individual OD cells for the raw and adjusted demands is shown below as a frequency count of the changes.

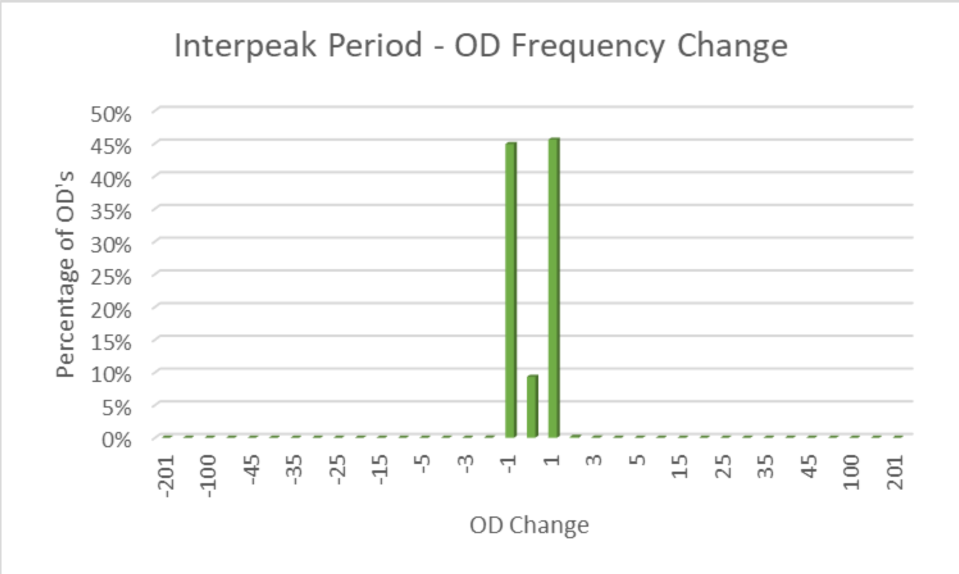


Figure 4-10: Interpeak, OD Change Frequency Count

On an individual cell value, minimal change has been introduced through matrix estimation with most ODs changing by +/-1 trip for the average hour.

The adjusted matrix is provided in Appendix B aggregated to 11 sectors. The difference between the adjusted and raw for the interpeak period is provided below. This is six hours in duration. The percentage difference is provided in Table 4-6.

Table 4-5: Interpeak, Difference, Adjusted minus Raw Demands

Adjusted Demands, 6 hours												
	CBD	Eastern suburbs	Kapiti	Lower Hutt	North & Western suburbs	Petone	Porirua	Southern suburbs	Tawa & Johnsonville	Upper Hutt	Wairarapa	Grand Total
CBD	6,915	1,334	-169	-455	825	-241	-625	1,601	146	-249	-133	8,948
Eastern suburbs	1,781	826	177	201	262	111	19	1,078	260	33	-23	4,726
Kapiti	125	279	-337	47	36	30	201	-31	69	-46	-126	247
Lower Hutt	545	412	-6	-984	168	1,484	45	-85	482	-153	-112	1,795
North & Western suburbs	1,781	175	-27	-105	166	-81	-138	2	400	-67	-39	2,065
Petone	81	144	-20	-571	8	-3	-70	-82	135	-159	-57	-593
Porirua	20	110	96	61	-19	5	698	-158	-1,052	-22	-25	-286
Southern suburbs	2,093	898	5	36	304	22	-62	374	147	-15	-25	3,775
Tawa & Johnsonville	1,067	443	-12	220	588	173	-1,269	-28	-193	-3	-30	956
Upper Hutt	56	87	-45	168	10	35	-4	-40	59	475	-87	714
Wairarapa	-29	8	-109	-61	-10	-20	-21	-31	-6	-65	-226	-571
Grand Total	14,435	4,717	-447	-1,444	2,337	1,515	-1,226	2,600	446	-273	-883	21,777

Table 4-6: Interpeak, Percentage Difference, Adjusted minus Raw Demands

Adjusted Demands, 6 hours												
	CBD	Eastern suburbs	Kapiti	Lower Hutt	North & Western suburbs	Petone	Porirua	Southern suburbs	Tawa & Johnsonville	Upper Hutt	Wairarapa	Grand Total
CBD	42%	44%	-22%	-17%	17%	-14%	-36%	40%	4%	-27%	-53%	23%
Eastern suburbs	67%	9%	23%	36%	43%	32%	6%	47%	47%	20%	-25%	27%
Kapiti	25%	54%	-1%	11%	20%	13%	24%	-15%	14%	-14%	-47%	1%
Lower Hutt	25%	76%	-1%	-3%	25%	19%	5%	-13%	37%	-4%	-38%	3%
North & Western suburbs	42%	28%	-11%	-13%	2%	-15%	-26%	0%	23%	-26%	-53%	11%
Petone	6%	47%	-8%	-7%	2%	0%	-12%	-23%	13%	-13%	-41%	-3%
Porirua	2%	39%	8%	7%	-5%	1%	3%	-33%	-16%	-4%	-35%	-1%
Southern suburbs	50%	38%	2%	6%	27%	5%	-12%	4%	20%	-7%	-37%	20%
Tawa & Johnsonville	44%	87%	-2%	16%	29%	15%	-19%	-4%	-1%	-1%	-35%	3%
Upper Hutt	9%	54%	-13%	5%	7%	3%	-1%	-25%	17%	2%	-18%	2%
Wairarapa	-16%	11%	-37%	-22%	-21%	-19%	-26%	-49%	-9%	-15%	0%	-1%
Grand Total	40%	27%	-1%	-3%	12%	7%	-3%	14%	1%	-1%	-2%	6%

The interpeak demand has increased by 6% in total, which is considered acceptable. The numeric increase (+21,700) appears large, but this represents a six hour demand.

The changes are dominated by the CBD. The largest increase is trips to the CBD (+14,400), followed by trips from the CBD (+8,900). This is driven by a large increase in intra-CBD trips (+6,900, +42%). This almost the same as the change introduced in the AM peak period, so is considered acceptable.

4.2.5 PM Peak Hour

The trip length distribution is provided below for the raw (demands from Qrious, processed, and globally factored to approximately an hour) compared with the matrix output from the estimation ("adjusted").

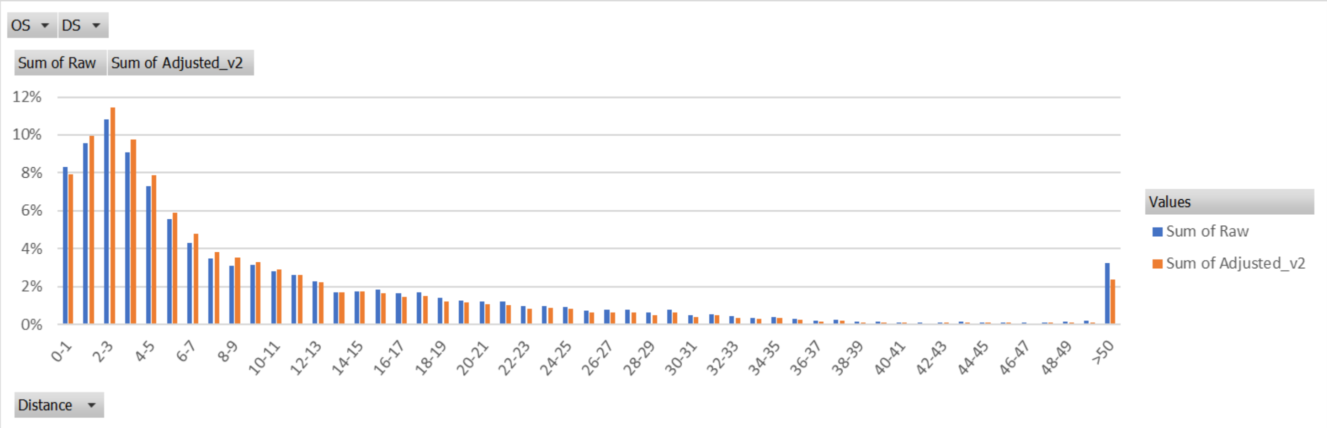


Figure 4-11: PM Peak Hour, Trip Length Distribution

Figure 4-11 demonstrates that the shape of the matrix has been retained. Very short trips (0-1km) have been reduced slightly, while trips from 1-9km have increased marginally.

The difference in origins and destinations for the raw and adjusted demands is shown below as a frequency count of the changes.

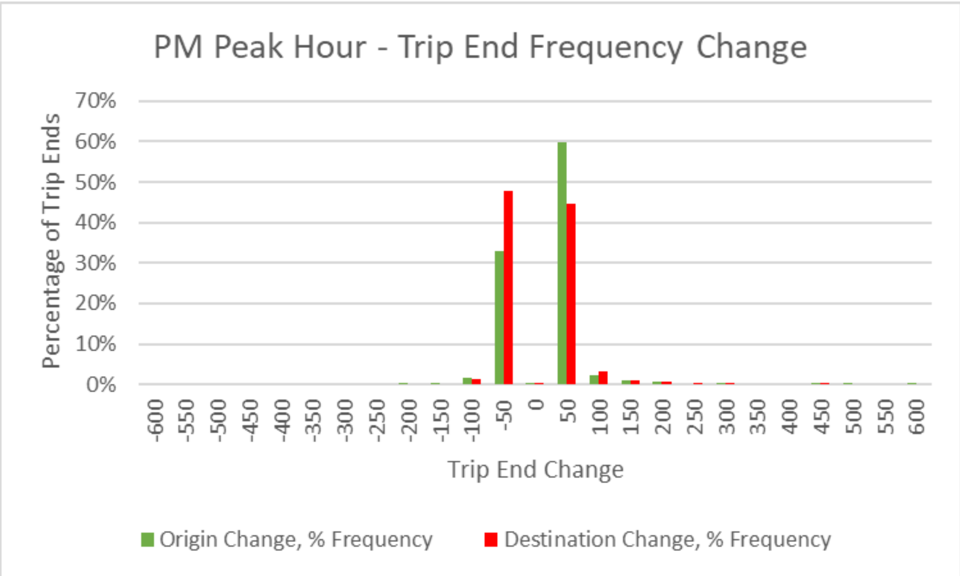


Figure 4-12: PM Peak Hour, Trip End Change Frequency Count

This shows that for origins and destinations, minimal change has been made with most changing by +/- 50 trips.

The difference in individual OD cells for the raw and adjusted demands is shown below as a frequency count of the changes.

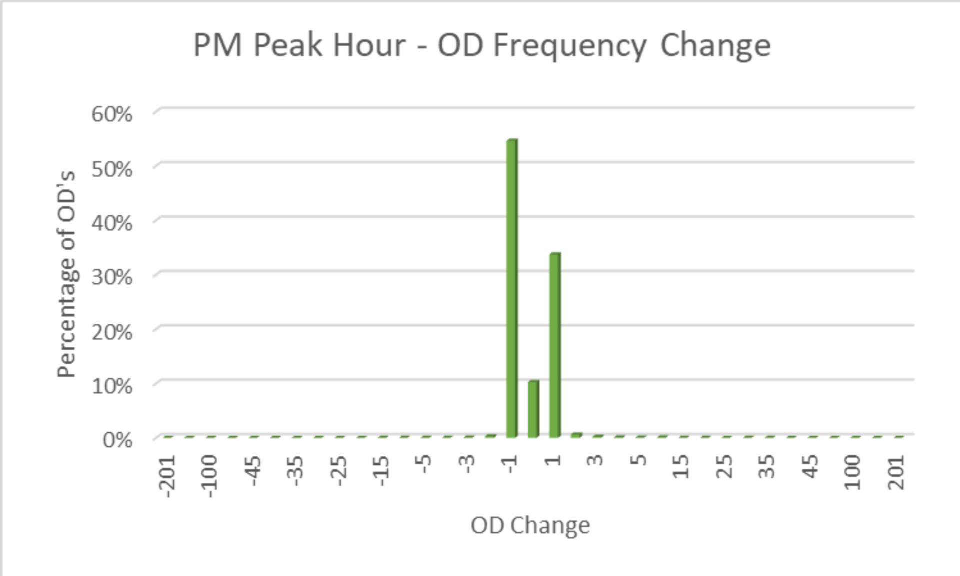


Figure 4-13: PM Peak Hour, OD Change Frequency Count

This demonstrates each OD cell is not changing by much, with most changing +/-1 trip.

Figure 4-14 shows that traffic is where it is expected for the PM peak hour. Select link analysis has been undertaken at key points in the network. These show that there are no issues with traffic routeing through the selected locations based on local knowledge and judgement. Select link plots for light vehicles in the PM peak hour are also shown in Appendix E.

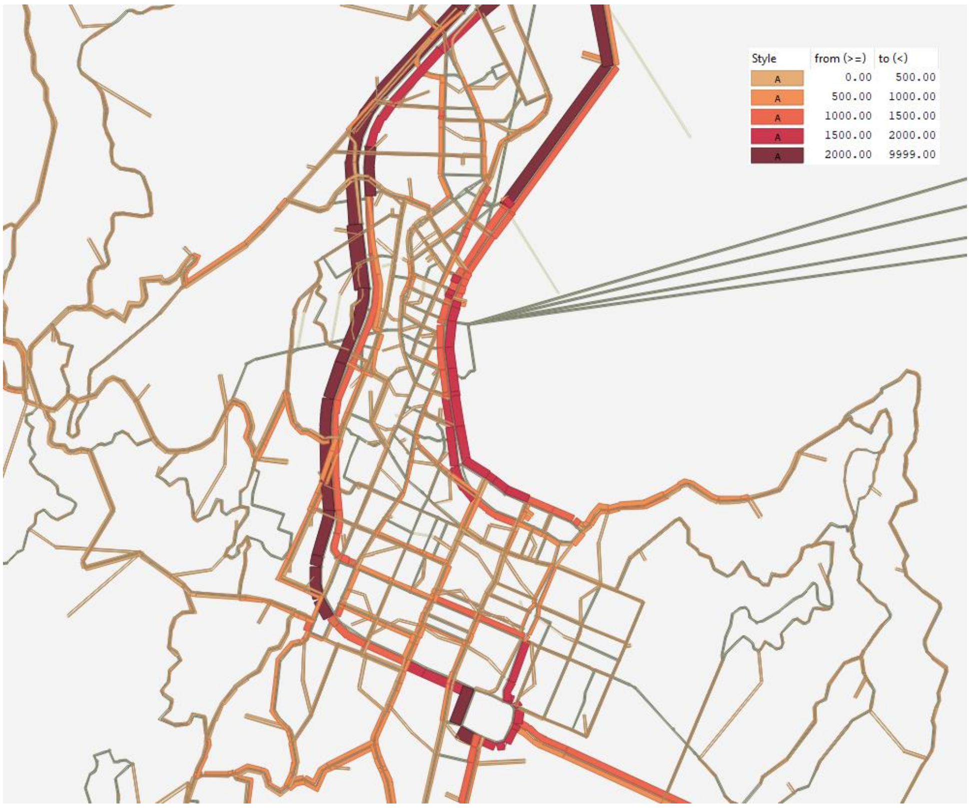


Figure 4-14: PM Peak Hour Light Vehicle Volumes (Wellington CBD)

Demand changes are only provided for the period.

4.2.6 PM Shoulder Period

The trip length distribution is provided below for the raw (demands from Qrious, processed, and globally factored to approximately an hour) compared with the matrix output from the estimation ("adjusted").

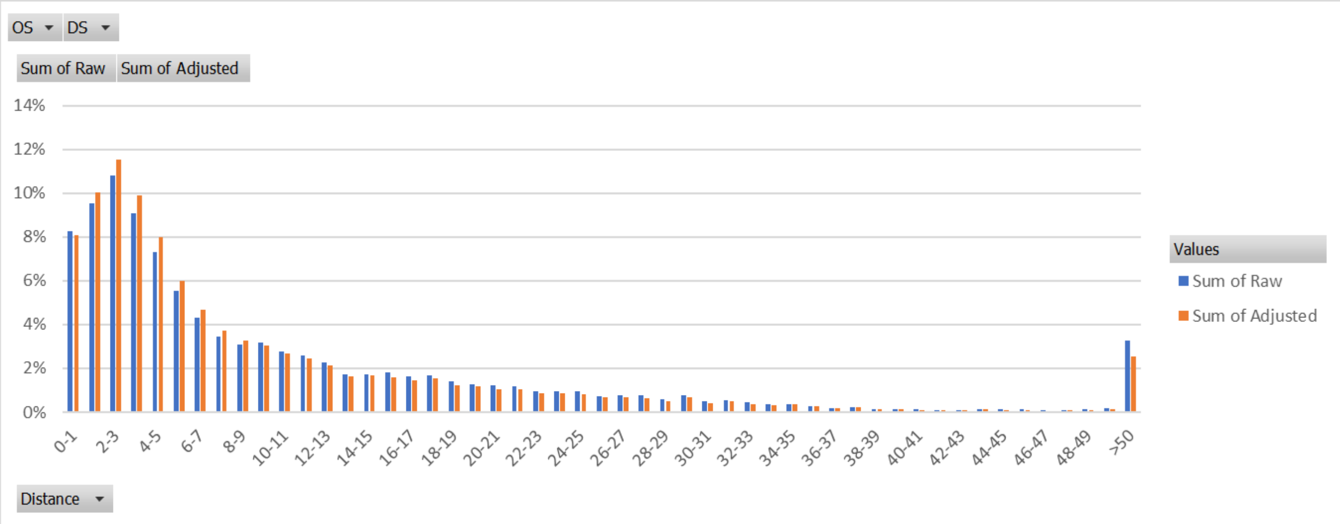


Figure 4-15: PM Shoulder, Trip Length Distribution

The shape of the demand has not been altered by matrix estimation. Very short trips (<1km) have again been reduced slightly, while trips 1-8km in length have increased marginally. The changes are considered appropriate.

The difference in origins and destinations for the raw and adjusted demands (average hour) is shown below as a frequency count of the changes.

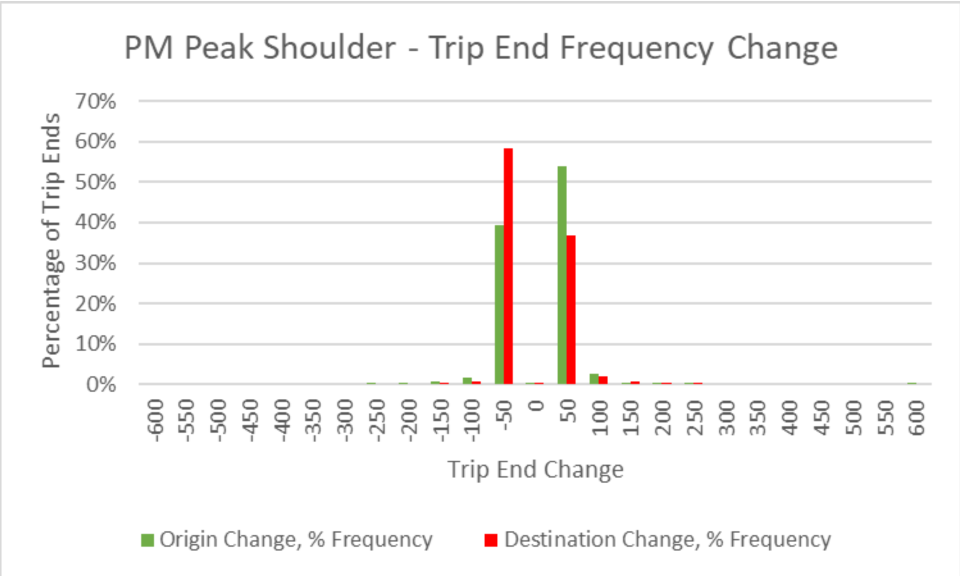


Figure 4-16: PM Shoulder, Trip End Change Frequency Count

Most origins and destinations change by less than 50 trips for the average hour, which is considered acceptable.

The difference in individual OD cells for the raw and adjusted demands (average hour) is shown below as a frequency count of the changes.

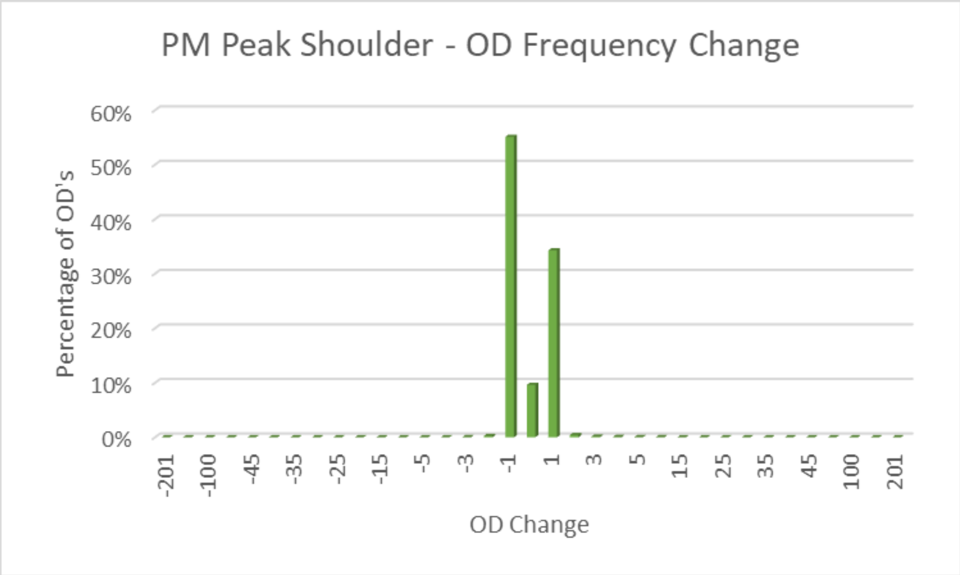


Figure 4-17: PM Shoulder, OD Change Frequency Count

No cells in the matrix have been changed significantly through matrix estimation.

4.2.7 PM Peak Period

The adjusted matrices (PM peak hour, PM shoulder, PM peak period) are provided in Appendix B aggregated to 11 sectors.

The difference between the adjusted and raw for the PM peak period is provided below. This is three hours in duration. The percentage difference is provided in Table 4-8.

Table 4-7: PM Peak Period, Difference, Adjusted minus Raw Demands

	Adjusted Demands, 3 hours											
	CBD	Eastern suburbs	Kapiti	Lower Hutt	North & Western suburbs	Petone	Porirua	Southern suburbs	Tawa & Johnsonville	Upper Hutt	Wairarapa	Grand Total
CBD	4,294	420	-640	-1,131	-437	-462	-891	625	-333	-864	-150	431
Eastern suburbs	80	1,863	-103	-100	-271	-55	-123	1,303	-126	-60	-20	2,389
Kapiti	52	-90	-10	138	-18	10	-122	-64	-49	86	55	-11
Lower Hutt	564	68	-182	-578	-14	1,318	-19	-220	491	403	-99	1,731
North & Western suburbs	1,225	-33	-30	-199	537	-115	-57	-233	265	-145	-31	1,185
Petone	202	-25	-50	-729	-132	-1	-45	-140	32	-308	-44	-1,239
Porirua	381	-13	-217	240	1	71	776	-126	218	154	8	1,494
Southern suburbs	1,247	837	-18	58	574	22	-22	652	191	-24	-12	3,503
Tawa & Johnsonville	533	34	14	-224	571	-132	313	-184	127	-191	-35	826
Upper Hutt	146	-15	-78	277	-35	62	32	-61	36	432	-147	648
Wairarapa	23	-15	-64	-1	-10	-1	-1	-16	0	-54	-49	-188
Grand Total	8,746	3,032	-1,378	-2,249	765	717	-159	1,536	852	-571	-524	10,768

Table 4-8: PM Peak Period, Percentage Difference, Adjusted vs Raw Demands

	Adjusted Demands, 3 hours											
	CBD	Eastern suburbs	Kapiti	Lower Hutt	North & Western suburbs	Petone	Porirua	Southern suburbs	Tawa & Johnsonville	Upper Hutt	Wairarapa	Grand Total
CBD	53%	15%	-43%	-31%	-8%	-29%	-39%	16%	-7%	-47%	-59%	1%
Eastern suburbs	6%	38%	-23%	-23%	-54%	-26%	-41%	89%	-24%	-39%	-50%	23%
Kapiti	22%	-22%	0%	69%	-16%	10%	-19%	-70%	-16%	50%	36%	0%
Lower Hutt	50%	21%	-45%	-3%	-3%	28%	-2%	-50%	47%	11%	-33%	5%
North & Western suburbs	66%	-10%	-16%	-33%	10%	-37%	-13%	-40%	16%	-54%	-65%	10%
Petone	33%	-14%	-21%	-14%	-36%	0%	-9%	-61%	4%	-25%	-39%	-9%
Porirua	62%	-9%	-16%	33%	1%	22%	6%	-53%	6%	26%	13%	7%
Southern suburbs	67%	56%	-14%	12%	61%	9%	-6%	13%	27%	-12%	-31%	31%
Tawa & Johnsonville	49%	12%	2%	-20%	49%	-19%	7%	-49%	1%	-38%	-53%	4%
Upper Hutt	50%	-19%	-29%	12%	-32%	10%	6%	-61%	14%	3%	-29%	3%
Wairarapa	31%	-24%	-34%	-1%	-34%	-2%	-3%	-64%	1%	-23%	0%	-1%
Grand Total	51%	27%	-5%	-6%	5%	5%	-1%	12%	4%	-2%	-2%	5%

The matrix estimation has increased the PM peak period by 5%, which is considered acceptable.

Again, the changes are predominantly CBD-related. The largest change is an increase in trips destined for the CBD (+8,700, +51%). The reverse occurred in the AM peak (the largest change was trips originating in the CBD) and so it seems that the counter-peak direction in the Qrious matrices is less robust than the peak direction.

Intra-CBD trips have again been increased through matrix estimation. In all three periods, an additional 40-55% trips have been required. Based on the analysis completed for the AM peak, this increase is considered acceptable.

4.3 Summary of Demand Adjustment

The matrix totals by period (i.e., not average hour) before and after estimation are provided below, with the absolute and percentage difference. The cells shaded grey are not observed data but were derived by applying a global factor to the period observed demands from Qrious.

Table 4-9: Matrix Totals, Before and After Estimation

	Raw	Adjusted	Diff	% Diff
AM Peak Hour	80,567	83,529	2,962	4%
AM Shoulder	120,850	115,837	-5,013	-4%
AM Peak Period	201,417	199,366	-2,051	-1%
Interpeak	367,850	389,628	21,777	6%
PM Peak Hour	75,721	82,892	7,171	9%
PM Shoulder	153,736	157,333	3,597	2%
PM Peak Period	229,457	240,225	10,768	5%

The largest percentage change has been introduced in the PM peak hour, with 9% trips required to match screenlines. This will partly be affected by the choice of global factor to produce the raw peak hour demands.

While the profile of trip lengths has not changed, the 'shape' of the demands has changed. In particular, trips within the CBD were increased considerably for the AM, interpeak, and PM peak periods. In the AM peak period, trips from the CBD to other areas were also increased significantly while the converse occurred in the PM peak period with trips to the CBD increased. For the interpeak, trips to and from the CBD were increased. These changes were required to replicate traffic counts.

In most other locations, the changes to the demands are not significant.

Overall, it was considered that the changes introduced were the best compromise.

5. Validation

Comparisons of modelled against observed traffic counts and observed travel times are provided in the next two sections respectively. For traffic counts, light and heavy vehicles are reported separately, noting that the focus in the WTAM is light vehicles as heavy vehicles demands are sourced directly from WTSM (and hence will be reported with the WTSM road assignment).

5.1 Traffic Counts

Tables are provided below for the:

- AM peak hour
- AM shoulder
- Interpeak period
- PM peak hour
- PM shoulder

The full AM and PM peak periods are also provided to confirm the validation is acceptable across the demand period, noting that the model will not be set up to run these normally. This is designed as a one-off validation check.

Tables for each modelled period are in pairs for screenlines followed by individual links (on screenlines). The screenline comparisons to observed traffic counts include:

- GEH
- Percentage differences
- R-squared and slope of the trendline, noting there is no validation target for this comparison

For individual links, comparisons to traffic counts include:

- GEH
- Absolute or percentage differences for specific flow bands
- R-squared
- Slope of the trendline
- RMSE

In Appendix C, the following additional information is provided:

- Modelled and observed flows by screenline for light, heavy, and total vehicles. All flows are average hour.
- Scatter plots of modelled vs observed for light vehicles on links and heavy vehicles. Flows are average hour.

Section 5.1.8 summaries the validation, including a table with an overall comment on whether the targets are achieved for each time period, lights vs heavies, and screenlines vs links.

Of note, buses are excluded from the heavy vehicle count and modelled flows. Heavy vehicles are reported in units of vehicles, even though the assignment is in PCUs.

It is noted that as the traffic counts were used in the matrix estimation to adjust the demands, this dataset is not truly independent, and this is therefore more a calibration check than validation. However, since the model has not been overly fitted, evident below with the screenline counts matching observed better than the links, this is not considered an issue.

5.1.1 AM Peak Hour

Evaluation Criteria		Target	Screenline Summary					
			Light		Medium + Heavy		Total	
			Abs.	(%)	Abs.	(%)	Abs.	(%)
GEH	< 5	75%	58	(91%)	39	(61%)	56	(88%)
	< 7.5	85%	3	(95%)	10	(77%)	5	(95%)
	< 10	95%	1	(97%)	7	(88%)	2	(98%)
	<= Max		2	(100%)	8	(100%)	1	(100%)
% Difference Less Than	10%	80%	52	(79%)	7	(11%)	49	(74%)
	20%	90%	64	(97%)	15	(23%)	61	(92%)
R^2		-	1.00		0.82		0.99	
Slope of trendline		-	0.98		1.06		1.00	

Figure 5-1: Traffic Count Screenline Validation, AM Peak Hour

Evaluation Criteria		Target	Individual Link Summary					
			Light		Medium + Heavy		Total	
			Abs.	(%)	Abs.	(%)	Abs.	(%)
GEH	< 5	80%	136	(71%)	121	(63%)	129	(68%)
	< 7.5	85%	21	(82%)	37	(83%)	22	(79%)
	< 10	90%	16	(91%)	15	(91%)	21	(90%)
	< 12	95%	4	(93%)	7	(94%)	7	(94%)
	<= Max		14	(100%)	11	(100%)	12	(100%)
Flow <700vph	Within 100 vph	80%	88	(79%)	168	(90%)	83	(76%)
Flow, 700-2700 vph	Within 15%	80%	51	(70%)	0	(0%)	50	(66%)
Flow, >2700vph	Within 400vph	80%	2	(100%)	0	(0%)	2	(100%)
R^2		0.9	0.98		0.45		0.98	
Slope of trendline		0.9-1.1	0.97		0.82		0.99	
RMSE		0.35	19%		140%		20%	

Figure 5-2: Traffic Count Link Validation, AM Peak Hour

For screenlines:

- Almost all criteria are met for light vehicles. The exception is 80% of screenlines within 10%, where the model is one percent below (79%). The R-squared value and slope of the trendline is strong.
- For heavy vehicles, none of the GEH criteria are met for model type B. For model category A, the targets are met for GEH < 7.5, with < 10 just missed (88% achieved vs 90% target). The percentage differences are considerably off the target, which reflects the numerically small volumes of heavy vehicles and the challenge of a synthetic model (i.e. without matrix estimation) replicating these flows. The slope of the trendline is sound and the R-squared value acceptable.

For links:

- There is more variation than screenlines, which is expected.
- For light vehicles, the GEH targets are not quite met but are close. Model type A targets are achieved, aside from GEH < 12 (93% achieved vs 95% target).
- Flow band comparisons for light vehicles are also not met but are close. The R-squared value, slope of the trendline, and the RMSE are all robust for light vehicles.
- For heavy vehicles, the GEH targets for model type B are not met aside from GEH < 10. Model type A criteria would be met aside from GEH < 5 (63% achieved vs 65% target).
- The R-squared value for heavy vehicles is very low reflecting considerable variation between modelled and observed. The slope of the trendline, while outside the targets, is relatively good. The RMSE is extremely poor.

5.1.2 AM Shoulder

Evaluation Criteria		Target	Screenline Summary: Light Abs.	Light (%)	Medium + Heavy Abs.	Medium + Heavy (%)	Total Abs.	Total (%)
GEH	< 5	75%	56	(88%)	47	(73%)	56	(88%)
	< 7.5	85%	5	(95%)	12	(92%)	5	(95%)
	< 10	95%	2	(98%)	4	(98%)	2	(98%)
	<= Max		1	(100%)	1	(100%)	1	(100%)
% Difference Less Than	10%	80%	50	(76%)	10	(15%)	48	(73%)
	20%	90%	61	(92%)	23	(35%)	57	(86%)
R^2		-	1.00		0.87		1.00	
Slope of trendline		-	1.02		0.97		1.02	

Figure 5-3: Traffic Count Screenline Validation, AM Shoulder

Evaluation Criteria		Target	Individual Link Summary: Light Abs.	Light (%)	Medium + Heavy Abs.	Medium + Heavy (%)	Total Abs.	Total (%)
GEH	< 5	80%	143	(75%)	156	(82%)	137	(72%)
	< 7.5	85%	17	(84%)	26	(95%)	20	(82%)
	< 10	90%	12	(90%)	7	(99%)	16	(91%)
	< 12	95%	5	(93%)	1	(99%)	6	(94%)
	<= Max		14	(100%)	1	(100%)	12	(100%)
Flow <700vph	Within 100 vph	80%	118	(86%)	184	(98%)	116	(85%)
Flow, 700-2700 vph	Within 15%	80%	33	(73%)	0	(0%)	34	(74%)
Flow, >2700vph	Within 400vph	80%	5	(100%)	0	(0%)	5	(100%)
R^2		0.9	0.98		0.69		0.98	
Slope of trendline		0.9-1.1	0.98		0.87		0.99	
RMSE		0.35	22%		90%		21%	

Figure 5-4: Traffic Count Link Validation, AM Shoulder

For screenlines:

- For light vehicles, almost all of the criteria are met aside from 80% of flows being within 10% (76% achieved). The slope of the trendline and R-squared are excellent.
- For heavy vehicles, the GEH criteria are mostly met with GEH < 5 achieving 73% for a target of 75%. The percentage differences are considerable, representative of the small volumes. The slope of the trendline is excellent, and the R-squared sound.

For links:

- For light vehicles, most of the GEH are not achieved (aside from GEH<10), however all are very close. For model type A, all GEH targets achieved aside from GEH < 12. The slope of the trendline, R-squared, and RMSE are all robust.
- For heavy vehicles, the GEH and flow band criteria are achieved. The RMSE is way off, the slope of the trendline is just below the target, while the R-squared is low, reflecting the variation between modelled and observed, but acceptable.

5.1.3 AM Peak Period

Evaluation Criteria		Target	Screenline Summary					
			Light		Medium + Heavy		Total	
			Abs.	(%)	Abs.	(%)	Abs.	(%)
GEH	< 5	75%	61	(95%)	52	(79%)	64	(97%)
	< 7.5	85%	3	(100%)	6	(88%)	2	(100%)
	< 10	95%	0	(100%)	5	(95%)	0	(100%)
	<= Max		0	(100%)	3	(100%)	0	(100%)
% Difference Less Than	10%	80%	54	(82%)	7	(11%)	55	(83%)
	20%	90%	63	(95%)	17	(26%)	62	(94%)
R^2		-	1.00		0.85		1.00	
Slope of trendline		-	1.00		1.01		1.00	

Figure 5-5: Traffic Count Screenline Validation, AM Peak Period

Evaluation Criteria		Target	Individual Link Summary					
			Light		Medium + Heavy		Total	
			Abs.	(%)	Abs.	(%)	Abs.	(%)
GEH	< 5	80%	161	(86%)	146	(77%)	163	(86%)
	< 7.5	85%	15	(94%)	29	(93%)	16	(95%)
	< 10	90%	7	(98%)	9	(97%)	4	(97%)
	< 12	95%	4	(100%)	3	(99%)	6	(100%)
	<= Max		0	(100%)	2	(100%)	0	(100%)
Flow <700vph	Within 100 vph	80%	122	(92%)	184	(97%)	115	(89%)
Flow, 700-2700 vph	Within 15%	80%	46	(90%)	0	(0%)	50	(91%)
Flow, >2700vph	Within 400vph	80%	3	(100%)	0	(0%)	5	(100%)
R^2		0.9	0.99		0.64		0.99	
Slope of trendline		0.9-1.1	0.99		0.91		1.00	
RMSE		35%	12%		102%		12%	

Figure 5-6: Traffic Count Link Validation, AM Peak Period

For the full peak period, all the validation criteria for screenlines and links are met for light vehicles, while most are met heavy vehicles. The exceptions for heavy vehicles are:

- Percentage differences on screenlines are way off the target. This is due to the numerically small flows.
- Link GEH < 5, 77% achieved with a target of 80%.
- Link R-squared is low, reflecting the considerable scatter, although the slope of the trendline is solid. The RMSE is again considerably different to the target.

5.1.4 Interpeak

Evaluation Criteria		Target	Screenline Summary: Light Abs.	Light (%)	Medium + Heavy Abs.	Medium + Heavy (%)	Total Abs.	Total (%)
GEH	< 5	75%	58	(91%)	56	(85%)	62	(94%)
	< 7.5	85%	3	(95%)	6	(94%)	2	(97%)
	< 10	95%	2	(98%)	3	(98%)	0	(97%)
	<= Max		1	(100%)	1	(100%)	2	(100%)
% Difference Less Than	10%	80%	48	(73%)	6	(9%)	50	(76%)
	20%	90%	60	(91%)	19	(29%)	62	(94%)
R^2		-	1.00		0.88		1.00	
Slope of trendline		-	0.96		0.98		0.97	

Figure 5-7: Traffic Count Screenline Validation, Interpeak

Evaluation Criteria		Target	Individual Link Summary: Light Abs.	Light (%)	Medium + Heavy Abs.	Medium + Heavy (%)	Total Abs.	Total (%)
GEH	< 5	80%	139	(74%)	155	(82%)	143	(76%)
	< 7.5	85%	24	(87%)	22	(94%)	17	(85%)
	< 10	90%	16	(96%)	9	(99%)	20	(95%)
	< 12	95%	5	(98%)	1	(99%)	5	(98%)
	<= Max		3	(100%)	1	(100%)	4	(100%)
Flow <700vph	Within 100 vph	80%	109	(80%)	185	(98%)	105	(80%)
Flow, 700-2700 vph	Within 15%	80%	45	(90%)	0	(0%)	44	(80%)
Flow, >2700vph	Within 400vph	80%	0	(0%)	0	(0%)	0	(0%)
R^2		0.9	0.99		0.67		0.98	
Slope of trendline		0.9-1.1	0.97		0.86		0.99	
RMSE		0.35	16%		92%		17%	

Figure 5-8: Traffic Count Link Validation, Interpeak

For screenlines:

- Light vehicles meet all the criteria aside from differences within 10%, where 73% is achieved vs 80% target
- Heavy vehicles meet the GEH targets, but not the percentage differences.

For links:

- Light vehicles meet most criteria, aside from GEH < 5, and two of the three difference bands. The R-squared, trendline slope, and RMSE are all excellent.
- Heavy vehicles meet all of the GEH targets and the flow bands. The RMSE is exceptionally high, the slope of the trendline is just below ideal, while the low R-squared value reflects the variation with observed. This is to be expected in synthetic estimation of small numeric values without matrix estimation.

5.1.5 PM Peak Hour

Evaluation Criteria		Target	Screenline Summary					
			Light		Medium + Heavy		Total	
			Abs.	(%)	Abs.	(%)	Abs.	(%)
GEH	< 5	75%	59	(92%)	43	(67%)	59	(92%)
	< 7.5	85%	3	(97%)	9	(81%)	2	(95%)
	< 10	95%	0	(97%)	7	(92%)	1	(97%)
	<= Max		2	(100%)	5	(100%)	2	(100%)
% Difference Less Than	10%	80%	57	(86%)	4	(6%)	56	(85%)
	20%	90%	61	(92%)	7	(11%)	62	(94%)
R^2		-	1.00		0.73		1.00	
Slope of trendline		-	0.99		0.89		1.00	

Figure 5-9: Traffic Count Screenline Validation, PM Peak Hour

Evaluation Criteria		Target	Individual Link Summary					
			Light		Medium + Heavy		Total	
			Abs.	(%)	Abs.	(%)	Abs.	(%)
GEH	< 5	80%	142	(74%)	134	(71%)	140	(73%)
	< 7.5	85%	17	(83%)	29	(86%)	18	(83%)
	< 10	90%	10	(88%)	15	(94%)	9	(87%)
	< 12	95%	4	(91%)	7	(97%)	4	(90%)
	<= Max		18	(100%)	5	(100%)	20	(100%)
Flow <700vph	Within 100 vph	80%	85	(74%)	180	(96%)	82	(74%)
Flow, 700-2700 vph	Within 15%	80%	54	(83%)	0	(0%)	56	(81%)
Flow, >2700vph	Within 400vph	80%	7	(100%)	0	(0%)	7	(100%)
R^2		0.9	0.99		0.34		0.99	
Slope of trendline		0.9-1.1	0.99		0.59		1.00	
RMSE		0.35	16%		163%		16%	

Figure 5-10: Traffic Count Link Validation, PM Peak Hour

For screenlines:

- All criteria are met for light vehicles.
- None of the criteria are met for heavy vehicles. The GEH targets for model type A are met, indicating the results are just below the type B target. The percentage differences are considerably way off target.

For links:

- For light vehicles, the GEH targets are not met, but are just below. Considering model type A, all targets are achieved aside from GEH < 12 (91% achieved vs 95% target).
- For light vehicles less than 700 vph, 74% of links are within 100 vph although the target is 80% - so not achieved but close. The R-squared and slope of the trendline is excellent.
- For heavy vehicles, most GEH targets are met aside from GEH < 5 (71% achieved vs 80% target). The R-squared is extremely poor, the slope of the trendline average, and the RMSE excessive. This reflects the numerically small flows and the challenge in predicting them synthetically. The model is definitely stronger at screenline level for heavy vehicles.

5.1.6 PM Shoulder

Evaluation Criteria			Target	Screenline Summary					
				Light		Medium + Heavy		Total	
				Abs.	(%)	Abs.	(%)	Abs.	(%)
GEH	<	5	75%	61	(95%)	47	(73%)	62	(97%)
	<	7.5	85%	2	(98%)	8	(86%)	1	(98%)
	<	10	95%	1	(100%)	2	(89%)	1	(100%)
	<=	Max		0	(100%)	7	(100%)	0	(100%)
% Difference Less Than	10%		80%	58	(88%)	14	(21%)	59	(89%)
	20%		90%	63	(95%)	24	(36%)	63	(95%)
R^2			-	1.00		0.77		1.00	
Slope of trendline			-	0.99		0.92		0.99	

Figure 5-11: Traffic Count Screenline Validation, PM Shoulder

Evaluation Criteria			Target	Individual Link Summary					
				Light		Medium + Heavy		Total	
				Abs.	(%)	Abs.	(%)	Abs.	(%)
GEH	<	5	80%	159	(83%)	133	(70%)	151	(79%)
	<	7.5	85%	13	(90%)	28	(85%)	18	(88%)
	<	10	90%	8	(94%)	12	(91%)	6	(92%)
	<	12	95%	0	(94%)	11	(97%)	3	(93%)
	<=	Max		11	(100%)	6	(100%)	13	(100%)
Flow <700vph	Within 100 vph		80%	103	(86%)	174	(93%)	97	(83%)
Flow, 700-2700 vph	Within 15%		80%	58	(94%)	0	(0%)	57	(88%)
Flow, >2700vph	Within 400vph		80%	5	(100%)	0	(0%)	5	(100%)
R^2			0.9	0.99		0.41		0.99	
Slope of trendline			0.9-1.1	0.98		0.68		1.00	
RMSE			0.35	11%		142%		13%	

Figure 5-12: Traffic Count Link Validation, PM Shoulder

For screenlines:

- Light vehicles achieve all targets.
- Heavy vehicles only meet the GEH < 7.5 target but are close for the other criteria. For model type A, all GEH criteria would be met aside from GEH < 10 (89% achieved vs 90% target). The slope of the trendline is good, and the R-squared acceptable although on the low side.

For links:

- Light vehicles achieve all criteria aside from GEH < 12 (94% achieved vs 95% target).
- Heavy vehicles don't quite meet the GEH <5 and GEH < 7.5 targets but are close (model type A targets are achieved). The RMSE is extremely poor, as is the R-squared, and the slope of the trendline is low.

5.1.7 PM Peak Period

Evaluation Criteria			Target	Screenline Summary					
				Light		Medium + Heavy		Total	
				Abs.	(%)	Abs.	(%)	Abs.	(%)
GEH	<	5	75%	59	(92%)	48	(73%)	55	(83%)
	<	7.5	85%	2	(95%)	6	(82%)	8	(95%)
	<	10	95%	2	(98%)	6	(91%)	2	(98%)
	<=	Max							
% Difference Less Than		10%	80%	52	(79%)	11	(17%)	51	(77%)
		20%	90%	60	(91%)	19	(29%)	61	(92%)
R^2			-	1.00		0.76		1.00	
Slope of trendline			-	1.00		0.93		1.01	

Figure 5-13: Traffic Count Screenline Validation, PM Peak Period

Evaluation Criteria			Target	Individual Link Summary					
				Light		Medium + Heavy		Total	
				Abs.	(%)	Abs.	(%)	Abs.	(%)
GEH	<	5	80%	130	(70%)	141	(75%)	122	(65%)
	<	7.5	85%	27	(84%)	22	(87%)	34	(83%)
	<	10	90%	17	(93%)	10	(92%)	16	(91%)
	<	12	95%	3	(95%)	9	(97%)	7	(95%)
	<=	Max		10	(100%)	6	(100%)	10	(100%)
Flow <700vph	Within 100 vph		80%	84	(70%)	175	(93%)	73	(63%)
Flow, 700-2700 vph	Within 15%		80%	46	(75%)	0	(0%)	48	(73%)
Flow, >2700vph	Within 400vph		80%	5	(83%)	0	(0%)	5	(71%)
R^2			0.9	0.98		0.39		0.98	
Slope of trendline			0.9-1.1	1.02		0.66		1.03	
RMSE			35%	17%		147%		19%	

Figure 5-14: Traffic Count Link Validation, PM Peak Period

For screenlines:

- Light vehicles achieve all targets.
- Heavy vehicles do not meet most targets but are close.

For links:

- Light vehicles only meet the criteria for GEH < 10, although GEH<7.5 and GEH<12 are very close. There is more deviation for GEH<5, with only 70% of links meeting the criteria with a target of 80%.
- Heavy vehicles again show more variation. The RMSE is extremely poor, as is the R-squared, and the slope of the trendline is low. The GEH targets for model type A are achieved, but sit just below model type B thresholds.

5.1.8 Summary of Traffic Count Validation

The table below summarises the validation to observed traffic counts for each time period, for light and heavy vehicles, and for screenlines and links. The following classifications have been used, with colour coding used in Table 5-1 listed in brackets:

- All achieved (pale green)
- Almost all achieved, one criteria not met (pale green)
- Mostly achieved (dark green)

- Mostly not achieved, but close (yellow)
- GEH are mostly achieved, but RMSE and R2 are poor (light red)
- Not achieved, RMSE and R2 are poor (dark red)

Table 5-1: Summary of Traffic Count Validation

Period	Screenlines		Links	
	Lights	Heavies	Lights	Heavies
AM Peak Hour	Almost all achieved	Mostly not achieved, but close	Mostly not achieved, but close	Mostly not achieved. Poor RMSE and R2
AM Shoulder	Almost all achieved	Mostly achieved	Mostly not achieved, but close	Mostly achieved
AM Peak Period	All achieved	Mostly achieved	All achieved	Mostly achieved
Interpeak	Almost all achieved	Mostly achieved	Mostly achieved	Mostly achieved
PM Peak Hour	All achieved	Mostly not achieved, but close	Mostly not achieved, but close	Mostly achieved. Poor RMSE and R2
PM Shoulder	All achieved	Mostly not achieved, but close	Mostly achieved	Mostly achieved. Poor RMSE and R2
PM Peak Period	Almost all achieved	Mostly not achieved, but close	Mostly not achieved, but close	Mostly achieved. Poor RMSE and R2

In summary, the light vehicle screenlines achieve all validation targets, or are just below one criteria. There is more variation in link flow validation, but the results are generally achieving or just below target.

Heavy vehicles show considerably more variability, noting they are fully synthetic and numerically small. In most cases, the link flow RMSE is very high, the R-squared relatively low, and the percentage differences in link flows are not achieved. It is noted that the targets in the TMDG are not for specific vehicle types, and it is very difficult to replicate the low volumes of heavy vehicles to within 10-15%. Heavy vehicle flows do perform better at screenline level, compared with links. More care will be required if heavy vehicle flows are used explicitly and on a link basis.

5.2 Travel Times

Modelled travel times are compared to observed in this section.

The source of the March 2018 observed data is TomTom, which is described in Technical Note 4: Data Analysis. There are eight routes which are listed below and also reported in TN4. The travel time routes are shown diagrammatically in Figure 5-15 and Figure 5-16.

Table 5-2: WTSM Travel Time Routes

Route	Direction	Description	via
1	N	Wellington Airport to North of Masterton	SH1 and SH2
1	S	North of Masterton to Wellington Airport	SH1 and SH2
2	N	Island Bay to Paekakariki	Waterfront
2	S	Paekakariki to Island Bay	Waterfront
3	N	Centreport to Seaview	Petone Esplanade
3	S	Seaview to Centreport	Petone Esplanade
4	N	Wellington Station to Newlands	Hutt Road

Route	Direction	Description	via
4	S	Newlands to Wellington Station	Hutt Road
5	E	Karori to Miramar	Waterfront and Evans Bay
5	W	Miramar to Karori	Waterfront and Evans Bay
6	E	Waterfront to Airport	Kilbirnie, Newtown and Adelaide Rd
6	W	Airport to Waterfront	Kilbirnie, Newtown and Adelaide Rd
7	E	Wellington Station to Seatoun	Taranaki St, Waterfront
7	W	Seatoun to Wellington Station	via Taranaki St, Waterfront
8	E	Paremata to Haywards	SH 58
8	W	Haywards to Paremata	SH 58

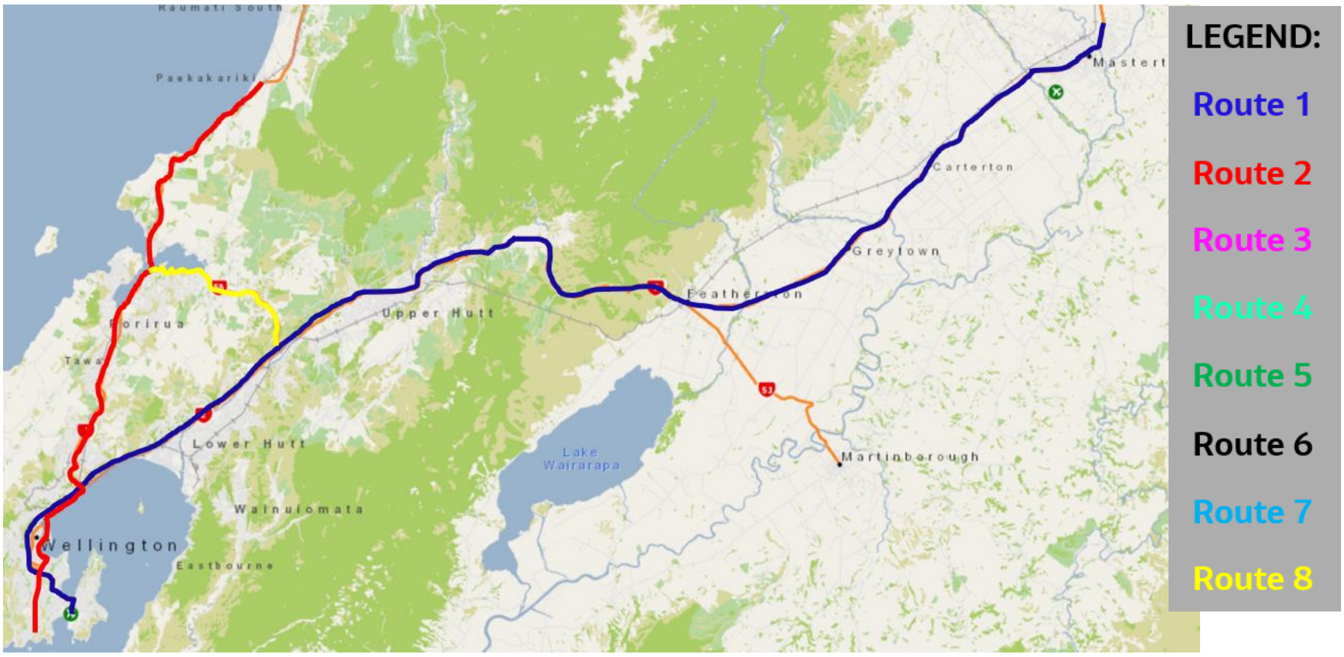


Figure 5-15: Travel Time Routes

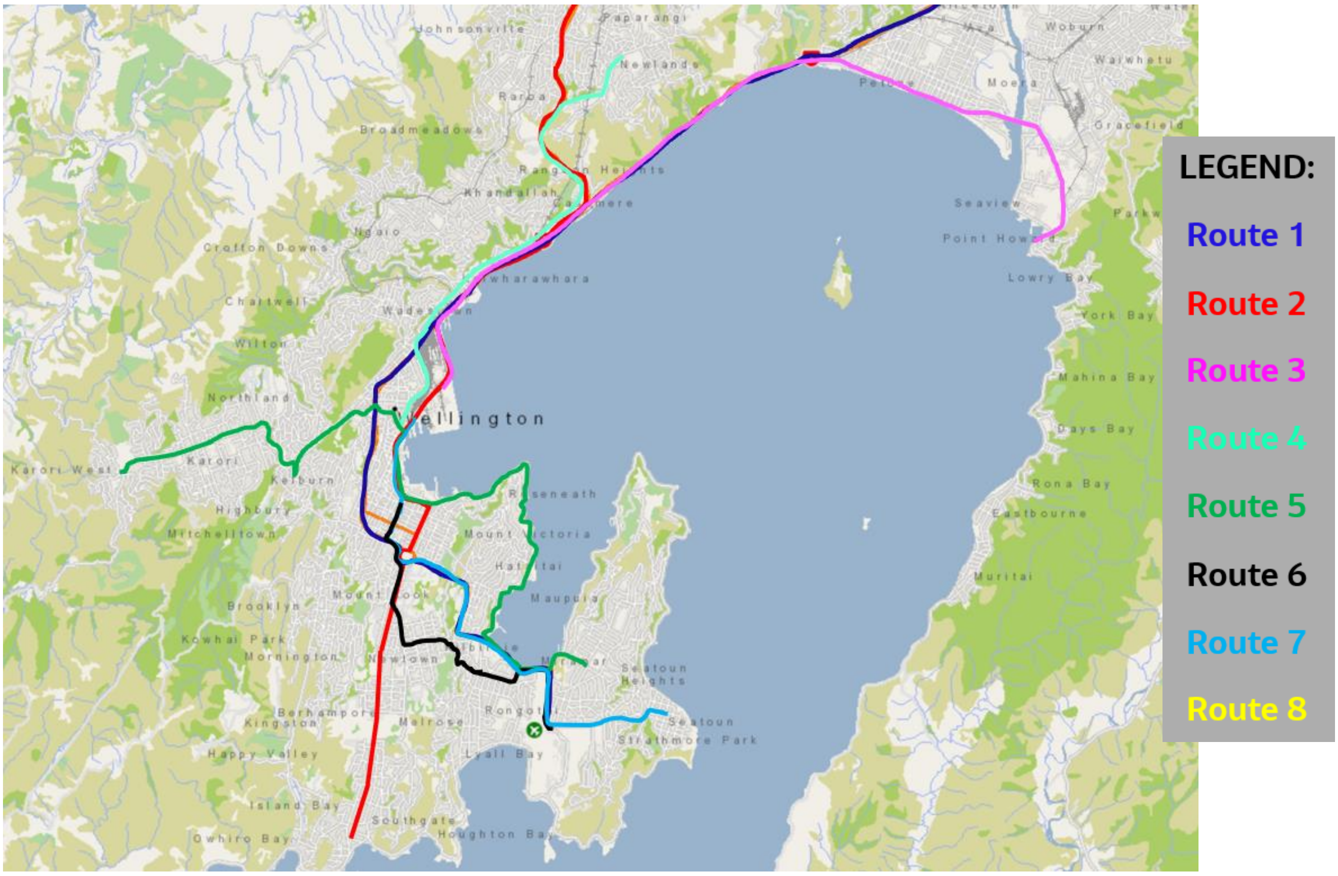


Figure 5-16: Travel Time Routes – Wellington

Summary tables are provided below for each of the five modelled periods. In these, total modelled and observed travel times for each route are tabulated, and whether the criterium is achieved. Targets for model purpose B are provided as well as the percentage of routes that achieve the targets. Figures in red indicate the target is not met.

In Appendix D, charts for each route and peak period are shown, plotting modelled travel times against distance travelled. The average observed is also shown, along with +/-15%. Minimum and maximum observed travel times are not plotted because of the type of data used. Minimum and maximum travel times in TomTom are the minimum/maximum that occurs on that segment for any time within the analysis period. Hence summing maximum travel times along a route produces a travel time that is not experienced by anyone in reality.

Table 5-3: Travel Time Validation, AM Peak Hour

Route	Direction	Observed (mins)	Modelled (mins)	Within 15% or 1 min	Within 25% or 1.5mins
1	N	125	116	Y	Y
1	S	138	134	Y	Y
2	N	56	60	Y	Y
2	S	75	69	Y	Y
3	N	19	17	Y	Y
3	S	41	38	Y	Y
4	N	16	14	Y	Y
4	S	28	20	N	N
5	E	40	36	Y	Y
5	W	40	42	Y	Y
6	E	20	15	N	Y

Route	Direction	Observed (mins)	Modelled (mins)	Within 15% or 1 min	Within 25% or 1.5mins
6	W	25	22	Y	Y
7	E	22	22	Y	Y
7	W	39	33	N	Y
8	E	14	14	Y	Y
8	W	18	18	Y	Y
			Target, Purpose B	85%	90%
			Achieved	81%	94%

For routes within 1 minute or 15%, the target is not quite met. The target for model purpose A is 80% and this has been achieved, acknowledging the WTAM is aiming for type B. The second criteria, within 25% or 1.5 minutes, is achieved for the AM peak hour.

Table 5-4: Travel Time Validation, AM Shoulder

Route	Direction	Observed (mins)	Modelled (mins)	Within 15% or 1 min	Within 25% or 1.5mins
1	N	105	104	Y	Y
1	S	124	138	Y	Y
2	N	52	49	Y	Y
2	S	66	67	Y	Y
3	N	18	15	N	Y
3	S	32	37	N	Y
4	N	14	13	Y	Y
4	S	17	16	Y	Y
5	E	28	28	Y	Y
5	W	30	30	Y	Y
6	E	17	13	N	Y
6	W	17	17	Y	Y
7	E	19	18	Y	Y
7	W	22	23	Y	Y
8	E	13	13	Y	Y
8	W	14	16	Y	Y
			Target, Purpose B	85%	90%
			Achieved	81%	100%

In the AM shoulder, three routes do not meet the 1 minute or 15% criteria and hence the overall target is not met. The targets for model purpose A have been achieved. All routes achieve the second criteria.

Table 5-5: Travel Time Validation, Interpeak

Route	Direction	Observed (mins)	Modelled (mins)	Within 15% or 1 min	Within 25% or 1.5mins
1	N	108	107	Y	Y
1	S	113	110	Y	Y
2	N	53	52	Y	Y
2	S	54	53	Y	Y
3	N	19	17	Y	Y

Route	Direction	Observed (mins)	Modelled (mins)	Within 15% or 1 min	Within 25% or 1.5mins
3	S	19	18	Y	Y
4	N	14	13	Y	Y
4	S	14	11	N	Y
5	E	30	27	Y	Y
5	W	31	31	Y	Y
6	E	20	14	N	N
6	W	19	15	N	Y
7	E	21	21	Y	Y
7	W	22	23	Y	Y
8	E	14	13	Y	Y
8	W	14	13	Y	Y
Target, Purpose B				85%	90%
Achieved				81%	94%$

In the interpeak, three routes do not meet the 1 minute or 15% criteria and hence the overall target is not met, again with model purpose A achieved. One route fails the second criteria, which means the overall target is achieved.

Table 5-6: Travel Time Validation, PM Peak Hour

Route	Direction	Observed (mins)	Modelled (mins)	Within 15% or 1 min	Within 25% or 1.5mins
1	N	127	123	Y	Y
1	S	116	118	Y	Y
2	N	83	71	Y	Y
2	S	66	57	Y	Y
3	N	27	21	N	Y
3	S	19	20	Y	Y
4	N	16	16	Y	Y
4	S	15	12	N	Y
5	E	34	35	Y	Y
5	W	43	38	Y	Y
6	E	23	22	Y	Y
6	W	24	13	N	N
7	E	26	28	Y	Y
7	W	32	20	N	N
8	E	13	14	Y	Y
8	W	13	14	Y	Y
Target, Purpose B				85%	90%
Achieved				75%	88%

Four routes fail the first criteria, and two fail the second meaning the overall target is not achieved for the PM peak hour. It is noted that for the second criteria, the model is very close.

Table 5-7: Travel Time Validation, PM Shoulder

Route	Direction	Observed (mins)	Modelled (mins)	Within 15% or 1 min	Within 25% or 1.5mins
1	N	116	121	Y	Y
1	S	117	113	Y	Y
2	N	58	69	N	Y
2	S	55	54	Y	Y
3	N	20	20	Y	Y
3	S	18	19	Y	Y
4	N	15	15	Y	Y
4	S	14	12	Y	Y
5	E	30	28	Y	Y
5	W	36	35	Y	Y
6	E	22	16	N	N
6	W	23	17	N	N
7	E	23	21	Y	Y
7	W	30	22	N	N
8	E	14	14	Y	Y
8	W	14	14	Y	Y
			Target, Purpose B	85%	90%
			Achieved	75%	81%

For the PM shoulder, the model is just below both targets.

While for many of the modelled time periods lie just outside the first criteria (within 15% or 1 minute), they are not significantly different and the pattern over distance generally aligns. The target for the second criteria is achieved for both AM peak models and the interpeak. The target for the second criteria is not met for the PM shoulder, while the PM peak hour is nearly achieved.

A summary table is provided below to determine if there is any systematic issue geographically.

Table 5-8: Travel Time Validation, Summary of Targets Achievement

		AM Peak Hour (8-9am)		AM Peak Shoulder (6-8am)		Interpeak (9am-3pm)		PM Peak Hour (5-6pm)		PM Peak Shoulder (3-5pm)	
		within 15% - 1min	within 25% - 1.5min	within 15% - 1min	within 25% - 1.5min	within 15% - 1min	within 25% - 1.5min	within 15% - 1min	within 25% - 1.5min	within 15% - 1min	within 25% - 1.5min
1	NB	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	SB	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
2	NB	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
	SB	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
3	NB	Y	Y	N	Y	Y	Y	N	Y	Y	Y
	SB	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
4	NB	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	SB	N	N	Y	Y	N	Y	N	Y	Y	Y
5	EB	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

		AM Peak Hour (8-9am)		AM Peak Shoulder (6-8am)		Interpeak (9am-3pm)		PM Peak Hour (5-6pm)		PM Peak Shoulder (3-5pm)	
		within 15% - 1min	within 25% - 1.5min	within 15% - 1min	within 25% - 1.5min	within 15% - 1min	within 25% - 1.5min	within 15% - 1min	within 25% - 1.5min	within 15% - 1min	within 25% - 1.5min
	WB	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
6	EB	N	Y	N	Y	N	N	Y	Y	N	N
	WB	Y	Y	Y	Y	N	Y	N	N	N	N
7	EB	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	WB	N	Y	Y	Y	Y	Y	N	N	N	N
8	EB	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	WB	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
% Routes Achieved		81%	94%	81%	100%	81%	94%	75%	88%	75%	81%
Routes Faster		69%		44%		81%		56%		56%	
Routes Same		19%		25%		13%		6%		25%	
Routes Slower		13%		31%		6%		38%		19%	

Aside from the PM peak hour, the other modelled time periods tend to underestimate travel on Route 6 Eastbound, which is the Waterfront to Airport. The overall pattern generally aligns, however, as seen from the graphs by distance in Appendix D.

The model tends to be slightly faster than observed for all time periods aside from the AM shoulder.

Overall, for a strategic assignment model which models queuing vertically (i.e. upstream impacts are not considered), the observed travel times are replicated to acceptable levels in all five models.

6. Validation Update

After completing the validation and calibration of WTAM, minor changes were made to the network for the WTSM validation, which is the same network used by WTAM. The base year WTAM assignment was rerun with the updated network and the validation results reviewed.

Generally, using the updated network produces results that are within a few percentage points of the results tabulated in the preceding sections of this report. The biggest difference is for the PM peak shoulder, with the percentage of screenlines with a GEH<5 dropping from 95% to 86%, which is still above the target of 75%. Individual links on screenlines for the PM peak shoulder also drop from 83% having a GEH<5 to 75% (target 80%), which is a similar level of validation as the other four modelled periods.

Overall, the results are very similar, and it was therefore agreed not to rewrite this technical note. Instead, the updated validation results were provided in spreadsheet format to the peer reviewer for comment. No issues were raised, with agreement on the points summarised above.

One further change was made to the base year demands. There was no demand in the WTAM for the special generator zones representing the Airport (passenger-related flights) or the two Ferry Terminals. Instead, demand for these generators is in the zone physically containing them. So that the forecasts are representative, the demand in the WTAM for the physical location was split using WTSM proportions into the physical location and the special generator. As an example, the Airport is in zone 71 with air-related trips in zone 2311. WTAM has demand in zone 71 but not for 2311. The demand for zone 71 was split into 71 and 2311 using WTSM proportions. These change does not affect the validation at all, but it does mean growth in air patronage or residential trips is appropriately taken from WTSM and applied to the WTAM.

7. Forecasting

7.1 Approach

Future year WTAM forecasts are calculated based on growth predicted by WTSM.

The same approach as for the WPTM has been adopted, which is documented in "Technical Note 20: WPTM Forecasting", written by Arup/Opus and produced as part of the 2011 model update. The WPTM is similar to the WTAM in that it has base year demands from observed data sources, with future predictions based on the change forecast by WTSM.

Key issues in taking growth from one model, WTSM in this case, and applying it to a second model (WTAM) include:

- Whether to apply the growth from WTSM to WTAM in an additive or multiplicative manner.
- How to handle large growth in WTSM from a small base year value (i.e.: large percentage growth), when the base year value in WTAM is much larger.
- Treatment of new greenfield sites, where there is no base year demand in WTAM.
- Cases where the WTAM base year model has a zero value and WTSM does not.

These issues are not unusual, in fact, they represent the typical challenges for assignment modelling within the coverage of a strategic model.

To forecast growth in the WPTM, guidance was drawn from the conference paper "Pivot Point Procedures in Practical Travel Demand Forecasting" by Andrew Daly, James Fox, Jan Gerrit Tuinenga (RAND Europe)[1]. In TN20 (2011 update), it is stated that the approach adopted for WPTM "is generally consistent with the RAND approach".

The ten situations ("cases") from which future year WTAM demand is calculated are shown in the table below, which is based on Table 4-1 from TN20 (2011 update). Each OD pair will fall into one of these ten cases.

Table 7-1: Ten Cases for Demand Growth

Case	Input Demands			Output Demand	Context
	WTAM Observed Base (A)	WTSM Synthetic Base (B)	WTSM Synthetic Future (C)	WTAM Factored Future (D)	
1	0	0	0	0	Empty zone
2	0	0	>0	C	Greenfield development
3	0	>0	0	0	Removal of development
4a	0	>0	>0 ($C>K_2$*B)	C-K_2*B	Significant development, not greenfield. Add damped growth
4b	0	>0	>0 ($C<K_2$*B)	0	Typical growth, maintain WTAM zero base value in future
5	>0	0	0	A	No WTSM observations, maintain WTAM non-zero base value in future
6	>0	0	>0	A+C	New development, add
7	>0	>0	0	0	Removal of development, zero

[1] https://core.ac.uk/download/pdf/7046092.pdf

Case	Input Demands			Output Demand	Context
	WTAM Observed Base (A)	WTSM Synthetic Base (B)	WTSM Synthetic Future (C)	WTAM Factored Future (D)	
8a	>0	>0	>0 (C>X)	A*X/B + (C-X)	Significant development, not greenfield. Incorporate damped growth
8b	>0	>0	>0 (C<X)	A*C/B	Typical growth, include as multiplicative increase

Where:

0 (Zero)	=0.0001, small value rather than zero
X[2]	$= B * [K_1 + \max(K_2*B/A, K_1)]$
K_1	= 0.7, parameter value adjusted for WPTM and adopted for WTAM
K_2	=8.5, parameter value adjusted for WPTM and adopted for WTAM

7.2 Checking the Growth Application

To confirm that applying this growth method produced plausible future demands for the WTAM, demands for the year 2053 were calculated using a WTSM forecast. The results are analysed in detail below for the AM peak hour. The same pattern was found in the other time periods and so these are not reported, aside from the total growth for WTSM and WTAM.

For each of the ten cases, a count of the number of OD pairs that sits within each case is shown in Table 7-2, with the percentage. In addition, trips in the four demand matrices (WTSM and WTAM, base and future year) are summed by OD by the "case" they fall into.

Table 7-2: Occurrences and Demand by Case

Case	Count of Occurrences	Percentage of Occurrences	WTAM Observed Base (A)	WTSM Synthetic Base (B)	WTSM Synthetic Future (C)	WTAM Factored Future (D)
1	35,976	5%	0	1	1	0
2	3,427	1%	0	0	0	0
3	1,149	0%	0	0	0	0
4a	6	0%	0	0	0	0
4b	353,429	53%	0	13,248	15,022	0
5	4,748	1%	654	0	0	654
6	342	0%	11	0	0	11
7	186	0%	15	0	0	0
8a	6,094	1%	4,223	224	469	6,305
8b	265,404	40%	78,627	72,104	84,766	92,627
Total		100%	**83,529**	**85,577**	**100,258**	**99,598**

Similar to the WPTM, the vast majority of OD pairs fall into case 4b (typical growth in WTSM, zero base value in WTAM). This is because WTSM is synthetic and therefore generates trips anywhere that there is land use.

[2] Note, equation for X in TN20 (2011 update) is incorrect. It shows $5K_2/A$ as the first term in the maximum calculation. It should be BK_2/A and is correct in the model.

The next dominant occurrence for the WTAM is case 8b (typical growth in WTSM, non-zero base value in WTAM). Case 4b and 8b combined constitute 92% of OD pairs for the WTAM.

The majority of the demand comes from the application of case 8b, even though it only applies to 40% of OD pairs. Case 8b is where there are trips in the WTAM base year and the WTSM base and future years, and the increase in demand in WTSM is not excessive. The resulting demand for WTAM for case 8b is multiplicative, with the percentage increase in WTSM applied to WTAM. The trip numbers shown in Table 7-2 for case 8b are considered reasonable.

There is a high proportion of OD pairs for case 4b, and also a relatively large number of trips in WTSM. This is more concerning as case 4b is where there are no trips in the WTAM base year, but trips in WTSM for the base and future year with typical growth. For case 4b, no future year trips are included for WTAM (i.e. future year trips remain as zero). This warrants monitoring over time to ensure problems do not arise.

It is noted that the checks above were carried out prior to splitting the three zones physically containing the Airport and two Ferry terminals. This does not make any notable change to the analysis or conclusions.

To confirm the application of growth is as expected (i.e. similar growth is produced in WTAM as was forecast by WTSM), demand totals for WTSM and the WTAM for the five assignment periods are shown below.

Table 7-3: WTAM and WTSM Matrix Totals, AM Peak Hour

Period	WTAM Base	WTSM Base	WTSM Future	WTAM Future	Growth, WTSM	Growth, WTAM
AM Peak Hour	83,529	85,577	100,258	99,598	17.2%	19.2%
AM Shoulder	57,919	58,781	68,878	68,997	17.2%	19.1%
Interpeak	64,938	73,202	86,416	78,017	18.1%	20.1%
PM Peak Hour	82,892	98,730	116,088	98,515	17.6%	18.8%
PM Shoulder	78,666	93,578	110,173	93,721	17.7%	19.1%

After application of the RAND growth method, the growth in WTAM is similar to WTSM. Growth in the WTAM is marginally higher than WTSM, in the order of 1.5-2 percentage points higher, which is considered acceptable.

8. Summary

The WTAM is a new traffic assignment model in the Wellington analytics model suite. The 2018 base year demands are "observed" and sourced from mobile phone tracking data. The tracking data was expanded from the sample to the total by the provider (Qrious), and this involved several iterations where the resulting demands were compared with standard trip rates and strategic traffic counts. These demands were person trips and were re-processed by this project team to remove PT trips, walk trips (using a flag provided by Qrious), and apply vehicle occupancy to produce vehicle demands. The AM (6-9am) and PM (3-6pm) peak period demands also had to be split into the peak hour and shoulder, which had not been envisioned when the tracking data was procured. The resulting matrices were assigned and found not to replicate traffic counts sufficiently, and hence matrix estimation was required.

Matrix estimation was applied using link traffic counts. While changes in individual OD pairs and trip end totals are minimal, the resulting adjusted demands have some notable changes in sector-to-sector movements. Tests were conducted introducing less change in the demands, but the observed traffic counts were not suitably replicated. On balance, it was decided that as the "observed" demands were sample with significant processing already, further adjustment by matrix estimation was warranted to achieve a better match to traffic counts.

Screenline traffic counts are replicated well for light vehicles using model type B targets, with more variation at link level. Most targets for the specified criteria are achieved, or almost achieved.

Heavy vehicles from WTSM (synthetic) are also assigned in PCUs. As expected, traffic counts are not replicated as well. Screenline totals are mostly achieved, with link counts generally not achieving model type B standard. Targets for model type A are mostly achieved. This is considered acceptable given the relatively small volumes. It is recommended that if link-level heavy vehicles are specifically used, that the level of accuracy is confirmed and taken into account.

Travel time comparisons achieve the +/-1.5 minutes or 25% target for the two AM peak assignments and the interpeak, with the two PM peak assignments just under the target. Similarly, the +/-1 minute or 15% target is not achieved in any assignment, although the results are close.

Overall, for the base year model, a careful balance has been struck between not overly adjusting the demand through matrix estimation, but still replicating observed traffic counts and travel times to appropriate levels. It has been demonstrated that the demands have been altered quite a lot for certain sector-to-sector movements, however, the validation is just under the targets at a link level. Further improving the match to link traffic counts would require more adjustment of the base year demands which is not considered desirable.

Future year demands are created using a “pivot” from WTSM forecasts. This pivot is based on the RAND approach, the same as for WPTM, with ten cases to identify OD pairs and apply different methods to produce the WTAM future demands depending on the case.

The majority of future year demand in the WTAM comes from OD pairs where there are values in the WTAM base as well as WTSM base and future years with typical growth forecast by WTSM. In addition, there are large numbers of OD pairs where there are no trips in the WTAM base year, but trips in WTSM for the base and future years. This is not unexpected as WTSM is fully synthetic, but warrants monitoring as the RAND approach means zero future year demand for WTAM for these OD pairs. Monitoring involves checking matrix totals (WTSM and WTAM, base and future years) and ensuring the growth predicted by WTSM appears in the WTAM future year matrix.

The application of this forecasting approach produces demands in the WTAM in line with growth predicted by WTSM, albeit slightly higher.

Appendices

Appendix A Qrious Observed Matrices

Table A 1: Qrious Observed, AM Peak Period

Qrious AM 6am - 9am												
	CBD	Eastern suburbs	Kapiti	Lower Hutt	North & Western suburbs	Petone	Porirua	Southern suburbs	Tawa & Johnsonville	Upper Hutt	Wairarapa	Grand Total
CBD	6,473	1,016	173	638	1,002	365	336	1,182	593	175	55	12,007
Eastern suburbs	3,090	4,240	534	307	327	197	148	1,280	268	74	49	10,514
Kapiti	1,182	155	16,663	342	114	240	1,069	97	515	227	52	20,657
Lower Hutt	3,817	486	202	18,399	515	4,614	790	447	879	2,058	115	32,321
North & Western suburbs	6,369	576	98	604	4,982	391	344	974	1,070	121	27	15,555
Petone	1,783	238	107	3,617	284	3,909	322	268	566	533	51	11,678
Porirua	1,813	283	636	812	308	502	10,840	366	3,555	535	53	19,702
Southern suburbs	4,398	1,243	90	472	496	227	225	4,355	361	104	22	11,992
Tawa & Johnsonville	5,644	578	298	1,150	1,491	880	2,783	752	9,221	298	56	23,151
Upper Hutt	1,935	152	192	3,409	235	1,295	585	207	450	12,070	222	20,753
Wairarapa	220	28	129	198	25	86	42	24	32	334	21,969	23,087
Grand Total	36,725	8,997	19,120	29,947	9,780	12,705	17,483	9,950	17,511	16,527	22,671	201,417

Table A 2: Qrious Observed, Interpeak Period

Qrious IP 9am - 3pm												
	CBD	Eastern suburbs	Kapiti	Lower Hutt	North & Western suburbs	Petone	Porirua	Southern suburbs	Tawa & Johnsonville	Upper Hutt	Wairarapa	Grand Total
CBD	16,333	3,044	770	2,690	4,839	1,712	1,717	4,001	3,382	915	253	39,654
Eastern suburbs	2,647	9,143	766	559	615	341	306	2,310	555	169	92	17,501
Kapiti	507	513	40,043	406	180	234	820	205	506	326	268	44,007
Lower Hutt	2,195	543	448	36,991	666	7,798	982	641	1,317	3,545	298	55,423
North & Western suburbs	4,222	626	236	796	8,779	526	523	1,023	1,742	258	74	18,804
Petone	1,367	305	253	7,875	478	8,570	584	350	1,082	1,202	140	22,207
Porirua	1,113	286	1,235	935	393	525	23,001	474	6,751	582	72	35,368
Southern suburbs	4,166	2,360	225	654	1,145	410	534	8,626	725	201	69	19,114
Tawa & Johnsonville	2,406	509	584	1,364	1,995	1,146	6,804	706	16,886	413	85	32,899
Upper Hutt	592	161	336	3,556	142	1,075	535	157	349	27,171	493	34,569
Wairarapa	187	73	293	272	49	105	80	64	67	436	46,679	48,305
Grand Total	35,733	17,562	45,189	56,098	19,282	22,442	35,887	18,555	33,361	35,217	48,524	367,850

Table A 3: Qrious Observed, PM Peak Period

Qrious PM 3pm - 6pm												
	CBD	Eastern suburbs	Kapiti	Lower Hutt	North & Western suburbs	Petone	Porirua	Southern suburbs	Tawa & Johnsonville	Upper Hutt	Wairarapa	Grand Total
CBD	8091	2884	1480	3704	5637	1586	2274	3791	4691	1826	254	36217
Eastern suburbs	1373	4906	451	439	504	210	300	1469	528	153	40	10372
Kapiti	239	409	21068	199	114	103	637	91	310	173	151	23494
Lower Hutt	1117	320	402	22778	491	4645	819	442	1045	3556	298	35913
North & Western suburbs	1867	323	185	601	5449	313	449	583	1680	269	47	11768
Petone	618	173	237	5280	367	4517	515	228	822	1247	113	14117
Porirua	614	152	1377	724	293	321	12374	238	3483	589	64	20228
Southern suburbs	1866	1504	126	467	938	254	404	4961	699	203	39	11460
Tawa & Johnsonville	1099	287	612	1111	1173	689	4411	378	9771	505	66	20102
Upper Hutt	290	83	269	2336	109	628	548	100	260	15728	499	20849
Wairarapa	73	61	188	118	31	42	45	25	41	232	24079	24936
Grand Total	17246	11101	26395	37758	15106	13307	22777	12306	23330	24479	25651	229457

Appendix B Adjusted Demands

Table B 1: AM Peak Hour, Adjusted Demands, 1 hour

	Adjusted Demands											
	CBD	Eastern suburbs	Kapiti	Lower Hutt	North & Western suburbs	Petone	Porirua	Southern suburbs	Tawa & Johnsonville	Upper Hutt	Wairarapa	Grand Total
CBD	4,733	1,407	71	418	774	232	162	1,364	662	119	20	9,962
Eastern suburbs	1,067	2,418	77	68	103	42	21	823	90	15	5	4,731
Kapiti	305	3	6,757	208	15	57	296	0	90	106	26	7,862
Lower Hutt	1,231	40	86	6,998	35	2,192	310	25	182	728	23	11,850
North & Western suburbs	2,624	102	22	197	2,002	111	92	178	588	36	4	5,956
Petone	586	19	29	1,759	18	1,555	85	16	123	222	10	4,420
Porirua	523	4	183	404	68	119	4,804	3	1,104	223	11	7,448
Southern suburbs	1,890	752	21	189	231	91	70	1,923	224	41	4	5,436
Tawa & Johnsonville	1,886	31	105	369	838	263	1,621	35	3,986	99	8	9,240
Upper Hutt	574	7	80	1,080	9	374	270	6	69	5,222	46	7,737
Wairarapa	60	1	27	43	0	12	10	0	2	81	8,652	8,889
Grand Total	15,480	4,784	7,457	11,733	4,092	5,048	7,742	4,373	7,119	6,892	8,808	83,529

Table B 2: AM Shoulder, Adjusted Demands, 2 hours

	Adjusted Demands											
	CBD	Eastern suburbs	Kapiti	Lower Hutt	North & Western suburbs	Petone	Porirua	Southern suburbs	Tawa & Johnsonville	Upper Hutt	Wairarapa	Grand Total
CBD	4,774	847	58	409	1,066	307	215	832	613	137	18	9,277
Eastern suburbs	1,885	3,142	192	205	174	166	90	843	255	54	12	7,019
Kapiti	672	360	9,608	209	56	140	596	71	282	105	14	12,112
Lower Hutt	2,114	263	141	10,791	52	2,623	596	329	212	1,009	29	18,159
North & Western suburbs	2,426	176	14	175	2,931	151	99	348	558	42	4	6,923
Petone	1,182	162	42	1,643	33	2,345	165	261	187	301	13	6,333
Porirua	1,184	252	192	551	122	315	6,725	229	1,860	350	14	11,795
Southern suburbs	2,215	896	24	240	204	144	109	2,636	264	61	5	6,799
Tawa & Johnsonville	2,841	426	85	504	775	487	1,513	381	5,669	159	12	12,852
Upper Hutt	1,136	100	104	861	31	1,570	485	213	183	6,613	74	11,370
Wairarapa	259	35	35	52	6	96	24	39	15	101	12,536	13,198
Grand Total	20,687	6,659	10,496	15,639	5,451	8,343	10,619	6,181	10,097	8,933	12,731	115,837

Table B 3: AM Peak Period, Adjusted Demands, 3 hours

Adjusted Demands												
	CBD	Eastern suburbs	Kapiti	Lower Hutt	North & Western suburbs	Petone	Porirua	Southern suburbs	Tawa & Johnsonville	Upper Hutt	Wairarapa	Grand Total
CBD	9,507	2,254	129	828	1,840	539	377	2,196	1,275	256	38	19,238
Eastern suburbs	2,952	5,561	270	273	277	208	111	1,666	345	70	17	11,750
Kapiti	977	363	16,365	417	71	196	892	71	372	211	39	19,974
Lower Hutt	3,345	303	227	17,788	87	4,816	906	354	394	1,737	52	30,009
North & Western suburbs	5,050	278	36	372	4,932	262	192	525	1,146	78	8	12,879
Petone	1,767	180	70	3,402	51	3,899	251	277	310	523	22	10,753
Porirua	1,707	257	375	956	190	434	11,529	232	2,963	573	26	19,243
Southern suburbs	4,105	1,648	45	429	436	235	179	4,558	488	102	9	12,234
Tawa & Johnsonville	4,727	458	190	873	1,613	750	3,134	416	9,655	258	20	22,092
Upper Hutt	1,710	108	184	1,941	40	1,943	755	219	251	11,835	121	19,107
Wairarapa	319	36	62	95	6	109	34	39	18	182	21,188	22,087
Grand Total	36,167	11,444	17,954	27,372	9,543	13,391	18,361	10,553	17,217	15,825	21,539	199,366

Table B 4: Interpeak, Adjusted Demands, 6 hours

Adjusted Demands												
	CBD	Eastern suburbs	Kapiti	Lower Hutt	North & Western suburbs	Petone	Porirua	Southern suburbs	Tawa & Johnsonville	Upper Hutt	Wairarapa	Grand Total
CBD	23,248	4,377	601	2,235	5,665	1,471	1,092	5,602	3,527	665	120	48,603
Eastern suburbs	4,429	9,968	943	760	877	451	325	3,388	815	203	69	22,227
Kapiti	632	792	39,706	452	216	264	1,021	174	575	279	143	44,254
Lower Hutt	2,740	955	442	36,007	834	9,282	1,027	555	1,799	3,391	186	57,218
North & Western suburbs	6,002	801	209	690	8,945	445	385	1,024	2,142	190	35	20,869
Petone	1,448	449	232	7,304	487	8,567	514	268	1,218	1,043	83	21,614
Porirua	1,133	397	1,332	997	374	530	23,699	315	5,698	560	47	35,082
Southern suburbs	6,258	3,258	230	690	1,448	432	472	9,000	872	186	44	22,889
Tawa & Johnsonville	3,473	952	572	1,584	2,583	1,319	5,535	678	16,693	410	56	33,854
Upper Hutt	648	248	290	3,724	153	1,110	531	118	409	27,646	406	35,283
Wairarapa	157	81	185	211	39	85	59	32	61	371	46,453	47,734
Grand Total	50,168	22,279	44,741	54,654	21,620	23,957	34,660	21,155	33,808	34,945	47,641	389,628

Table B 5: PM Peak Hour, Adjusted Demands, 1 hour

Adjusted Demands												
	CBD	Eastern suburbs	Kapiti	Lower Hutt	North & Western suburbs	Petone	Porirua	Southern suburbs	Tawa & Johnsonville	Upper Hutt	Wairarapa	Grand Total
CBD	4,626	1,579	288	929	2,043	388	541	1,770	1,648	336	42	14,190
Eastern suburbs	562	2,381	88	94	85	42	53	626	129	23	5	4,089
Kapiti	109	43	7,020	116	29	40	156	6	75	100	92	7,785
Lower Hutt	686	87	81	7,614	170	1,886	296	56	560	1,465	72	12,974
North & Western suburbs	1,058	77	43	126	2,058	59	127	143	632	38	6	4,367
Petone	349	36	69	1,542	88	1,507	187	22	322	300	25	4,447
Porirua	418	32	330	349	100	143	4,335	30	1,240	260	28	7,265
Southern suburbs	1,063	798	34	180	608	93	131	2,029	342	58	10	5,346
Tawa & Johnsonville	606	73	173	301	606	182	1,539	52	3,338	99	11	6,980
Upper Hutt	179	13	65	874	26	216	205	10	107	5,397	111	7,201
Wairarapa	36	6	42	35	6	12	14	2	14	55	8,026	8,249
Grand Total	9,691	5,125	8,231	12,160	5,819	4,568	7,584	4,746	8,406	8,133	8,429	82,892

Table B 6: PM Shoulder, Adjusted Demands, 2 hours

Adjusted Demands												
	CBD	Eastern suburbs	Kapiti	Lower Hutt	North & Western suburbs	Petone	Porirua	Southern suburbs	Tawa & Johnsonville	Upper Hutt	Wairarapa	Grand Total
CBD	7,758	1,724	552	1,644	3,157	736	841	2,646	2,710	626	62	22,457
Eastern suburbs	891	4,388	260	245	148	113	124	2,146	273	69	15	8,672
Kapiti	183	277	14,039	221	66	73	358	21	186	159	114	15,699
Lower Hutt	995	301	139	14,586	307	4,077	505	166	975	2,493	127	24,670
North & Western suburbs	2,034	214	113	276	3,928	138	265	208	1,314	86	11	8,585
Petone	472	113	118	3,009	148	3,008	284	66	532	639	44	8,431
Porirua	577	106	831	615	194	249	8,815	82	2,461	482	45	14,457
Southern suburbs	2,050	1,543	74	345	904	184	251	3,583	548	120	17	9,617
Tawa & Johnsonville	1,026	248	452	587	1,138	374	3,186	143	6,560	215	20	13,948
Upper Hutt	257	54	126	1,739	49	474	375	29	189	10,763	242	14,297
Wairarapa	60	41	82	82	14	30	30	7	28	123	16,004	16,499
Grand Total	16,302	9,009	16,787	23,350	10,051	9,456	15,034	9,096	15,777	15,774	16,699	157,333

Table B 7: PM Peak Period, Adjusted Demands, 3 hours

Adjusted Demands												
	CBD	Eastern suburbs	Kapiti	Lower Hutt	North & Western suburbs	Petone	Porirua	Southern suburbs	Tawa & Johnsonville	Upper Hutt	Wairarapa	Grand Total
CBD	12,385	3,303	840	2,574	5,199	1,124	1,382	4,416	4,357	962	104	36,647
Eastern suburbs	1,453	6,769	348	339	233	155	177	2,772	402	92	20	12,760
Kapiti	292	320	21,058	337	96	113	515	27	261	259	206	23,483
Lower Hutt	1,680	388	220	22,200	477	5,963	801	222	1,536	3,958	199	37,644
North & Western suburbs	3,092	290	156	402	5,986	198	392	351	1,946	124	17	12,952
Petone	821	148	187	4,551	235	4,516	471	88	854	939	69	12,878
Porirua	994	139	1,160	964	295	392	13,150	112	3,701	742	73	21,722
Southern suburbs	3,113	2,341	108	525	1,511	277	382	5,612	890	178	27	14,963
Tawa & Johnsonville	1,632	321	625	887	1,744	557	4,725	194	9,898	314	31	20,929
Upper Hutt	436	67	190	2,613	75	690	580	39	296	16,160	352	21,498
Wairarapa	96	47	124	117	20	42	44	9	41	178	24,030	24,748
Grand Total	25,993	14,133	25,017	35,509	15,870	14,024	22,619	13,842	24,182	23,907	25,127	240,225

Appendix C Traffic Count Validation Tables

The link scatter plots have observed on the x-axis and modelled on the y-axis. All periods are plotted as average hour. As noted in Section 2.4, the Port count for heavy vehicles is only available by peak period and is shown as zero in the hour and shoulder tables (indicating not calculated).

C.1 AM Peak Hour

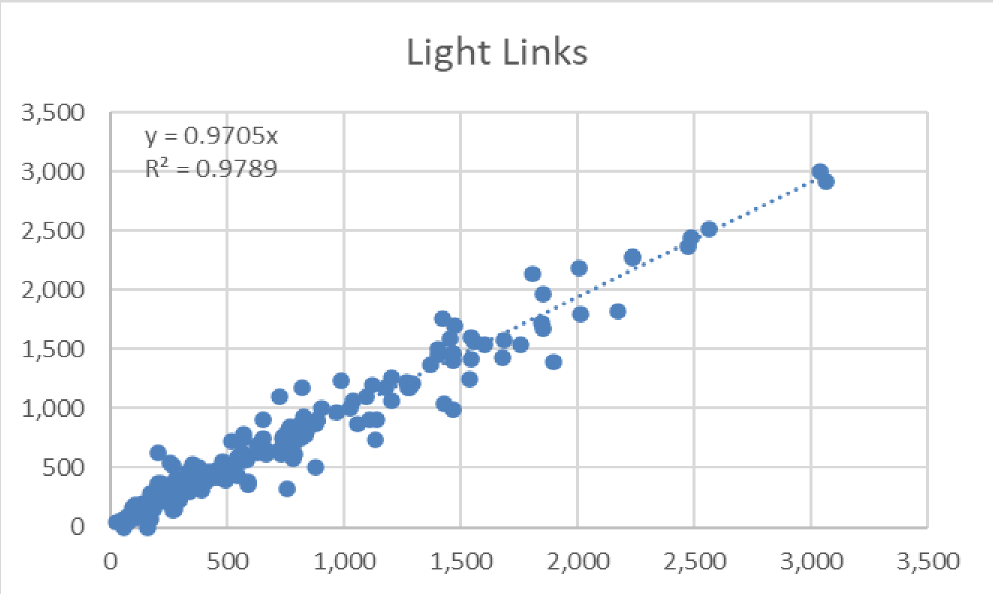


Figure C 1: Link Flow Scatter Plot, Light Vehicles

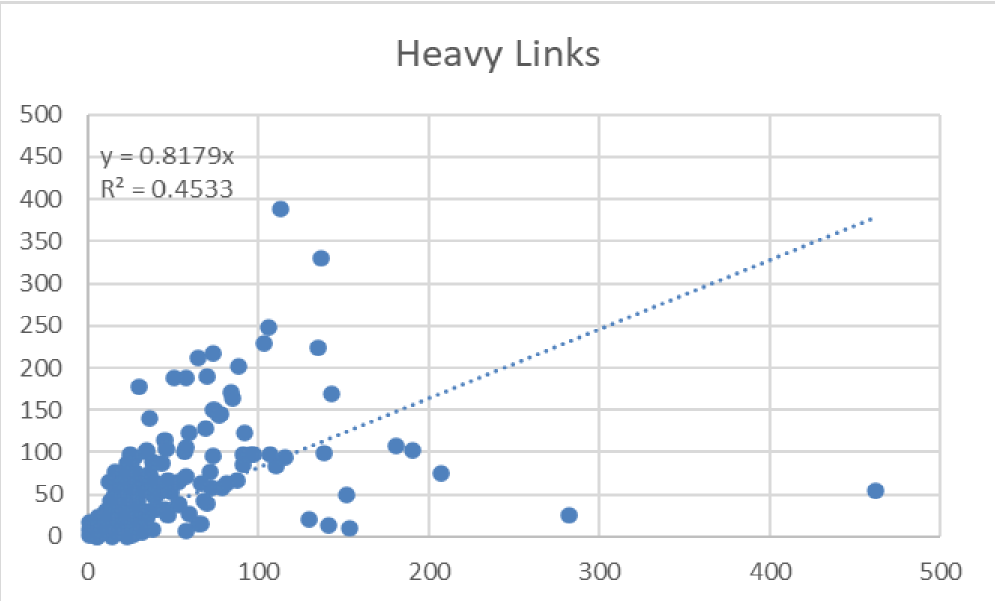


Figure C 2: Link Flow Scatter Plot, Heavy Vehicles

Note: the biggest outliers are northbound on Jervois Quay (model undercount) and SH2 just before Ngauranga (model overcount).

Table C 1: Screenline Table, Modelled vs Observed

:reenline/Cordon Comparison Summary

Screenline	Direction	Description	Ref	Link Counts	Light, Average Hour					Medium + Heavy, Average Hour					Total, Average Hour				
					Observed	Modelled	Difference	% Diff	GEH	Observed	Modelled	Difference	% Diff	GEH	Observed	Modelled	Difference	% Diff	GEH
C1	I	Wairarapa South In	C1-I	2	529	585	56	11%	2.4	34	68	33	97%	4.7	563	653	90	16%	3.6
C1	O	Wairarapa South Out	C1-O	2	518	586	68	13%	2.9	32	65	33	104%	4.8	550	651	101	18%	4.1
C2	I	Wairarapa North In	C2-I	1	410	408	-2	0%	0.1	40	52	12	31%	1.8	450	460	10	2%	0.5
C2	O	Wairarapa North Out	C2-O	1	630	631	1	0%	0.0	40	52	12	29%	1.7	670	683	12	2%	0.5
K1	I	Kapiti North In	K1-I	4	1,347	1,244	-103	-8%	2.9	64	114	51	80%	5.4	1,411	1,358	-52	-4%	1.4
K1	O	Kapiti North Out	K1-O	4	958	916	-42	-4%	1.4	83	115	32	38%	3.2	1,041	1,031	-10	-1%	0.3
K2	I	Kapiti South In	K2-I	1	1,037	1,071	34	3%	1.1	95	97	2	2%	0.2	1,132	1,168	36	3%	1.1
K2	O	Kapiti South Out	K2-O	1	741	751	10	1%	0.4	107	97	-10	-9%	1.0	848	848	0	0%	0.0
L1	I	Lower Hutt South In	L1-I	1	3,035	3,008	-27	-1%	0.5	113	387	274	242%	17.3	3,148	3,396	248	8%	4.3
L1	O	Lower Hutt South Out	L1-O	1	2,487	2,443	-44	-2%	0.9	136	331	194	142%	12.7	2,623	2,774	151	6%	2.9
L2	I	Lower Hutt North In	L2-I	2	3,278	3,432	154	5%	2.7	228	183	-45	-20%	3.2	3,506	3,615	109	3%	1.8
L2	O	Lower Hutt North Out	L2-O	2	1,707	1,772	65	4%	1.6	126	196	70	56%	5.5	1,833	1,968	135	7%	3.1
L3	I	Lower Hutt Central In	L3-I	4	4,350	4,515	165	4%	2.5	349	392	43	12%	2.2	4,699	4,907	207	4%	3.0
L3	O	Lower Hutt Central Out	L3-O	4	4,036	3,894	-142	-4%	2.3	206	260	54	26%	3.5	4,242	4,154	-88	-2%	1.4
L4	I	Lower Hutt East In	L4-I	3	2,777	2,777	0	0%	0.0	139	119	-21	-15%	1.8	2,916	2,895	-21	-1%	0.4
L4	O	Lower Hutt East Out	L4-O	3	1,062	1,050	-12	-1%	0.4	82	99	17	20%	1.8	1,144	1,149	5	0%	0.1
P1	I	Porirua North In	P1-I	2	1,891	1,781	-110	-6%	2.6	98	138	40	41%	3.7	1,989	1,919	-70	-4%	1.6
P1	O	Porirua North Out	P1-O	2	1,225	1,134	-91	-7%	2.6	85	144	59	70%	5.5	1,310	1,279	-31	-2%	0.9
P2	I	SH58 In	P2-I	1	858	875	17	2%	0.6	43	88	45	104%	5.5	901	962	61	7%	2.0
P2	O	SH58 Out	P2-O	1	907	1,006	99	11%	3.2	53	65	12	23%	1.6	960	1,071	111	12%	3.5
P3	I	Porirua South In	P3-I	2	2,439	2,308	-131	-5%	2.7	131	222	91	69%	6.9	2,570	2,530	-40	-2%	0.8
P3	O	Porirua South Out	P3-O	2	2,265	2,313	48	2%	1.0	111	199	89	80%	7.1	2,376	2,512	137	6%	2.8
U1	I	Upper Hutt North In	U1-I	1	1,029	1,005	-24	-2%	0.7	34	63	29	83%	4.1	1,063	1,068	5	0%	0.2
U1	O	Upper Hutt North Out	U1-O	1	452	451	-1	0%	0.0	17	62	45	265%	7.2	469	513	44	9%	2.0
U2	I	Upper Hutt South In	U2-I	3	2,834	2,786	-48	-2%	0.9	77	193	116	150%	10.0	2,911	2,979	68	2%	1.3
U2	O	Upper Hutt South Out	U2-O	3	1,839	1,877	38	2%	0.9	84	189	105	125%	9.0	1,923	2,066	143	7%	3.2
U4	I	Upper Hutt Central In	U4-I	4	1,968	1,938	-30	-2%	0.7	127	150	23	18%	1.9	2,095	2,087	-8	0%	0.2
U4	O	Upper Hutt Central Out	U4-O	4	1,820	1,829	9	0%	0.2	100	146	46	46%	4.2	1,920	1,975	55	3%	1.2
W1A	I	CBD South In	W1A-I	5	2,649	2,792	143	5%	2.7	172	124	-48	-28%	4.0	2,821	2,916	95	3%	1.8
W1A	O	CBD South Out	W1A-O	5	1,684	1,615	-69	-4%	1.7	111	97	-14	-13%	1.4	1,795	1,712	-83	-5%	2.0
W1B	I	CBD North In	W1B-I	5	7,223	6,853	-370	-5%	4.4	445	435	-10	-2%	0.5	7,668	7,288	-380	-5%	4.4
W1B	O	CBD North Out	W1B-O	6	3,716	3,776	60	2%	1.0	208	337	129	62%	7.8	3,924	4,113	189	5%	3.0
W1C	I	CBD West In	W1C-I	2	1,271	1,212	-59	-5%	1.7	37	39	2	5%	0.3	1,308	1,251	-58	-4%	1.6
W1C	O	CBD West Out	W1C-O	2	712	743	31	4%	1.2	23	41	18	80%	3.2	735	784	49	7%	1.8
W1D	I	CBD East In	W1D-I	3	2,285	2,463	178	8%	3.6	108	126	18	17%	1.7	2,393	2,589	196	8%	3.9
W1D	O	CBD East Out	W1D-O	3	1,827	1,840	13	1%	0.3	61	102	41	68%	4.6	1,888	1,942	54	3%	1.2
W2	I	Miramar Peninsula In	W2-I	2	2,185	2,199	14	1%	0.3	49	88	39	80%	4.7	2,234	2,287	53	2%	1.1
W2	O	Miramar Peninsula Ou	W2-O	2	1,865	1,749	-116	-6%	2.7	35	75	40	112%	5.3	1,900	1,824	-77	-4%	1.8
W3	I	Karori In	W3-I	2	1,109	1,272	163	15%	4.7	60	39	-22	-36%	3.1	1,169	1,311	141	12%	4.0
W3	O	Karori Out	W3-O	2	450	488	38	8%	1.7	17	31	14	86%	2.9	467	519	52	11%	2.3
W4	I	Kaiwharawhara In	W4-I	4	7,038	6,778	-260	-4%	3.1	395	497	102	26%	4.8	7,433	7,275	-158	-2%	1.8
W4	O	Kaiwharawhara Out	W4-O	4	3,659	3,691	32	1%	0.5	206	387	181	88%	10.5	3,865	4,078	213	6%	3.4
W5	I	Churton Park In	W5-I	2	2,828	2,727	-101	-4%	1.9	136	241	105	77%	7.6	2,964	2,968	4	0%	0.1
W5	O	Churton Park Out	W5-O	2	1,926	2,113	187	10%	4.2	115	214	100	87%	7.8	2,041	2,327	286	14%	6.1
W6	I	South Wellington In	W6-I	5	2,103	1,961	-142	-7%	3.2	95	72	-22	-23%	2.4	2,198	2,033	-165	-7%	3.6
W6	O	South Wellington Out	W6-O	5	1,131	1,187	56	5%	1.6	67	59	-7	-11%	0.9	1,198	1,246	49	4%	1.4
W7	I	Tawa In	W7-I	3	2,304	2,188	-116	-5%	2.5	133	214	82	62%	6.2	2,437	2,402	-35	-1%	0.7
W7	O	Tawa Out	W7-O	3	2,158	2,181	23	1%	0.5	111	243	132	118%	9.9	2,269	2,424	154	7%	3.2
W8	I	North Wellington In	W8-I	3	4,611	4,429	-182	-4%	2.7	174	299	125	72%	8.1	4,785	4,728	-57	-1%	0.8
W8	O	North Wellington Out	W8-O	3	2,252	2,259	7	0%	0.1	100	263	163	163%	12.1	2,352	2,522	170	7%	3.4
W9	I	Thorndon In	W9-I	6	4,566	5,200	634	14%	9.1	268	340	72	27%	4.1	4,834	5,540	706	15%	9.8
W9	O	Thorndon Out	W9-O	5	3,065	3,251	186	6%	3.3	112	251	139	124%	10.3	3,177	3,502	325	10%	5.6
W10	N	CBD Lambton North	W10-N	6	4,355	4,806	451	10%	6.7	616	373	-243	-39%	10.9	4,971	5,179	208	4%	2.9
W10	S	CBD Lambton South	W10-S	7	5,184	4,465	-719	-14%	10.3	387	413	26	7%	1.3	5,571	4,878	-693	-12%	9.6
W11	N	CBD Te Aro North	W11-N	5	2,770	2,391	-379	-14%	7.5	177	223	47	26%	3.3	2,947	2,615	-332	-11%	6.3
W11	S	CBD Te Aro South	W11-S	6	2,911	2,378	-533	-18%	10.4	327	166	-161	-49%	10.3	3,238	2,544	-694	-21%	12.9
W12	E	CBD Mount Cook East	W12-E	5	3,315	3,110	-205	-6%	3.6	361	190	-171	-47%	10.3	3,676	3,300	-376	-10%	6.4
W12	W	CBD Mount Cook West	W12-W	4	3,927	3,864	-63	-2%	1.0	230	172	-57	-25%	4.0	4,157	4,036	-121	-3%	1.9
E	I	External In	E-I	2	620	585	-35	-6%	1.4	88	102	14	15%	1.4	708	687	-21	-3%	0.8
E	O	External Out	E-O	2	624	597	-27	-4%	1.1	77	99	22	29%	2.4	701	696	-5	-1%	0.2
U3	I	Remutaka In	U3-I	1	222	240	18	8%	1.2	15	46	31	203%	5.5	237	286	49	21%	3.0
U3	O	Remutaka Out	U3-O	1	145	165	20	14%	1.6	17	41	24	143%	4.5	162	206	44	27%	3.2
P4	I	Pukerua Bay In	P4-I	1	1,060	876	-184	-17%	5.9	97	97	0	0%	0.0	1,157	973	-184	-16%	5.7
P4	O	Pukerua Bay Out	P4-O	1	629	694	65	10%	2.5	91	97	6	7%	0.7	720	791	71	10%	2.6
P	I	Port In	P-I	0						0	0	0	-	-	0	0	0	-	-
P	O	Port Out	P-O	0						0	0	0	-	-	0	0	0	-	-

C.2 AM Shoulder

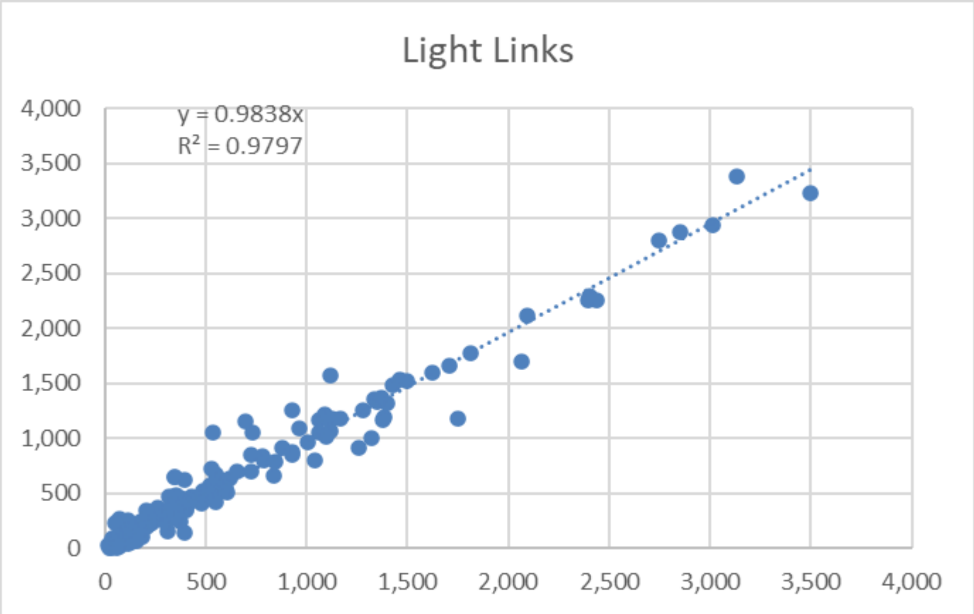


Figure C 3: Link Flow Scatter Plot, Light Vehicles

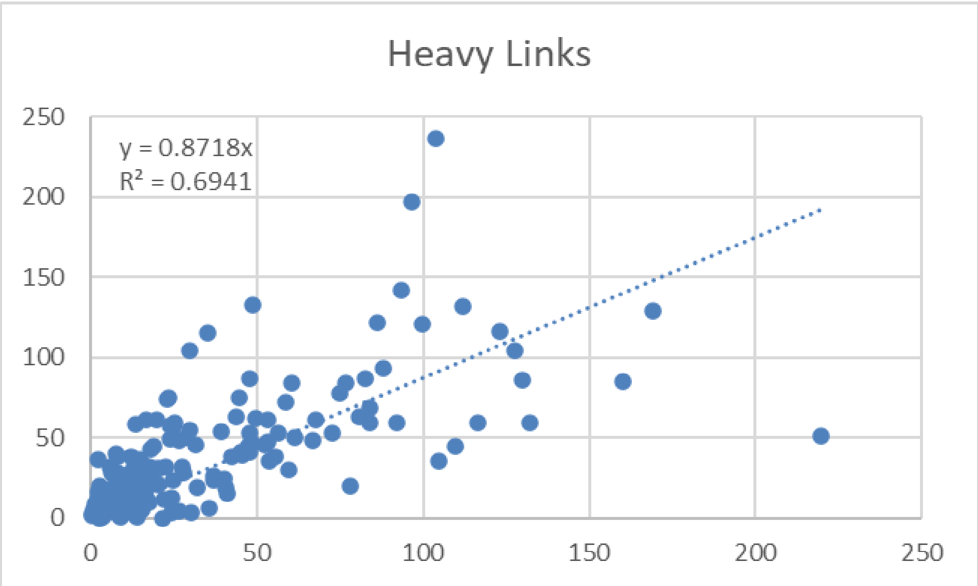


Figure C 4: Link Flow Scatter Plot, Heavy Vehicles

Table C 2: Screenline Table, Modelled vs Observed

:reenline/Cordon Comparison Summary

Screenline	Direction	Description	Ref	Link Counts	Light, Average Hour					Medium + Heavy, Average Hour					Total, Average Hour				
					Observed	Modelled	Difference	% Diff	GEH	Observed	Modelled	Difference	% Diff	GEH	Observed	Modelled	Difference	% Diff	GEH
C1	I	Wairarapa South In	C1-I	2	360	425	66	18%	3.3	24	41	17	70%	3.0	384	466	83	22%	4.0
C1	O	Wairarapa South Out	C1-O	2	310	363	53	17%	2.9	21	40	18	86%	3.3	331	402	71	21%	3.7
C2	I	Wairarapa North In	C2-I	1	306	295	-11	-4%	0.6	28	32	4	16%	0.8	334	327	-7	-2%	0.4
C2	O	Wairarapa North Out	C2-O	1	368	367	-1	0%	0.0	23	32	9	39%	1.7	390	398	8	2%	0.4
K1	I	Kapiti North In	K1-I	4	960	1,004	45	5%	1.4	60	71	11	18%	1.4	1,020	1,075	56	5%	1.7
K1	O	Kapiti North Out	K1-O	4	548	557	9	2%	0.4	63	70	7	11%	0.9	611	627	16	3%	0.6
K2	I	Kapiti South In	K2-I	1	1,277	1,258	-18	-1%	0.5	132	59	-73	-55%	7.5	1,409	1,318	-91	-6%	2.5
K2	O	Kapiti South Out	K2-O	1	410	450	40	10%	1.9	92	59	-33	-36%	3.8	502	509	7	1%	0.3
L1	I	Lower Hutt South In	L1-I	1	3,135	3,384	249	8%	4.4	104	236	132	128%	10.2	3,239	3,620	381	12%	6.5
L1	O	Lower Hutt South Out	L1-O	1	1,810	1,776	-34	-2%	0.8	96	196	100	104%	8.3	1,906	1,972	66	3%	1.5
L2	I	Lower Hutt North In	L2-I	2	3,180	3,271	92	3%	1.6	151	116	-35	-23%	3.0	3,330	3,388	57	2%	1.0
L2	O	Lower Hutt North Out	L2-O	2	1,160	1,208	48	4%	1.4	64	119	55	87%	5.8	1,224	1,327	103	8%	2.9
L3	I	Lower Hutt Central In	L3-I	4	3,293	3,854	561	17%	9.4	254	235	-20	-8%	1.3	3,547	4,088	542	15%	8.8
L3	O	Lower Hutt Central Out	L3-O	4	2,203	2,069	-134	-6%	2.9	126	158	32	25%	2.6	2,329	2,227	-102	-4%	2.1
L4	I	Lower Hutt East In	L4-I	3	2,580	2,579	0	0%	0.0	158	73	-85	-54%	7.9	2,737	2,652	-86	-3%	1.7
L4	O	Lower Hutt East Out	L4-O	3	474	506	32	7%	1.5	27	61	33	122%	5.0	501	567	66	13%	2.8
P1	I	Porirua North In	P1-I	2	1,607	1,601	-6	0%	0.2	79	84	6	7%	0.6	1,686	1,685	-1	0%	0.0
P1	O	Porirua North Out	P1-O	2	838	677	-161	-19%	5.9	87	88	2	2%	0.2	924	765	-159	-17%	5.5
P2	I	SH58 In	P2-I	1	791	808	17	2%	0.6	30	54	24	81%	3.7	821	862	41	5%	1.4
P2	O	SH58 Out	P2-O	1	659	700	41	6%	1.6	32	45	14	44%	2.2	690	745	55	8%	2.1
P3	I	Porirua South In	P3-I	2	2,881	2,780	-101	-4%	1.9	130	131	1	1%	0.1	3,011	2,911	-100	-3%	1.8
P3	O	Porirua South Out	P3-O	2	1,319	1,242	-77	-6%	2.1	97	122	25	26%	2.4	1,416	1,364	-52	-4%	1.4
U1	I	Upper Hutt North In	U1-I	1	1,059	1,052	-7	-1%	0.2	45	39	-6	-14%	0.9	1,104	1,091	-13	-1%	0.4
U1	O	Upper Hutt North Out	U1-O	1	232	242	10	4%	0.6	8	38	29	349%	6.1	240	279	39	16%	2.4
U2	I	Upper Hutt South In	U2-I	3	2,796	2,747	-49	-2%	0.9	53	119	65	122%	7.0	2,849	2,865	16	1%	0.3
U2	O	Upper Hutt South Out	U2-O	3	1,277	1,327	50	4%	1.4	56	116	60	108%	6.5	1,333	1,443	110	8%	3.0
U4	I	Upper Hutt Central In	U4-I	4	1,796	1,892	96	5%	2.2	87	92	4	5%	0.5	1,883	1,984	100	5%	2.3
U4	O	Upper Hutt Central Out	U4-O	4	925	933	8	1%	0.3	68	89	22	32%	2.4	993	1,022	30	3%	0.9
W1A	I	CBD South In	W1A-I	5	1,668	1,755	87	5%	2.1	71	82	11	15%	1.2	1,739	1,837	98	6%	2.3
W1A	O	CBD South Out	W1A-O	5	1,006	991	-15	-1%	0.5	59	58	-1	-2%	0.2	1,065	1,049	-16	-1%	0.5
W1B	I	CBD North In	W1B-I	5	6,216	6,411	195	3%	2.5	349	266	-83	-24%	4.7	6,565	6,677	113	2%	1.4
W1B	O	CBD North Out	W1B-O	6	2,403	2,514	111	5%	2.2	128	206	77	60%	6.0	2,532	2,720	188	7%	3.7
W1C	I	CBD West In	W1C-I	2	632	812	180	29%	6.7	9	23	15	169%	3.7	641	836	195	30%	7.2
W1C	O	CBD West Out	W1C-O	2	330	364	35	11%	1.9	15	25	10	65%	2.2	345	389	45	13%	2.3
W1D	I	CBD East In	W1D-I	3	1,588	1,617	29	2%	0.7	39	70	31	80%	4.2	1,627	1,687	60	4%	1.5
W1D	O	CBD East Out	W1D-O	3	1,463	1,423	-40	-3%	1.1	38	63	25	65%	3.5	1,501	1,486	-15	-1%	0.4
W2	I	Miramar Peninsula In	W2-I	2	1,707	1,681	-26	-2%	0.6	48	54	6	12%	0.8	1,755	1,735	-20	-1%	0.5
W2	O	Miramar Peninsula Ou	W2-O	2	1,502	1,424	-78	-5%	2.0	66	46	-21	-31%	2.7	1,568	1,470	-99	-6%	2.5
W3	I	Karori In	W3-I	2	803	861	58	7%	2.0	23	24	0	2%	0.1	826	885	59	7%	2.0
W3	O	Karori Out	W3-O	2	239	371	132	55%	7.6	7	19	12	164%	3.3	246	390	144	59%	8.1
W4	I	Kaiwharawhara In	W4-I	4	6,516	6,589	74	1%	0.9	293	304	11	4%	0.6	6,809	6,893	85	1%	1.0
W4	O	Kaiwharawhara Out	W4-O	4	2,322	2,302	-20	-1%	0.4	132	236	104	79%	7.7	2,454	2,538	84	3%	1.7
W5	I	Churton Park In	W5-I	2	3,178	3,110	-68	-2%	1.2	115	142	27	23%	2.4	3,293	3,252	-41	-1%	0.7
W5	O	Churton Park Out	W5-O	2	1,374	1,506	132	10%	3.5	114	130	16	14%	1.5	1,488	1,636	149	10%	3.8
W6	I	South Wellington In	W6-I	5	1,144	1,054	-90	-8%	2.7	51	43	-7	-14%	1.0	1,195	1,097	-97	-8%	2.9
W6	O	South Wellington Out	W6-O	5	581	726	145	25%	5.7	32	43	12	36%	1.9	612	769	157	26%	6.0
W7	I	Tawa In	W7-I	3	1,724	1,499	-225	-13%	5.6	113	130	17	15%	1.5	1,837	1,629	-208	-11%	5.0
W7	O	Tawa Out	W7-O	3	2,528	2,649	121	5%	2.4	107	143	36	34%	3.2	2,634	2,792	157	6%	3.0
W8	I	North Wellington In	W8-I	3	4,603	4,521	-82	-2%	1.2	147	177	31	21%	2.4	4,749	4,698	-51	-1%	0.7
W8	O	North Wellington Out	W8-O	3	1,440	1,347	-93	-6%	2.5	63	160	97	152%	9.1	1,503	1,507	3	0%	0.1
W9	I	Thorndon In	W9-I	6	4,478	5,263	785	18%	11.3	177	144	-33	-18%	2.6	4,655	5,407	753	16%	10.6
W9	O	Thorndon Out	W9-O	5	2,173	1,957	-216	-10%	4.8	70	142	72	104%	7.0	2,243	2,099	-144	-6%	3.1
W10	N	CBD Lambton North	W10-N	6	2,821	2,887	66	2%	1.2	337	232	-105	-31%	6.2	3,157	3,118	-39	-1%	0.7
W10	S	CBD Lambton South	W10-S	7	3,849	3,877	28	1%	0.4	231	258	27	12%	1.7	4,080	4,134	55	1%	0.9
W11	N	CBD Te Aro North	W11-N	5	1,410	1,462	52	4%	1.4	67	130	63	94%	6.4	1,477	1,592	115	8%	2.9
W11	S	CBD Te Aro South	W11-S	6	1,860	1,892	33	2%	0.8	186	161	-25	-13%	1.9	2,046	2,054	8	0%	0.2
W12	E	CBD Mount Cook East	W12-E	5	2,511	2,451	-60	-2%	1.2	203	118	-84	-42%	6.6	2,713	2,569	-144	-5%	2.8
W12	W	CBD Mount Cook West	W12-W	4	2,317	2,076	-240	-10%	5.1	126	105	-20	-16%	1.9	2,442	2,182	-260	-11%	5.4
E	I	External In	E-I	2	452	434	-18	-4%	0.9	67	62	-5	-7%	0.6	519	496	-23	-4%	1.0
E	O	External Out	E-O	2	378	350	-28	-7%	1.5	59	61	2	3%	0.2	437	411	-26	-6%	1.3
U3	I	Remutaka In	U3-I	1	296	346	50	17%	2.8	16	28	12	79%	2.6	311	373	62	20%	3.4
U3	O	Remutaka Out	U3-O	1	98	109	12	12%	1.2	14	25	11	81%	2.5	112	135	23	21%	2.1
P4	I	Pukerua Bay In	P4-I	1	1,115	1,070	-45	-4%	1.4	117	59	-57	-49%	6.1	1,232	1,130	-102	-8%	3.0
P4	O	Pukerua Bay Out	P4-O	1	373	438	66	18%	3.3	84	60	-24	-29%	2.9	457	498	42	9%	1.9
P	I	Port In	P-I	0						0	0	0	-	-	0	0	0	-	-
P	O	Port Out	P-O	0						0	0	0	-	-	0	0	0	-	-

C.3 AM Peak Period

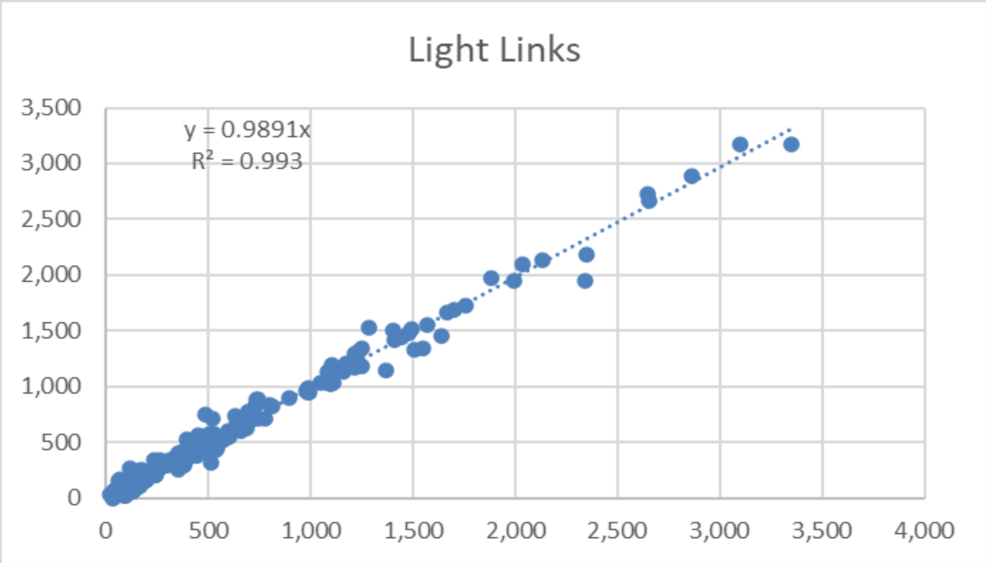


Figure C 5: Link Flow Scatter Plot, Light Vehicles

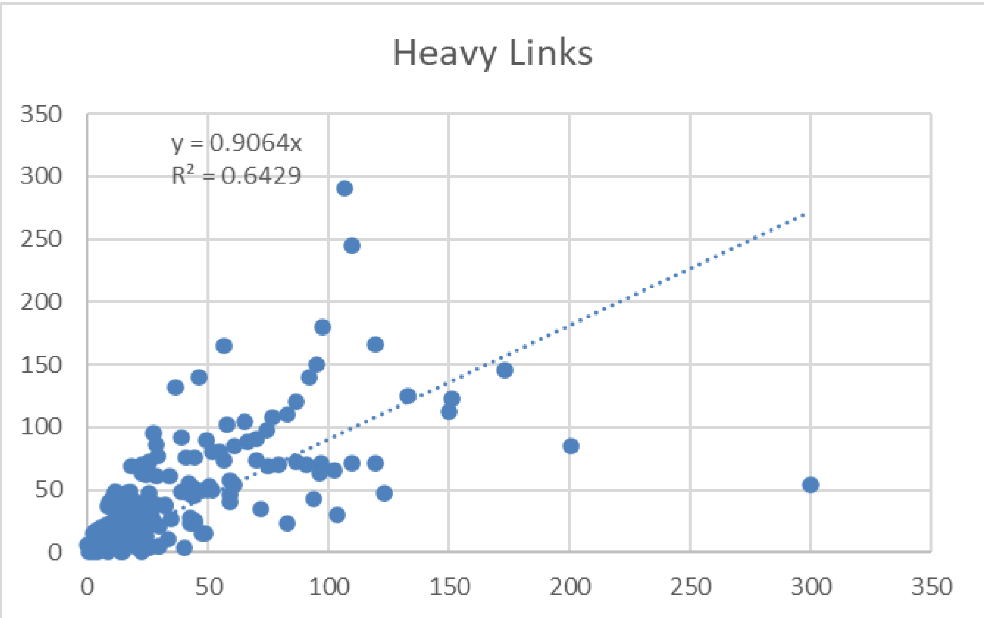


Figure C 6: Link Flow Scatter Plot, Heavy Vehicles

The largest outlier for HCVs is northbound on Jervois Quay.

Table C 3: Screenline Table, Modelled vs Observed

:reenline/Cordon Comparison Summary

Screenline	Direction	Description	Ref	Link Counts	Light, Average Hour					Medium + Heavy, Average Hour					Total, Average Hour				
					Observed	Modelled	Difference	% Diff	GEH	Observed	Modelled	Difference	% Diff	GEH	Observed	Modelled	Difference	% Diff	GEH
C1	I	Wairarapa South In	C1-I	2	416	422	5	1%	0.3	28	49	21	76%	3.4	444	470	26	6%	1.2
C1	O	Wairarapa South Out	C1-O	2	379	383	4	1%	0.2	24	47	22	90%	3.7	403	429	26	6%	1.3
C2	I	Wairarapa North In	C2-I	1	341	351	10	3%	0.6	32	39	7	21%	1.1	373	390	17	5%	0.9
C2	O	Wairarapa North Out	C2-O	1	455	455	0	0%	0.0	29	38	10	34%	1.7	483	493	10	2%	0.4
K1	I	Kapiti North In	K1-I	4	1,089	1,099	10	1%	0.3	62	86	24	39%	2.8	1,151	1,186	35	3%	1.0
K1	O	Kapiti North Out	K1-O	4	684	663	-21	-3%	0.8	69	85	16	23%	1.8	753	748	-5	-1%	0.2
K2	I	Kapiti South In	K2-I	1	1,197	1,204	7	1%	0.2	120	72	-48	-40%	4.9	1,316	1,276	-41	-3%	1.1
K2	O	Kapiti South Out	K2-O	1	520	543	23	4%	1.0	97	72	-25	-26%	2.7	617	615	-2	0%	0.1
L1	I	Lower Hutt South In	L1-I	1	3,102	3,169	67	2%	1.2	107	291	184	173%	13.1	3,208	3,460	252	8%	4.4
L1	O	Lower Hutt South Out	L1-O	1	2,036	2,095	60	3%	1.3	110	245	135	123%	10.2	2,145	2,340	195	9%	4.1
L2	I	Lower Hutt North In	L2-I	2	3,213	3,238	25	1%	0.4	177	135	-42	-24%	3.4	3,390	3,373	-17	-1%	0.3
L2	O	Lower Hutt North Out	L2-O	2	1,343	1,387	44	3%	1.2	84	141	57	67%	5.3	1,427	1,528	101	7%	2.6
L3	I	Lower Hutt Central In	L3-I	4	3,646	3,640	-5	0%	0.1	286	299	13	5%	0.8	3,931	3,939	8	0%	0.1
L3	O	Lower Hutt Central Out	L3-O	4	2,814	2,726	-89	-3%	1.7	153	194	41	27%	3.1	2,967	2,920	-47	-2%	0.9
L4	I	Lower Hutt East In	L4-I	3	2,645	2,609	-36	-1%	0.7	151	88	-63	-42%	5.8	2,796	2,697	-100	-4%	1.9
L4	O	Lower Hutt East Out	L4-O	3	670	693	23	3%	0.9	45	73	28	62%	3.6	715	766	51	7%	1.9
P1	I	Porirua North In	P1-I	2	1,702	1,710	8	0%	0.2	85	102	17	21%	1.8	1,786	1,812	26	1%	0.6
P1	O	Porirua North Out	P1-O	2	966	841	-125	-13%	4.2	86	107	21	24%	2.1	1,053	948	-104	-10%	3.3
P2	I	SH58 In	P2-I	1	814	826	12	2%	0.4	34	61	27	79%	3.9	848	888	40	5%	1.3
P2	O	SH58 Out	P2-O	1	741	714	-27	-4%	1.0	39	48	9	24%	1.4	780	762	-18	-2%	0.7
P3	I	Porirua South In	P3-I	2	2,733	2,738	5	0%	0.1	130	166	35	27%	2.9	2,864	2,904	40	1%	0.8
P3	O	Porirua South Out	P3-O	2	1,633	1,576	-57	-4%	1.4	102	152	50	50%	4.5	1,735	1,728	-7	0%	0.2
U1	I	Upper Hutt North In	U1-I	1	1,049	1,036	-13	-1%	0.4	42	47	6	14%	0.9	1,091	1,083	-8	-1%	0.2
U1	O	Upper Hutt North Out	U1-O	1	305	312	6	2%	0.4	11	46	35	320%	6.5	316	357	41	13%	2.2
U2	I	Upper Hutt South In	U2-I	3	2,808	2,730	-78	-3%	1.5	61	142	81	131%	8.0	2,869	2,872	2	0%	0.0
U2	O	Upper Hutt South Out	U2-O	3	1,463	1,475	12	1%	0.3	65	138	73	113%	7.3	1,528	1,614	85	6%	2.2
U4	I	Upper Hutt Central In	U4-I	4	1,853	1,982	129	7%	2.9	101	111	11	10%	1.0	1,954	2,093	139	7%	3.1
U4	O	Upper Hutt Central Out	U4-O	4	1,223	1,220	-3	0%	0.1	79	108	29	37%	3.0	1,302	1,328	26	2%	0.7
W1A	I	CBD South In	W1A-I	5	1,995	2,014	20	1%	0.4	105	92	-13	-13%	1.4	2,100	2,106	6	0%	0.1
W1A	O	CBD South Out	W1A-O	5	1,232	1,197	-35	-3%	1.0	76	73	-3	-4%	0.3	1,308	1,270	-38	-3%	1.1
W1B	I	CBD North In	W1B-I	5	6,550	6,474	-76	-1%	0.9	380	326	-54	-14%	2.9	6,931	6,800	-130	-2%	1.6
W1B	O	CBD North Out	W1B-O	6	2,841	2,947	106	4%	2.0	155	251	96	62%	6.7	2,996	3,197	202	7%	3.6
W1C	I	CBD West In	W1C-I	2	845	932	88	10%	2.9	18	27	9	49%	1.9	863	959	96	11%	3.2
W1C	O	CBD West Out	W1C-O	2	458	498	40	9%	1.8	9	31	21	227%	4.8	467	528	61	13%	2.7
W1D	I	CBD East In	W1D-I	3	1,820	1,855	35	2%	0.8	62	95	33	53%	3.7	1,882	1,950	68	4%	1.6
W1D	O	CBD East Out	W1D-O	3	1,584	1,585	1	0%	0.0	46	75	30	64%	3.8	1,630	1,660	30	2%	0.7
W2	I	Miramar Peninsula In	W2-I	2	1,866	1,785	-81	-4%	1.9	39	66	26	66%	3.6	1,906	1,851	-55	-3%	1.3
W2	O	Miramar Peninsula Ou	W2-O	2	1,623	1,560	-63	-4%	1.6	56	55	0	-1%	0.1	1,679	1,616	-63	-4%	1.6
W3	I	Karori In	W3-I	2	905	863	-42	-5%	1.4	35	28	-7	-20%	1.2	941	892	-49	-5%	1.6
W3	O	Karori Out	W3-O	2	310	381	71	23%	3.8	10	22	12	115%	3.0	320	403	83	26%	4.4
W4	I	Kaiwharawhara In	W4-I	4	6,689	6,588	-102	-2%	1.2	328	369	42	13%	2.2	7,017	6,957	-60	-1%	0.7
W4	O	Kaiwharawhara Out	W4-O	4	2,767	2,712	-55	-2%	1.1	156	287	131	84%	8.8	2,923	3,000	76	3%	1.4
W5	I	Churton Park In	W5-I	2	3,062	3,073	11	0%	0.2	123	179	56	45%	4.6	3,185	3,252	67	2%	1.2
W5	O	Churton Park Out	W5-O	2	1,558	1,649	91	6%	2.3	114	162	49	43%	4.1	1,672	1,811	140	8%	3.3
W6	I	South Wellington In	W6-I	5	1,464	1,307	-157	-11%	4.2	66	53	-12	-19%	1.6	1,529	1,360	-169	-11%	4.5
W6	O	South Wellington Out	W6-O	5	764	884	120	16%	4.2	42	44	2	5%	0.3	806	928	122	15%	4.1
W7	I	Tawa In	W7-I	3	1,917	1,668	-249	-13%	5.9	119	162	43	36%	3.6	2,037	1,830	-206	-10%	4.7
W7	O	Tawa Out	W7-O	3	2,404	2,572	167	7%	3.4	108	180	72	66%	6.0	2,513	2,752	239	10%	4.7
W8	I	North Wellington In	W8-I	3	4,605	4,626	21	0%	0.3	156	222	66	43%	4.8	4,761	4,848	88	2%	1.3
W8	O	North Wellington Out	W8-O	3	1,710	1,632	-78	-5%	1.9	76	199	123	163%	10.5	1,786	1,830	45	3%	1.1
W9	I	Thorndon In	W9-I	6	4,508	4,948	440	10%	6.4	207	187	-20	-10%	1.4	4,715	5,135	420	9%	6.0
W9	O	Thorndon Out	W9-O	5	2,470	2,277	-193	-8%	4.0	84	179	95	114%	8.3	2,553	2,456	-98	-4%	1.9
W10	N	CBD Lambton North	W10-N	6	3,331	3,451	119	4%	2.0	456	279	-176	-39%	9.2	3,787	3,730	-57	-2%	0.9
W10	S	CBD Lambton South	W10-S	7	4,293	4,325	31	1%	0.5	283	312	29	10%	1.7	4,576	4,637	61	1%	0.9
W11	N	CBD Te Aro North	W11-N	5	1,863	1,815	-48	-3%	1.1	103	156	53	52%	4.7	1,966	1,971	5	0%	0.1
W11	S	CBD Te Aro South	W11-S	6	2,210	1,976	-234	-11%	5.1	234	177	-58	-25%	4.0	2,445	2,153	-292	-12%	6.1
W12	E	CBD Mount Cook East	W12-E	5	2,778	2,798	20	1%	0.4	256	142	-113	-44%	8.0	3,034	2,941	-93	-3%	1.7
W12	W	CBD Mount Cook West	W12-W	4	2,853	2,650	-203	-7%	3.9	181	132	-49	-27%	3.9	3,035	2,783	-252	-8%	4.7
E	I	External In	E-I	2	507	488	-20	-4%	0.9	74	75	1	2%	0.1	581	563	-18	-3%	0.8
E	O	External Out	E-O	2	460	427	-33	-7%	1.5	65	73	8	13%	1.0	525	501	-24	-5%	1.1
U3	I	Remutaka In	U3-I	1	271	313	42	15%	2.4	15	34	18	120%	3.7	286	346	60	21%	3.4
U3	O	Remutaka Out	U3-O	1	113	130	17	15%	1.5	15	31	16	104%	3.3	128	161	33	25%	2.7
P4	I	Pukerua Bay In	P4-I	1	1,097	1,023	-74	-7%	2.3	110	72	-38	-35%	4.0	1,207	1,095	-112	-9%	3.3
P4	O	Pukerua Bay Out	P4-O	1	458	522	64	14%	2.9	86	72	-14	-16%	1.6	544	595	50	9%	2.1
P	I	Port In	P-I	1						61	85	24	39%	2.8	61	85	24	39%	2.8
P	O	Port Out	P-O	1						70	74	4	5%	0.4	70	74	4	5%	0.4

C.4 Interpeak

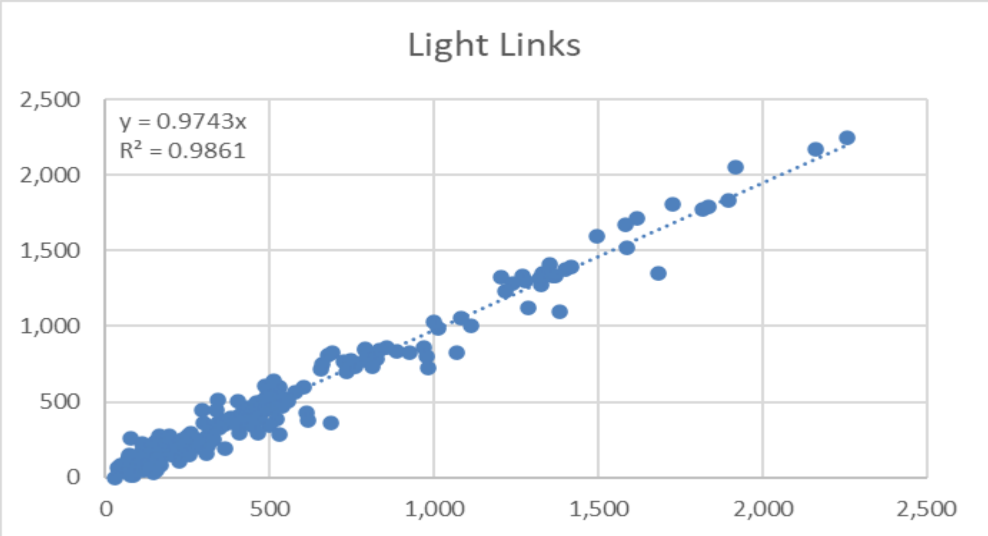


Figure C 7: Link Flow Scatter Plot, Light Vehicles

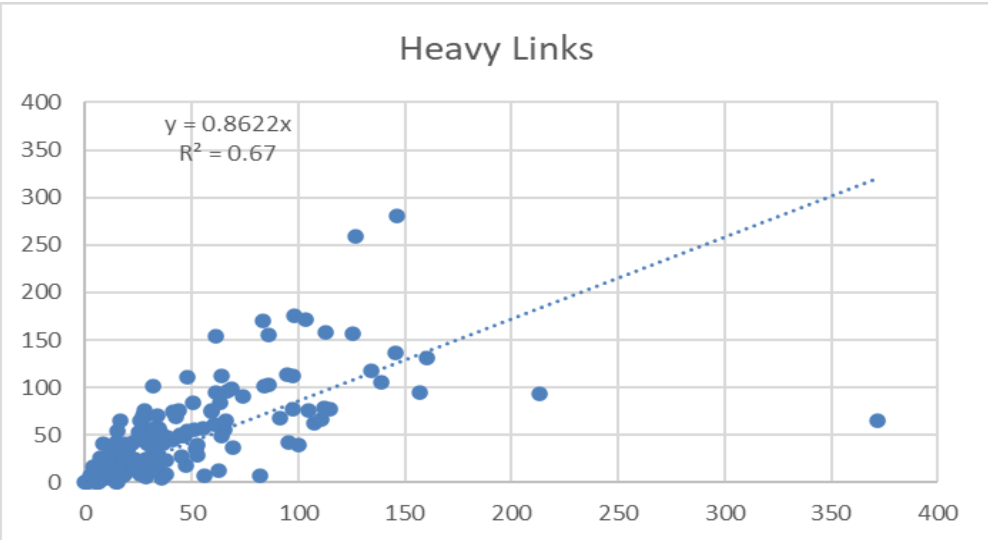


Figure C 8: Link Flow Scatter Plot, Heavy Vehicles

The largest outlier is northbound on Jervois Quay.

Table C 4: Screenline Table, Modelled vs Observed

:reenline/Cordon Comparison Summary

Screenline	Direction	Description	Ref	Link Counts	Light, Average Hour					Medium + Heavy, Average Hour					Total, Average Hour				
					Observed	Modelled	Difference	% Diff	GEH	Observed	Modelled	Difference	% Diff	GEH	Observed	Modelled	Difference	% Diff	GEH
C1	I	Wairarapa South In	C1-I	2	463	460	-2	0%	0.1	32	62	30	95%	4.4	494	522	28	6%	1.2
C1	O	Wairarapa South Out	C1-O	2	471	464	-7	-2%	0.3	31	59	28	89%	4.1	502	522	21	4%	0.9
C2	I	Wairarapa North In	C2-I	1	429	397	-33	-8%	1.6	33	50	16	49%	2.5	462	446	-16	-4%	0.8
C2	O	Wairarapa North Out	C2-O	1	461	437	-24	-5%	1.1	36	50	14	37%	2.1	497	487	-10	-2%	0.5
K1	I	Kapiti North In	K1-I	4	1,040	920	-120	-12%	3.8	75	102	27	36%	2.9	1,115	1,022	-93	-8%	2.8
K1	O	Kapiti North Out	K1-O	4	1,113	1,010	-103	-9%	3.2	78	103	25	32%	2.6	1,192	1,114	-78	-7%	2.3
K2	I	Kapiti South In	K2-I	1	724	770	46	6%	1.7	115	77	-38	-33%	3.8	839	847	8	1%	0.3
K2	O	Kapiti South Out	K2-O	1	793	845	52	7%	1.8	112	79	-33	-30%	3.4	905	923	19	2%	0.6
L1	I	Lower Hutt South In	L1-I	1	2,259	2,247	-12	-1%	0.2	127	259	132	104%	9.5	2,386	2,506	120	5%	2.4
L1	O	Lower Hutt South Out	L1-O	1	2,160	2,168	8	0%	0.2	146	281	135	92%	9.2	2,306	2,449	142	6%	2.9
L2	I	Lower Hutt North In	L2-I	2	1,608	1,582	-26	-2%	0.6	111	146	35	31%	3.0	1,719	1,728	9	1%	0.2
L2	O	Lower Hutt North Out	L2-O	2	1,503	1,551	47	3%	1.2	106	145	39	37%	3.5	1,609	1,696	87	5%	2.1
L3	I	Lower Hutt Central In	L3-I	4	3,340	3,186	-154	-5%	2.7	282	238	-44	-16%	2.7	3,622	3,424	-198	-5%	3.3
L3	O	Lower Hutt Central Out	L3-O	4	2,808	2,745	-63	-2%	1.2	229	265	36	16%	2.3	3,037	3,010	-27	-1%	0.5
L4	I	Lower Hutt East In	L4-I	3	1,209	1,263	54	4%	1.5	91	94	3	3%	0.3	1,300	1,357	57	4%	1.6
L4	O	Lower Hutt East Out	L4-O	3	1,161	1,210	48	4%	1.4	67	99	32	47%	3.5	1,229	1,309	80	7%	2.2
P1	I	Porirua North In	P1-I	2	1,225	976	-249	-20%	7.5	97	100	3	3%	0.3	1,322	1,076	-247	-19%	7.1
P1	O	Porirua North Out	P1-O	2	1,221	1,070	-151	-12%	4.5	92	103	11	12%	1.1	1,313	1,173	-140	-11%	4.0
P2	I	SH58 In	P2-I	1	421	409	-13	-3%	0.6	31	52	22	71%	3.4	452	461	9	2%	0.4
P2	O	SH58 Out	P2-O	1	428	386	-42	-10%	2.1	31	46	15	50%	2.5	459	432	-27	-6%	1.3
P3	I	Porirua South In	P3-I	2	1,947	1,898	-48	-2%	1.1	131	154	23	17%	1.9	2,078	2,052	-25	-1%	0.6
P3	O	Porirua South Out	P3-O	2	1,959	1,882	-76	-4%	1.7	126	153	27	21%	2.3	2,085	2,036	-49	-2%	1.1
U1	I	Upper Hutt North In	U1-I	1	540	518	-22	-4%	0.9	27	57	30	109%	4.6	567	576	8	1%	0.3
U1	O	Upper Hutt North Out	U1-O	1	521	534	13	2%	0.6	25	53	28	113%	4.5	546	587	41	8%	1.7
U2	I	Upper Hutt South In	U2-I	3	1,501	1,459	-43	-3%	1.1	72	147	76	106%	7.2	1,573	1,606	33	2%	0.8
U2	O	Upper Hutt South Out	U2-O	3	1,455	1,391	-64	-4%	1.7	76	140	64	85%	6.2	1,531	1,531	0	0%	0.0
U4	I	Upper Hutt Central In	U4-I	4	1,351	1,349	-2	0%	0.1	88	124	37	42%	3.6	1,439	1,473	34	2%	0.9
U4	O	Upper Hutt Central Out	U4-O	4	1,390	1,384	-5	0%	0.1	85	119	33	39%	3.3	1,475	1,503	28	2%	0.7
W1A	I	CBD South In	W1A-I	5	1,758	1,667	-92	-5%	2.2	142	88	-53	-38%	5.0	1,900	1,755	-145	-8%	3.4
W1A	O	CBD South Out	W1A-O	5	1,478	1,469	-9	-1%	0.2	105	77	-28	-27%	2.9	1,583	1,546	-37	-2%	0.9
W1B	I	CBD North In	W1B-I	5	4,035	3,801	-233	-6%	3.7	312	276	-36	-12%	2.1	4,347	4,077	-269	-6%	4.1
W1B	O	CBD North Out	W1B-O	6	3,771	3,795	24	1%	0.4	275	296	21	8%	1.3	4,046	4,091	45	1%	0.7
W1C	I	CBD West In	W1C-I	2	761	670	-91	-12%	3.4	19	26	7	38%	1.5	780	696	-84	-11%	3.1
W1C	O	CBD West Out	W1C-O	2	703	709	6	1%	0.2	33	27	-6	-19%	1.1	736	736	0	0%	0.0
W1D	I	CBD East In	W1D-I	3	1,793	1,729	-65	-4%	1.5	62	75	13	22%	1.6	1,855	1,804	-51	-3%	1.2
W1D	O	CBD East Out	W1D-O	3	1,795	1,747	-48	-3%	1.1	70	79	9	12%	1.0	1,865	1,825	-39	-2%	0.9
W2	I	Miramar Peninsula In	W2-I	2	1,479	1,378	-101	-7%	2.7	70	57	-13	-19%	1.7	1,549	1,435	-114	-7%	3.0
W2	O	Miramar Peninsula Ou	W2-O	2	1,576	1,441	-135	-9%	3.5	79	56	-24	-30%	2.9	1,655	1,497	-159	-10%	4.0
W3	I	Karori In	W3-I	2	555	619	63	11%	2.6	29	25	-4	-15%	0.8	585	643	59	10%	2.4
W3	O	Karori Out	W3-O	2	493	617	124	25%	5.3	35	24	-11	-31%	2.0	528	641	113	21%	4.7
W4	I	Kaiwharawhara In	W4-I	4	3,713	3,554	-158	-4%	2.6	279	326	48	17%	2.8	3,991	3,881	-110	-3%	1.8
W4	O	Kaiwharawhara Out	W4-O	4	3,627	3,579	-48	-1%	0.8	253	359	106	42%	6.1	3,880	3,938	59	2%	0.9
W5	I	Churton Park In	W5-I	2	1,957	1,960	3	0%	0.1	131	168	37	29%	3.1	2,088	2,128	40	2%	0.9
W5	O	Churton Park Out	W5-O	2	1,771	1,871	101	6%	2.4	123	170	47	38%	3.9	1,894	2,041	147	8%	3.3
W6	I	South Wellington In	W6-I	5	1,146	1,088	-58	-5%	1.7	74	52	-21	-29%	2.7	1,219	1,140	-79	-7%	2.3
W6	O	South Wellington Out	W6-O	5	1,134	1,000	-134	-12%	4.1	79	47	-32	-41%	4.1	1,213	1,047	-167	-14%	5.0
W7	I	Tawa In	W7-I	3	1,848	1,795	-53	-3%	1.2	127	169	42	33%	3.5	1,975	1,964	-11	-1%	0.2
W7	O	Tawa Out	W7-O	3	1,803	1,856	54	3%	1.3	126	167	41	33%	3.4	1,929	2,024	95	5%	2.1
W8	I	North Wellington In	W8-I	3	2,650	2,514	-137	-5%	2.7	146	206	60	41%	4.5	2,796	2,719	-77	-3%	1.5
W8	O	North Wellington Out	W8-O	3	2,556	2,406	-150	-6%	3.0	131	211	79	61%	6.1	2,687	2,617	-70	-3%	1.4
W9	I	Thorndon In	W9-I	6	3,006	2,995	-11	0%	0.2	181	146	-35	-19%	2.7	3,188	3,141	-46	-1%	0.8
W9	O	Thorndon Out	W9-O	5	2,800	2,948	149	5%	2.8	126	210	84	67%	6.5	2,925	3,158	232	8%	4.2
W10	N	CBD Lambton North	W10-N	6	3,408	3,604	196	6%	3.3	485	287	-198	-41%	10.1	3,893	3,891	-2	0%	0.0
W10	S	CBD Lambton South	W10-S	7	3,925	3,695	-230	-6%	3.7	277	269	-8	-3%	0.5	4,202	3,964	-238	-6%	3.7
W11	N	CBD Te Aro North	W11-N	5	2,314	2,015	-299	-13%	6.4	158	135	-22	-14%	1.9	2,472	2,150	-322	-13%	6.7
W11	S	CBD Te Aro South	W11-S	6	2,367	1,940	-426	-18%	9.2	273	179	-94	-35%	6.3	2,640	2,119	-521	-20%	10.7
W12	E	CBD Mount Cook East	W12-E	5	2,940	2,801	-139	-5%	2.6	262	141	-120	-46%	8.5	3,202	2,942	-260	-8%	4.7
W12	W	CBD Mount Cook West	W12-W	4	3,246	2,613	-634	-20%	11.7	162	134	-28	-17%	2.3	3,408	2,747	-662	-19%	11.9
E	I	External In	E-I	2	577	494	-82	-14%	3.6	76	81	5	7%	0.6	652	575	-77	-12%	3.1
E	O	External Out	E-O	2	633	534	-99	-16%	4.1	87	91	4	5%	0.5	720	626	-94	-13%	3.6
U3	I	Remutaka In	U3-I	1	183	227	44	24%	3.1	22	40	19	88%	3.4	205	268	63	31%	4.1
U3	O	Remutaka Out	U3-O	1	189	211	22	12%	1.5	20	36	16	78%	2.9	209	246	37	18%	2.5
P4	I	Pukerua Bay In	P4-I	1	660	749	89	13%	3.4	105	76	-29	-27%	3.0	765	825	60	8%	2.1
P4	O	Pukerua Bay Out	P4-O	1	689	828	139	20%	5.0	98	78	-20	-20%	2.1	787	906	119	15%	4.1
P	I	Port In	P-I	1						74	90	16	22%	1.8	74	90	16	22%	1.8
P	O	Port Out	P-O	1						63	84	21	33%	2.4	63	84	21	33%	2.4

C.5 PM Peak Hour

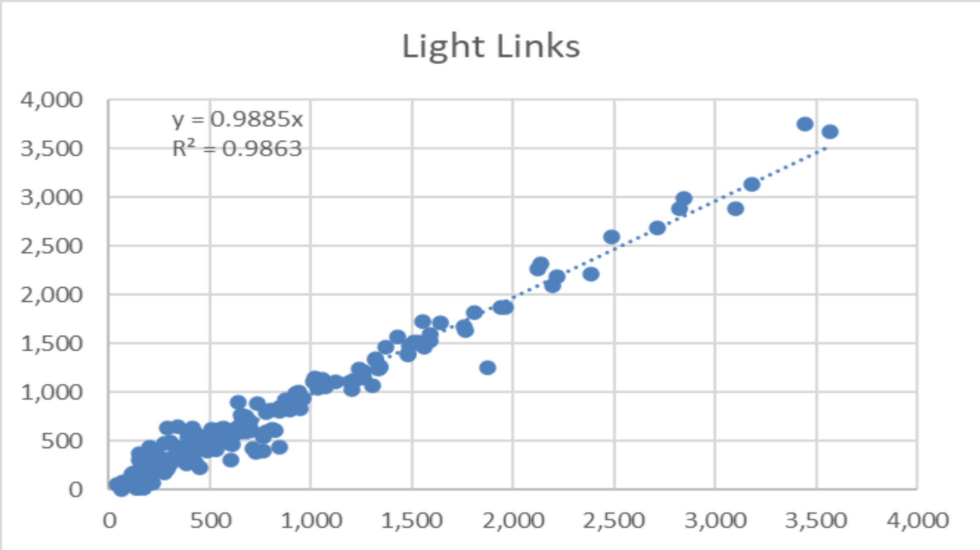


Figure C 9: Link Flow Scatter Plot, Light Vehicles

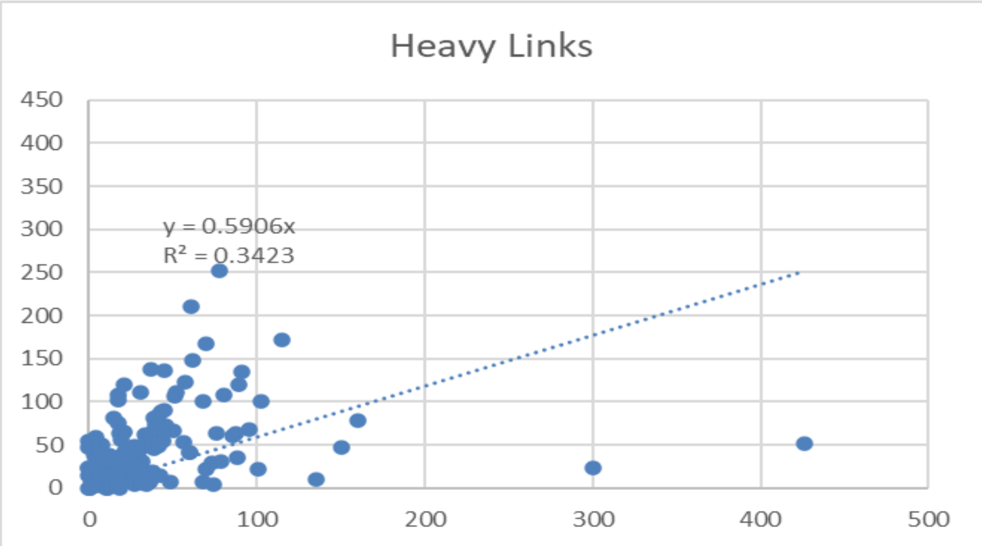


Figure C 10: Link Flow Scatter Plot, Heavy Vehicles

The largest outliers are the model undercounting for northbound on Jervois Quay and eastbound on Cable Street.

Table C 5: Screenline Table, Modelled vs Observed

reenline/Cordon Comparison Summary

Screenline	Direction	Description	Ref	Link Counts	Light, Average Hour					Medium + Heavy, Average Hour					Total, Average Hour				
					Observed	Modelled	Difference	% Diff	GEH	Observed	Modelled	Difference	% Diff	GEH	Observed	Modelled	Difference	% Diff	GEH
C1	I	Wairarapa South In	C1-I	2	589	619	30	5%	1.2	25	40	15	60%	2.6	614	659	45	7%	1.8
C1	O	Wairarapa South Out	C1-O	2	593	645	52	9%	2.1	28	39	11	41%	2.0	621	684	63	10%	2.5
C2	I	Wairarapa North In	C2-I	1	651	646	-5	-1%	0.2	32	32	0	0%	0.0	683	677	-5	-1%	0.2
C2	O	Wairarapa North Out	C2-O	1	526	522	-4	-1%	0.2	27	32	6	21%	1.0	553	554	2	0%	0.1
K1	I	Kapiti North In	K1-I	4	1,098	983	-115	-10%	3.6	55	82	27	48%	3.2	1,153	1,065	-88	-8%	2.7
K1	O	Kapiti North Out	K1-O	4	1,444	1,392	-52	-4%	1.4	42	85	43	102%	5.4	1,486	1,477	-9	-1%	0.2
K2	I	Kapiti South In	K2-I	1	782	797	15	2%	0.5	87	64	-23	-27%	2.7	869	861	-8	-1%	0.3
K2	O	Kapiti South Out	K2-O	1	1,342	1,270	-72	-5%	2.0	50	66	16	33%	2.2	1,392	1,336	-56	-4%	1.5
L1	I	Lower Hutt South In	L1-I	1	2,825	2,882	57	2%	1.1	61	210	150	245%	12.8	2,886	3,092	206	7%	3.8
L1	O	Lower Hutt South Out	L1-O	1	3,184	3,132	-52	-2%	0.9	78	251	174	223%	13.5	3,262	3,383	121	4%	2.1
L2	I	Lower Hutt North In	L2-I	2	1,981	2,017	36	2%	0.8	62	110	48	78%	5.2	2,043	2,127	84	4%	1.8
L2	O	Lower Hutt North Out	L2-O	2	3,744	3,701	-43	-1%	0.7	120	128	8	6%	0.7	3,864	3,829	-35	-1%	0.6
L3	I	Lower Hutt Central In	L3-I	4	4,490	4,543	53	1%	0.8	156	219	63	40%	4.6	4,646	4,761	115	2%	1.7
L3	O	Lower Hutt Central Out	L3-O	4	3,851	3,922	71	2%	1.1	168	224	56	33%	4.0	4,019	4,146	127	3%	2.0
L4	I	Lower Hutt East In	L4-I	3	1,203	1,290	87	7%	2.5	47	70	23	48%	3.0	1,250	1,359	109	9%	3.0
L4	O	Lower Hutt East Out	L4-O	3	3,240	3,238	-2	0%	0.0	120	74	-46	-38%	4.7	3,360	3,312	-48	-1%	0.8
P1	I	Porirua North In	P1-I	2	1,185	1,018	-167	-14%	5.0	68	83	15	22%	1.7	1,253	1,100	-153	-12%	4.4
P1	O	Porirua North Out	P1-O	2	1,852	1,811	-41	-2%	1.0	60	88	28	47%	3.2	1,912	1,899	-13	-1%	0.3
P2	I	SH58 In	P2-I	1	896	825	-71	-8%	2.4	28	47	19	70%	3.2	924	872	-52	-6%	1.7
P2	O	SH58 Out	P2-O	1	942	1,009	67	7%	2.1	22	44	22	100%	3.8	964	1,053	89	9%	2.8
P3	I	Porirua South In	P3-I	2	2,323	2,231	-92	-4%	1.9	65	117	52	79%	5.4	2,388	2,347	-41	-2%	0.8
P3	O	Porirua South Out	P3-O	2	3,120	3,192	72	2%	1.3	91	122	31	34%	3.0	3,211	3,314	104	3%	1.8
U1	I	Upper Hutt North In	U1-I	1	565	557	-8	-1%	0.3	12	38	26	217%	5.2	577	596	18	3%	0.8
U1	O	Upper Hutt North Out	U1-O	1	1,261	1,209	-52	-4%	1.5	19	38	19	102%	3.6	1,280	1,247	-33	-3%	0.9
U2	I	Upper Hutt South In	U2-I	3	1,965	2,014	49	2%	1.1	38	112	74	198%	8.6	2,003	2,126	123	6%	2.7
U2	O	Upper Hutt South Out	U2-O	3	3,107	3,114	7	0%	0.1	44	125	81	187%	8.9	3,151	3,239	89	3%	1.6
U4	I	Upper Hutt Central In	U4-I	4	1,834	1,837	3	0%	0.1	62	91	28	45%	3.2	1,896	1,928	31	2%	0.7
U4	O	Upper Hutt Central Out	U4-O	4	2,476	2,537	61	2%	1.2	82	97	14	17%	1.5	2,558	2,634	75	3%	1.5
W1A	I	CBD South In	W1A-I	5	2,171	2,326	155	7%	3.3	87	68	-19	-22%	2.1	2,258	2,393	136	6%	2.8
W1A	O	CBD South Out	W1A-O	5	2,294	2,138	-156	-7%	3.3	56	83	27	48%	3.2	2,350	2,221	-130	-6%	2.7
W1B	I	CBD North In	W1B-I	5	4,618	4,612	-6	0%	0.1	190	246	56	30%	3.8	4,808	4,859	50	1%	0.7
W1B	O	CBD North Out	W1B-O	6	6,812	6,755	-57	-1%	0.7	345	293	-52	-15%	2.9	7,157	7,048	-109	-2%	1.3
W1C	I	CBD West In	W1C-I	2	897	707	-190	-21%	6.7	7	23	16	220%	4.1	904	730	-174	-19%	6.1
W1C	O	CBD West Out	W1C-O	2	1,211	1,315	104	9%	2.9	44	25	-19	-43%	3.2	1,255	1,340	85	7%	2.4
W1D	I	CBD East In	W1D-I	3	1,559	1,590	31	2%	0.8	40	70	30	74%	4.0	1,599	1,660	61	4%	1.5
W1D	O	CBD East Out	W1D-O	3	2,316	2,299	-17	-1%	0.4	54	83	29	53%	3.5	2,370	2,382	12	0%	0.2
W2	I	Miramar Peninsula In	W2-I	2	1,724	1,590	-134	-8%	3.3	11	48	37	333%	6.8	1,735	1,638	-97	-6%	2.4
W2	O	Miramar Peninsula Ou	W2-O	2	2,414	2,444	30	1%	0.6	9	56	47	519%	8.2	2,423	2,499	76	3%	1.5
W3	I	Karori In	W3-I	2	565	569	4	1%	0.2	4	21	18	492%	5.0	569	591	22	4%	0.9
W3	O	Karori Out	W3-O	2	1,107	1,188	81	7%	2.4	42	25	-17	-40%	2.9	1,149	1,213	64	6%	1.9
W4	I	Kaiwharawhara In	W4-I	4	4,073	3,907	-166	-4%	2.6	150	284	134	89%	9.1	4,223	4,191	-32	-1%	0.5
W4	O	Kaiwharawhara Out	W4-O	4	7,488	7,231	-257	-3%	3.0	211	355	144	68%	8.5	7,699	7,586	-114	-1%	1.3
W5	I	Churton Park In	W5-I	2	2,151	2,168	17	1%	0.4	59	130	71	121%	7.3	2,210	2,299	89	4%	1.9
W5	O	Churton Park Out	W5-O	2	3,148	3,257	109	3%	1.9	101	141	40	40%	3.6	3,249	3,398	149	5%	2.6
W6	I	South Wellington In	W6-I	5	1,561	1,596	35	2%	0.9	36	39	4	10%	0.6	1,597	1,635	39	2%	1.0
W6	O	South Wellington Out	W6-O	5	2,071	1,577	-494	-24%	11.6	60	45	-15	-25%	2.1	2,131	1,621	-510	-24%	11.8
W7	I	Tawa In	W7-I	3	2,925	3,099	174	6%	3.2	90	140	50	56%	4.7	3,015	3,238	224	7%	4.0
W7	O	Tawa Out	W7-O	3	2,295	2,182	-113	-5%	2.4	69	130	61	89%	6.1	2,364	2,313	-51	-2%	1.1
W8	I	North Wellington In	W8-I	3	2,629	2,561	-68	-3%	1.3	71	163	92	130%	8.5	2,700	2,724	24	1%	0.5
W8	O	North Wellington Out	W8-O	3	4,991	5,098	107	2%	1.5	87	179	91	105%	7.9	5,078	5,277	198	4%	2.8
W9	I	Thorndon In	W9-I	6	3,224	3,197	-27	-1%	0.5	123	189	66	54%	5.3	3,347	3,386	39	1%	0.7
W9	O	Thorndon Out	W9-O	5	4,705	4,953	248	5%	3.6	170	228	58	34%	4.1	4,875	5,181	306	6%	4.3
W10	N	CBD Lambton North	W10-N	6	4,730	4,951	221	5%	3.2	542	268	-274	-51%	13.6	5,272	5,219	-53	-1%	0.7
W10	S	CBD Lambton South	W10-S	7	4,609	4,505	-104	-2%	1.5	239	250	11	4%	0.7	4,848	4,755	-93	-2%	1.3
W11	N	CBD Te Aro North	W11-N	5	2,835	2,309	-526	-19%	10.4	140	108	-33	-23%	3.0	2,975	2,417	-559	-19%	10.8
W11	S	CBD Te Aro South	W11-S	6	3,002	2,721	-281	-9%	5.3	304	117	-187	-62%	12.9	3,306	2,837	-469	-14%	8.5
W12	E	CBD Mount Cook East	W12-E	5	3,412	3,536	124	4%	2.1	331	124	-207	-62%	13.7	3,743	3,660	-83	-2%	1.4
W12	W	CBD Mount Cook West	W12-W	4	3,763	3,483	-280	-7%	4.6	172	128	-44	-25%	3.6	3,935	3,611	-323	-8%	5.3
E	I	External In	E-I	2	728	701	-27	-4%	1.0	49	63	14	29%	1.9	777	765	-12	-2%	0.4
E	O	External Out	E-O	2	738	701	-37	-5%	1.4	56	71	15	27%	1.9	794	772	-22	-3%	0.8
U3	I	Remutaka In	U3-I	1	187	239	52	28%	3.5	14	28	14	104%	3.1	201	267	66	33%	4.3
U3	O	Remutaka Out	U3-O	1	385	413	28	7%	1.4	9	27	18	203%	4.3	394	440	46	12%	2.3
P4	I	Pukerua Bay In	P4-I	1	680	755	75	11%	2.8	76	63	-13	-17%	1.6	756	818	62	8%	2.2
P4	O	Pukerua Bay Out	P4-O	1	964	937	-27	-3%	0.9	38	66	28	73%	3.9	1,002	1,003	1	0%	0.0
P	I	Port In	P-I	0						0	0	0	-	-	0	0	0	-	-
P	O	Port Out	P-O	0						0	0	0	-	-	0	0	0	-	-

C.6 PM Shoulder

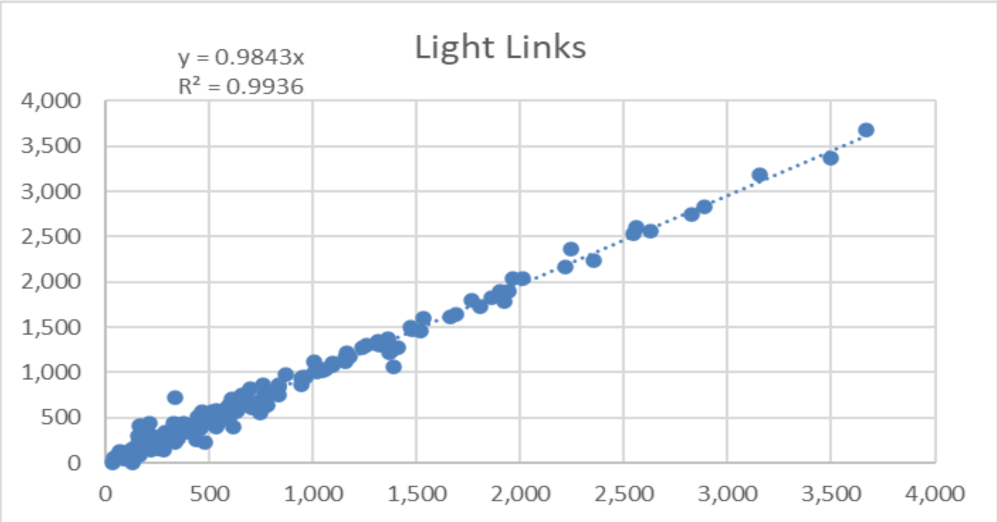


Figure C 11: Link Flow Scatter Plot, Light Vehicles

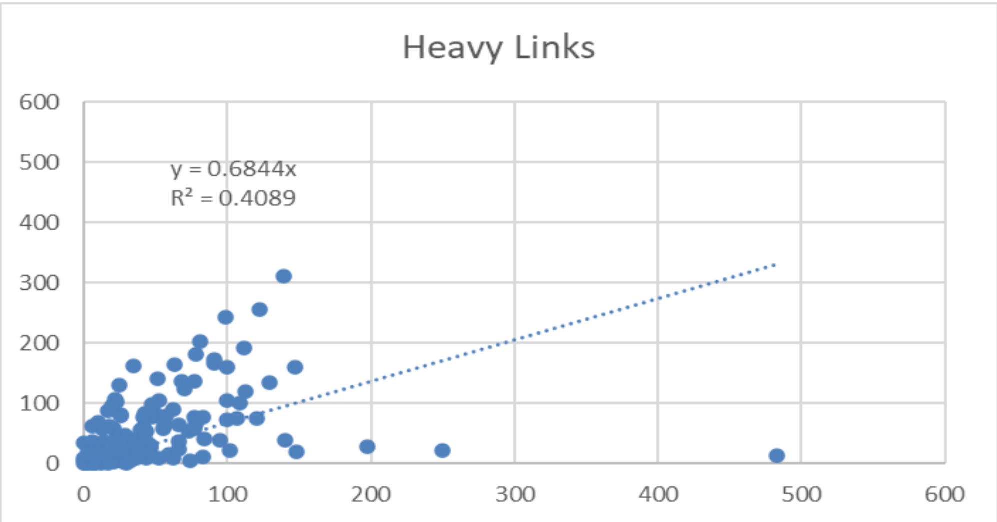


Figure C 12: Link Flow Scatter Plot, Heavy Vehicles

The largest outliers are the model undercounting for northbound on Jervois Quay and eastbound on Cable Street.

Table C 6: Screenline Table, Modelled vs Observed

:reenline/Cordon Comparison Summary

Screenline	Direction	Description	Ref	Link Counts	Light, Average Hour					Medium + Heavy, Average Hour					Total, Average Hour				
					Observed	Modelled	Difference	% Diff	GEH	Observed	Modelled	Difference	% Diff	GEH	Observed	Modelled	Difference	% Diff	GEH
C1	I	Wairarapa South In	C1-I	2	562	548	-14	-2%	0.6	28	44	16	57%	2.6	590	591	2	0%	0.1
C1	O	Wairarapa South Out	C1-O	2	605	580	-25	-4%	1.0	37	43	6	16%	0.9	642	623	-19	-3%	0.8
C2	I	Wairarapa North In	C2-I	1	601	595	-6	-1%	0.2	32	35	4	12%	0.7	632	630	-2	0%	0.1
C2	O	Wairarapa North Out	C2-O	1	529	522	-7	-1%	0.3	43	37	-6	-13%	0.9	572	560	-12	-2%	0.5
K1	I	Kapiti North In	K1-I	4	1,188	1,060	-127	-11%	3.8	70	93	24	34%	2.6	1,257	1,154	-103	-8%	3.0
K1	O	Kapiti North Out	K1-O	4	1,451	1,395	-56	-4%	1.5	66	98	32	48%	3.5	1,517	1,492	-25	-2%	0.6
K2	I	Kapiti South In	K2-I	1	838	858	20	2%	0.7	121	74	-46	-38%	4.7	959	932	-26	-3%	0.9
K2	O	Kapiti South Out	K2-O	1	1,263	1,301	38	3%	1.1	83	78	-5	-6%	0.6	1,345	1,378	33	2%	0.9
L1	I	Lower Hutt South In	L1-I	1	2,557	2,599	42	2%	0.8	99	243	144	145%	11.0	2,655	2,841	186	7%	3.5
L1	O	Lower Hutt South Out	L1-O	1	3,156	3,178	22	1%	0.4	139	312	173	125%	11.5	3,295	3,490	195	6%	3.3
L2	I	Lower Hutt North In	L2-I	2	1,935	1,925	-10	-1%	0.2	108	118	9	9%	0.9	2,043	2,043	-1	0%	0.0
L2	O	Lower Hutt North Out	L2-O	2	3,167	3,195	28	1%	0.5	134	160	26	19%	2.1	3,301	3,355	54	2%	0.9
L3	I	Lower Hutt Central In	L3-I	4	4,501	4,492	-9	0%	0.1	238	257	19	8%	1.2	4,738	4,749	10	0%	0.1
L3	O	Lower Hutt Central Out	L3-O	4	3,768	3,763	-5	0%	0.1	187	278	92	49%	6.0	3,955	4,041	87	2%	1.4
L4	I	Lower Hutt East In	L4-I	3	1,240	1,292	52	4%	1.4	89	81	-7	-8%	0.8	1,329	1,373	44	3%	1.2
L4	O	Lower Hutt East Out	L4-O	3	2,594	2,593	0	0%	0.0	116	86	-30	-26%	3.0	2,709	2,680	-30	-1%	0.6
P1	I	Porirua North In	P1-I	2	1,411	1,208	-203	-14%	5.6	91	108	17	19%	1.8	1,502	1,316	-185	-12%	4.9
P1	O	Porirua North Out	P1-O	2	2,035	1,960	-75	-4%	1.7	87	115	28	32%	2.7	2,122	2,075	-47	-2%	1.0
P2	I	SH58 In	P2-I	1	768	746	-21	-3%	0.8	42	61	20	47%	2.7	809	807	-2	0%	0.1
P2	O	SH58 Out	P2-O	1	787	771	-16	-2%	0.6	31	35	4	14%	0.7	818	807	-11	-1%	0.4
P3	I	Porirua South In	P3-I	2	2,315	2,312	-3	0%	0.1	108	152	44	41%	3.9	2,423	2,464	41	2%	0.8
P3	O	Porirua South Out	P3-O	2	3,261	3,171	-90	-3%	1.6	159	136	-23	-14%	1.9	3,420	3,308	-113	-3%	1.9
U1	I	Upper Hutt North In	U1-I	1	595	561	-34	-6%	1.4	22	46	24	109%	4.1	617	607	-10	-2%	0.4
U1	O	Upper Hutt North Out	U1-O	1	1,043	1,035	-8	-1%	0.3	28	47	19	68%	3.1	1,071	1,082	11	1%	0.3
U2	I	Upper Hutt South In	U2-I	3	1,922	1,969	47	2%	1.1	74	130	56	76%	5.5	1,996	2,098	103	5%	2.3
U2	O	Upper Hutt South Out	U2-O	3	2,863	2,805	-58	-2%	1.1	65	145	80	122%	7.8	2,928	2,950	22	1%	0.4
U4	I	Upper Hutt Central In	U4-I	4	1,858	1,839	-18	-1%	0.4	97	106	9	9%	0.9	1,954	1,945	-9	0%	0.2
U4	O	Upper Hutt Central Out	U4-O	4	2,298	2,327	29	1%	0.6	101	112	11	11%	1.1	2,399	2,439	40	2%	0.8
W1A	I	CBD South In	W1A-I	5	2,002	2,109	107	5%	2.4	131	80	-51	-39%	4.9	2,133	2,189	56	3%	1.2
W1A	O	CBD South Out	W1A-O	5	1,919	1,910	-8	0%	0.2	84	127	43	51%	4.2	2,003	2,037	35	2%	0.8
W1B	I	CBD North In	W1B-I	5	4,192	4,292	100	2%	1.5	237	287	50	21%	3.1	4,429	4,579	150	3%	2.2
W1B	O	CBD North Out	W1B-O	6	6,454	6,243	-211	-3%	2.6	372	345	-26	-7%	1.4	6,825	6,588	-237	-3%	2.9
W1C	I	CBD West In	W1C-I	2	822	782	-40	-5%	1.4	18	27	9	49%	1.9	840	809	-31	-4%	1.1
W1C	O	CBD West Out	W1C-O	2	871	952	81	9%	2.7	37	24	-12	-34%	2.3	908	976	69	8%	2.2
W1D	I	CBD East In	W1D-I	3	1,759	1,810	51	3%	1.2	85	91	5	6%	0.6	1,844	1,901	57	3%	1.3
W1D	O	CBD East Out	W1D-O	3	2,184	2,285	101	5%	2.1	58	77	20	34%	2.4	2,242	2,362	120	5%	2.5
W2	I	Miramar Peninsula In	W2-I	2	2,079	1,964	-115	-6%	2.6	89	56	-34	-38%	4.0	2,168	2,019	-149	-7%	3.3
W2	O	Miramar Peninsula Ou	W2-O	2	2,139	2,055	-84	-4%	1.8	68	65	-3	-4%	0.3	2,206	2,120	-86	-4%	1.9
W3	I	Karori In	W3-I	2	607	594	-13	-2%	0.5	27	28	1	2%	0.1	634	622	-12	-2%	0.5
W3	O	Karori Out	W3-O	2	831	846	15	2%	0.5	36	28	-7	-21%	1.3	867	874	8	1%	0.3
W4	I	Kaiwharawhara In	W4-I	4	3,957	3,878	-79	-2%	1.3	206	334	128	62%	7.8	4,163	4,213	50	1%	0.8
W4	O	Kaiwharawhara Out	W4-O	4	6,600	6,457	-143	-2%	1.8	231	417	186	81%	10.4	6,830	6,874	43	1%	0.5
W5	I	Churton Park In	W5-I	2	2,156	2,250	94	4%	2.0	105	175	70	67%	5.9	2,261	2,425	165	7%	3.4
W5	O	Churton Park Out	W5-O	2	3,122	3,039	-83	-3%	1.5	155	165	10	6%	0.8	3,277	3,203	-74	-2%	1.3
W6	I	South Wellington In	W6-I	5	1,484	1,537	54	4%	1.4	59	62	3	5%	0.4	1,543	1,599	56	4%	1.4
W6	O	South Wellington Out	W6-O	5	1,756	1,526	-230	-13%	5.7	61	48	-13	-21%	1.7	1,817	1,574	-243	-13%	5.9
W7	I	Tawa In	W7-I	3	2,971	2,937	-34	-1%	0.6	146	166	20	14%	1.6	3,116	3,103	-13	0%	0.2
W7	O	Tawa Out	W7-O	3	2,281	2,268	-13	-1%	0.3	120	177	57	48%	4.7	2,401	2,445	44	2%	0.9
W8	I	North Wellington In	W8-I	3	2,818	2,792	-25	-1%	0.5	115	209	94	82%	7.4	2,932	3,001	69	2%	1.3
W8	O	North Wellington Out	W8-O	3	4,651	4,519	-131	-3%	1.9	119	206	87	73%	6.8	4,769	4,726	-44	-1%	0.6
W9	I	Thorndon In	W9-I	6	3,265	3,194	-71	-2%	1.3	138	225	87	64%	6.5	3,403	3,419	16	0%	0.3
W9	O	Thorndon Out	W9-O	5	4,821	4,680	-141	-3%	2.0	170	332	162	95%	10.2	4,991	5,012	21	0%	0.3
W10	N	CBD Lambton North	W10-N	6	4,735	4,946	211	4%	3.0	649	303	-346	-53%	15.9	5,384	5,249	-135	-3%	1.9
W10	S	CBD Lambton South	W10-S	7	4,390	4,232	-158	-4%	2.4	236	274	38	16%	2.4	4,626	4,505	-120	-3%	1.8
W11	N	CBD Te Aro North	W11-N	5	2,760	2,366	-393	-14%	7.8	158	95	-63	-40%	5.6	2,918	2,461	-457	-16%	8.8
W11	S	CBD Te Aro South	W11-S	6	2,657	2,500	-156	-6%	3.1	245	162	-83	-34%	5.8	2,901	2,662	-239	-8%	4.5
W12	E	CBD Mount Cook East	W12-E	5	3,235	3,376	141	4%	2.5	286	121	-165	-58%	11.6	3,521	3,496	-24	-1%	0.4
W12	W	CBD Mount Cook West	W12-W	4	3,929	3,862	-67	-2%	1.1	261	95	-166	-64%	12.4	4,190	3,956	-233	-6%	3.7
E	I	External In	E-I	2	753	735	-18	-2%	0.6	69	74	5	7%	0.6	822	809	-13	-2%	0.4
E	O	External Out	E-O	2	798	734	-63	-8%	2.3	82	83	1	1%	0.1	880	817	-62	-7%	2.1
U3	I	Remutaka In	U3-I	1	210	268	58	28%	3.8	19	33	15	80%	2.9	229	301	73	32%	4.5
U3	O	Remutaka Out	U3-O	1	337	355	18	5%	1.0	19	32	13	67%	2.5	356	387	31	9%	1.6
P4	I	Pukerua Bay In	P4-I	1	699	822	123	18%	4.5	100	73	-26	-26%	2.8	798	895	97	12%	3.3
P4	O	Pukerua Bay Out	P4-O	1	1,158	1,116	-42	-4%	1.2	77	77	0	0%	0.0	1,235	1,193	-42	-3%	1.2
P	I	Port In	P-I	0						0	0	0	-	-	0	0	0	-	-
P	O	Port Out	P-O	0						0	0	0	-	-	0	0	0	-	-

C.7 PM Peak Period

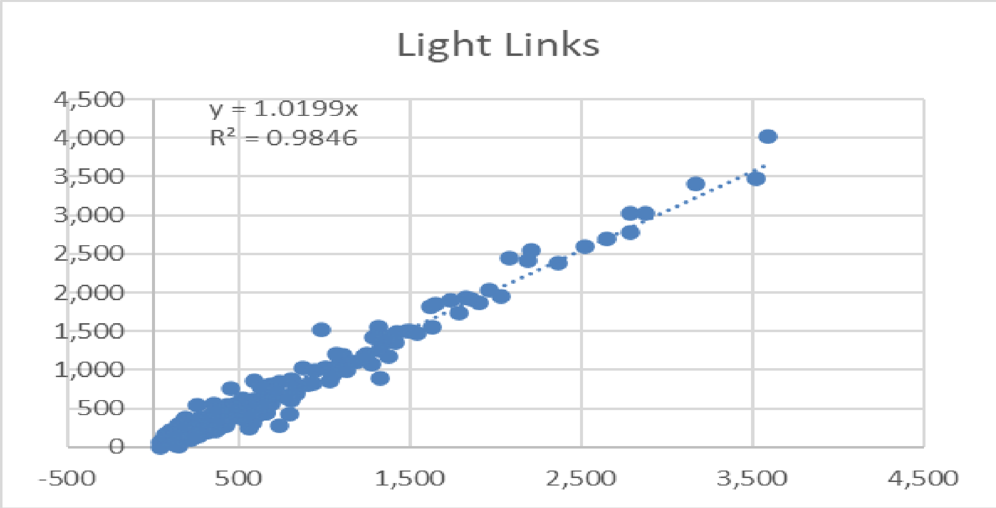


Figure C 13: Link Flow Scatter Plot, Light Vehicles

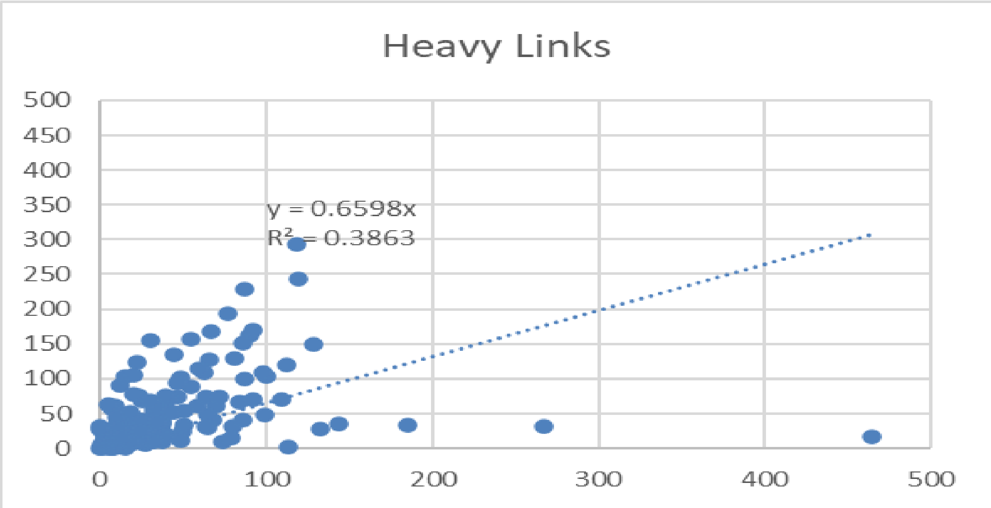


Figure C 14: Link Flow Scatter Plot, Heavy Vehicles

Table C 7: Screenline Table, Modelled vs Observed

:reenline/Cordon Comparison Summary

Screenline	Direction	Description	Ref	Link Counts	Light, Average Hour					Medium + Heavy, Average Hour					Total, Average Hour				
					Observed	Modelled	Difference	% Diff	GEH	Observed	Modelled	Difference	% Diff	GEH	Observed	Modelled	Difference	% Diff	GEH
C1	I	Wairarapa South In	C1-I	2	571	544	-27	-5%	1.1	27	42	15	55%	2.5	598	586	-12	-2%	0.5
C1	O	Wairarapa South Out	C1-O	2	601	608	7	1%	0.3	34	41	7	22%	1.2	634	649	15	2%	0.6
C2	I	Wairarapa North In	C2-I	1	617	589	-28	-5%	1.2	32	34	2	7%	0.4	649	623	-26	-4%	1.0
C2	O	Wairarapa North Out	C2-O	1	528	526	-2	0%	0.1	38	36	-2	-5%	0.3	566	562	-4	-1%	0.2
K1	I	Kapiti North In	K1-I	4	1,158	1,032	-126	-11%	3.8	65	89	24	37%	2.7	1,223	1,121	-102	-8%	3.0
K1	O	Kapiti North Out	K1-O	4	1,449	1,477	28	2%	0.7	58	93	35	60%	4.0	1,507	1,570	63	4%	1.6
K2	I	Kapiti South In	K2-I	1	819	850	31	4%	1.1	109	71	-38	-35%	4.0	929	921	-7	-1%	0.2
K2	O	Kapiti South Out	K2-O	1	1,289	1,426	137	11%	3.7	72	74	2	3%	0.3	1,361	1,500	139	10%	3.7
L1	I	Lower Hutt South In	L1-I	1	2,646	2,703	57	2%	1.1	87	229	143	165%	11.3	2,733	2,932	199	7%	3.7
L1	O	Lower Hutt South Out	L1-O	1	3,165	3,407	242	8%	4.2	118	292	174	147%	12.1	3,283	3,699	416	13%	7.0
L2	I	Lower Hutt North In	L2-I	2	1,950	1,922	-28	-1%	0.6	93	113	20	21%	1.9	2,043	2,035	-9	0%	0.2
L2	O	Lower Hutt North Out	L2-O	2	3,360	3,529	169	5%	2.9	130	150	20	16%	1.7	3,490	3,679	189	5%	3.2
L3	I	Lower Hutt Central In	L3-I	4	4,497	4,247	-250	-6%	3.8	211	229	18	9%	1.2	4,708	4,476	-232	-5%	3.4
L3	O	Lower Hutt Central Out	L3-O	4	3,796	3,563	-233	-6%	3.8	181	269	89	49%	5.9	3,976	3,832	-145	-4%	2.3
L4	I	Lower Hutt East In	L4-I	3	1,227	1,239	11	1%	0.3	75	78	3	4%	0.3	1,302	1,316	14	1%	0.4
L4	O	Lower Hutt East Out	L4-O	3	2,809	2,689	-120	-4%	2.3	117	82	-35	-30%	3.5	2,926	2,771	-154	-5%	2.9
P1	I	Porirua North In	P1-I	2	1,335	1,101	-234	-18%	6.7	83	104	20	24%	2.1	1,419	1,205	-214	-15%	5.9
P1	O	Porirua North Out	P1-O	2	1,974	1,949	-24	-1%	0.5	77	109	32	41%	3.3	2,051	2,059	8	0%	0.2
P2	I	SH58 In	P2-I	1	810	877	67	8%	2.3	37	60	23	62%	3.3	847	937	90	11%	3.0
P2	O	SH58 Out	P2-O	1	839	746	-93	-11%	3.3	28	38	10	35%	1.7	867	784	-83	-10%	2.9
P3	I	Porirua South In	P3-I	2	2,318	2,291	-27	-1%	0.6	93	140	47	50%	4.4	2,411	2,432	20	1%	0.4
P3	O	Porirua South Out	P3-O	2	3,214	3,172	-42	-1%	0.7	136	129	-8	-6%	0.7	3,350	3,301	-49	-1%	0.9
U1	I	Upper Hutt North In	U1-I	1	585	491	-94	-16%	4.0	19	44	25	135%	4.5	603	535	-69	-11%	2.9
U1	O	Upper Hutt North Out	U1-O	1	1,116	1,192	77	7%	2.3	25	42	16	65%	2.8	1,141	1,234	93	8%	2.7
U2	I	Upper Hutt South In	U2-I	3	1,936	2,011	75	4%	1.7	59	124	65	111%	6.8	1,995	2,134	140	7%	3.1
U2	O	Upper Hutt South Out	U2-O	3	2,944	2,969	26	1%	0.5	61	138	77	128%	7.8	3,004	3,107	103	3%	1.9
U4	I	Upper Hutt Central In	U4-I	4	1,849	1,704	-145	-8%	3.4	85	92	7	8%	0.7	1,935	1,797	-138	-7%	3.2
U4	O	Upper Hutt Central Out	U4-O	4	2,357	2,532	175	7%	3.5	95	96	1	1%	0.1	2,453	2,628	176	7%	3.5
W1A	I	CBD South In	W1A-I	5	2,058	2,126	68	3%	1.5	116	91	-25	-22%	2.5	2,174	2,216	42	2%	0.9
W1A	O	CBD South Out	W1A-O	5	2,044	2,151	107	5%	2.3	76	132	57	75%	5.6	2,120	2,283	164	8%	3.5
W1B	I	CBD North In	W1B-I	5	4,335	4,221	-114	-3%	1.7	221	273	52	24%	3.3	4,555	4,493	-62	-1%	0.9
W1B	O	CBD North Out	W1B-O	6	6,572	6,641	68	1%	0.8	363	328	-35	-10%	1.9	6,936	6,969	33	0%	0.4
W1C	I	CBD West In	W1C-I	2	847	668	-179	-21%	6.5	13	25	12	93%	2.8	860	694	-167	-19%	6.0
W1C	O	CBD West Out	W1C-O	2	984	1,018	34	3%	1.1	39	23	-16	-41%	2.9	1,023	1,041	18	2%	0.6
W1D	I	CBD East In	W1D-I	3	1,692	2,065	373	22%	8.6	71	63	-8	-11%	0.9	1,762	2,128	366	21%	8.3
W1D	O	CBD East Out	W1D-O	3	2,228	2,308	80	4%	1.7	57	54	-3	-6%	0.5	2,285	2,361	77	3%	1.6
W2	I	Miramar Peninsula In	W2-I	2	1,961	1,991	30	2%	0.7	59	53	-6	-11%	0.9	2,020	2,044	24	1%	0.5
W2	O	Miramar Peninsula Ou	W2-O	2	2,231	2,288	57	3%	1.2	44	62	18	42%	2.5	2,274	2,350	75	3%	1.6
W3	I	Karori In	W3-I	2	594	642	49	8%	2.0	19	26	7	37%	1.5	613	669	56	9%	2.2
W3	O	Karori Out	W3-O	2	923	974	51	6%	1.7	38	15	-23	-61%	4.5	961	989	28	3%	0.9
W4	I	Kaiwharawhara In	W4-I	4	3,996	3,911	-85	-2%	1.4	187	323	136	72%	8.5	4,183	4,234	50	1%	0.8
W4	O	Kaiwharawhara Out	W4-O	4	6,896	7,055	159	2%	1.9	223	402	179	80%	10.1	7,119	7,457	337	5%	4.0
W5	I	Churton Park In	W5-I	2	2,154	2,327	172	8%	3.6	90	162	72	80%	6.4	2,244	2,489	244	11%	5.0
W5	O	Churton Park Out	W5-O	2	3,131	3,247	116	4%	2.1	137	156	19	14%	1.5	3,268	3,403	135	4%	2.3
W6	I	South Wellington In	W6-I	5	1,509	1,420	-89	-6%	2.3	61	86	26	42%	3.0	1,570	1,507	-63	-4%	1.6
W6	O	South Wellington Out	W6-O	5	1,861	1,502	-358	-19%	8.7	68	57	-11	-16%	1.4	1,928	1,559	-369	-19%	8.8
W7	I	Tawa In	W7-I	3	2,955	3,129	174	6%	3.2	127	152	26	20%	2.2	3,082	3,281	200	6%	3.5
W7	O	Tawa Out	W7-O	3	2,286	2,310	25	1%	0.5	103	160	57	55%	5.0	2,388	2,470	82	3%	1.7
W8	I	North Wellington In	W8-I	3	2,755	2,698	-56	-2%	1.1	100	191	91	91%	7.6	2,855	2,890	35	1%	0.6
W8	O	North Wellington Out	W8-O	3	4,764	4,823	60	1%	0.9	108	192	83	77%	6.8	4,872	5,015	143	3%	2.0
W9	I	Thorndon In	W9-I	6	3,251	3,161	-90	-3%	1.6	133	257	123	93%	8.8	3,384	3,418	34	1%	0.6
W9	O	Thorndon Out	W9-O	5	4,782	5,075	293	6%	4.2	170	331	161	94%	10.2	4,952	5,406	454	9%	6.3
W10	N	CBD Lambton North	W10-N	6	4,733	5,034	301	6%	4.3	615	296	-319	-52%	15.0	5,348	5,330	-18	0%	0.2
W10	S	CBD Lambton South	W10-S	7	4,463	4,405	-58	-1%	0.9	236	271	35	15%	2.2	4,700	4,676	-24	-1%	0.3
W11	N	CBD Te Aro North	W11-N	5	2,784	2,249	-535	-19%	10.7	153	101	-51	-34%	4.6	2,937	2,351	-586	-20%	11.4
W11	S	CBD Te Aro South	W11-S	6	2,772	2,724	-48	-2%	0.9	264	131	-133	-50%	9.5	3,037	2,855	-181	-6%	3.3
W12	E	CBD Mount Cook East	W12-E	5	3,294	3,388	94	3%	1.6	301	108	-193	-64%	13.5	3,595	3,496	-99	-3%	1.7
W12	W	CBD Mount Cook West	W12-W	4	3,873	3,650	-223	-6%	3.6	232	116	-115	-50%	8.8	4,105	3,766	-339	-8%	5.4
E	I	External In	E-I	2	744	729	-15	-2%	0.6	62	70	8	13%	1.0	806	799	-7	-1%	0.3
E	O	External Out	E-O	2	777	753	-23	-3%	0.8	73	79	6	8%	0.7	850	832	-17	-2%	0.6
U3	I	Remutaka In	U3-I	1	203	253	50	25%	3.3	17	32	15	86%	3.0	220	285	65	30%	4.1
U3	O	Remutaka Out	U3-O	1	353	449	96	27%	4.8	16	30	15	93%	3.0	369	479	110	30%	5.4
P4	I	Pukerua Bay In	P4-I	1	692	814	122	18%	4.4	92	70	-22	-24%	2.4	784	884	100	13%	3.5
P4	O	Pukerua Bay Out	P4-O	1	1,093	1,138	45	4%	1.4	64	73	9	14%	1.1	1,157	1,212	55	5%	1.6
P	I	Port In	P-I	1						40	76	37	93%	4.8	40	76	37	93%	4.8
P	O	Port Out	P-O	1						31	69	38	125%	5.4	31	69	38	125%	5.4

Appendix D Travel Time Validation Charts

In the travel time graphs, the horizontal access shows distance in metres, while the vertical axis has time in seconds. The modelled and observed travel times are both cumulative.

D.1 AM Peak Hour

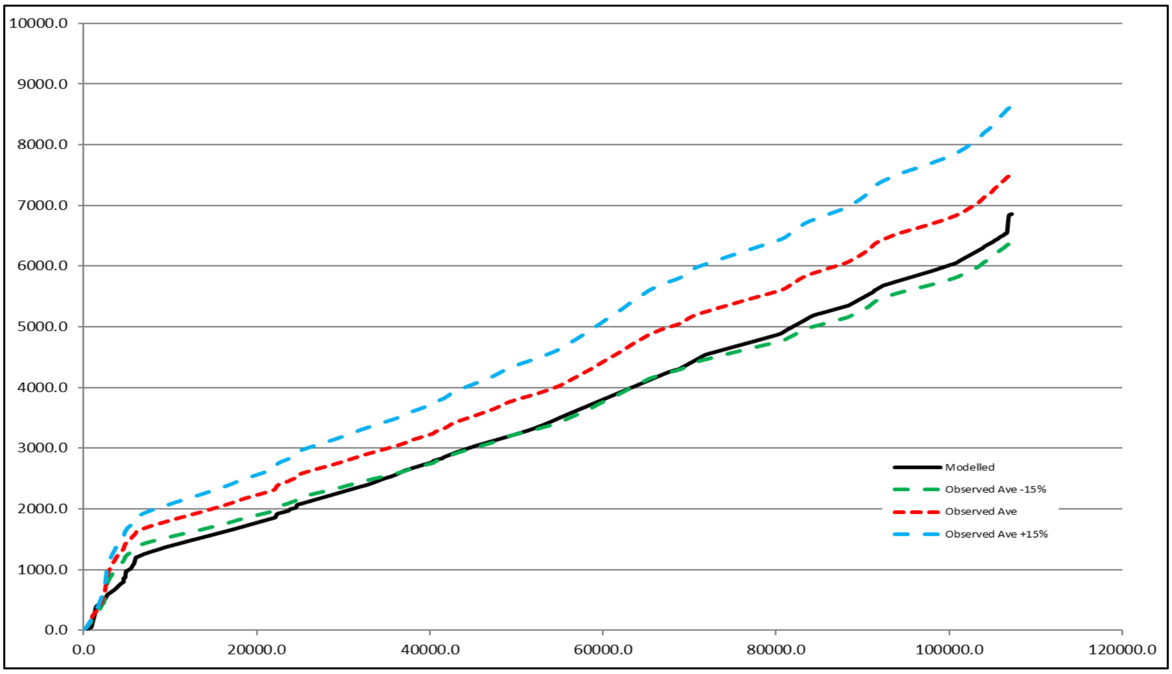


Figure D 1: Route 1, Northbound: Wellington Airport -> North of Masterton

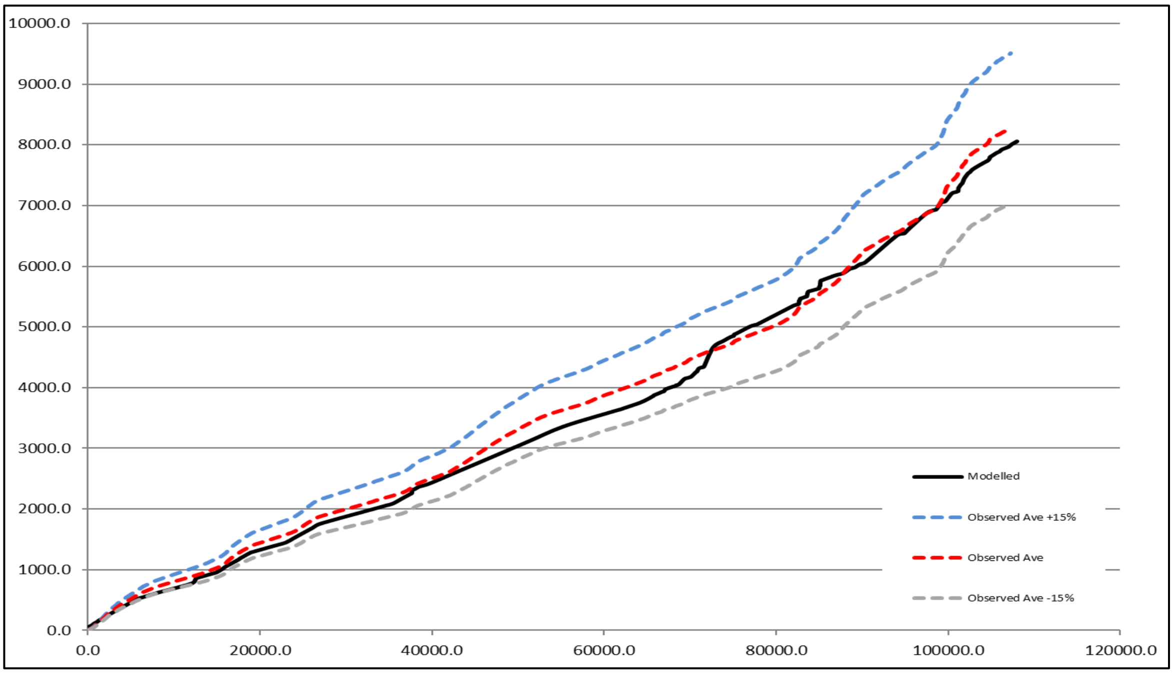


Figure D 2: Route 1, Southbound: North of Masterton -> Wellington Airport

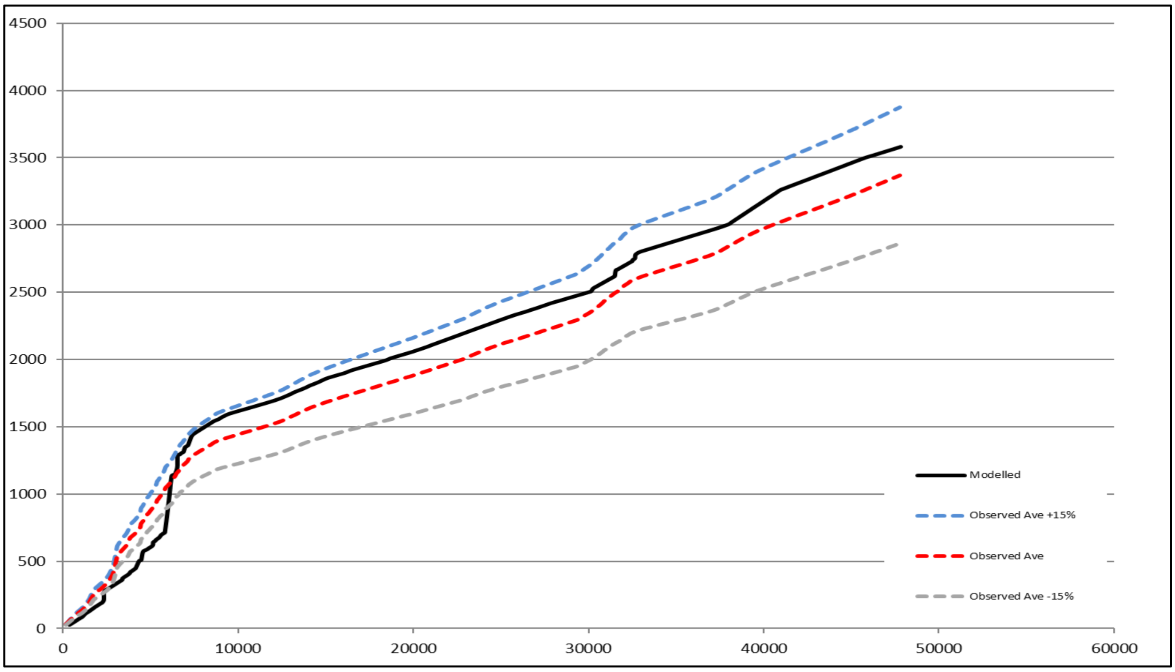


Figure D 3: Route 2, Northbound: Island Bay (via Waterfront) -> Paekakariki

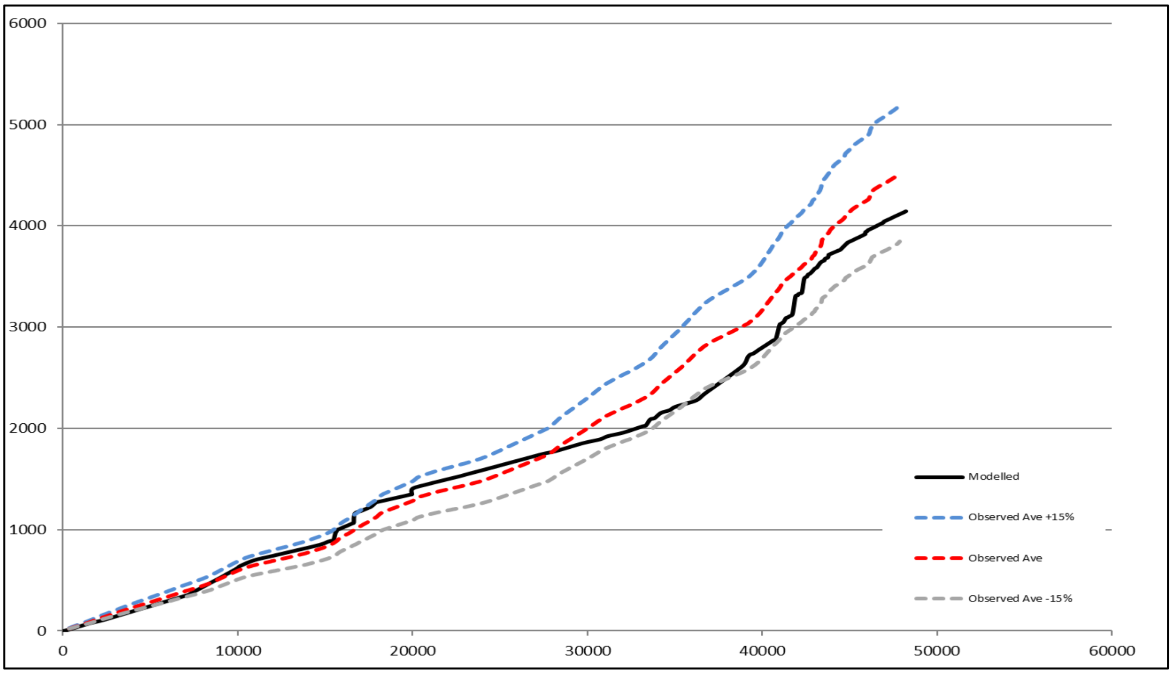


Figure D 4: Route 2, Southbound: Paekakariki -> Island Bay (via Waterfront)

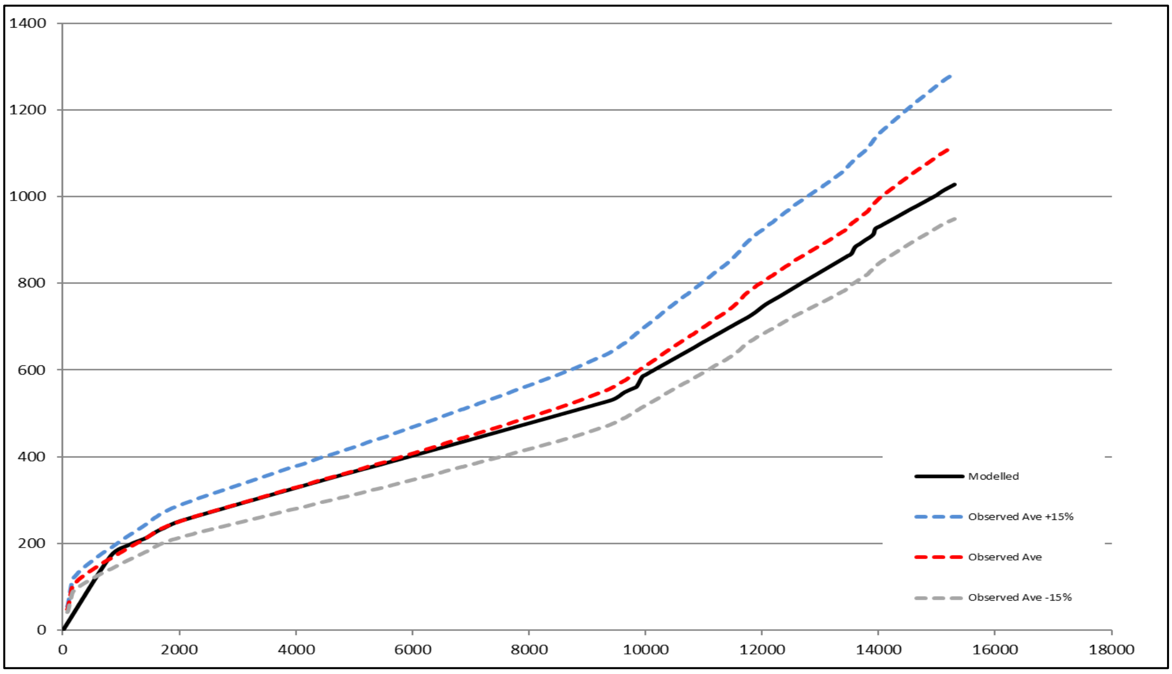


Figure D 5: Route 3, Northbound: Centreport -> Seaview

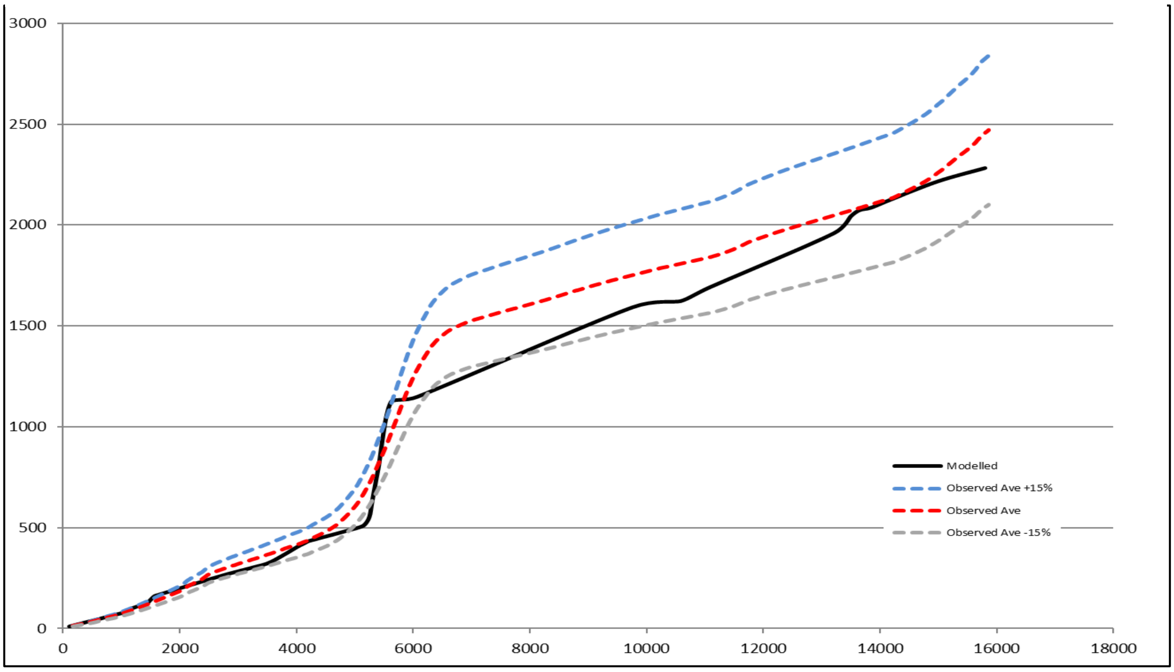


Figure D 6: Route 3, Southbound: Seaview -> Centreport

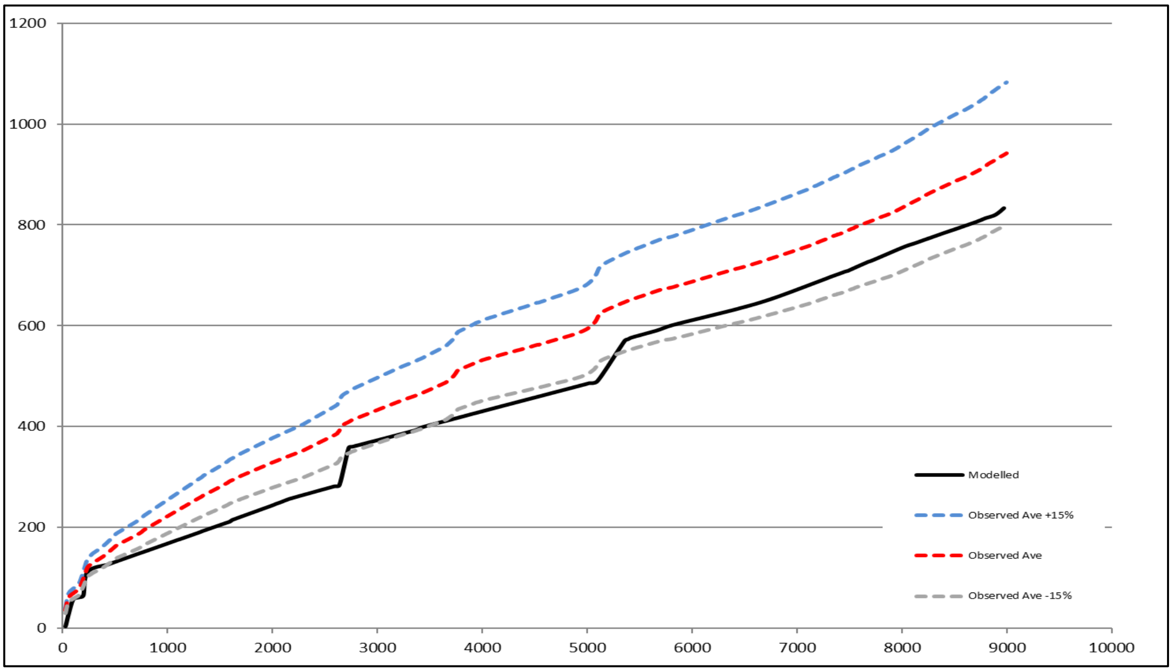


Figure D 7: Route 4, Northbound: Wellington Station (via Hutt Road) -> Newlands

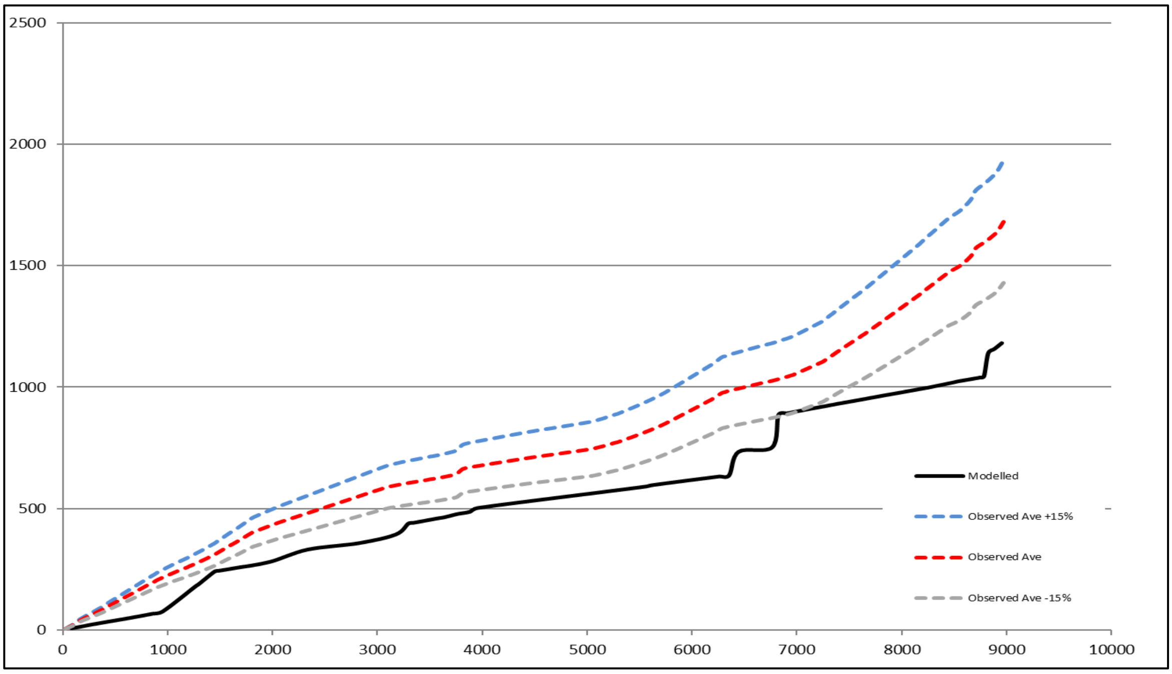


Figure D 8: Route 4, Southbound: Newlands -> Wellington Station (via Hutt Road)

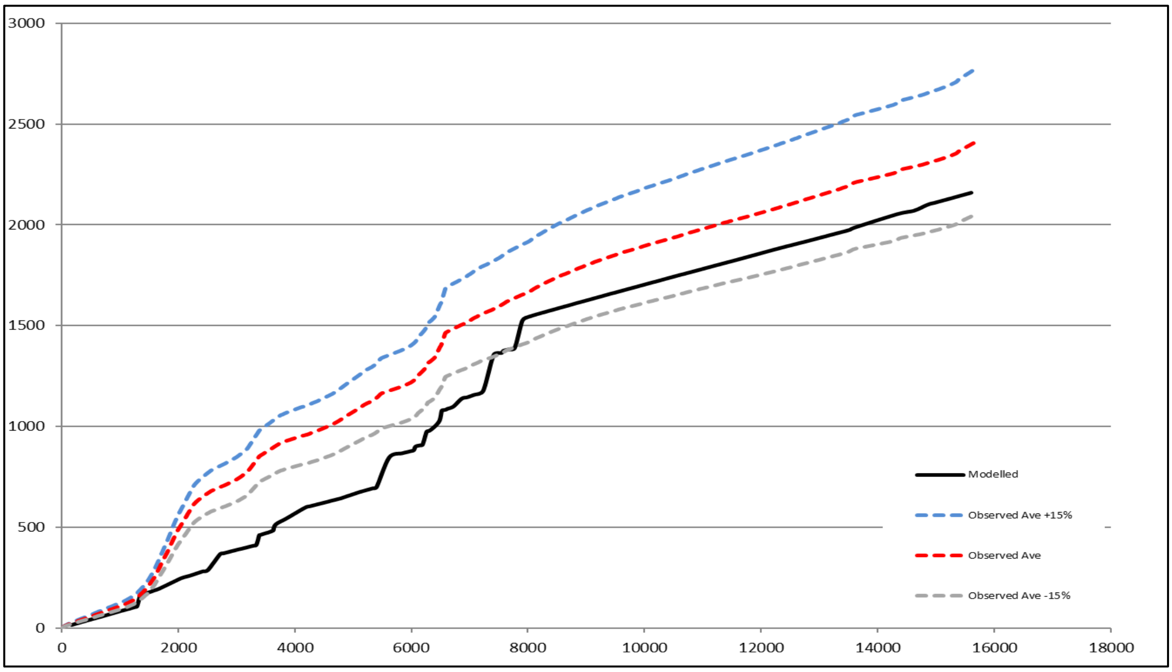


Figure D 9: Route 5, Eastbound: Karori -> Miramar (via Waterfront and Evans Bay)

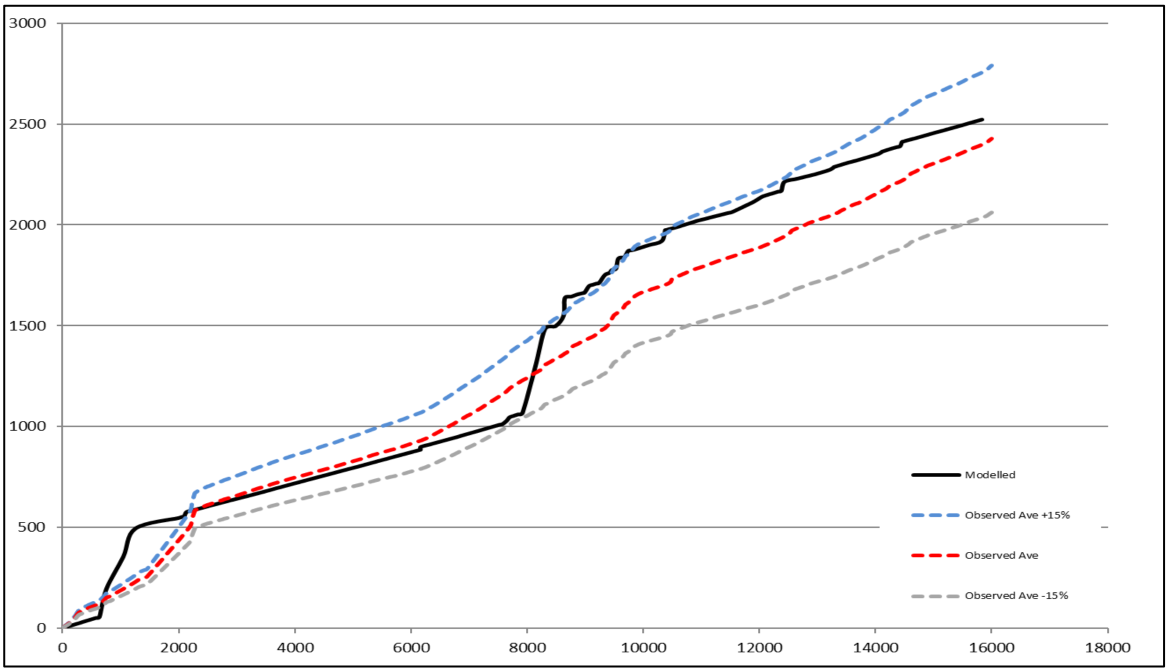


Figure D 10: Route 5, Westbound: Miramar (via Waterfront and Evans Bay) -> Karori

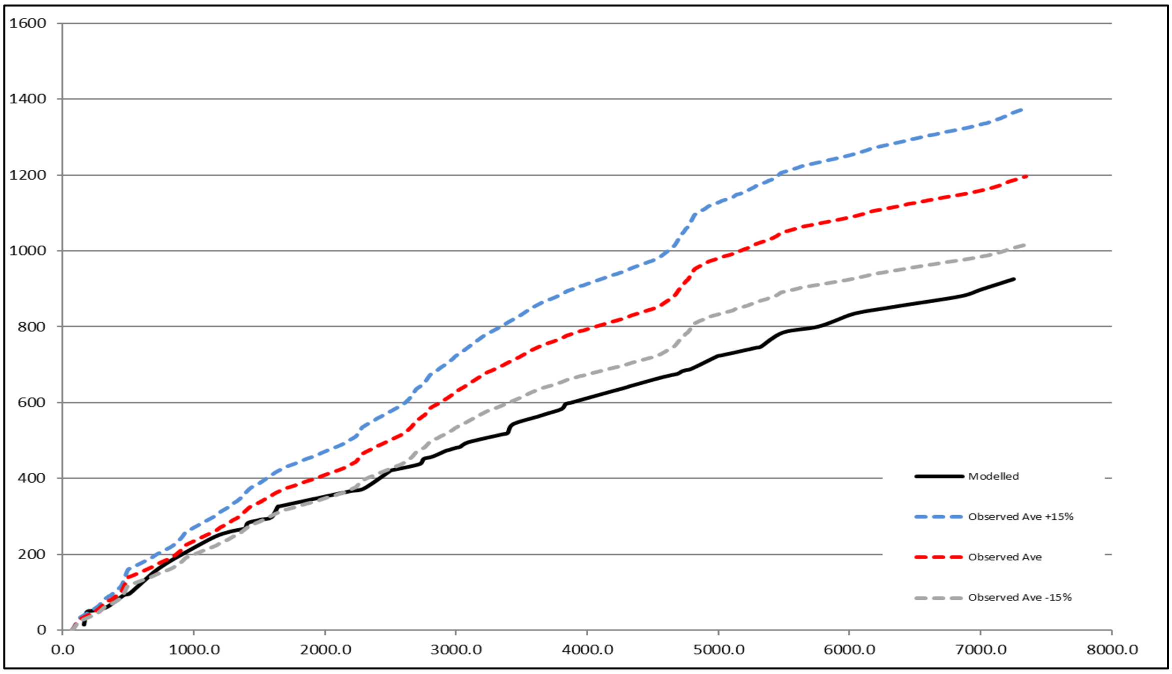


Figure D 11: Route 6, Eastbound: Waterfront (via Kilbirnie, Newtown and Wallace Street) -> Airport

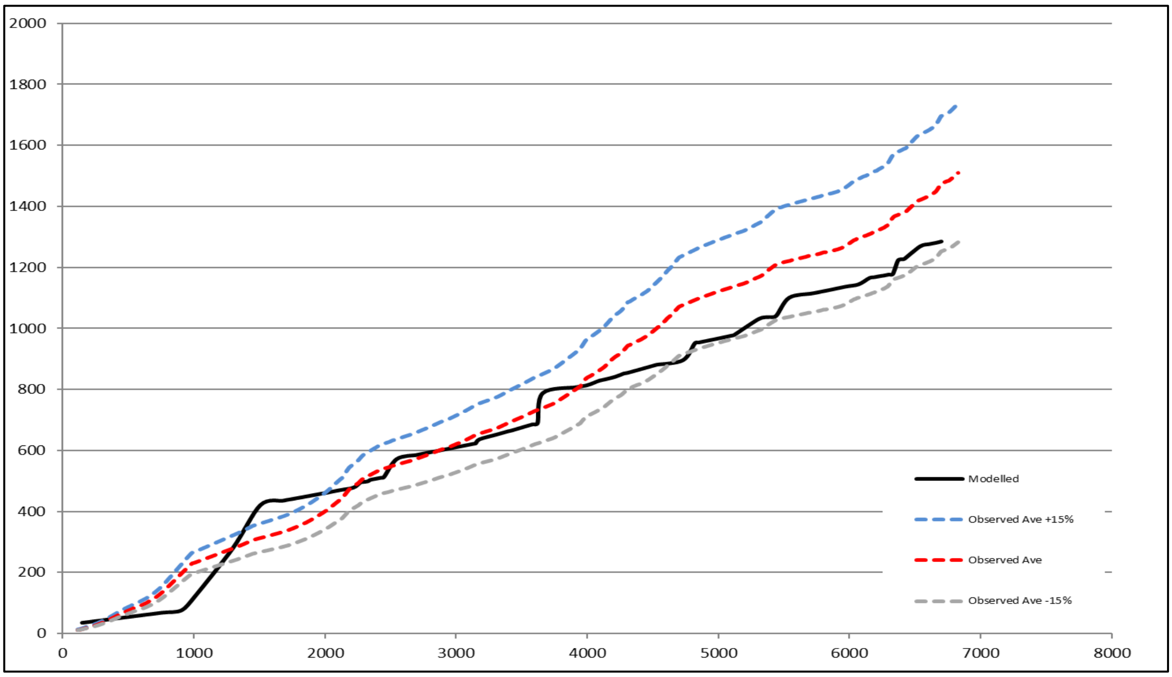


Figure D 12: Route 6, Westbound: Airport -> Waterfront (via Kilbirnie, Newtown and Wallace Street)

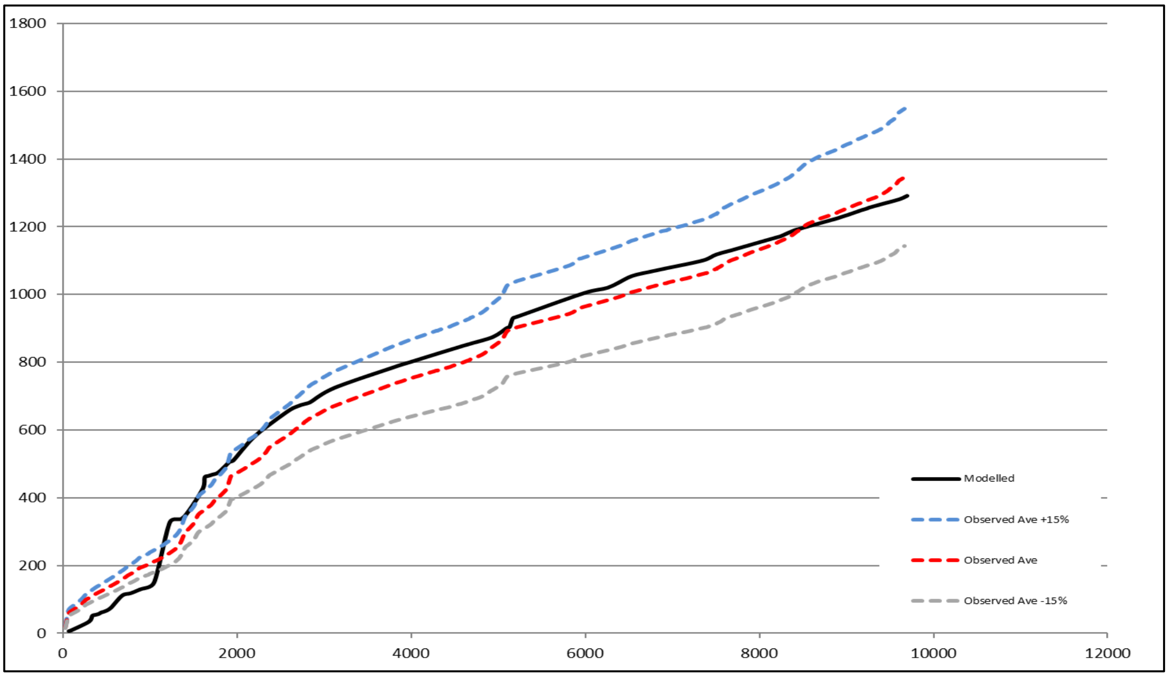


Figure D 13: Route 7, Eastbound: Wellington Station (via Taranaki St, Waterfront) -> Seatoun

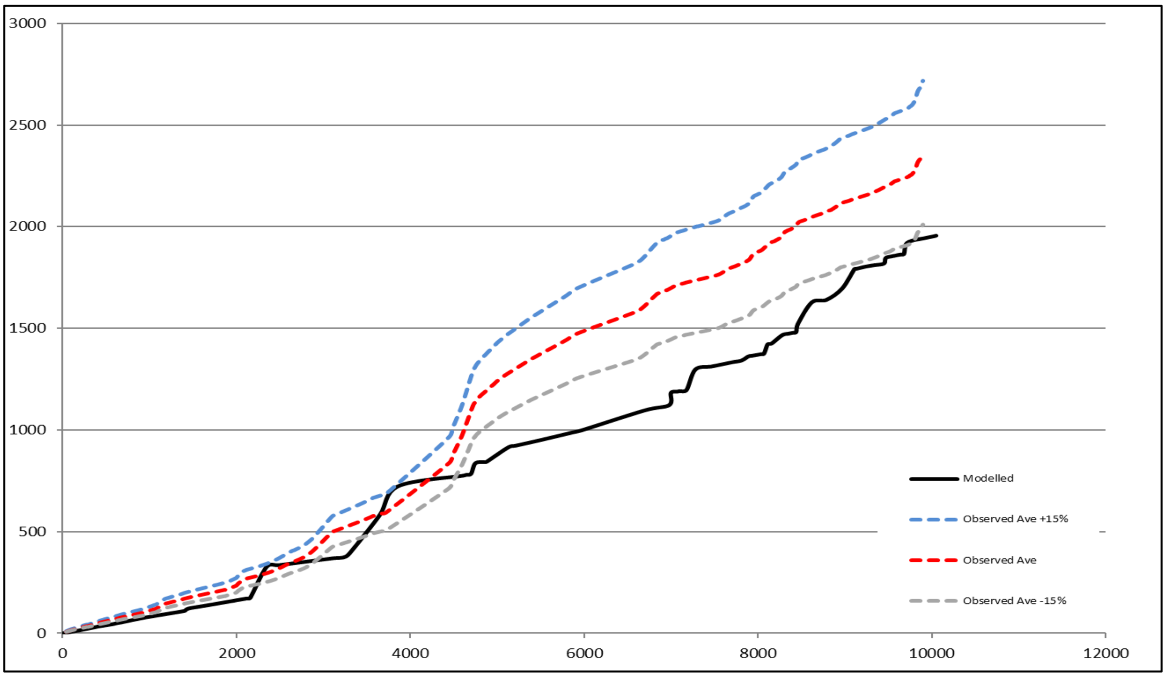


Figure D 14: Route 7, Westbound: Seatoun -> Wellington Station (via Taranaki St, Waterfront)

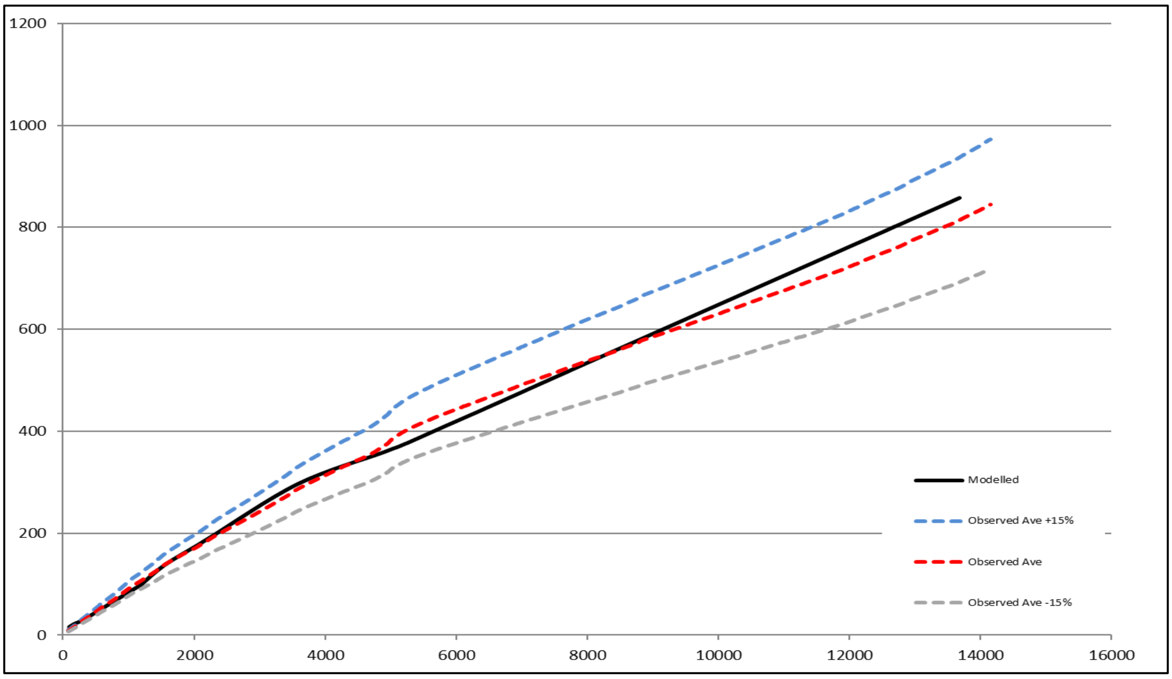


Figure D 15: Route 8, Eastbound: Paremata -> Haywards

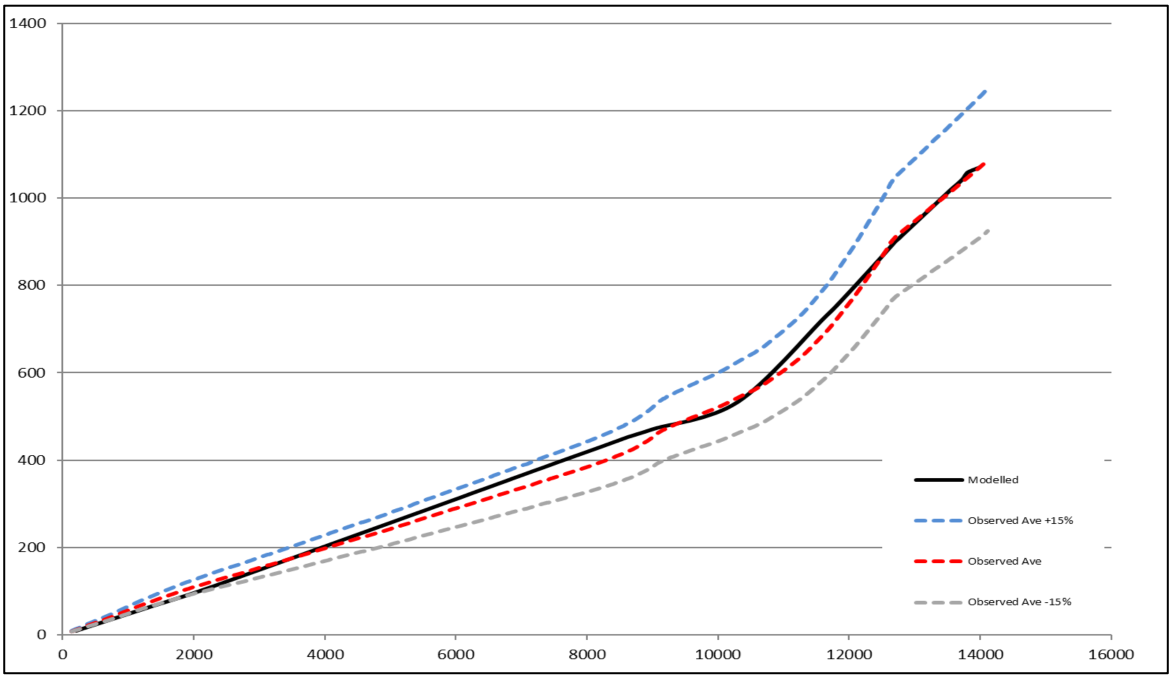


Figure D 16: Route 8, Westbound: Haywards -> Paremata

D.2 AM Shoulder

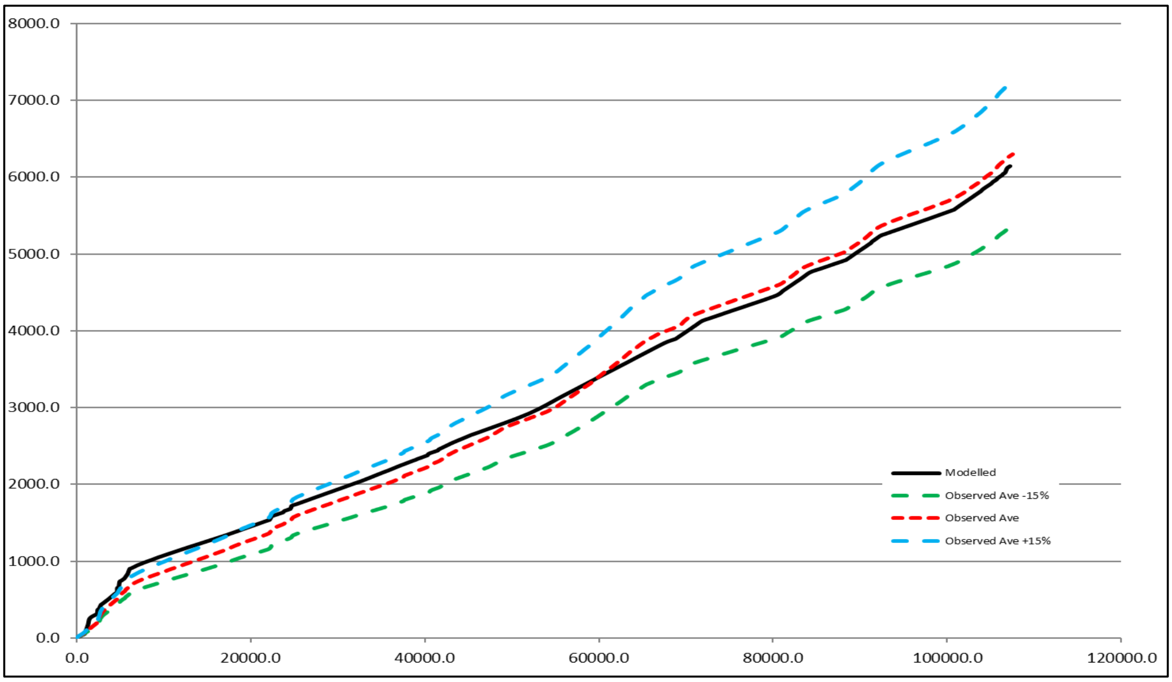


Figure D 17: Route 1, Northbound: Wellington Airport -> North of Masterton

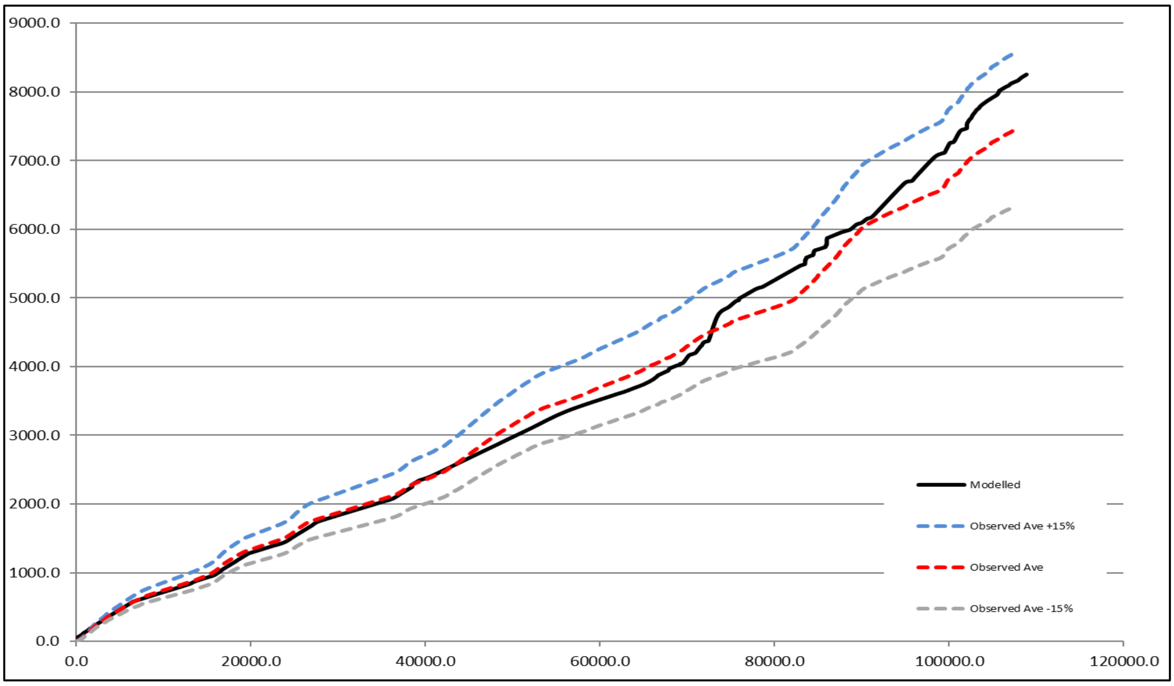


Figure D 18: Route 1, Southbound: North of Masterton -> Wellington Airport

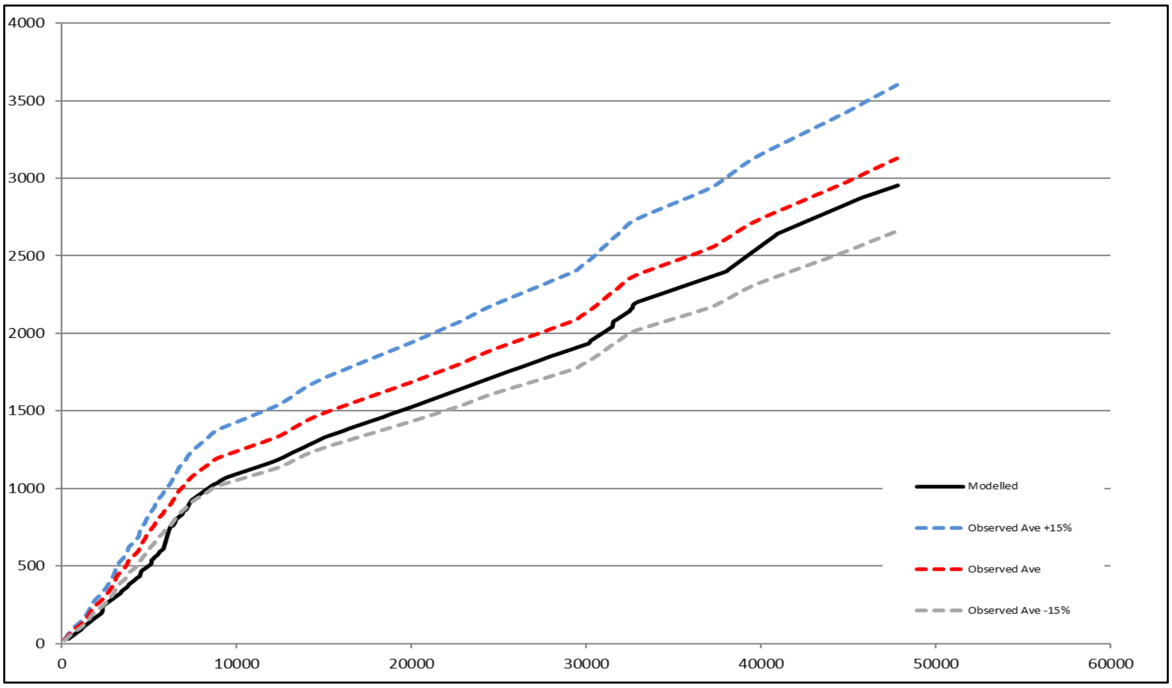


Figure D 19: Route 2, Northbound: Island Bay (via Waterfront) -> Paekakariki

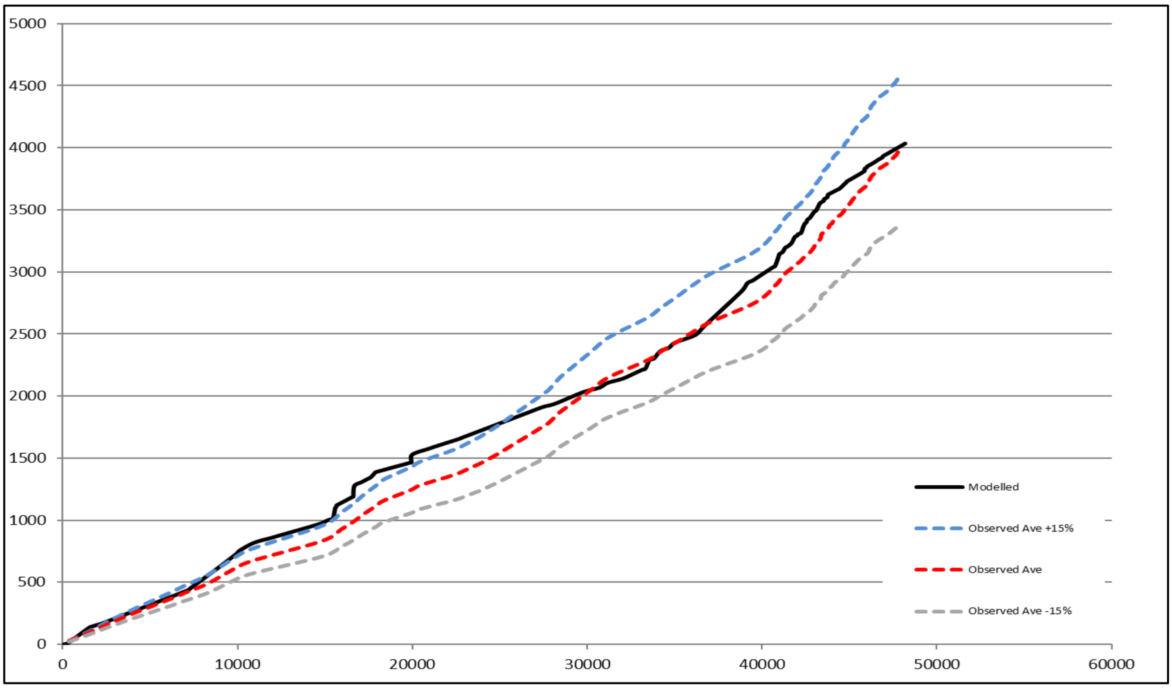


Figure D 20: Route 2, Southbound: Paekakariki -> Island Bay (via Waterfront)

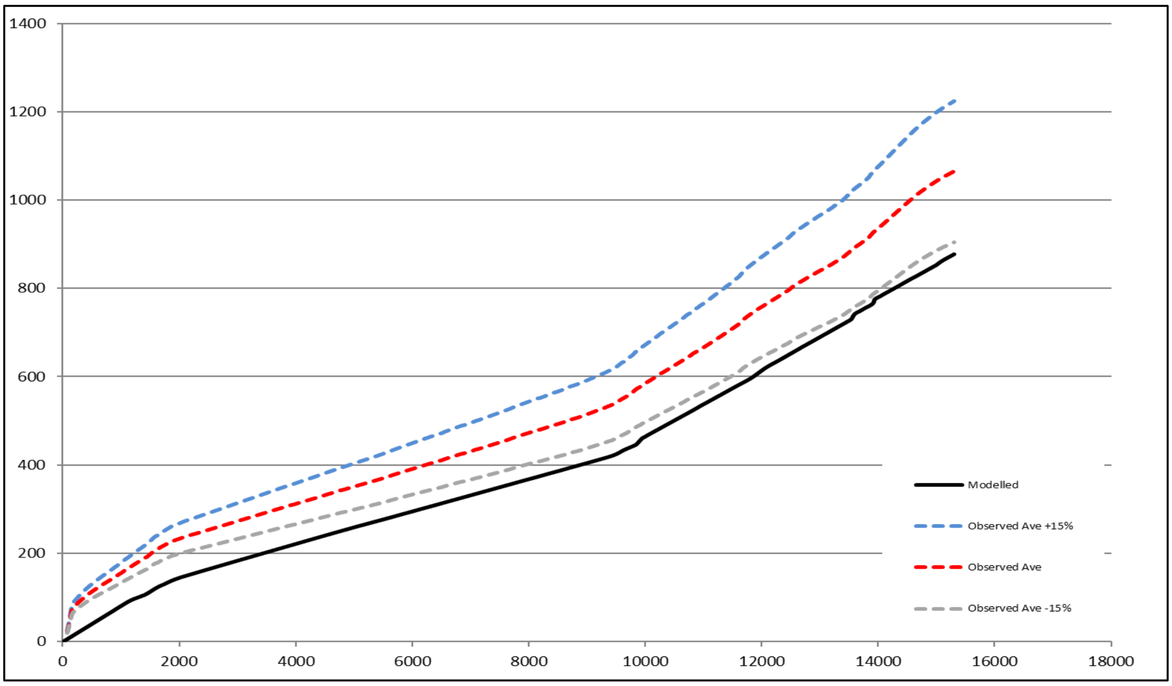


Figure D 21: Route 3, Northbound: Centreport -> Seaview

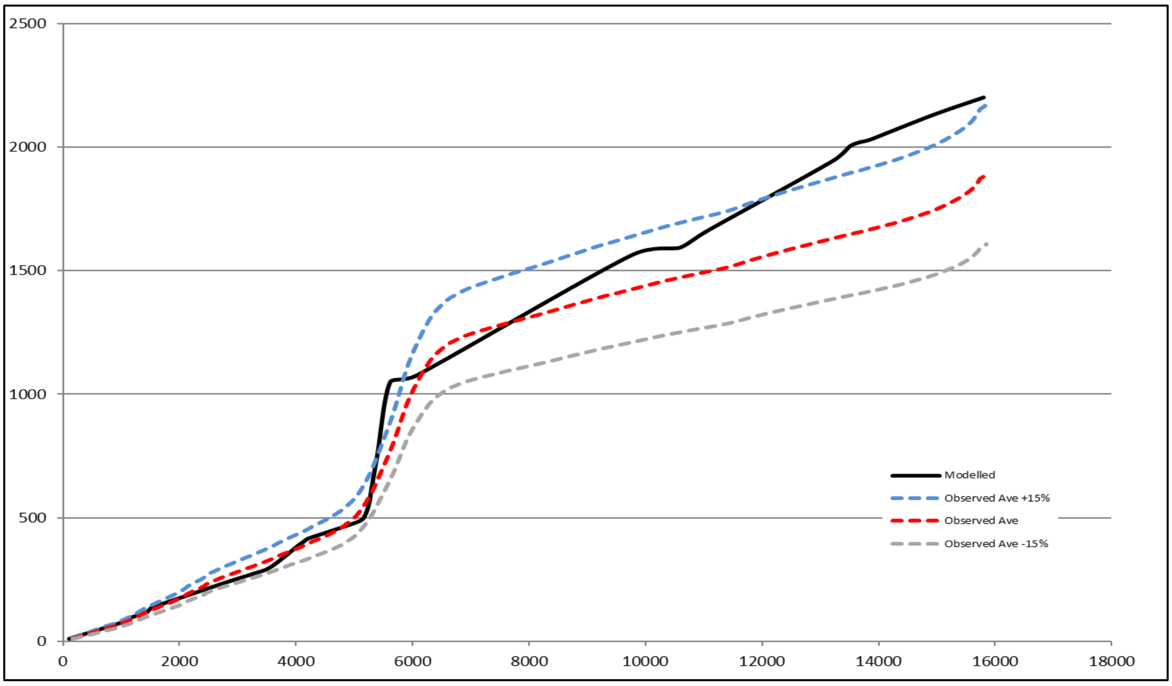


Figure D 22: Route 3, Southbound: Seaview -> Centreport

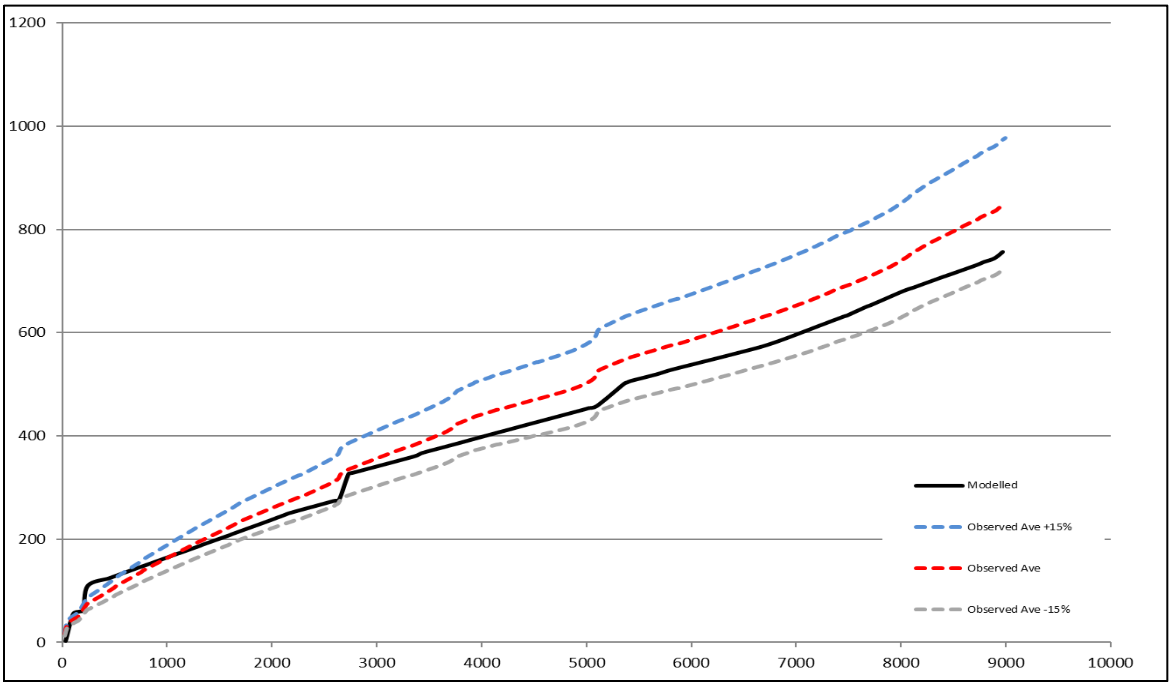


Figure D 23: Route 4, Northbound: Wellington Station (via Hutt Road) -> Newlands

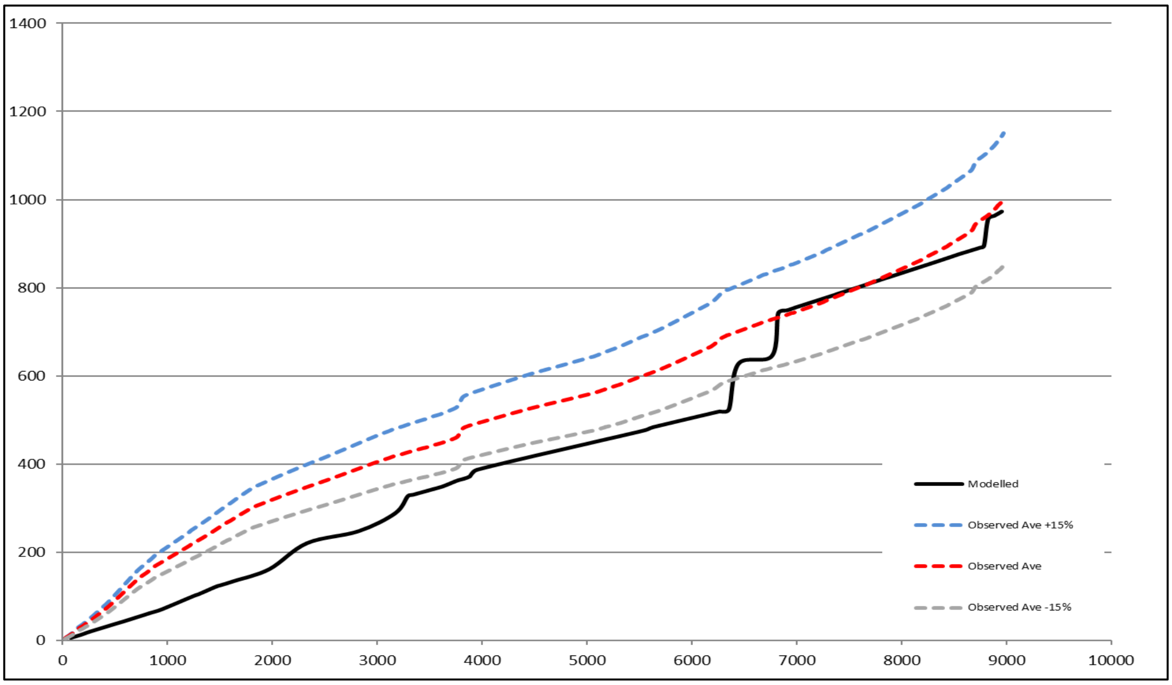


Figure D 24: Route 4, Southbound: Newlands -> Wellington Station (via Hutt Road)

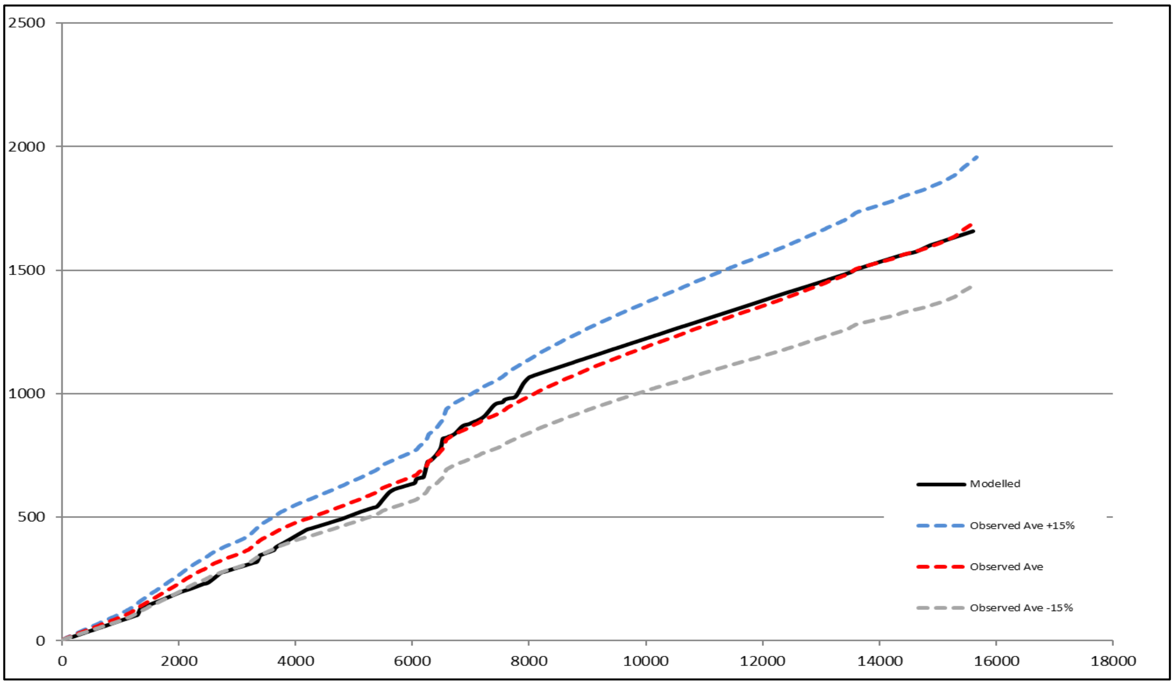


Figure D 25: Route 5, Eastbound: Karori -> Miramar (via Waterfront and Evans Bay)

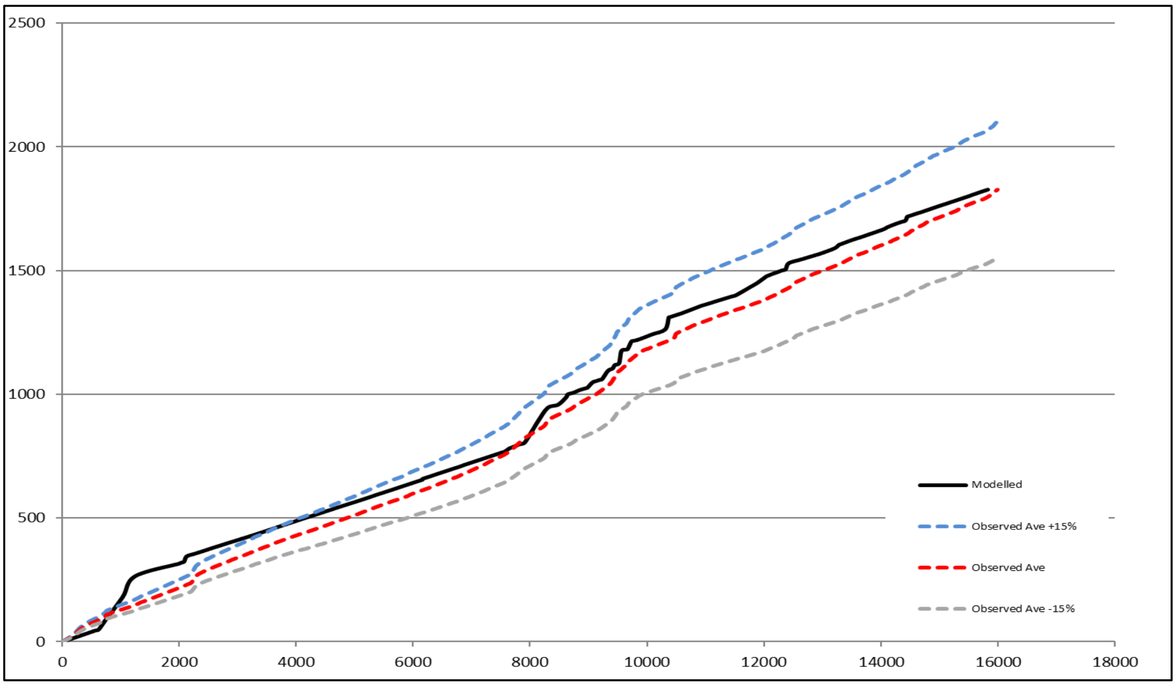


Figure D 26: Route 5, Westbound: Miramar (via Waterfront and Evans Bay) -> Karori

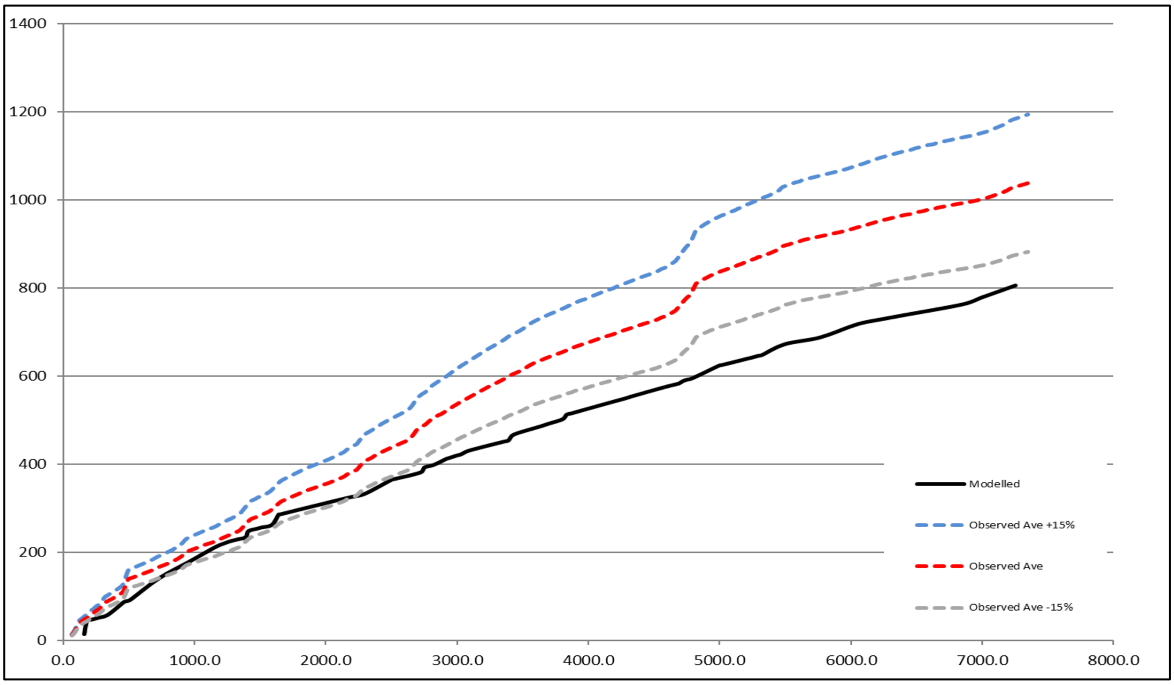


Figure D 27: Route 6, Eastbound: Waterfront (via Kilbirnie, Newtown and Wallace Street) -> Airport

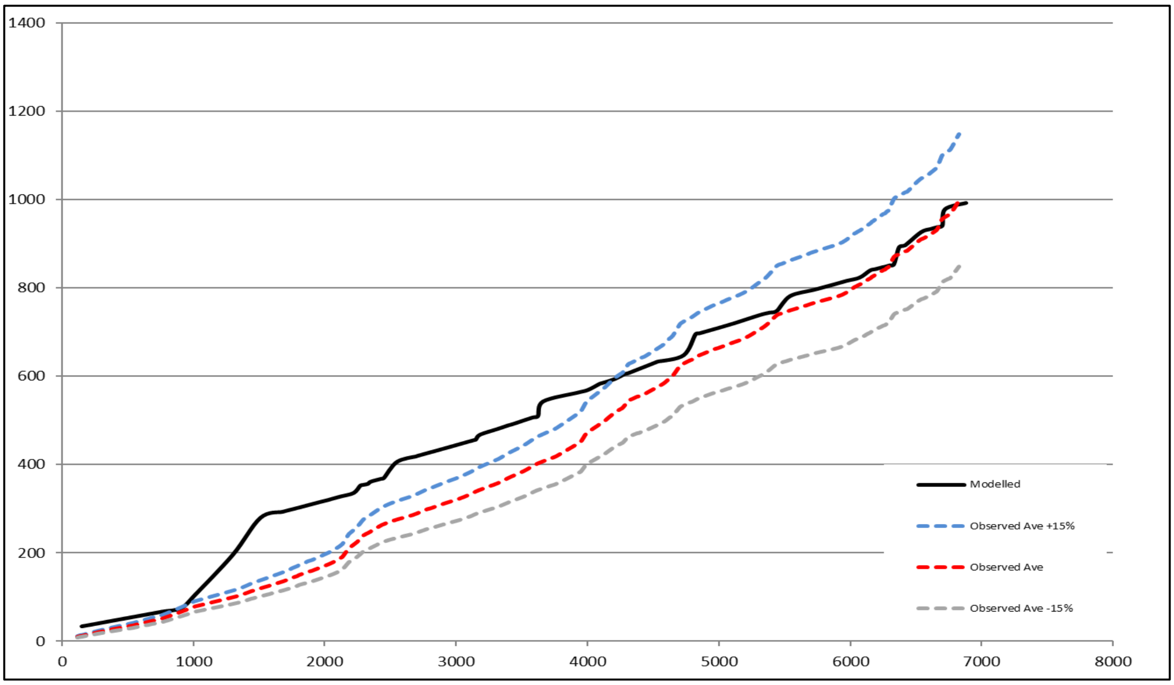


Figure D 28: Route 6, Westbound: Airport -> Waterfront (via Kilbirnie, Newtown and Wallace Street)

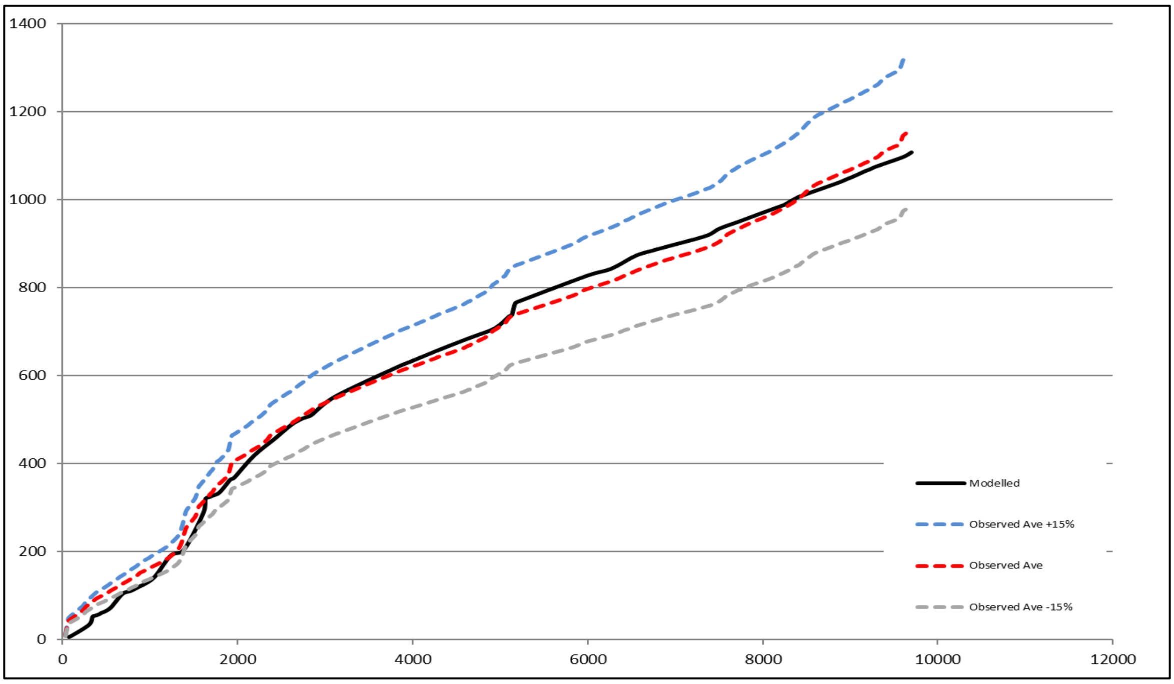


Figure D 29: Route 7, Eastbound: Wellington Station (via Taranaki St, Waterfront) -> Seatoun

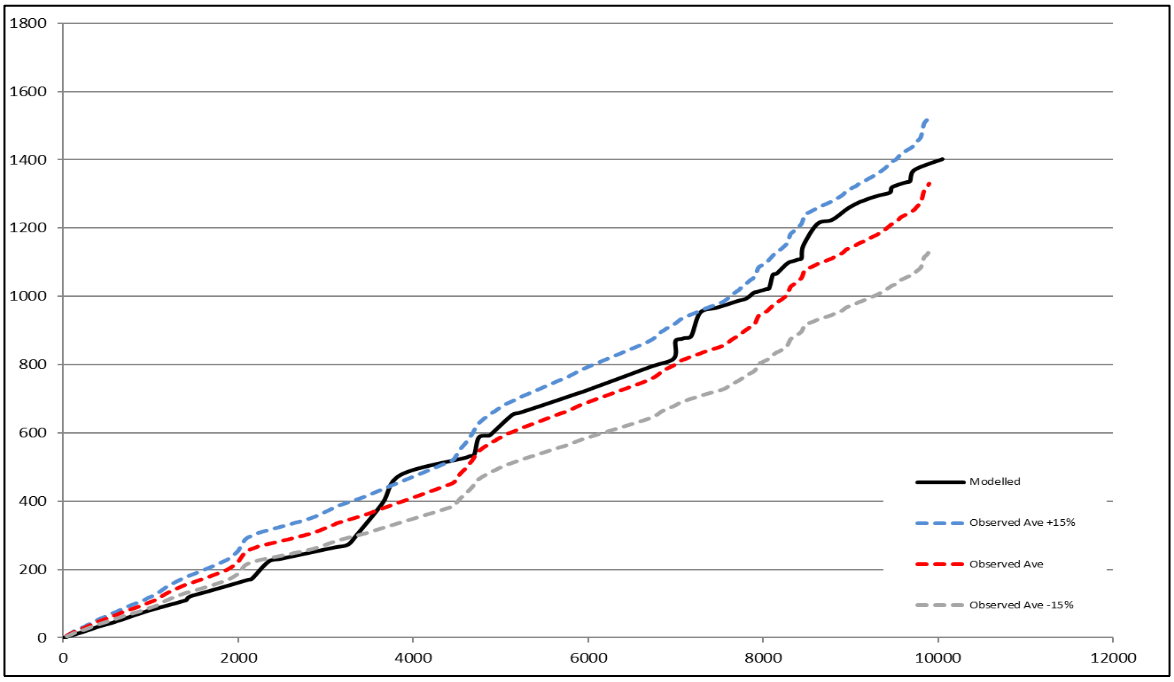


Figure D 30: Route 7, Westbound: Seatoun -> Wellington Station (via Taranaki St, Waterfront)

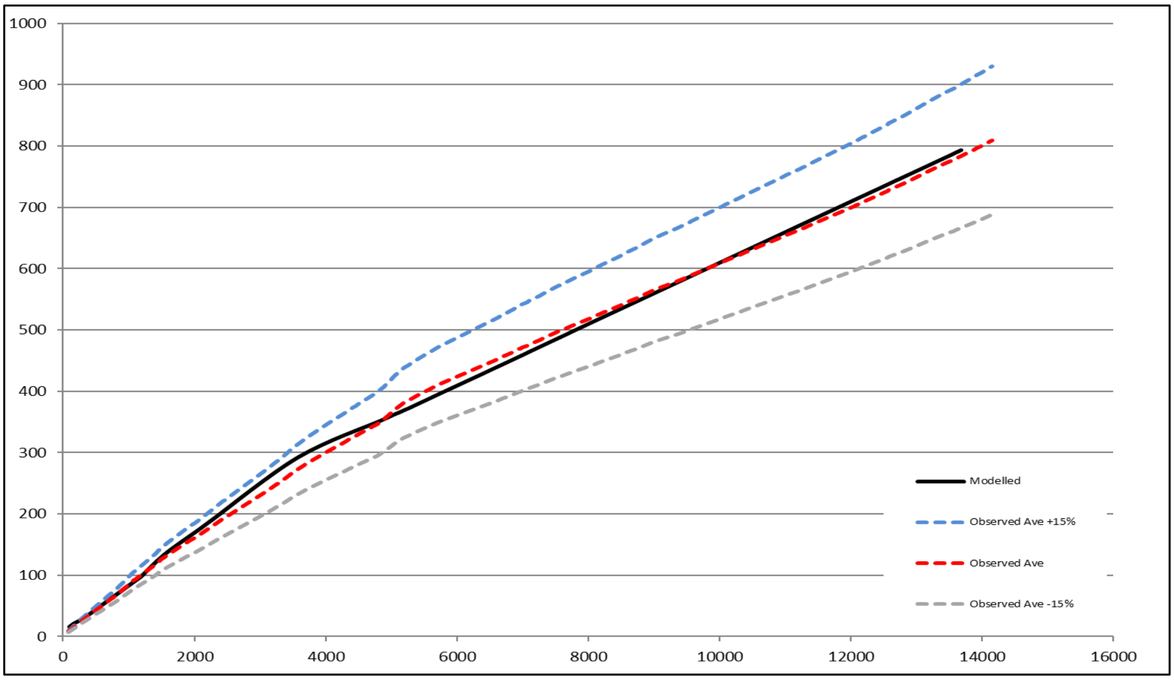


Figure D 31: Route 8, Eastbound: Paremata -> Haywards

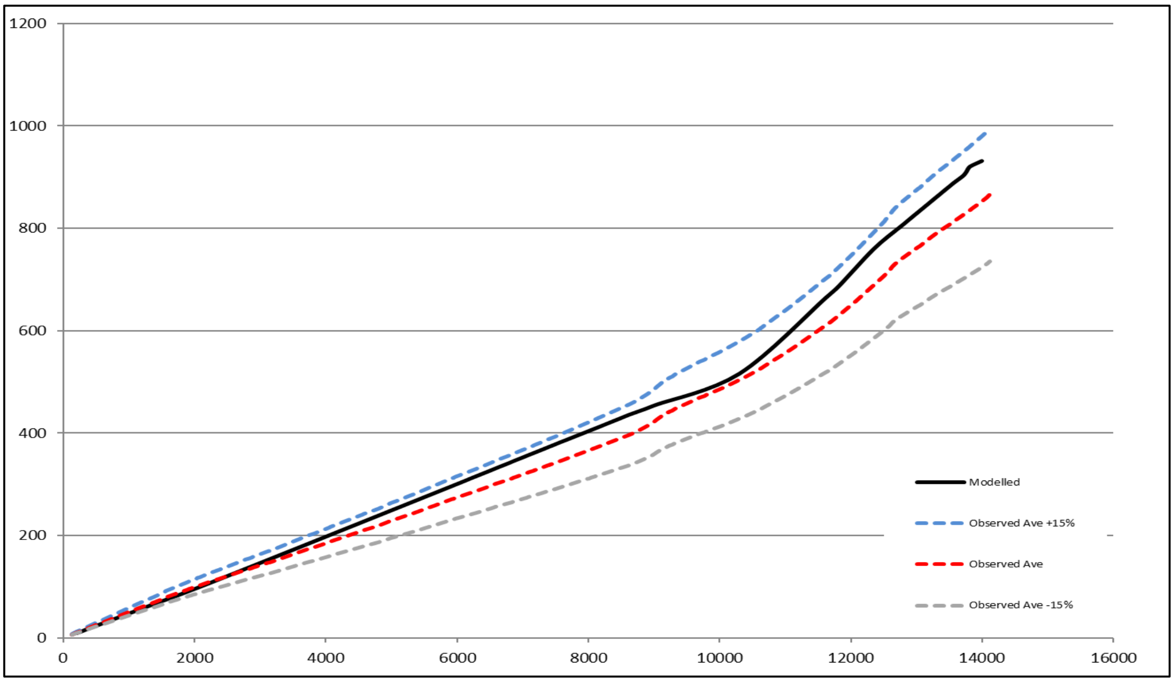


Figure D 32: Route 8, Westbound: Haywards -> Paremata

D.3 Interpeak

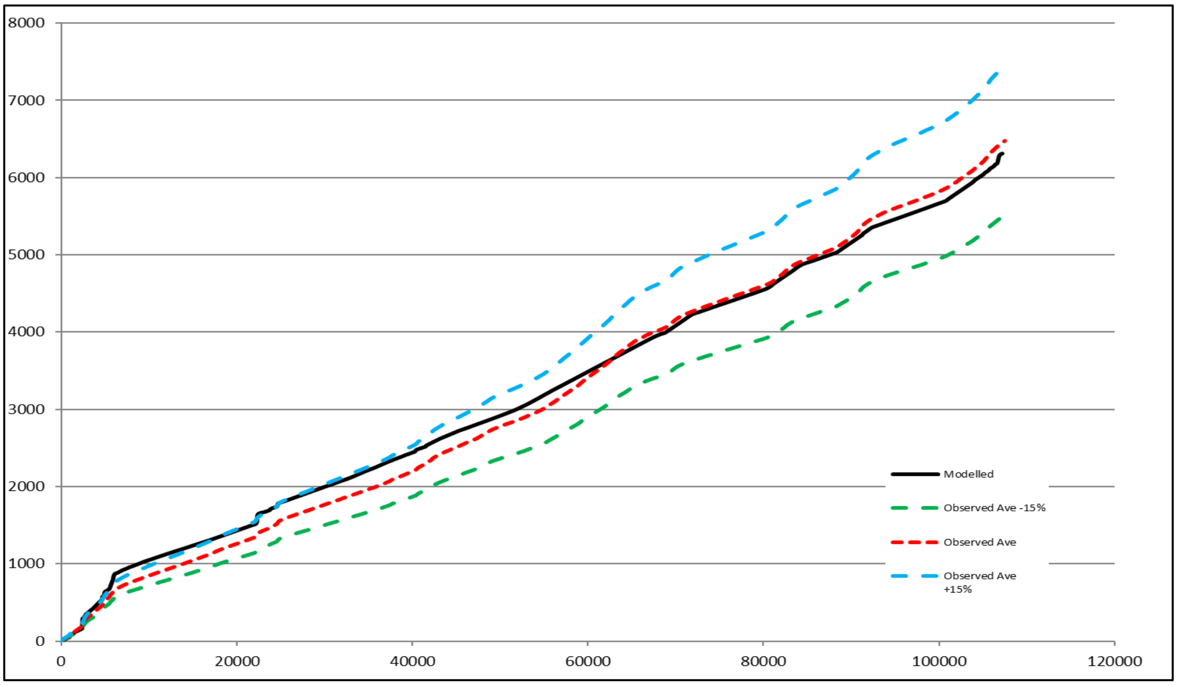


Figure D 33: Route 1, Northbound: Wellington Airport -> North of Masterton

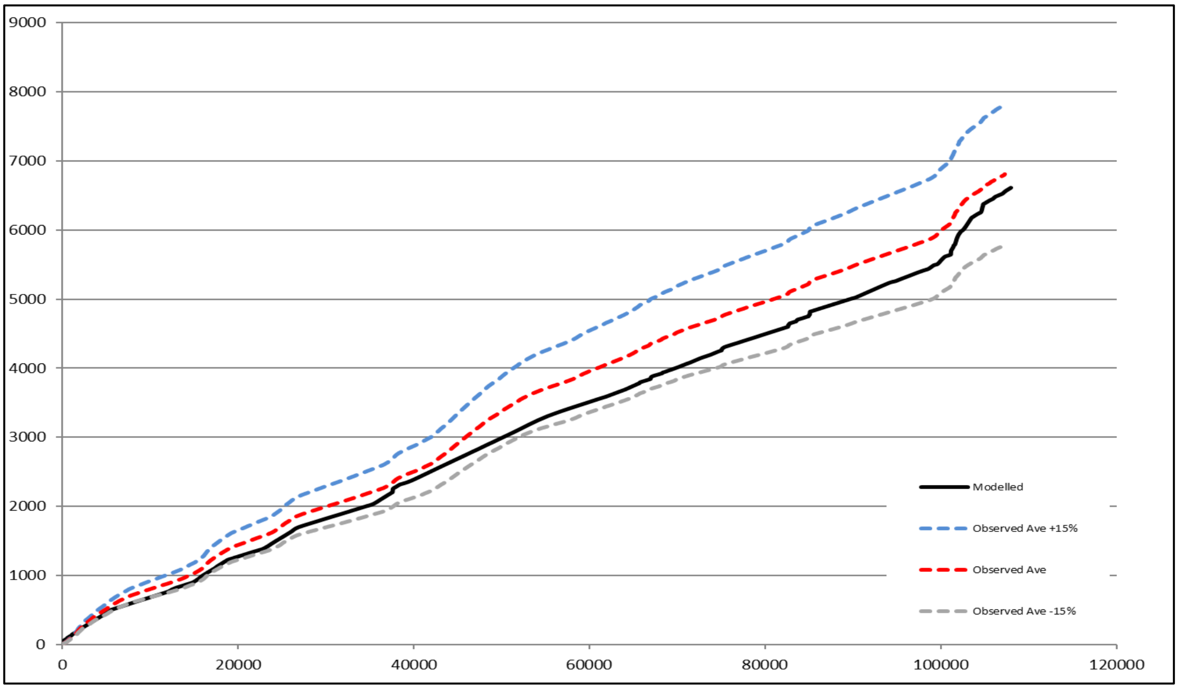


Figure D 34: Route 1, Southbound: North of Masterton -> Wellington Airport

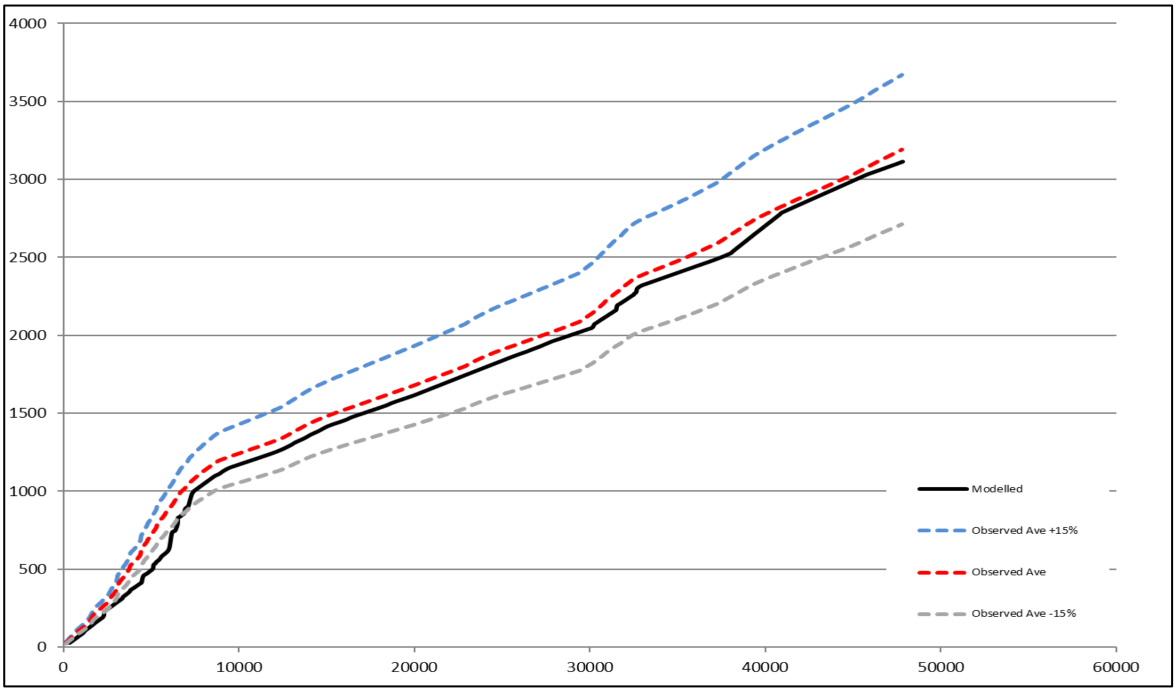


Figure D 35: Route 2, Northbound: Island Bay (via Waterfront) -> Paekakariki

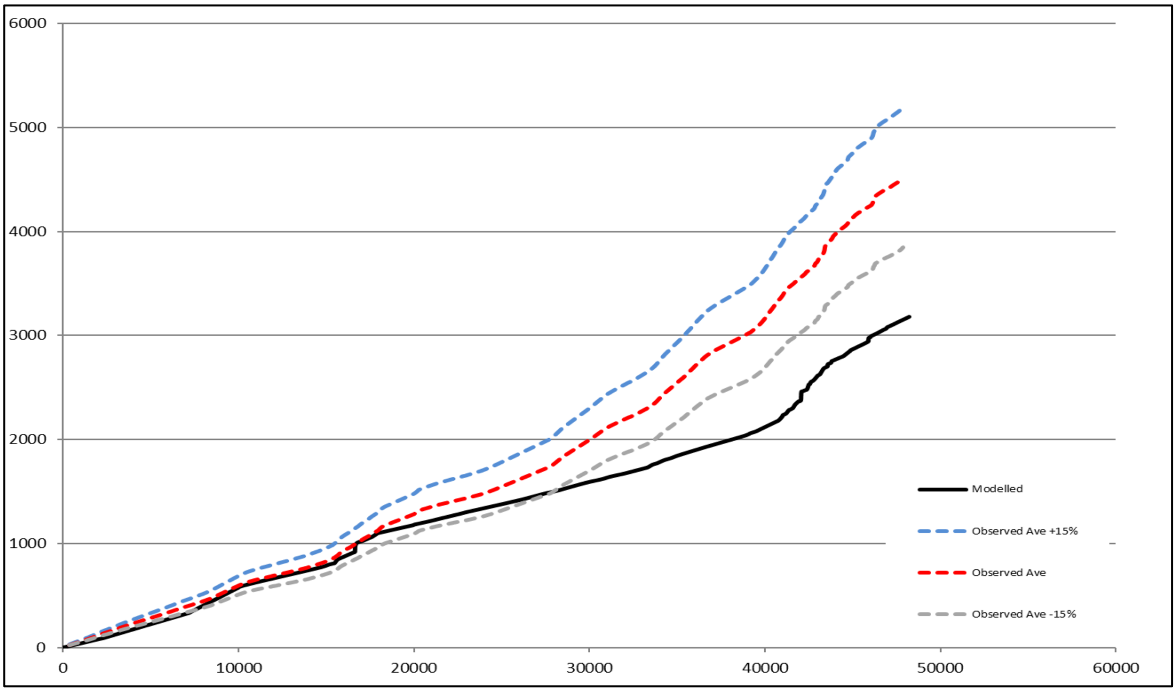


Figure D 36: Route 2, Southbound: Paekakariki -> Island Bay (via Waterfront)

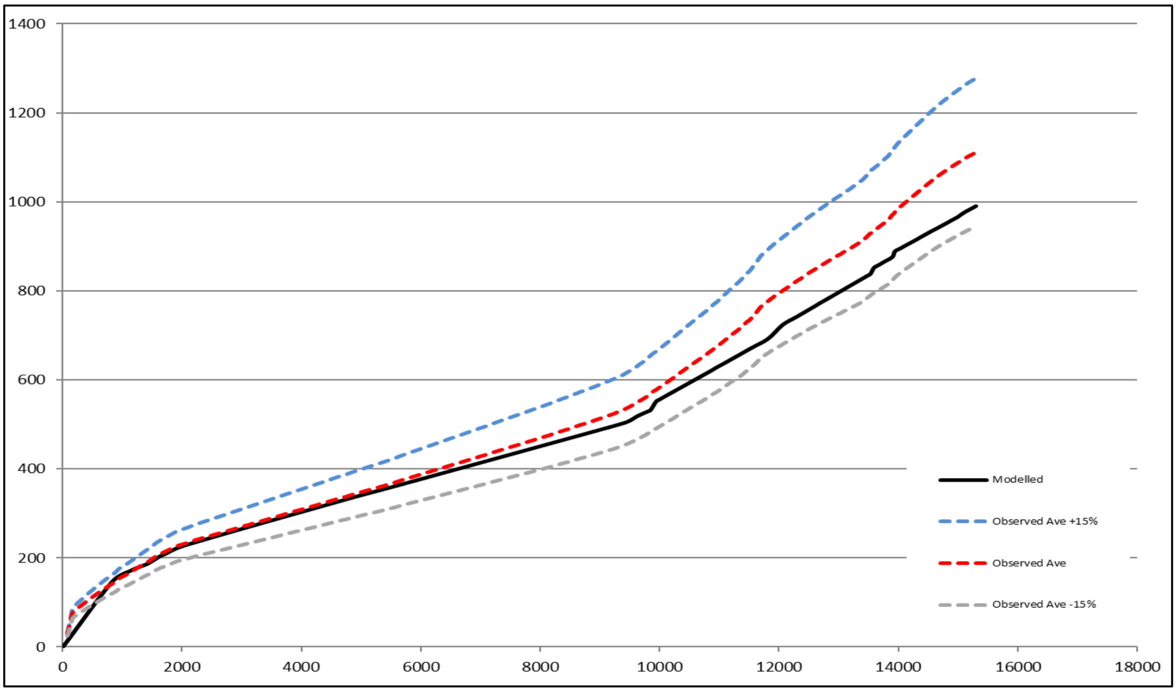


Figure D 37: Route 3, Northbound: Centreport -> Seaview

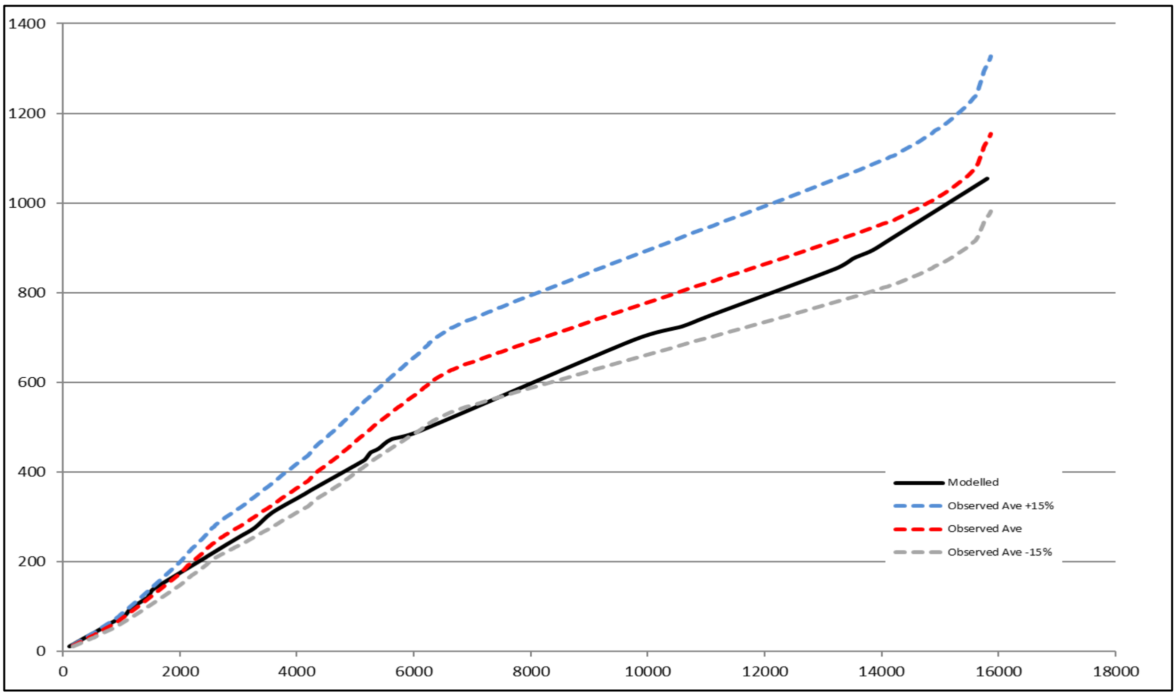


Figure D 38: Route 3, Southbound: Seaview -> Centreport

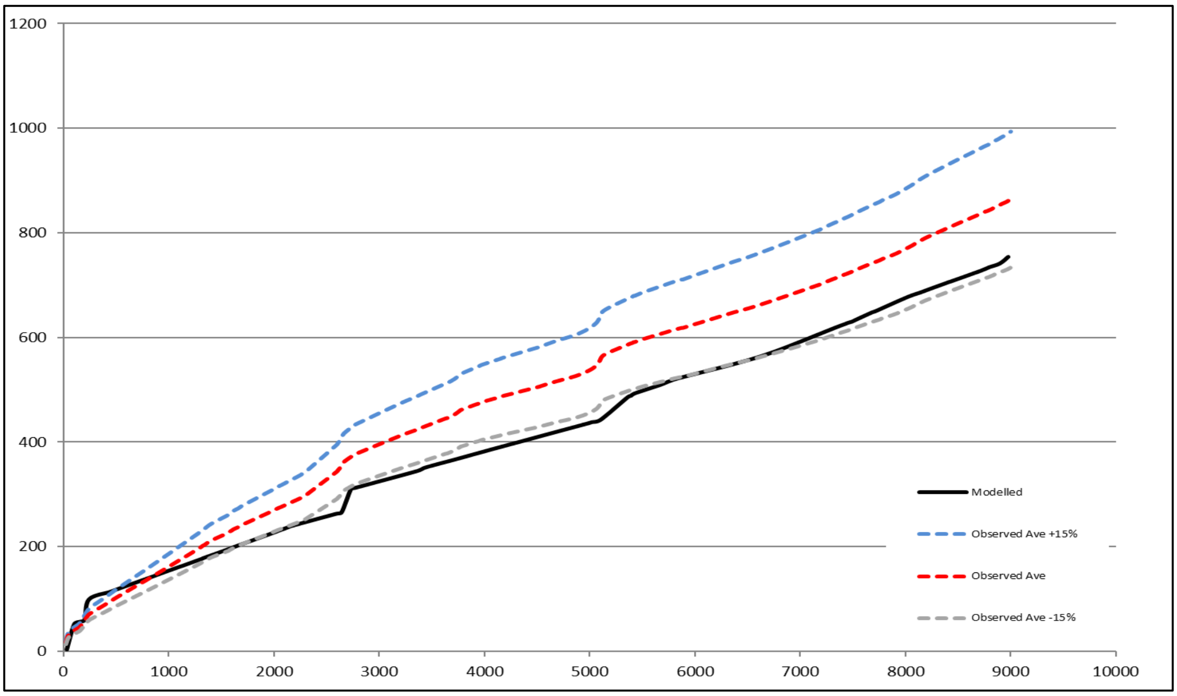


Figure D 39: Route 4, Northbound: Wellington Station (via Hutt Road) -> Newlands

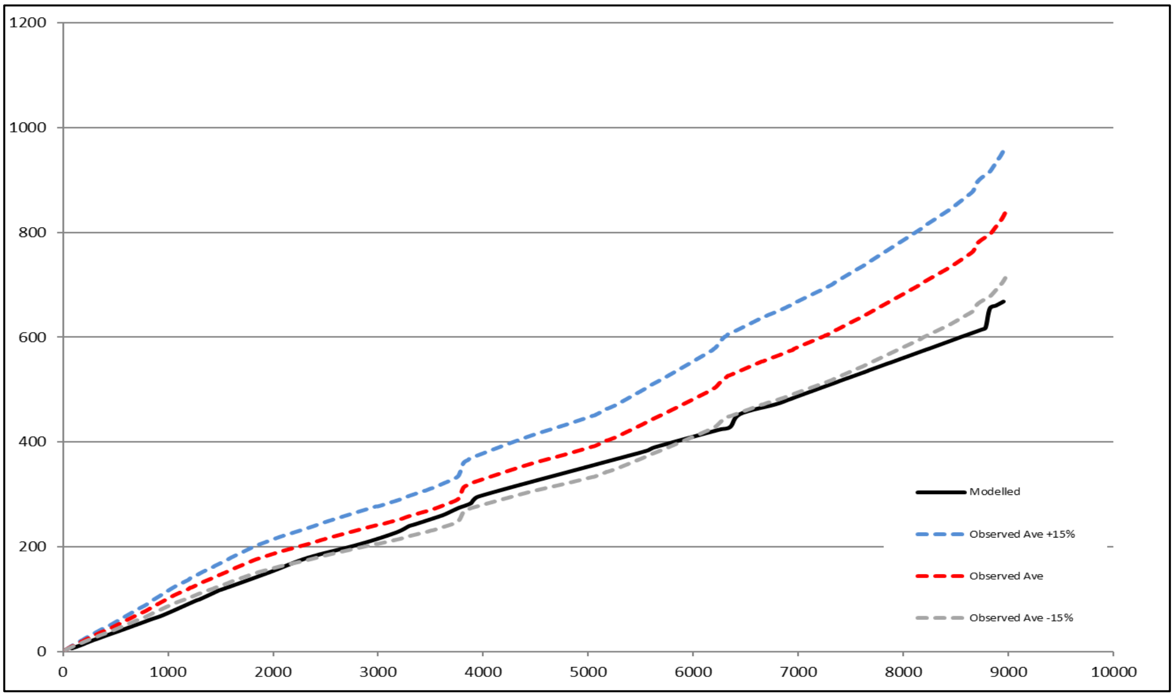


Figure D 40: Route 4, Southbound: Newlands -> Wellington Station (via Hutt Road)

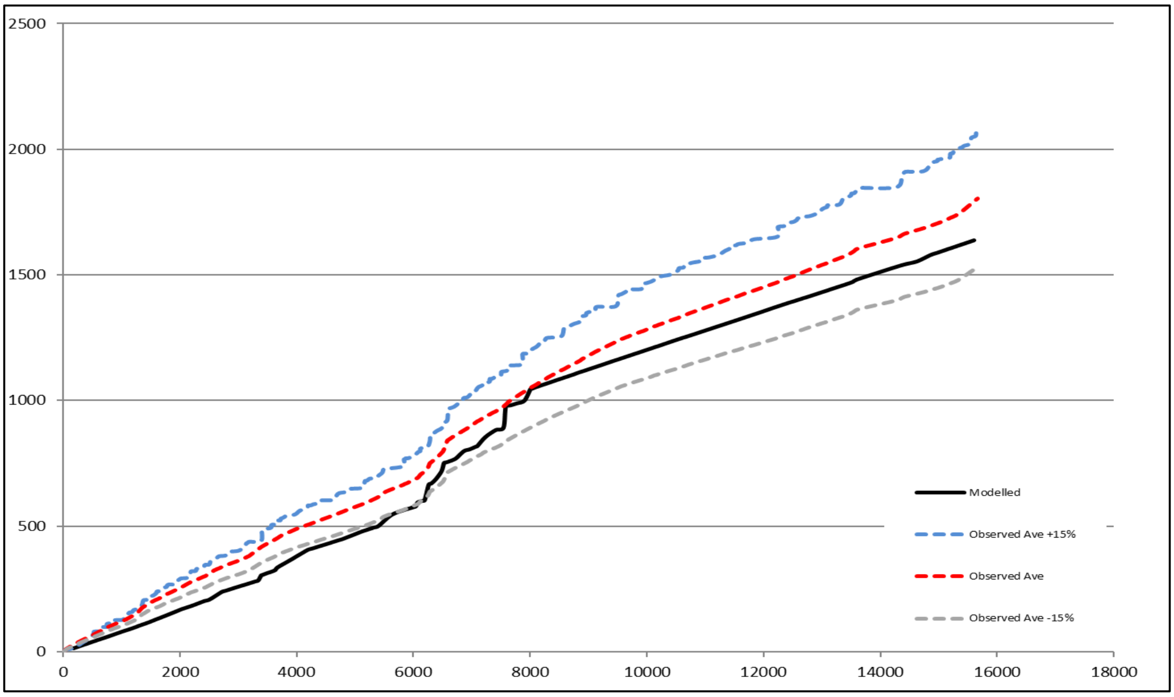


Figure D 41: Route 5, Eastbound: Karori -> Miramar (via Waterfront and Evans Bay)

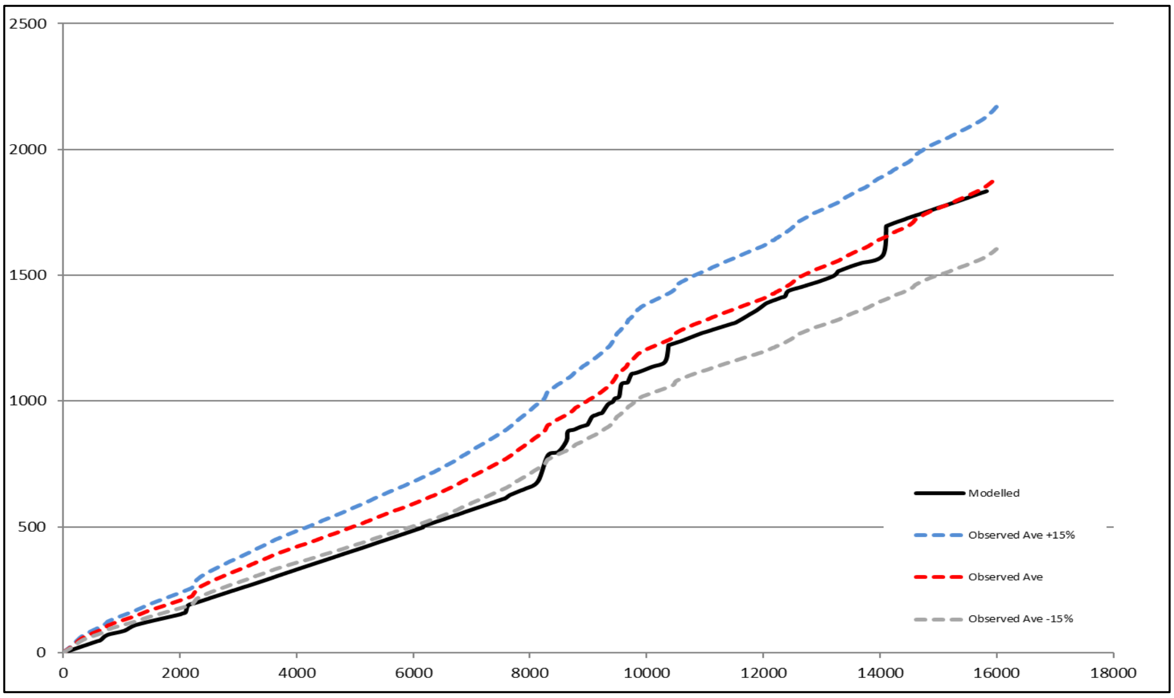


Figure D 42: Route 5, Westbound: Miramar (via Waterfront and Evans Bay) -> Karori

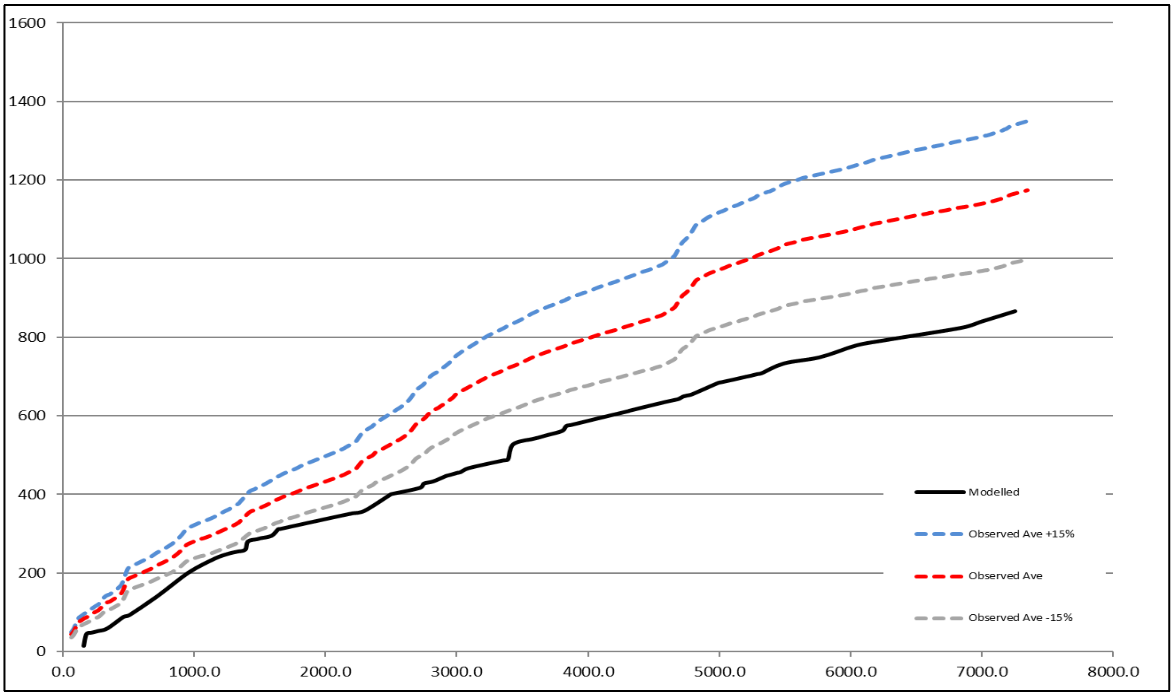


Figure D 43: Route 6, Eastbound: Waterfront (via Kilbirnie, Newtown and Wallace Street) -> Airport

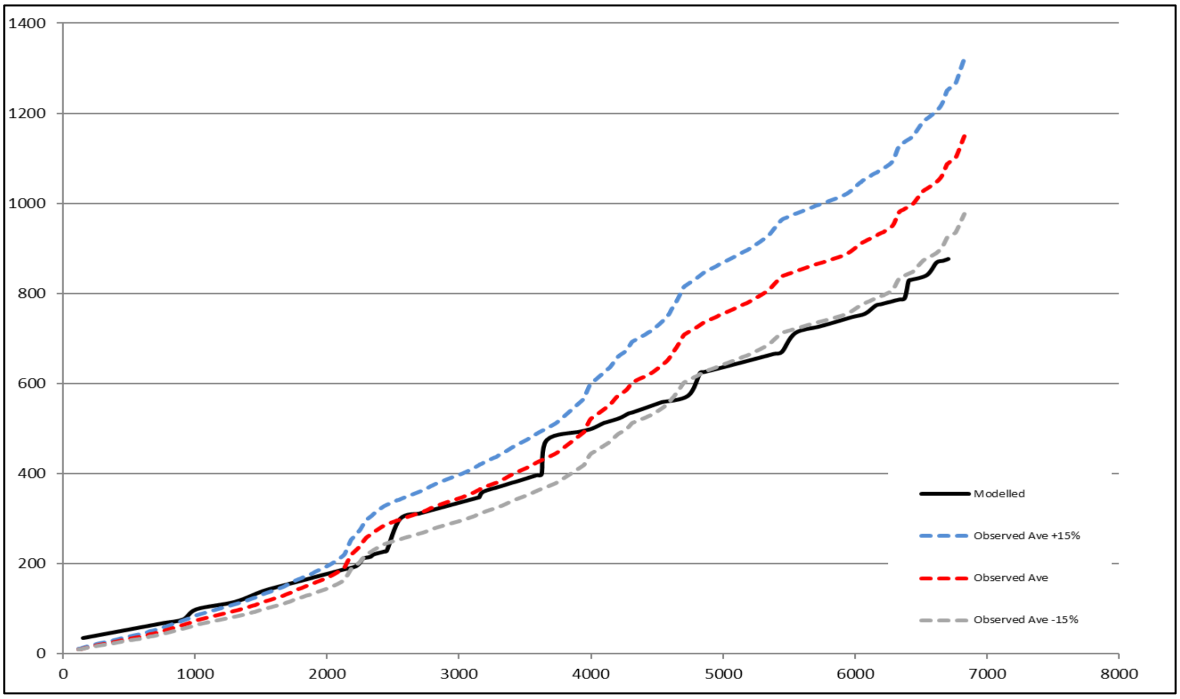


Figure D 44: Route 6, Westbound: Airport -> Waterfront (via Kilbirnie, Newtown and Wallace Street)

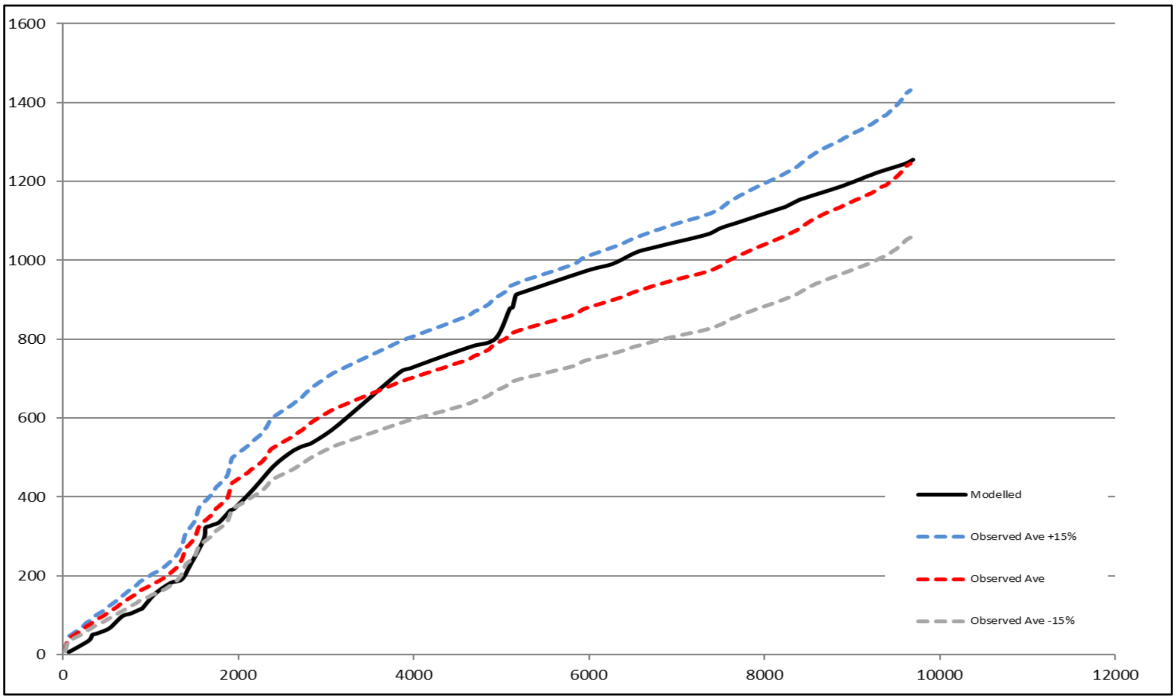


Figure D 45: Route 7, Eastbound: Wellington Station (via Taranaki St, Waterfront) -> Seatoun

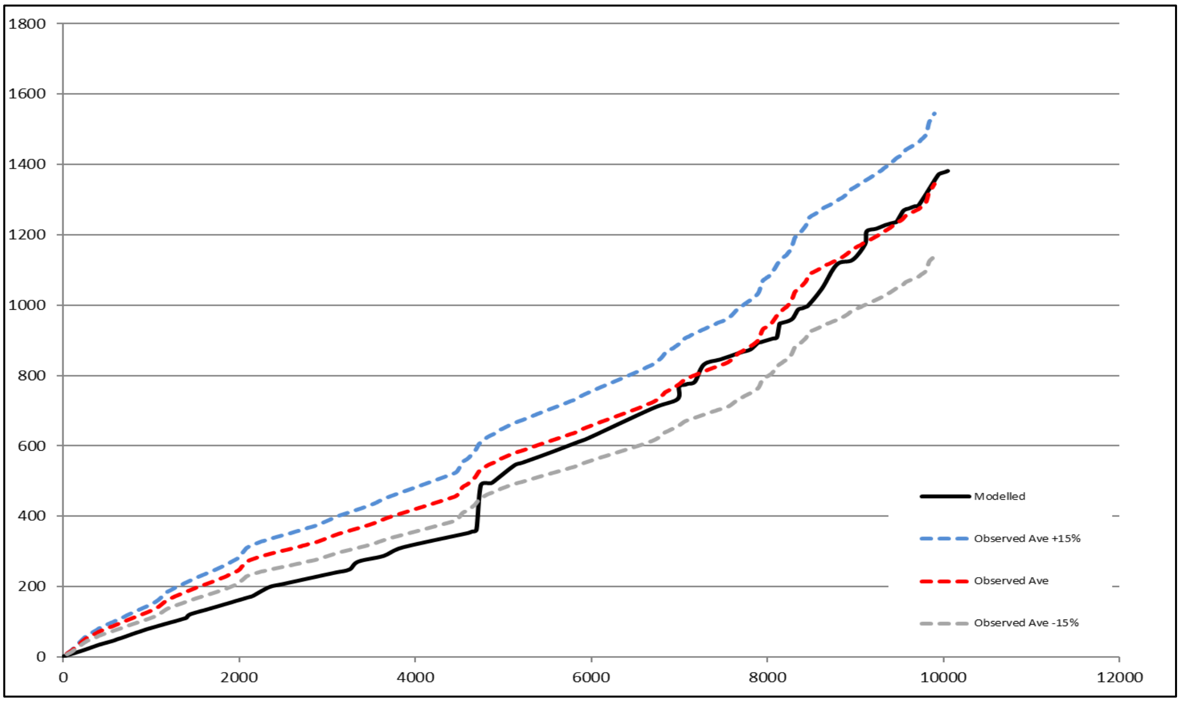


Figure D 46: Route 7, Westbound: Seatoun -> Wellington Station (via Taranaki St, Waterfront)

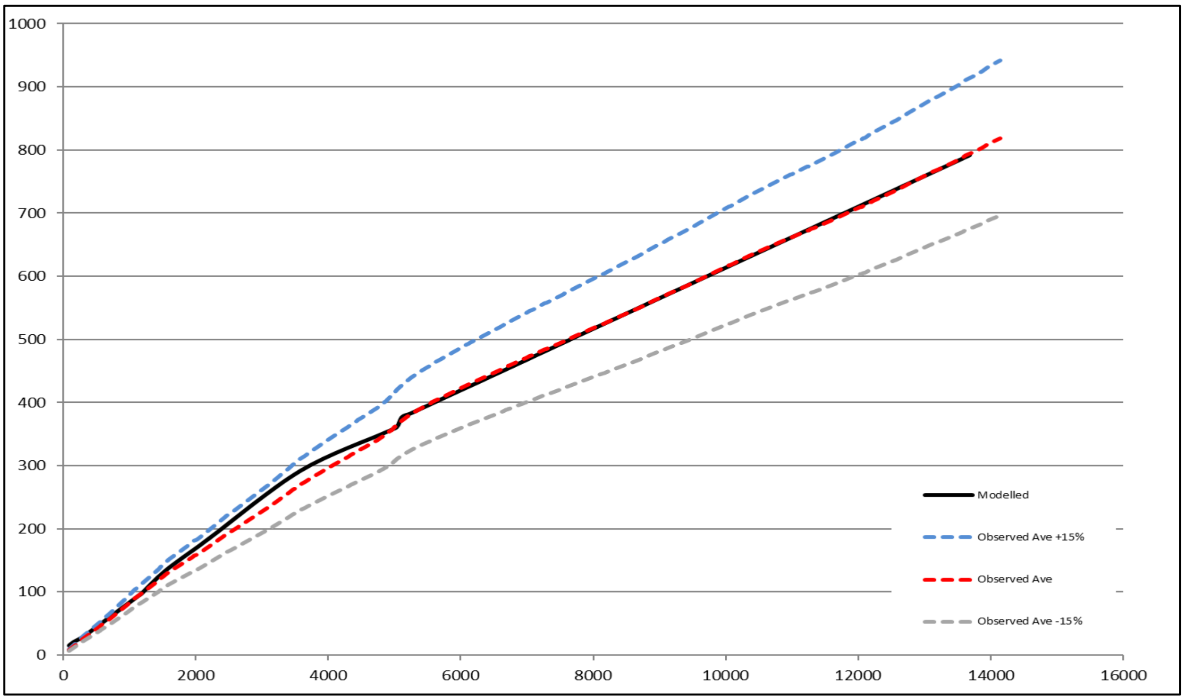


Figure D 47: Route 8, Eastbound: Paremata -> Haywards

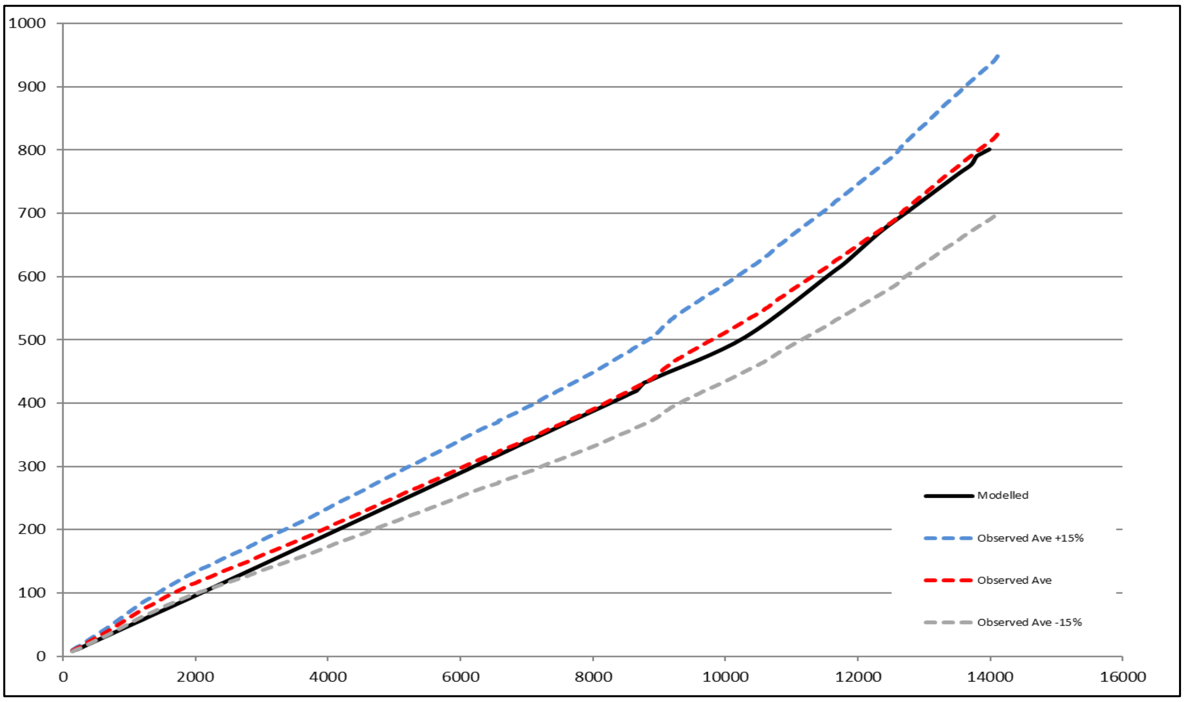


Figure D 48: Route 8, Westbound: Haywards -> Paremata

D.4 PM Peak Hour

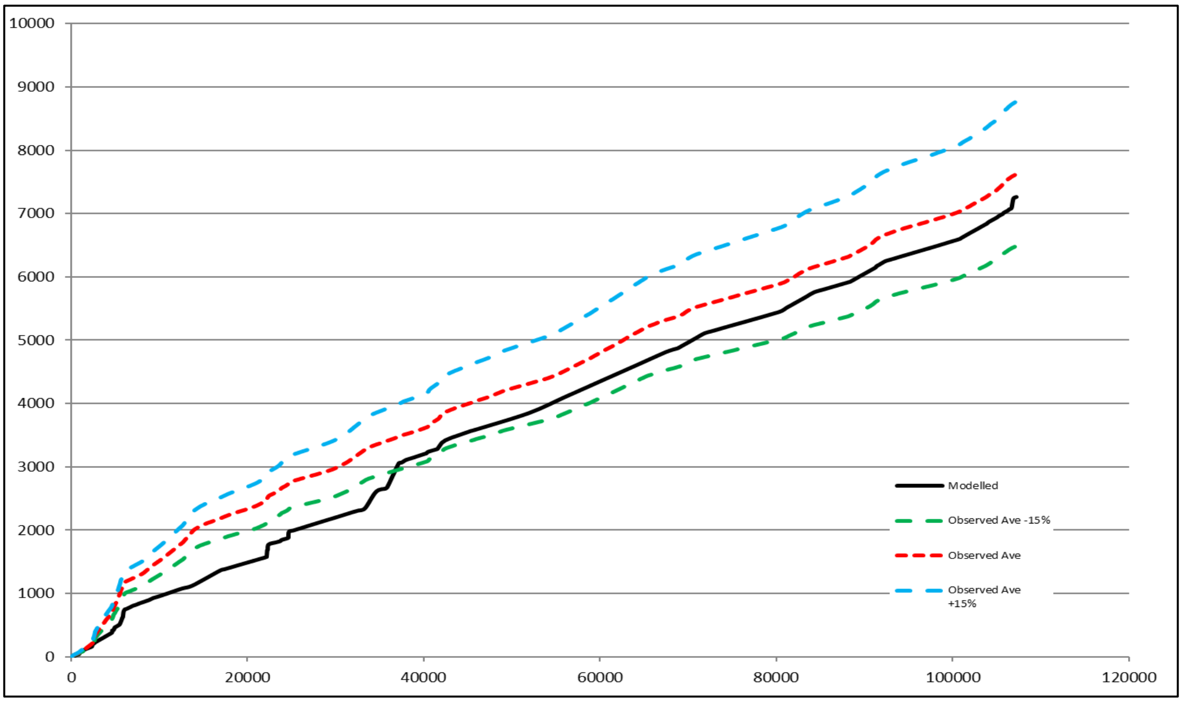


Figure D 49: Route 1, Northbound: Wellington Airport -> North of Masterton

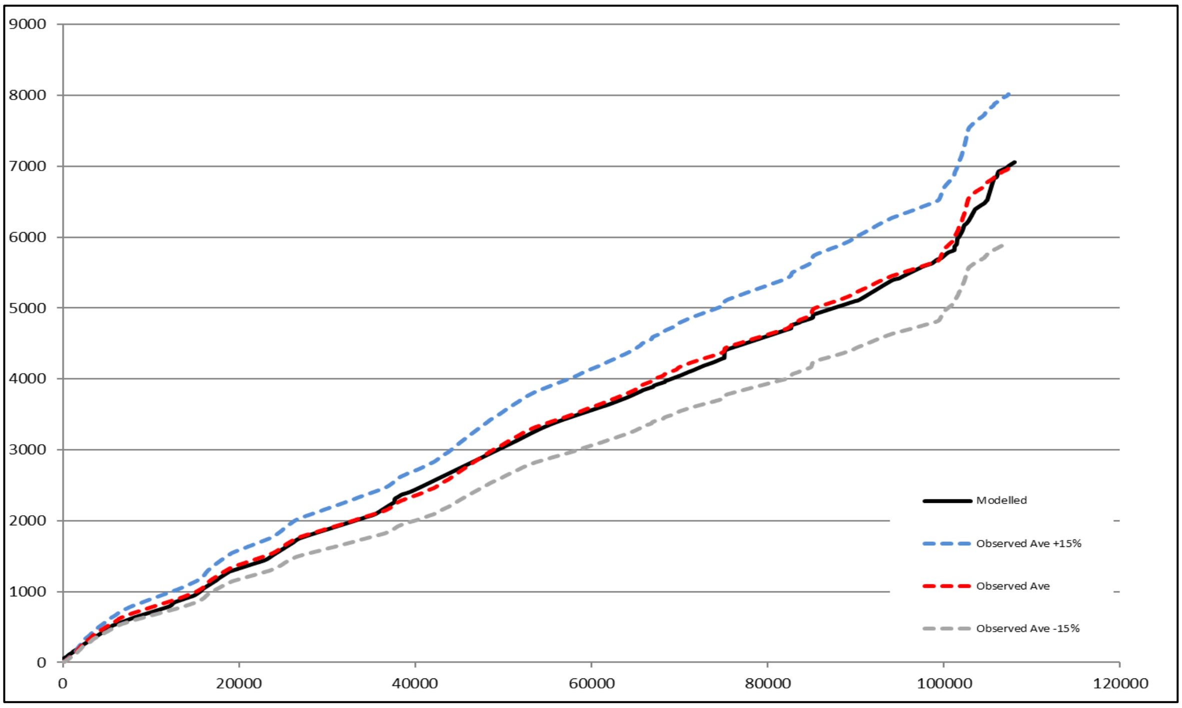


Figure D 50: Route 1, Southbound: North of Masterton -> Wellington Airport

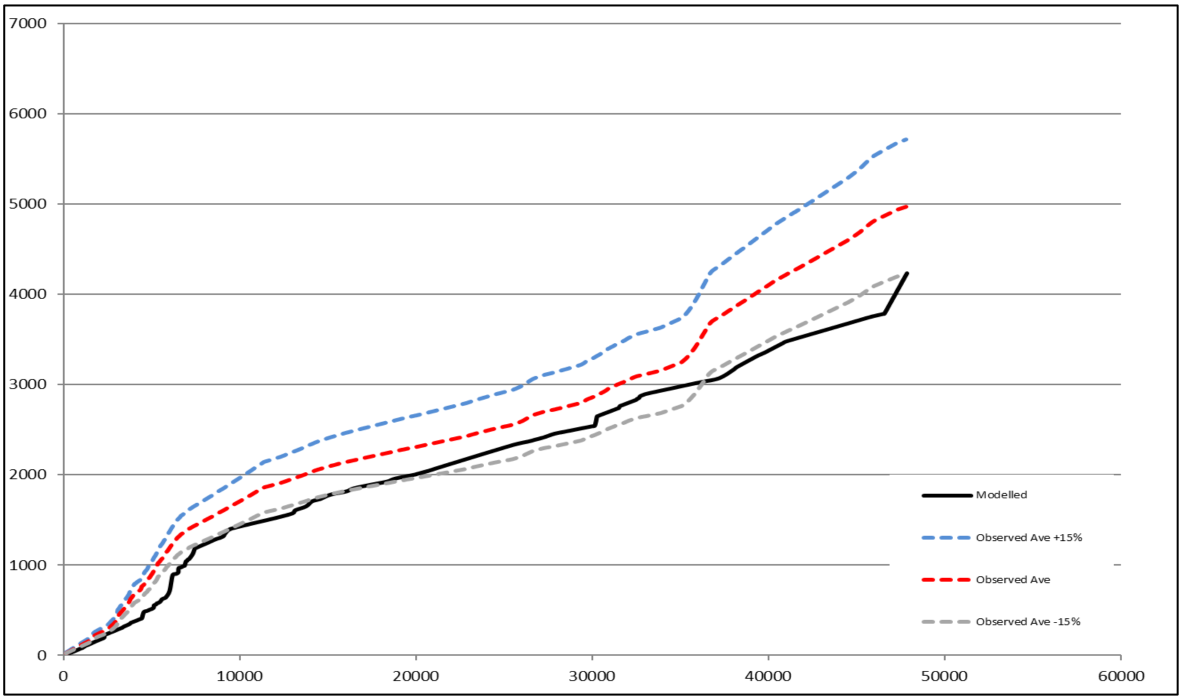


Figure D 51: Route 2, Northbound: Island Bay (via Waterfront) -> Paekakariki

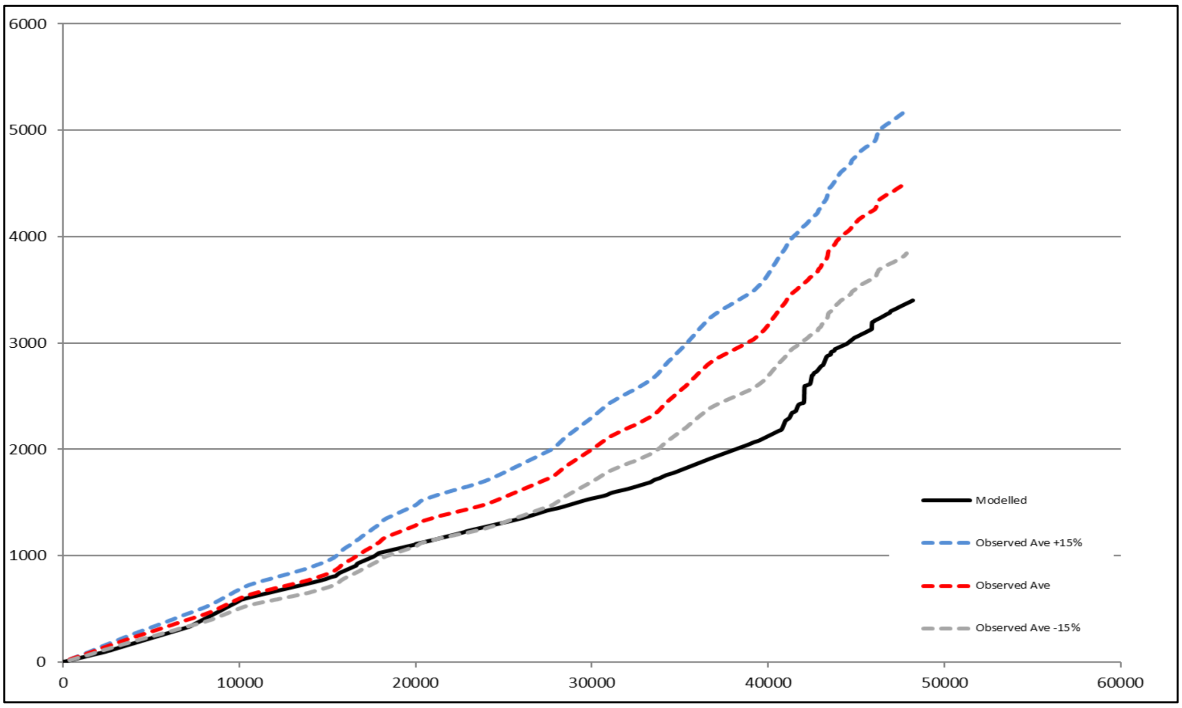


Figure D 52: Route 2, Southbound: Paekakariki -> Island Bay (via Waterfront)

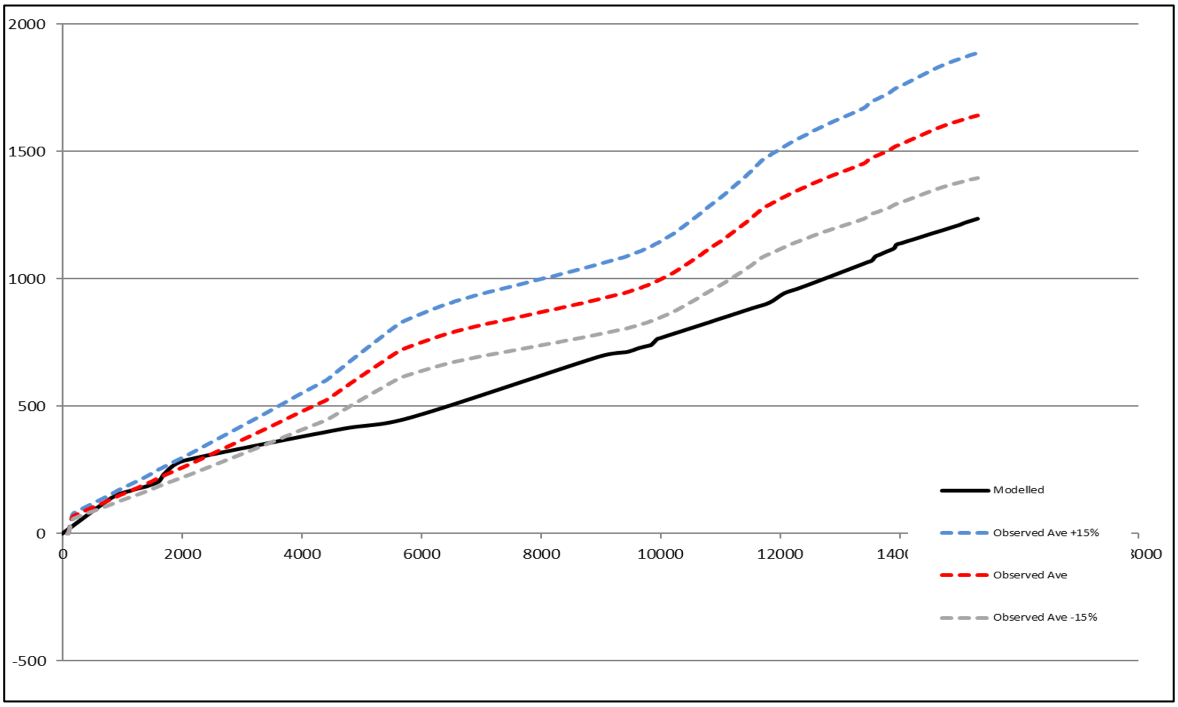


Figure D 53: Route 3, Northbound: Centreport -> Seaview

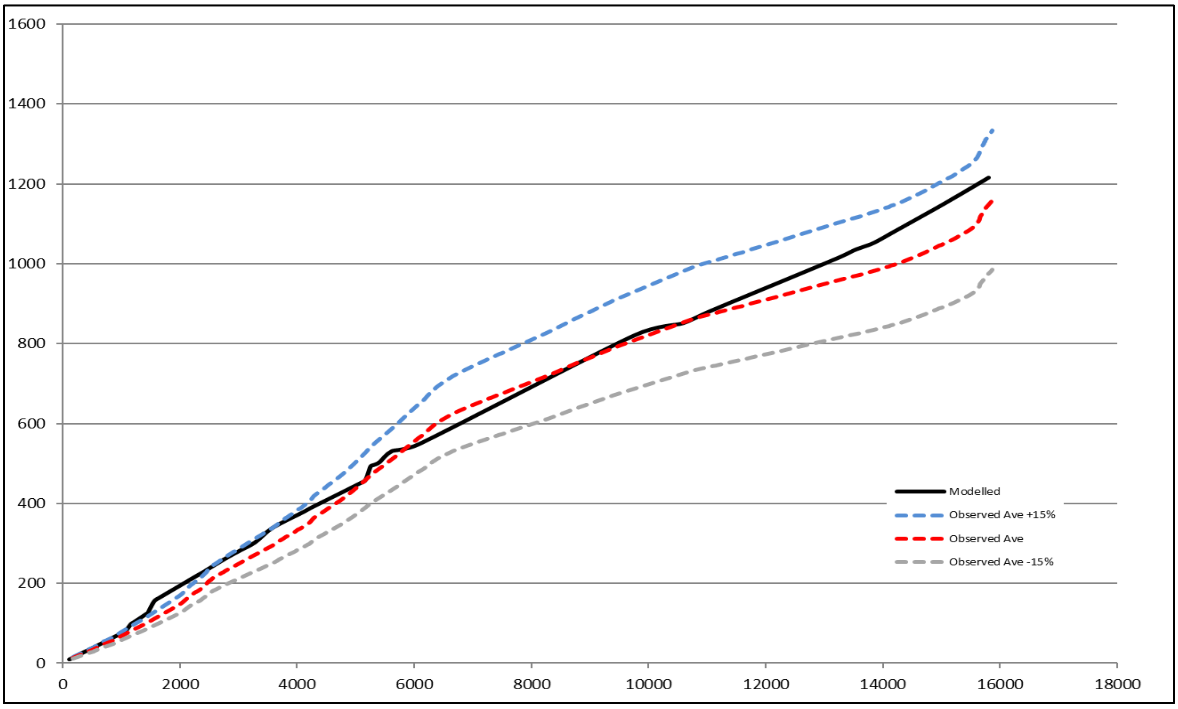


Figure D 54: Route 3, Southbound: Seaview -> Centreport

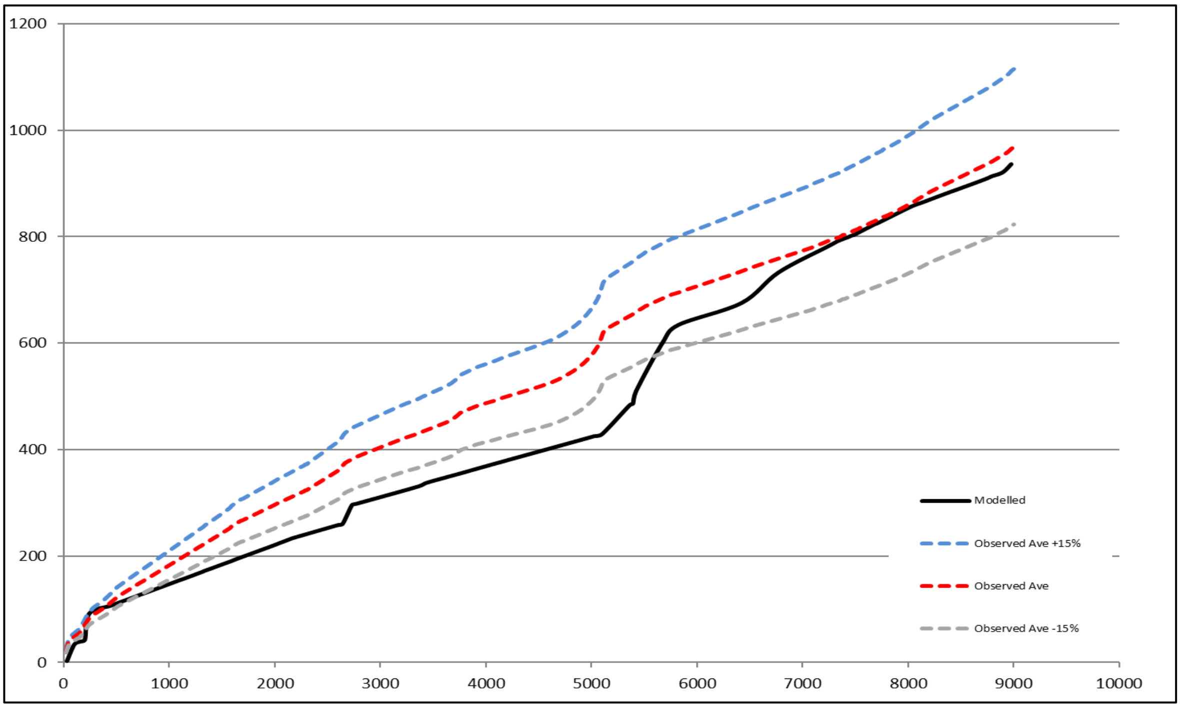


Figure D 55: Route 4, Northbound: Wellington Station (via Hutt Road) -> Newlands

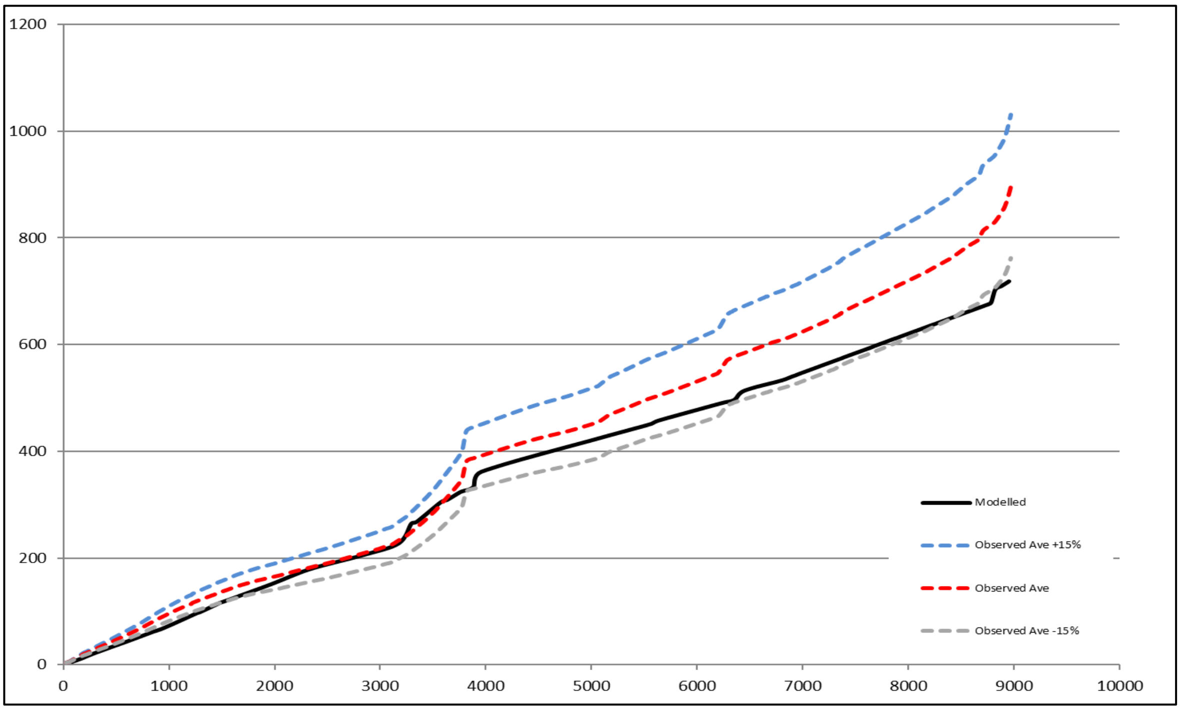


Figure D 56: Route 4, Southbound: Newlands -> Wellington Station (via Hutt Road)

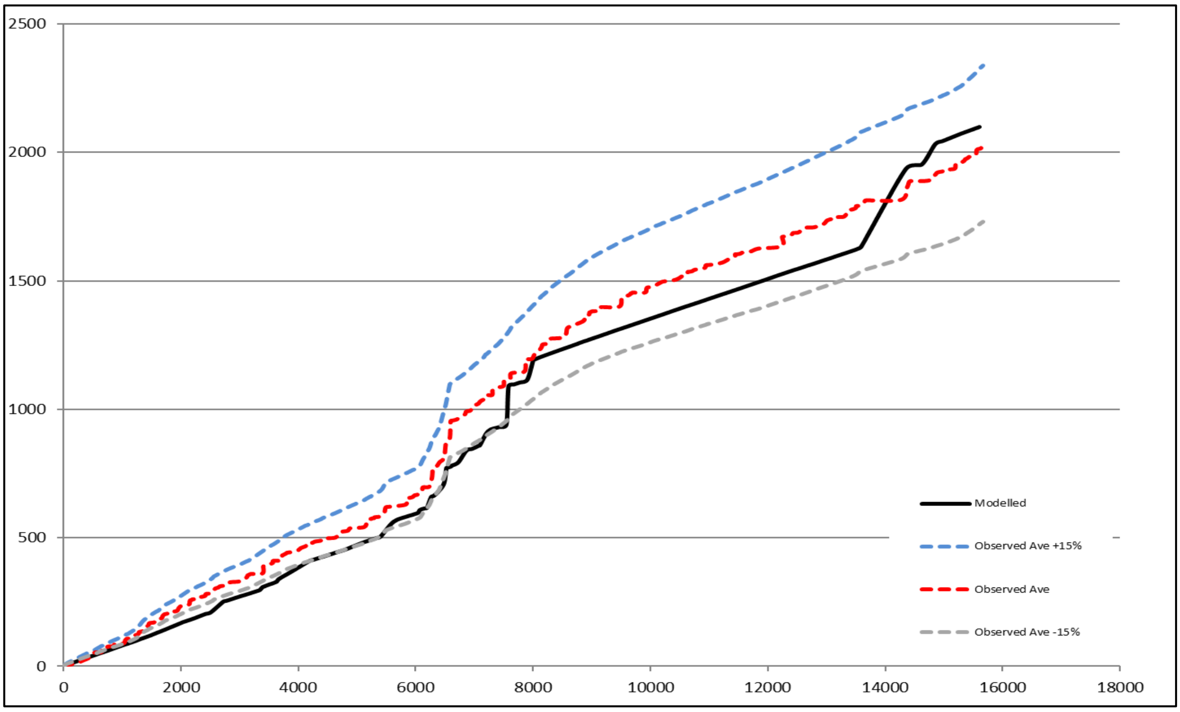


Figure D 57: Route 5, Eastbound: Karori -> Miramar (via Waterfront and Evans Bay)

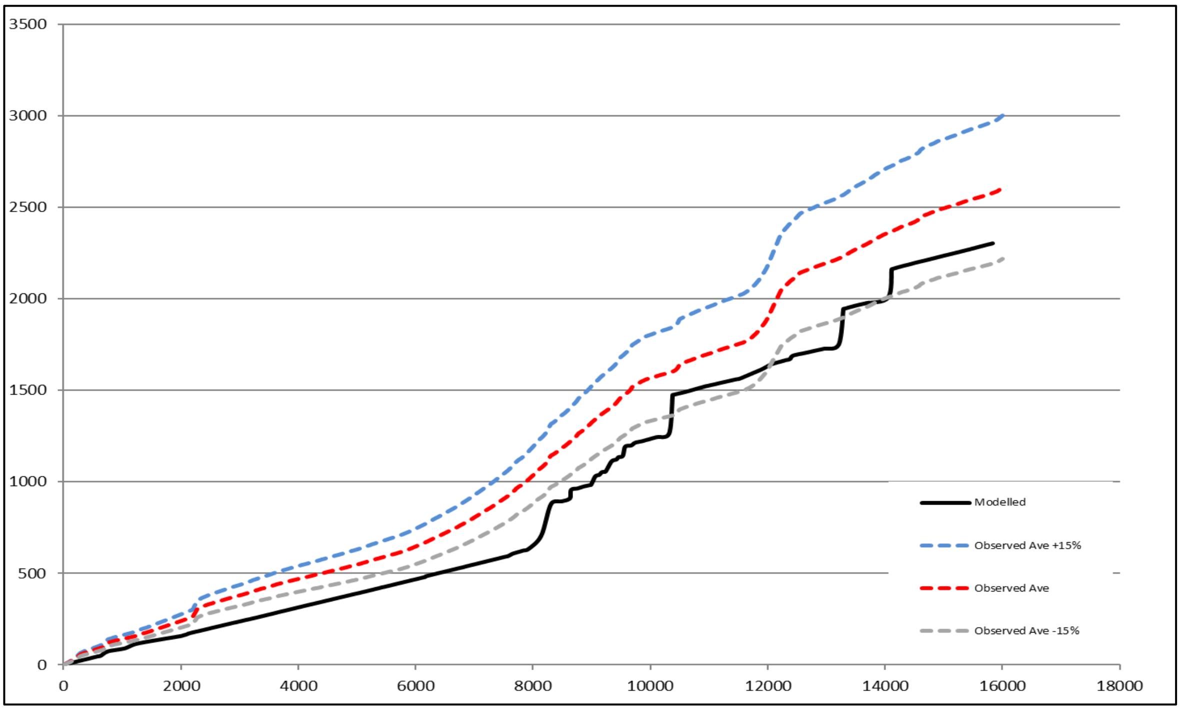


Figure D 58: Route 5, Westbound: Miramar (via Waterfront and Evans Bay) -> Karori

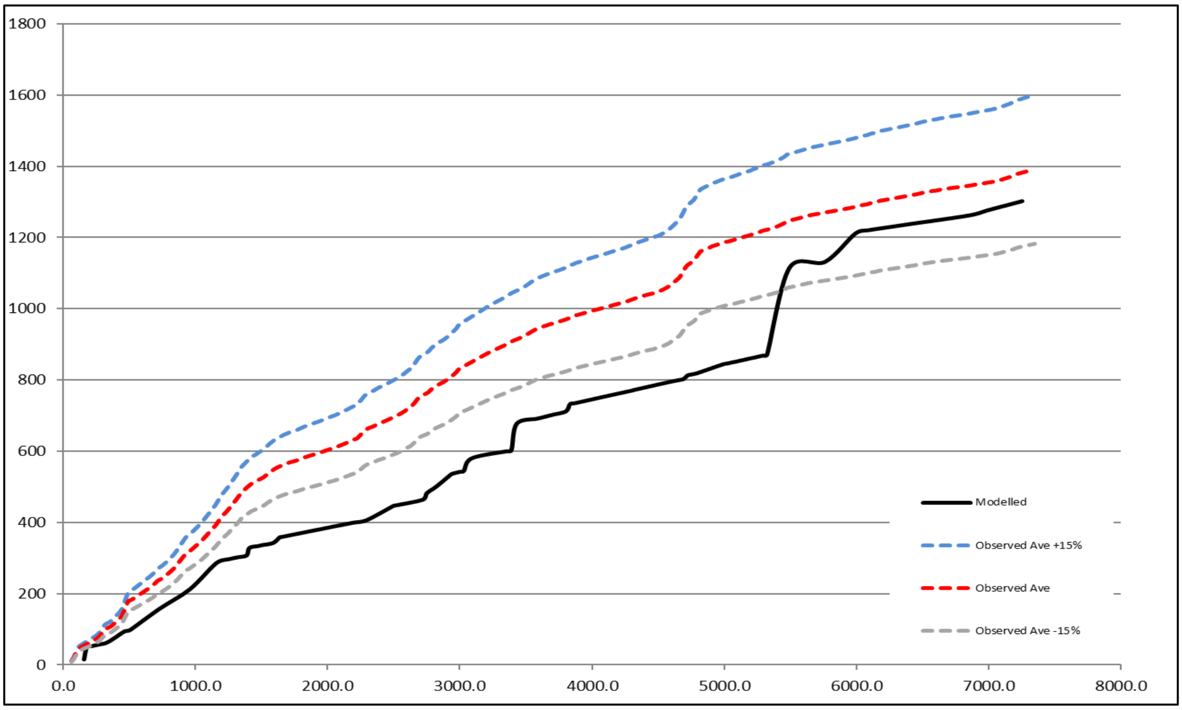


Figure D 59: Route 6, Eastbound: Waterfront (via Kilbirnie, Newtown and Wallace Street) -> Airport

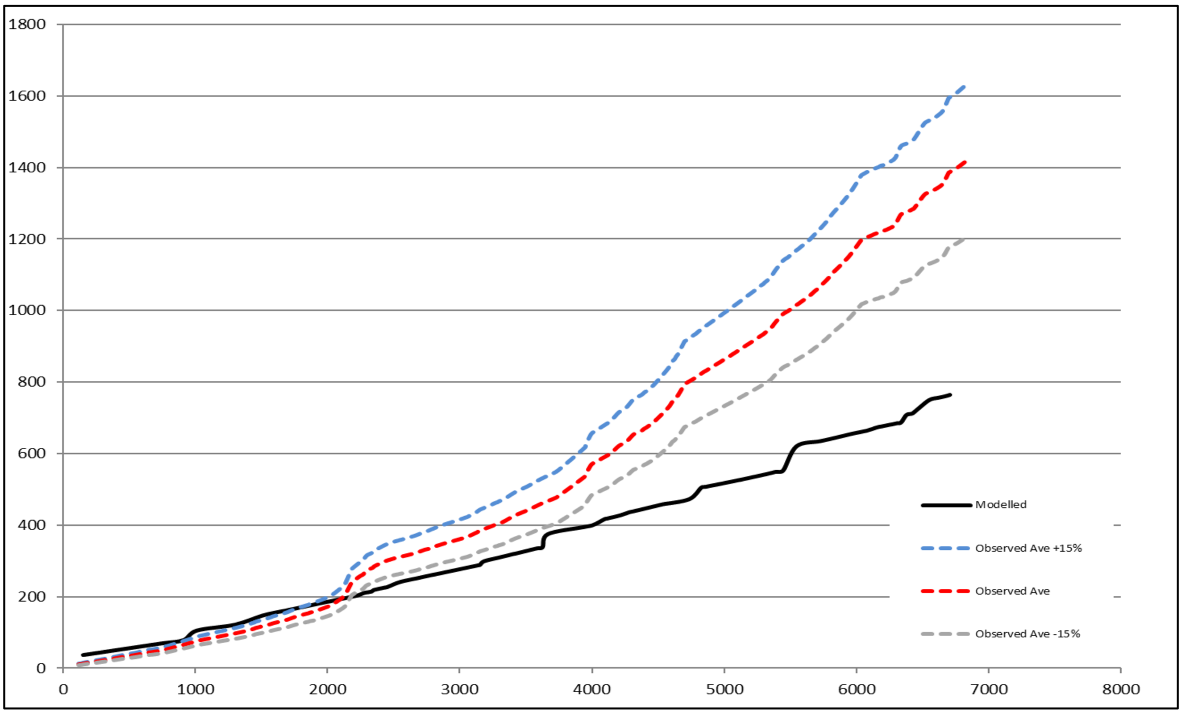


Figure D 60: Route 6, Westbound: Airport -> Waterfront (via Kilbirnie, Newtown and Wallace Street)

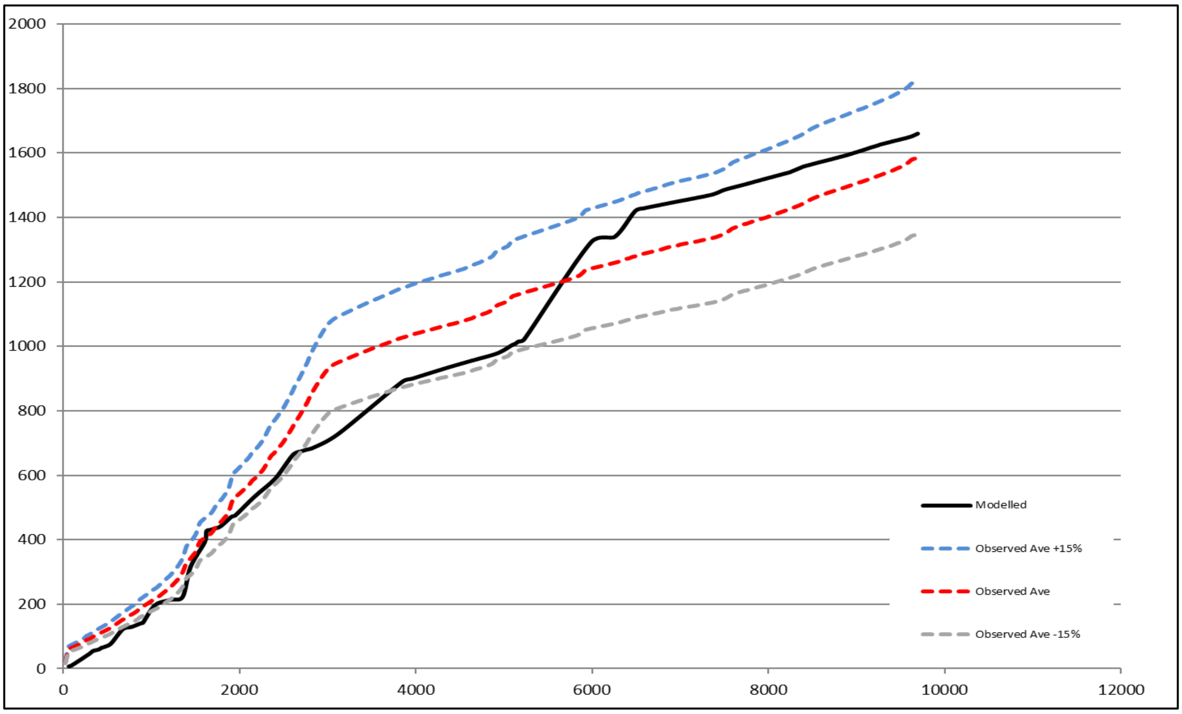


Figure D 61: Route 7, Eastbound: Wellington Station (via Taranaki St, Waterfront) -> Seatoun

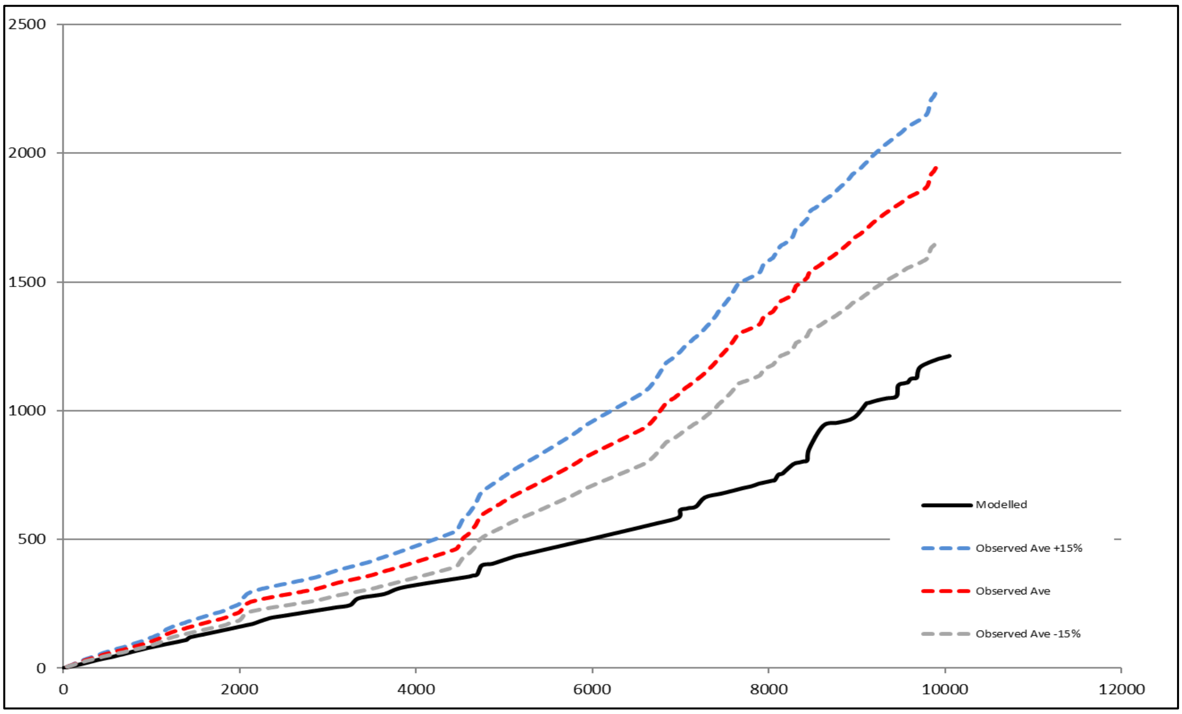


Figure D 62: Route 7, Westbound: Seatoun -> Wellington Station (via Taranaki St, Waterfront)

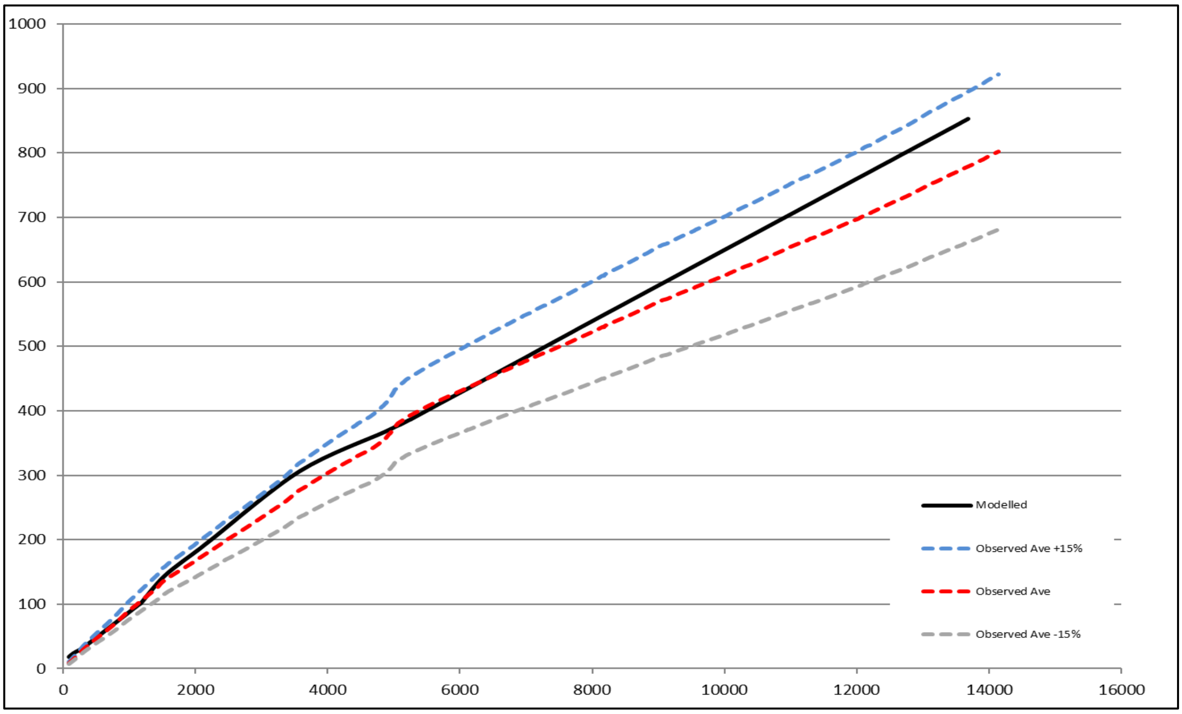


Figure D 63: Route 8, Eastbound: Paremata -> Haywards

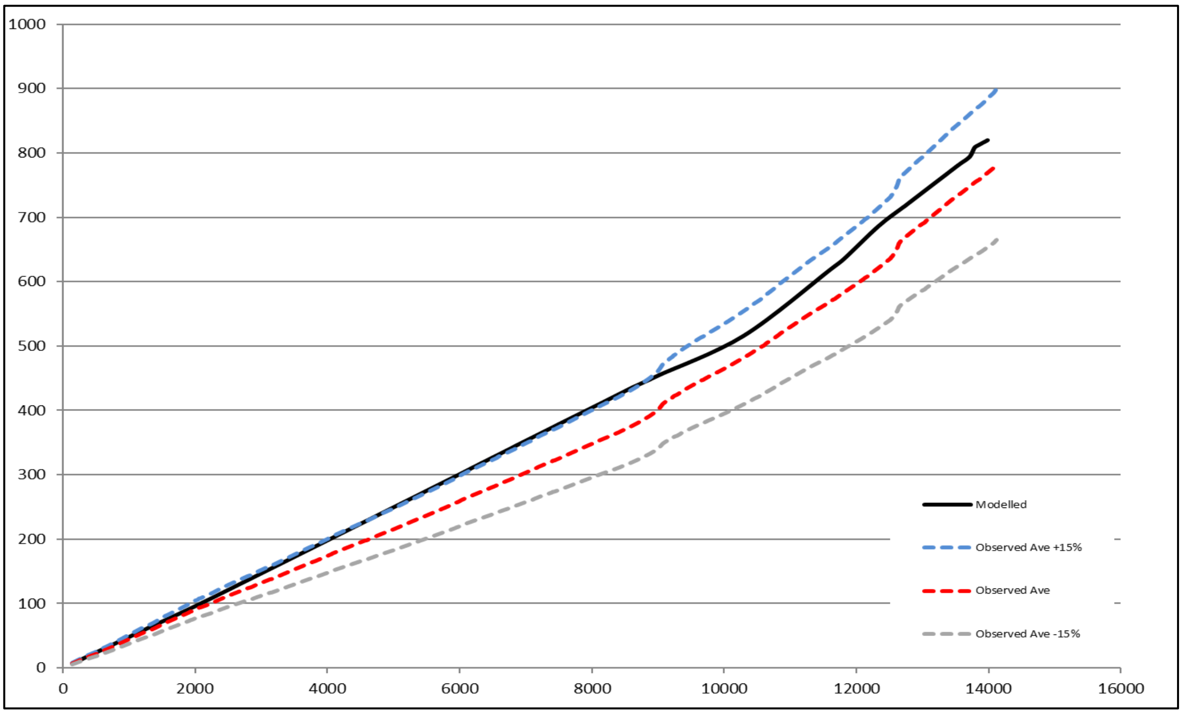


Figure D 64: Route 8, Westbound: Haywards -> Paremata

D.5 PM Shoulder

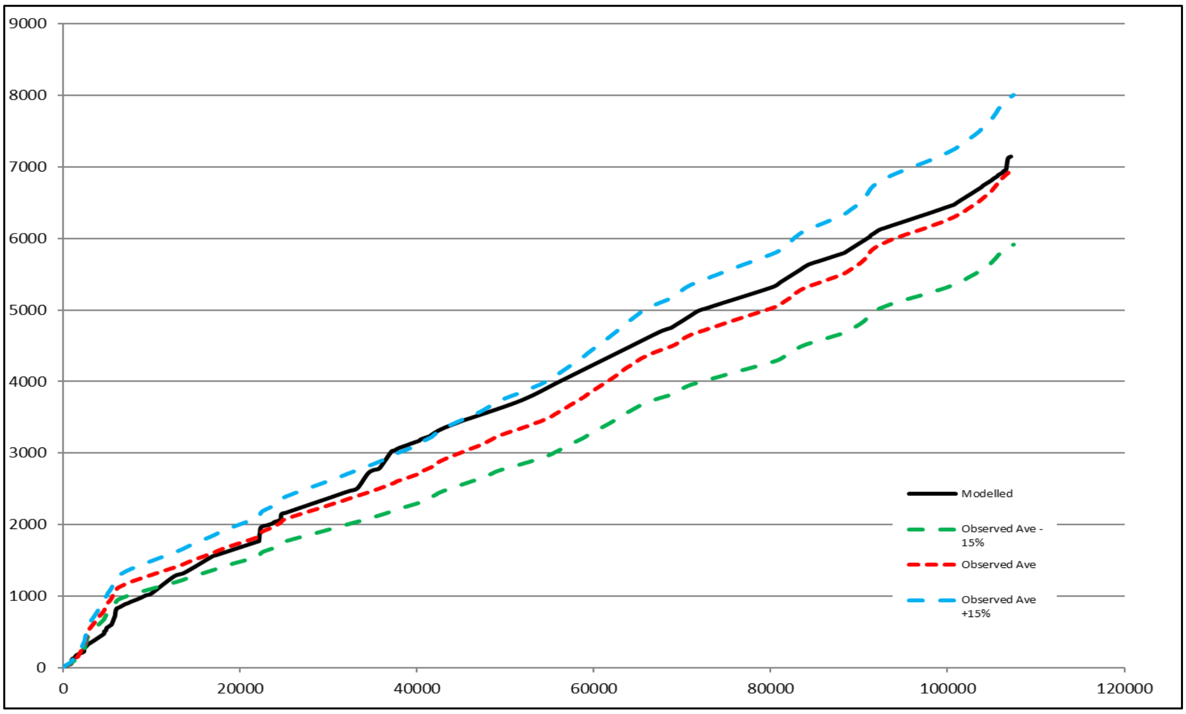


Figure D 65: Route 1, Northbound: Wellington Airport -> North of Masterton

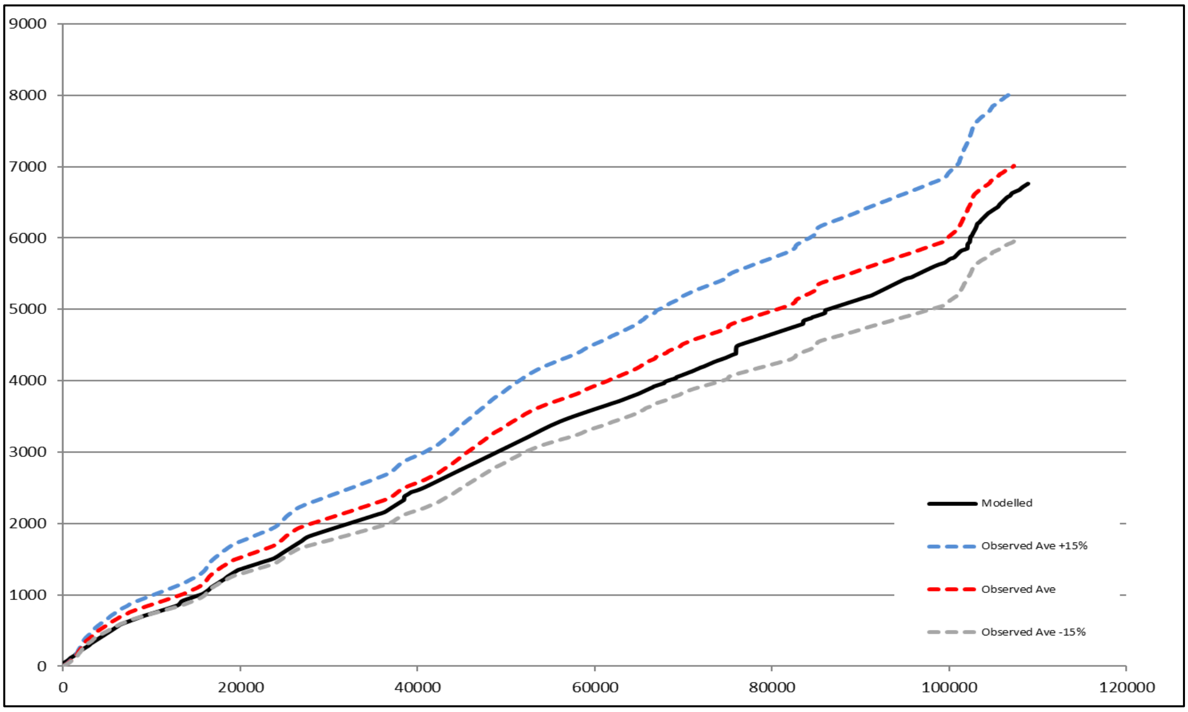


Figure D 66: Route 1, Southbound: North of Masterton -> Wellington Airport

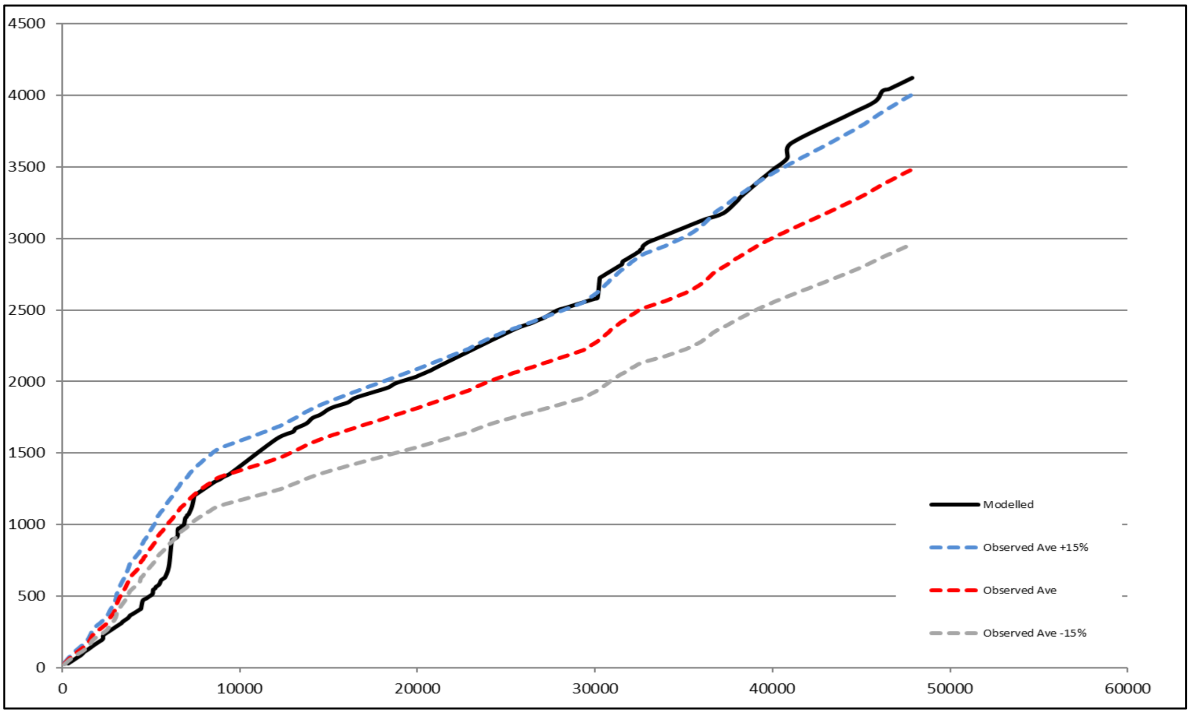


Figure D 67: Route 2, Northbound: Island Bay (via Waterfront) -> Paekakariki

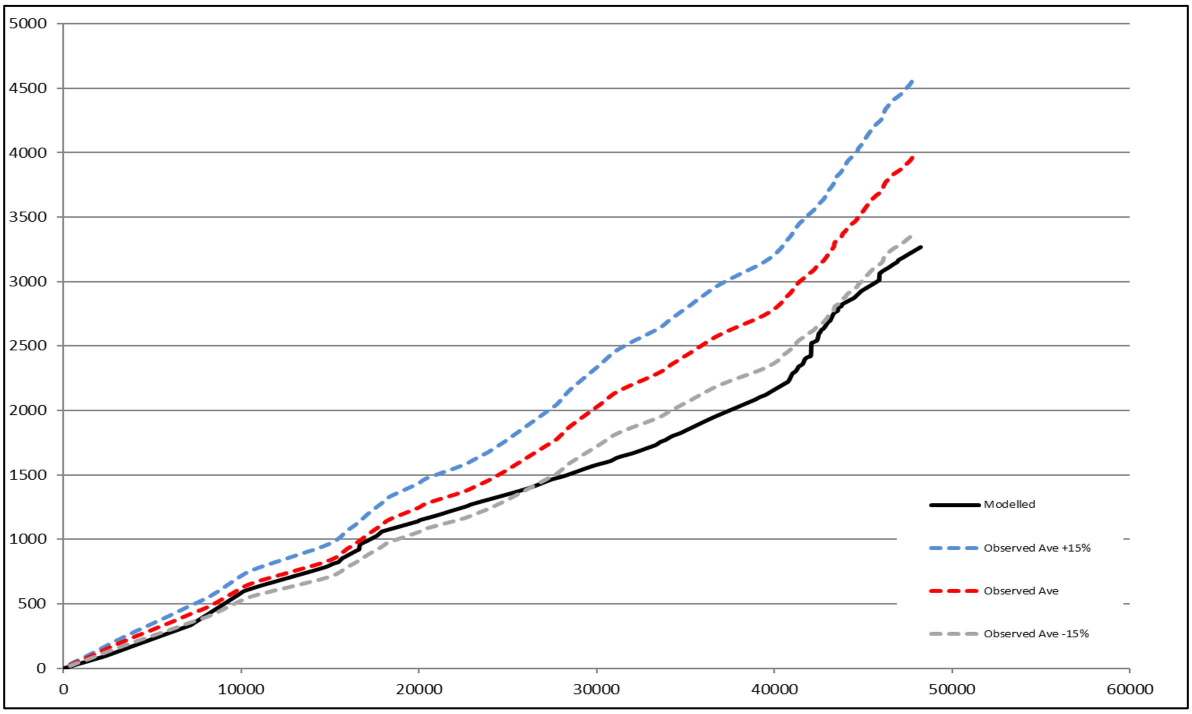


Figure D 68: Route 2, Southbound: Paekakariki -> Island Bay (via Waterfront)

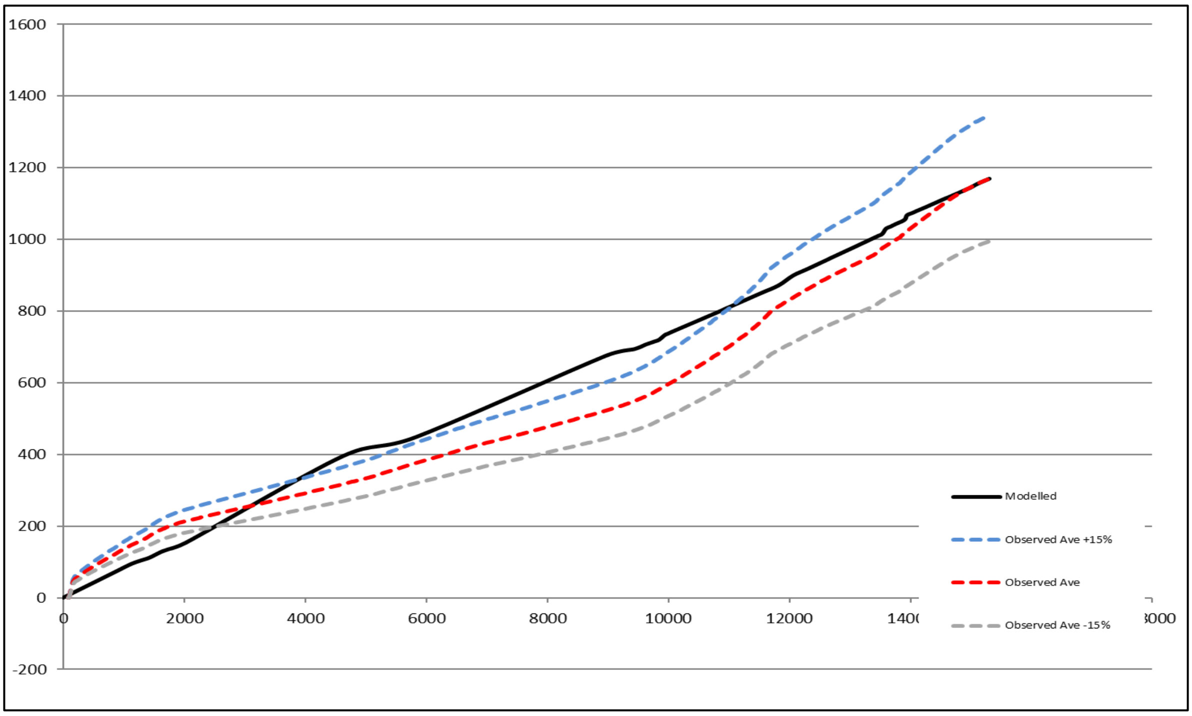


Figure D 69: Route 3, Northbound: Centreport -> Seaview

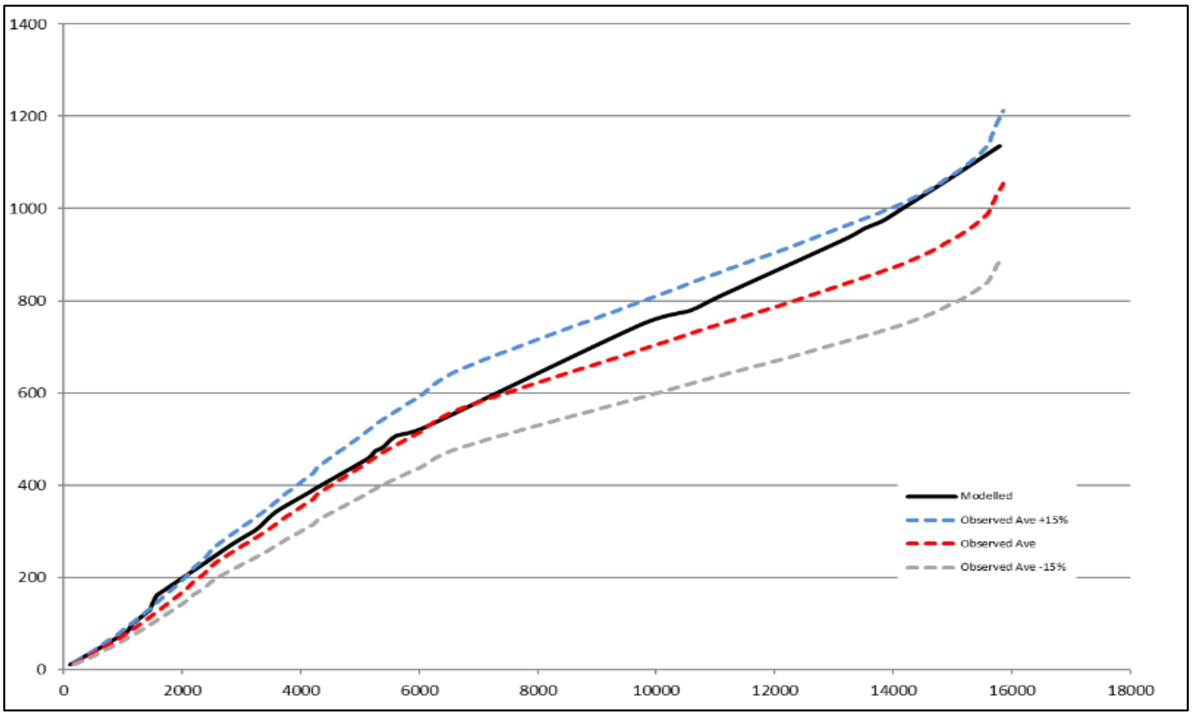


Figure D 70: Route 3, Southbound: Seaview -> Centreport

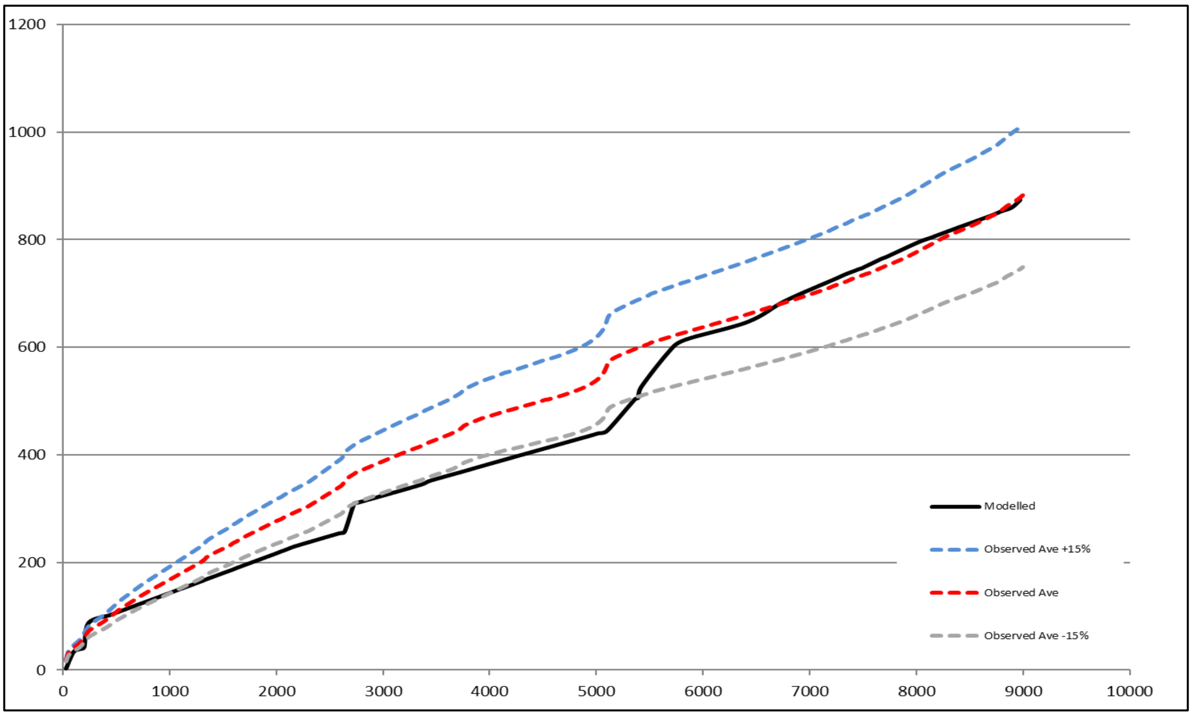


Figure D 71: Route 4, Northbound: Wellington Station (via Hutt Road) -> Newlands

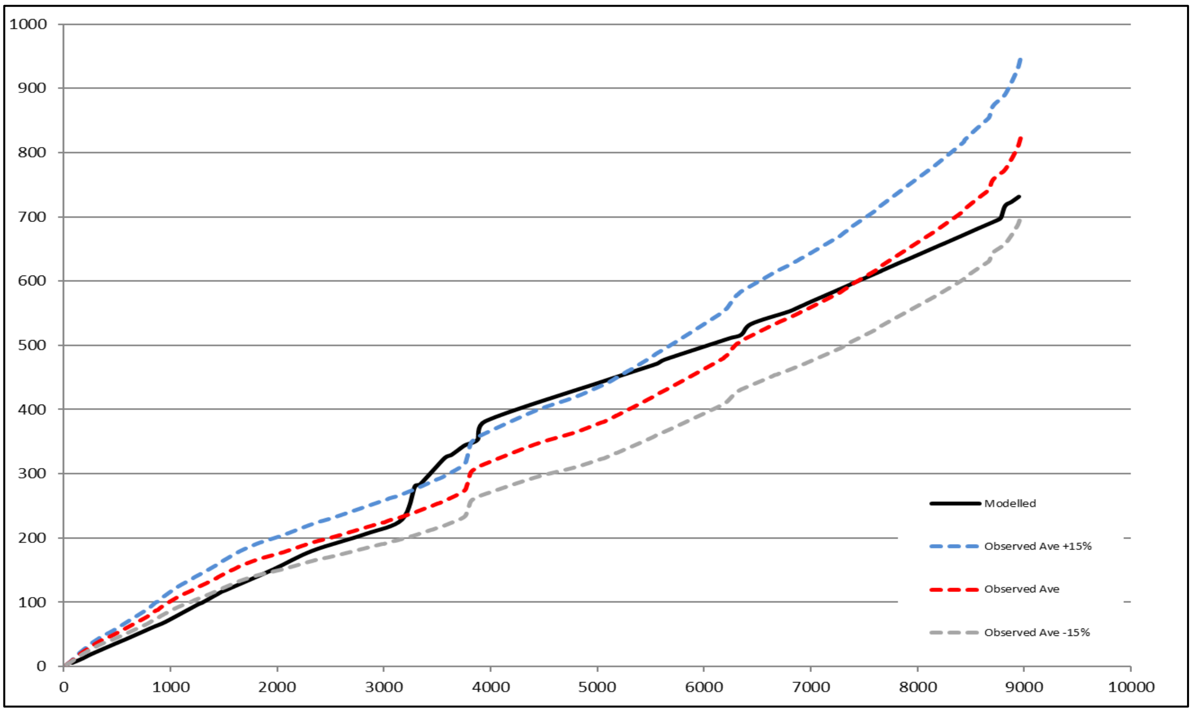


Figure D 72: Route 4, Southbound: Newlands -> Wellington Station (via Hutt Road)

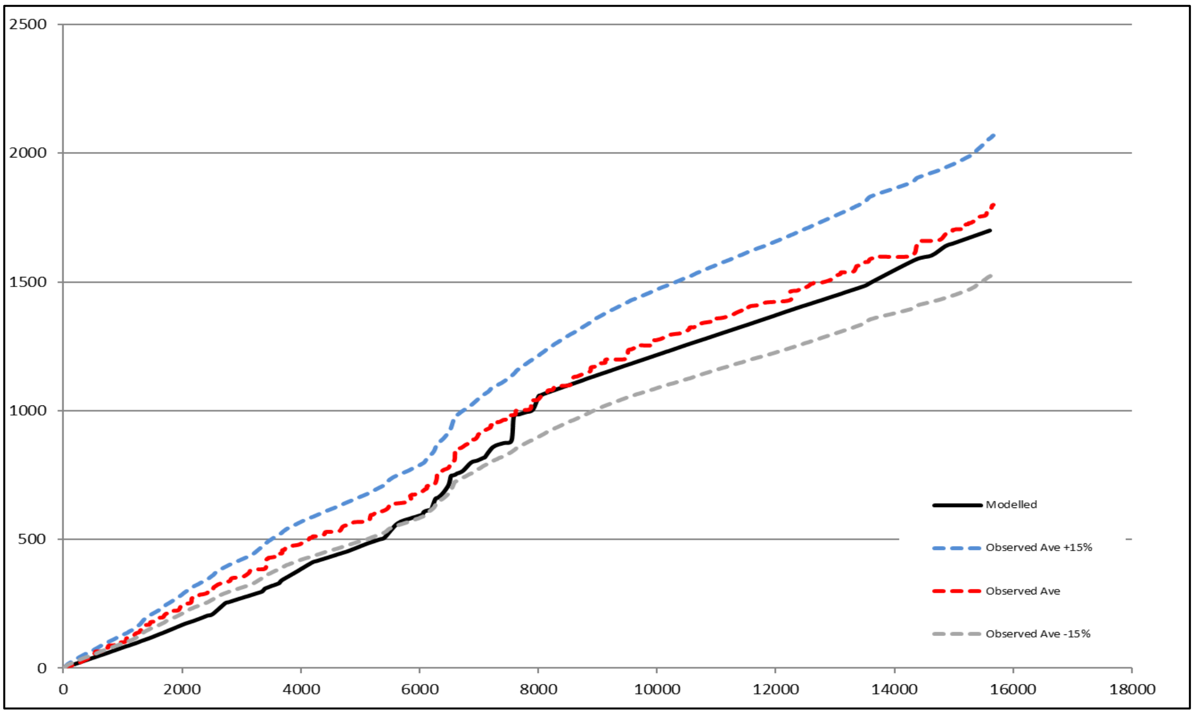


Figure D 73: Route 5, Eastbound: Karori -> Miramar (via Waterfront and Evans Bay)

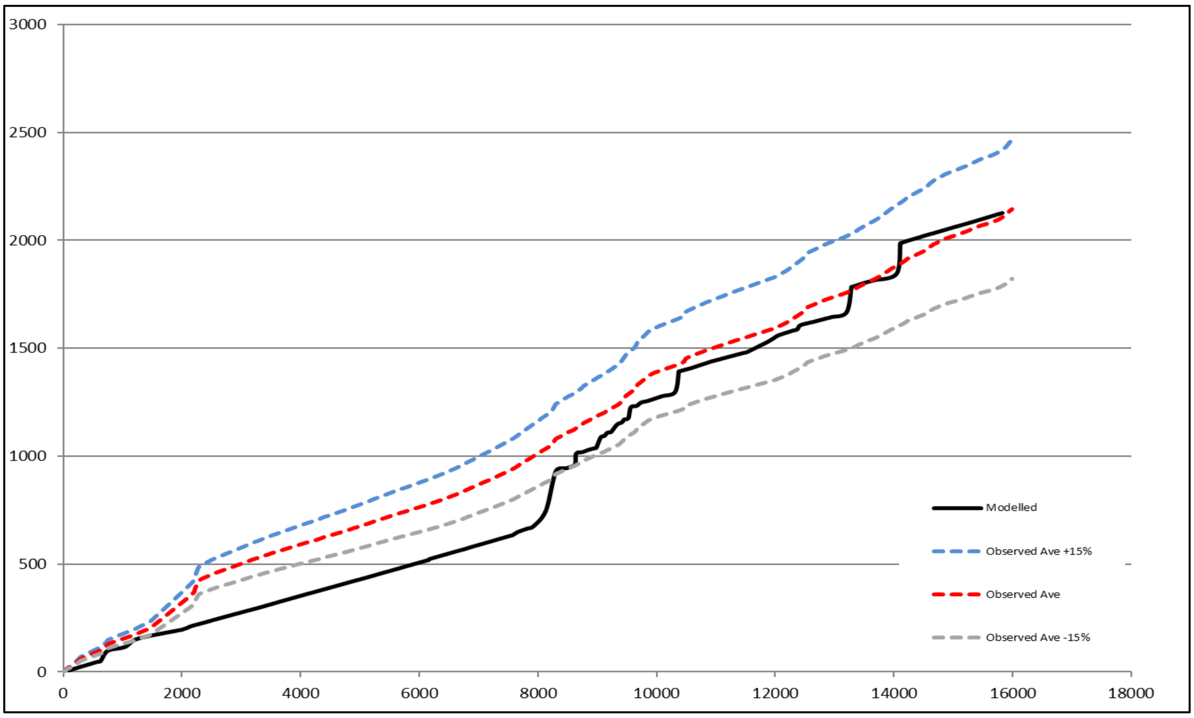


Figure D 74: Route 5, Westbound: Miramar (via Waterfront and Evans Bay) -> Karori

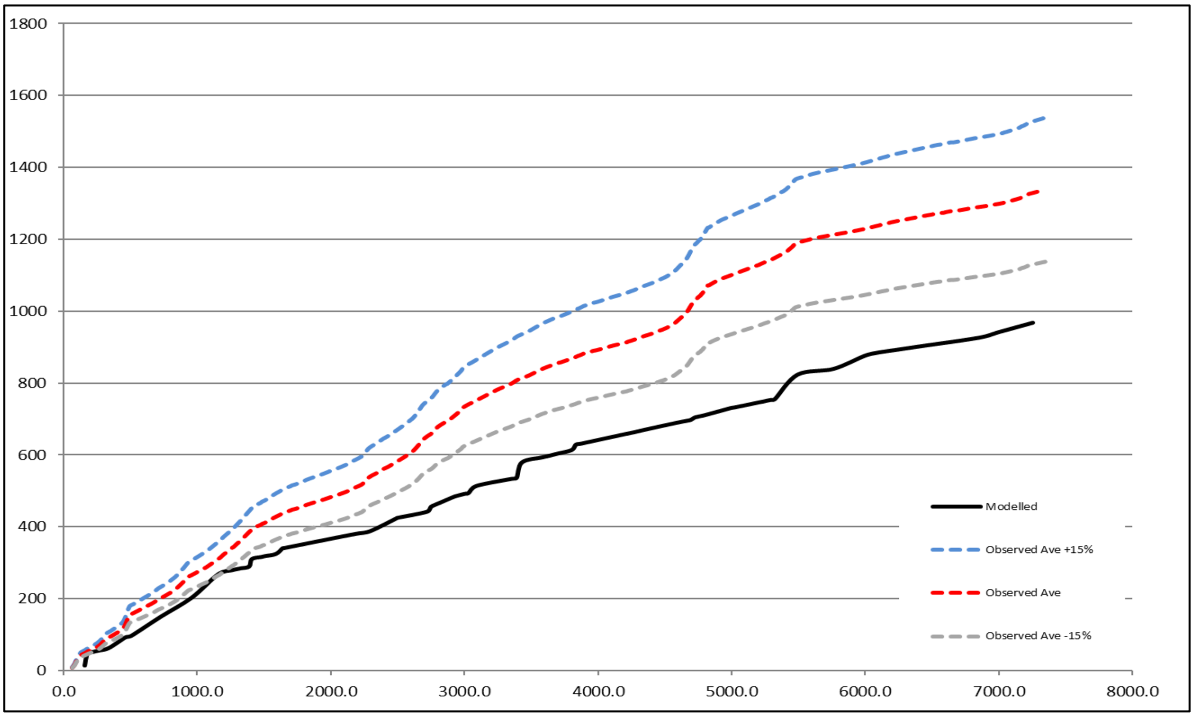


Figure D 75: Route 6, Eastbound: Waterfront (via Kilbirnie, Newtown and Wallace Street) -> Airport

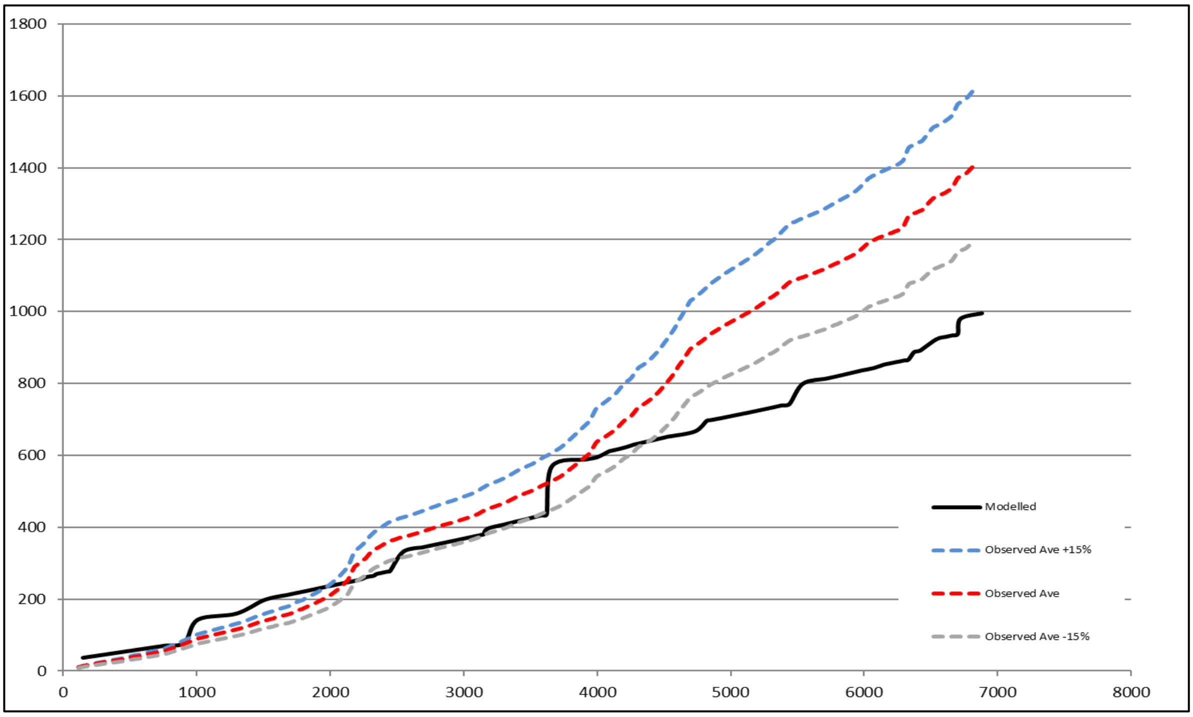


Figure D 76: Route 6, Westbound: Airport -> Waterfront (via Kilbirnie, Newtown and Wallace Street)

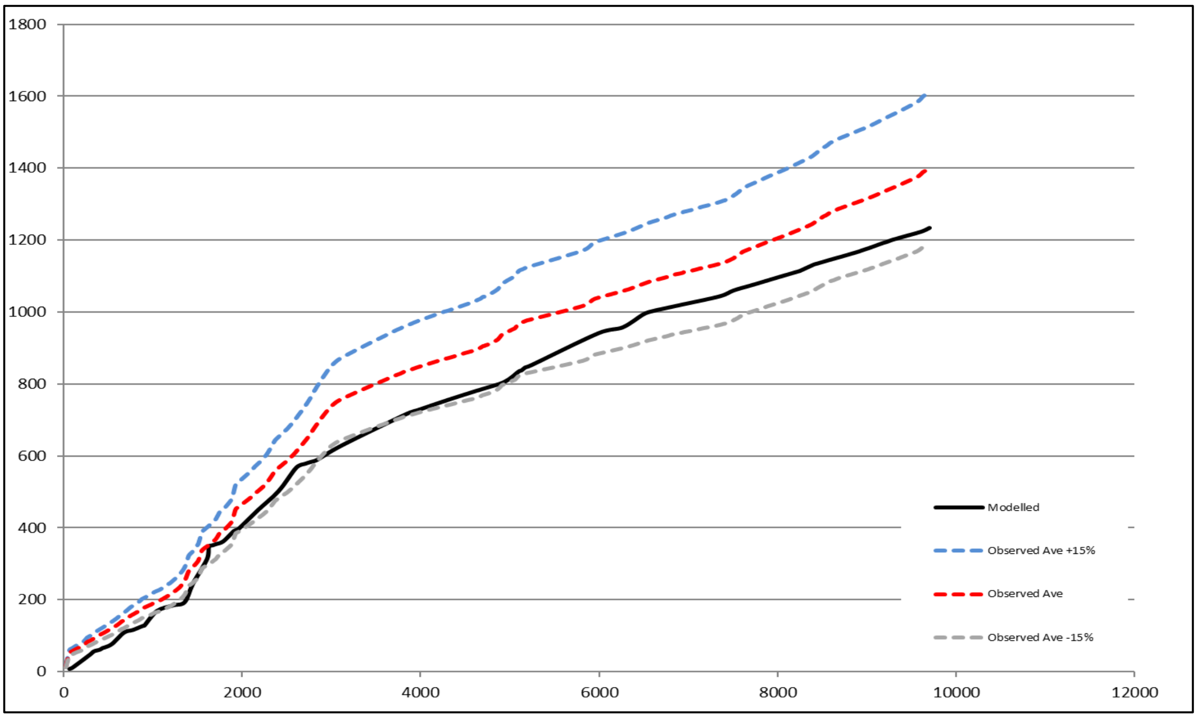


Figure D 77: Route 7, Eastbound: Wellington Station (via Taranaki St, Waterfront) -> Seatoun

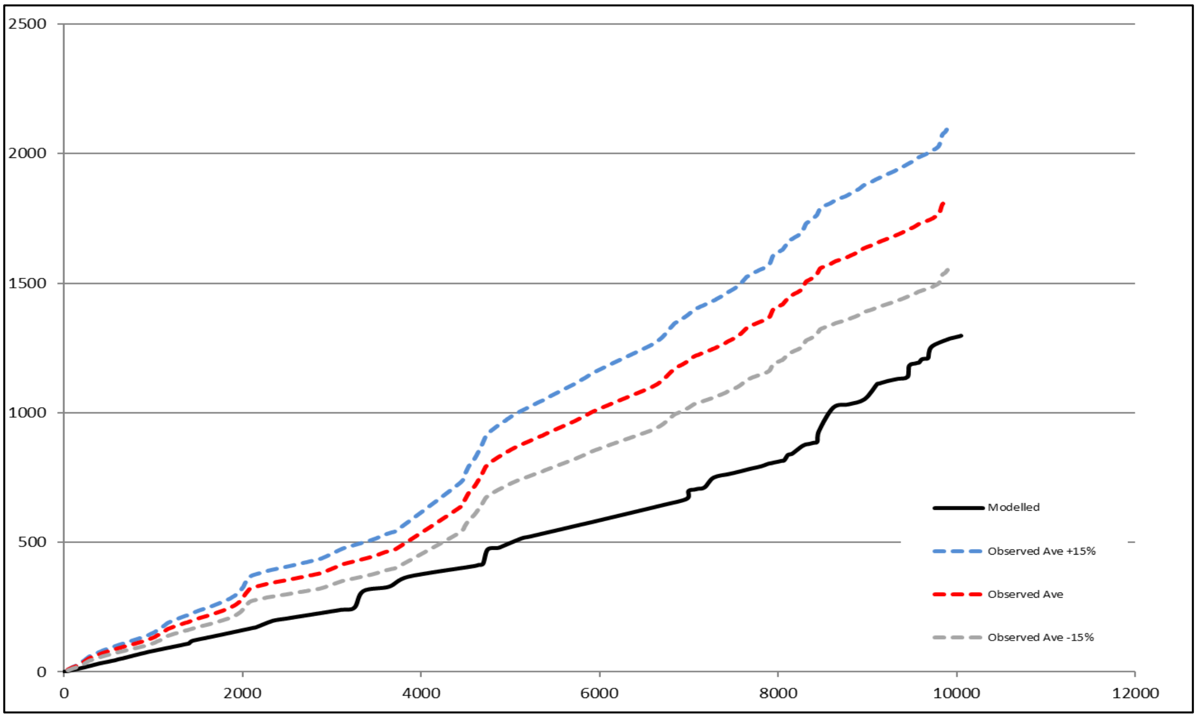


Figure D 78: Route 7, Westbound: Seatoun -> Wellington Station (via Taranaki St, Waterfront)

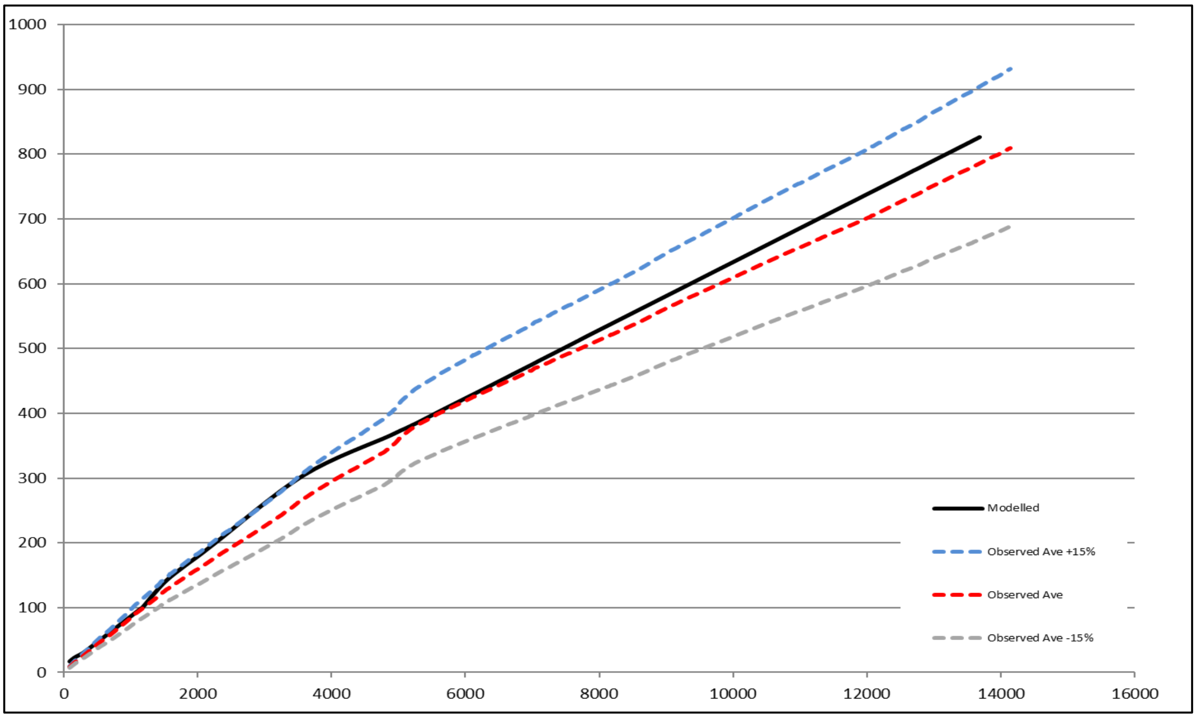


Figure D 79: Route 8, Eastbound: Paremata -> Haywards

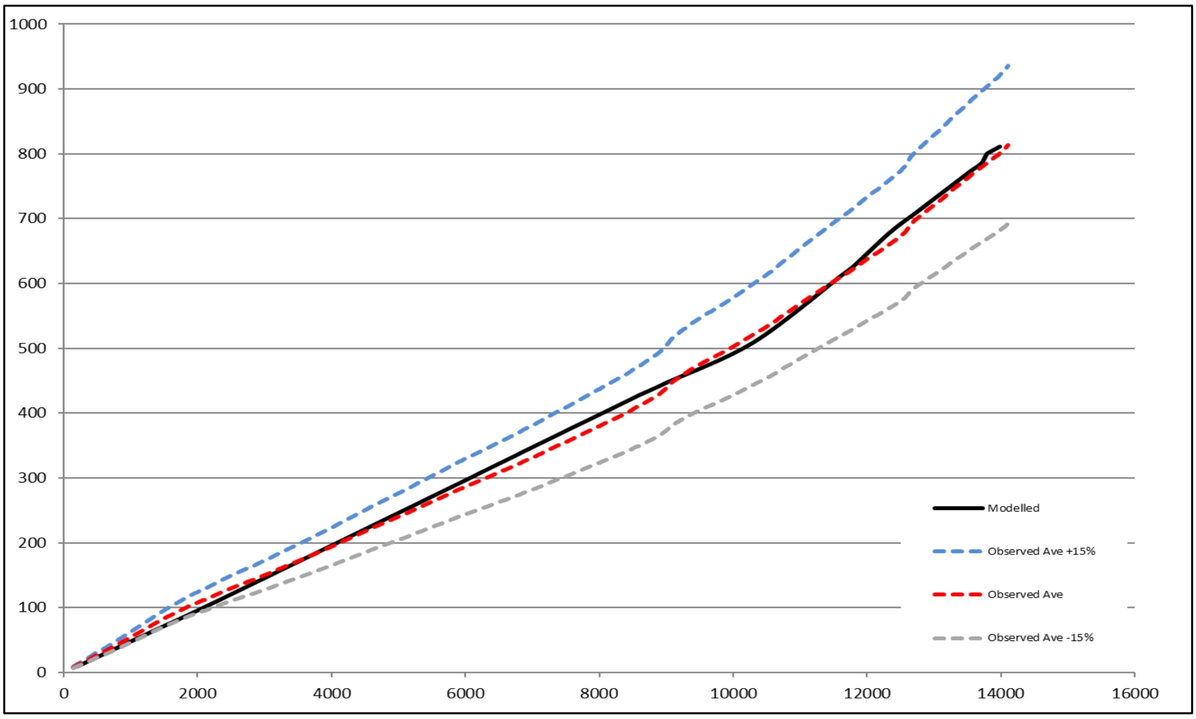


Figure D 80: Route 8, Westbound: Haywards -> Paremata

Appendix E Select Link Results

The select links below have been taken for the AM and PM peak hours to show route choice at certain key locations.

E.1 AM Peak Hour Select Links

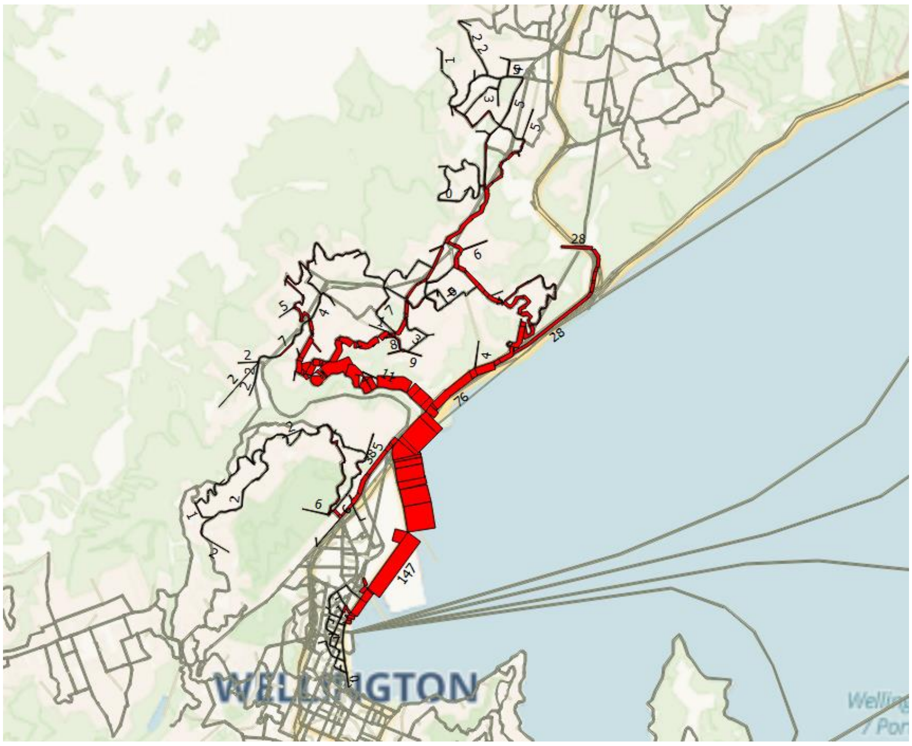


Figure E 1: Ngauranga to Aotea Quay (SB)

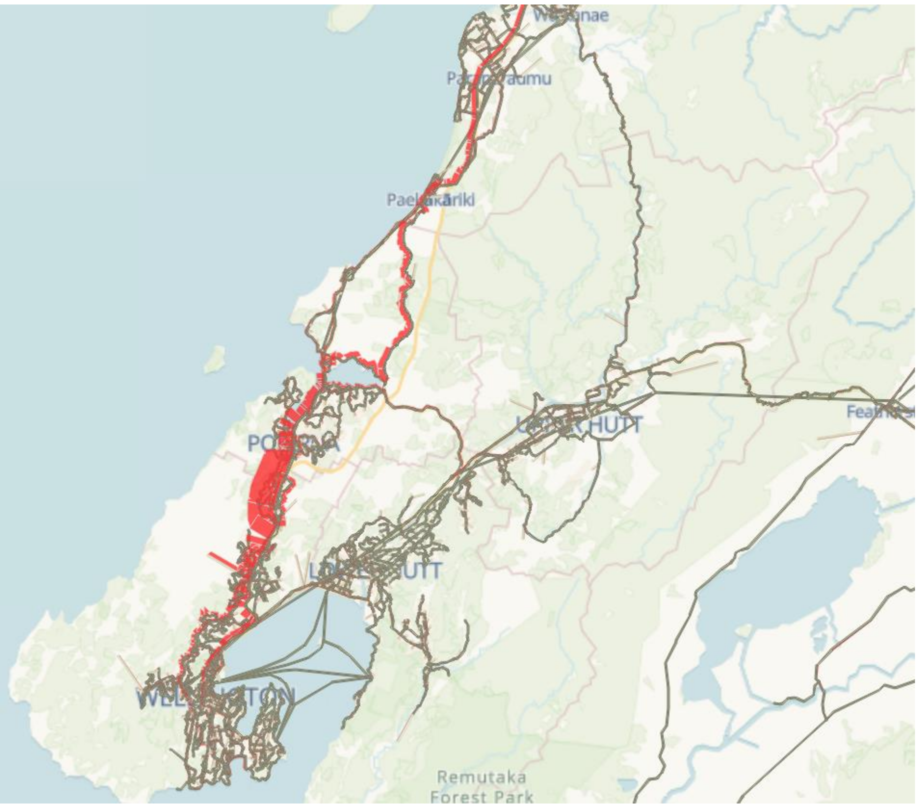


Figure E 2: Tawa SH1 (NB)

Figure E 3: Tawa SH1 (SB)

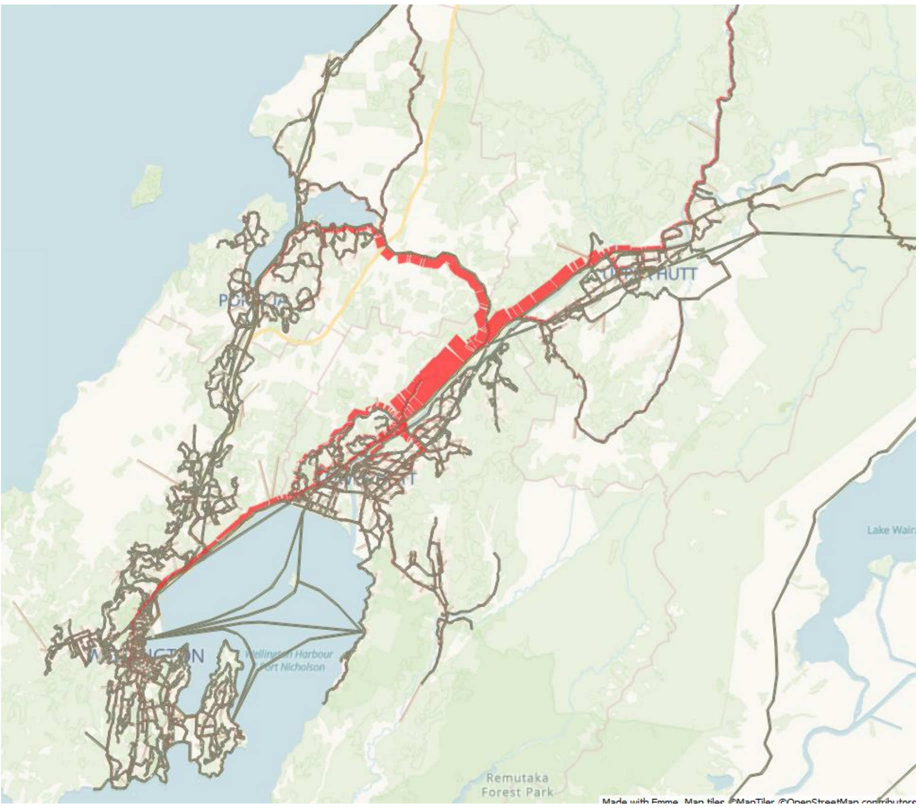


Figure E 4: Kelson SH2 (NB)

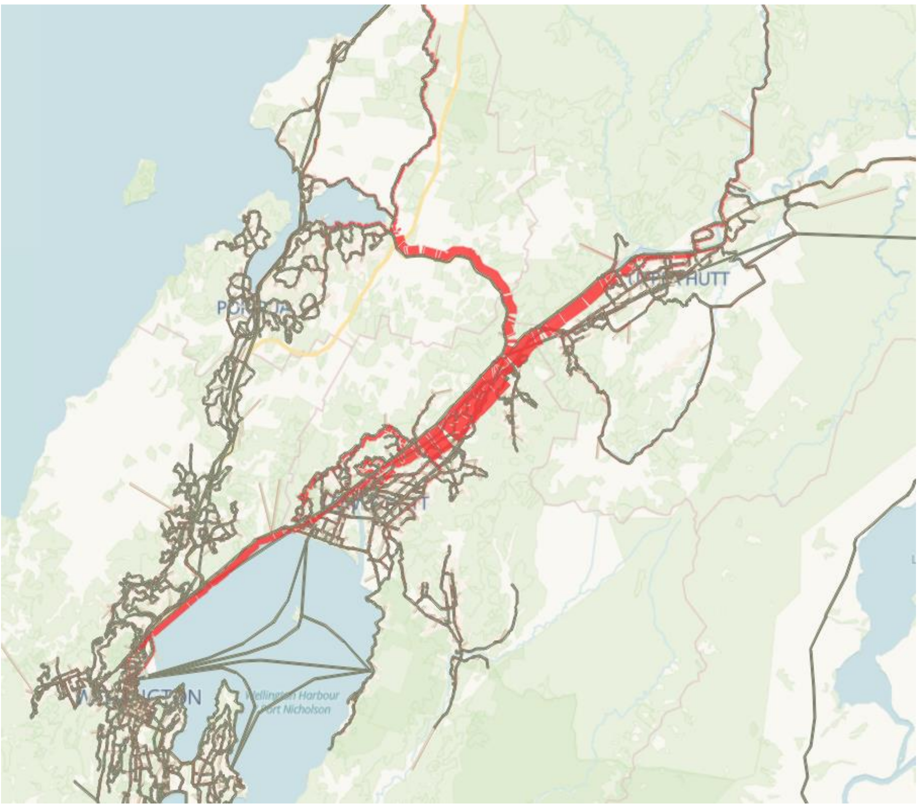


Figure E 5: Kelson SH2 (SB)

Figure E 6: Vivian St (SB)

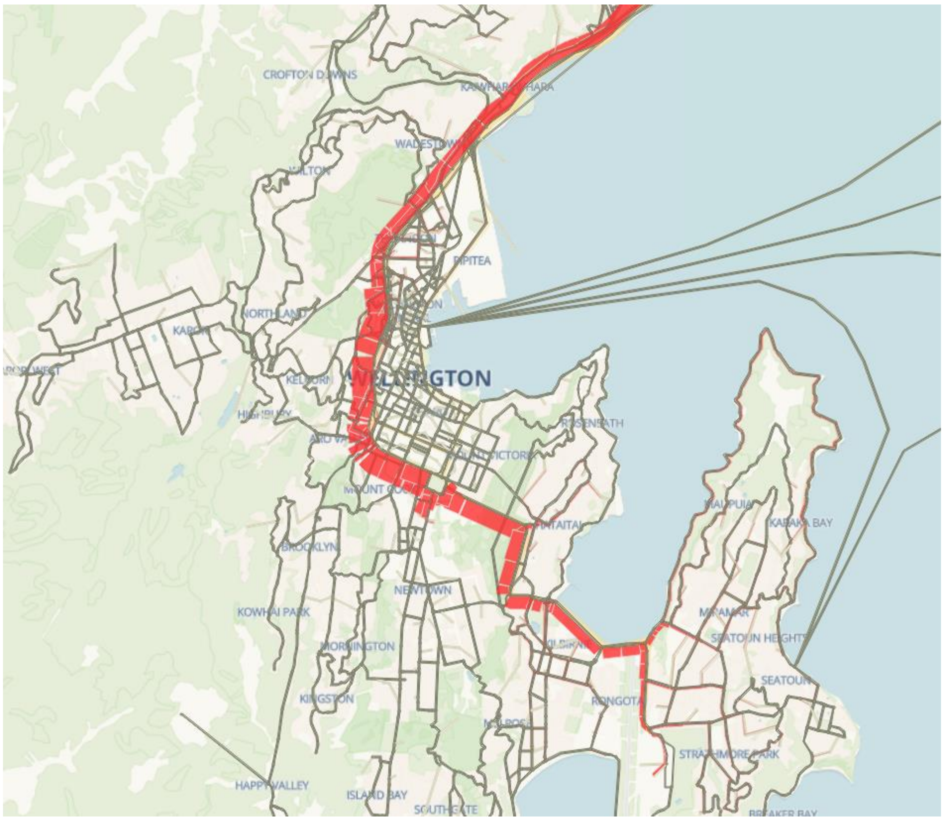


Figure E 7: Karo Drive (NB)

E.2 PM Peak Hour Select Links

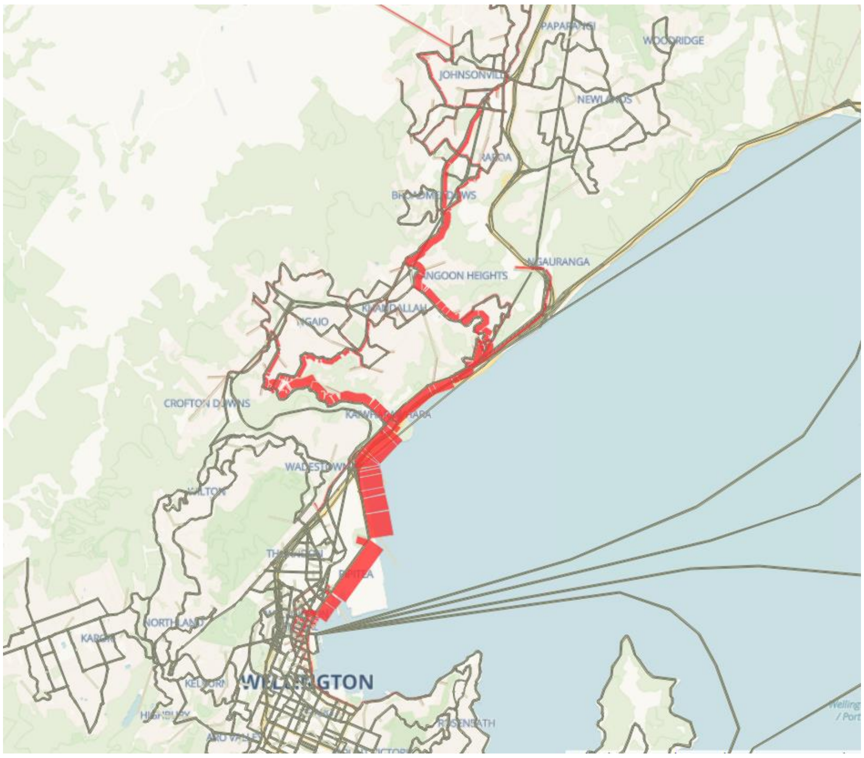


Figure E 8: Ngauranga to Aotea (SB)

Figure E 9: Tawa SH1 (NB)

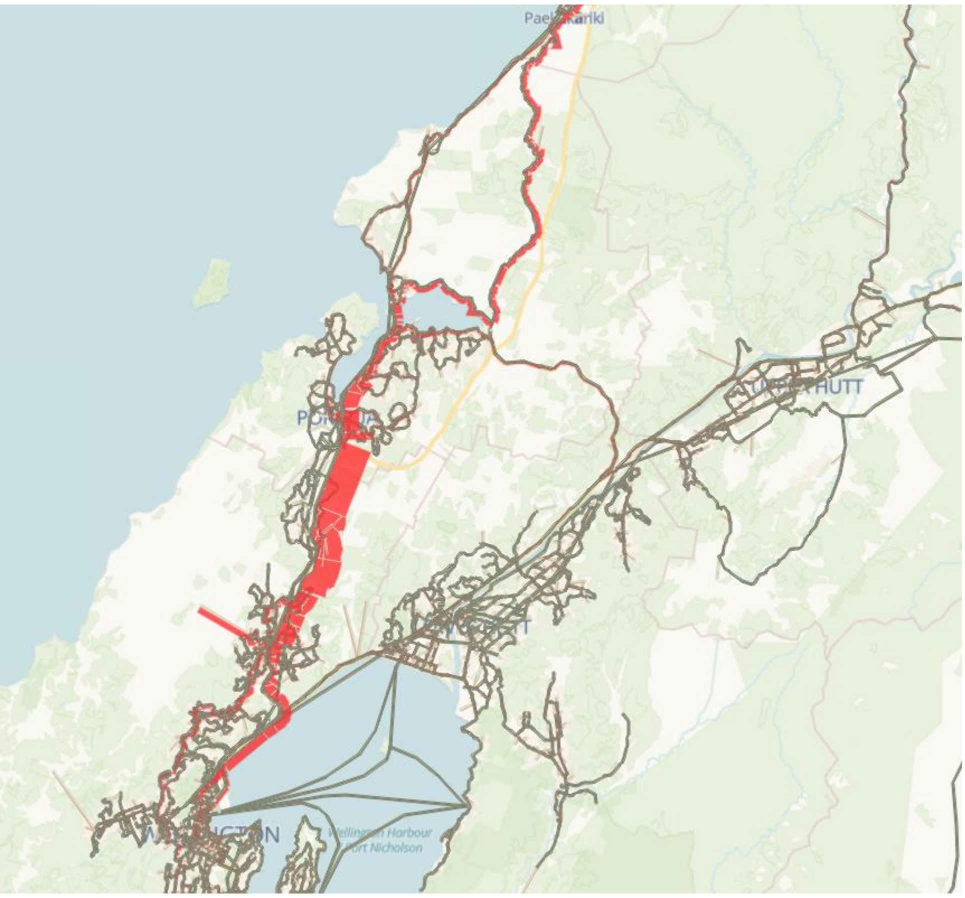


Figure E 10: Tawa SH1 (SB)

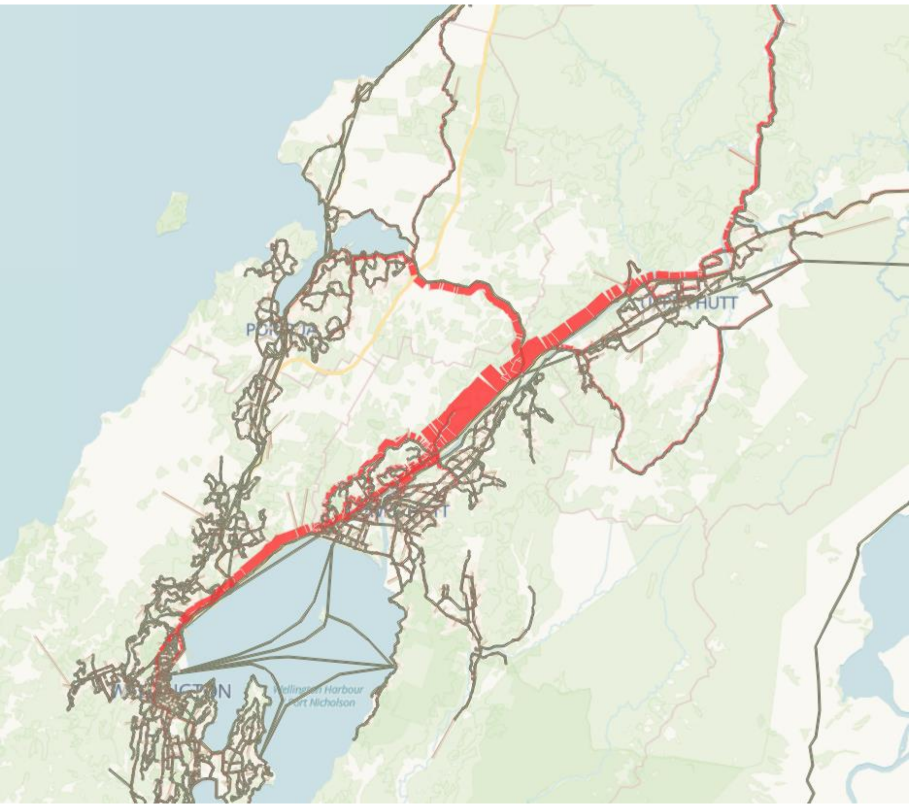


Figure E 11: Kelson SH2 (NB)

Figure E 12: Kelson SH2 (SB)

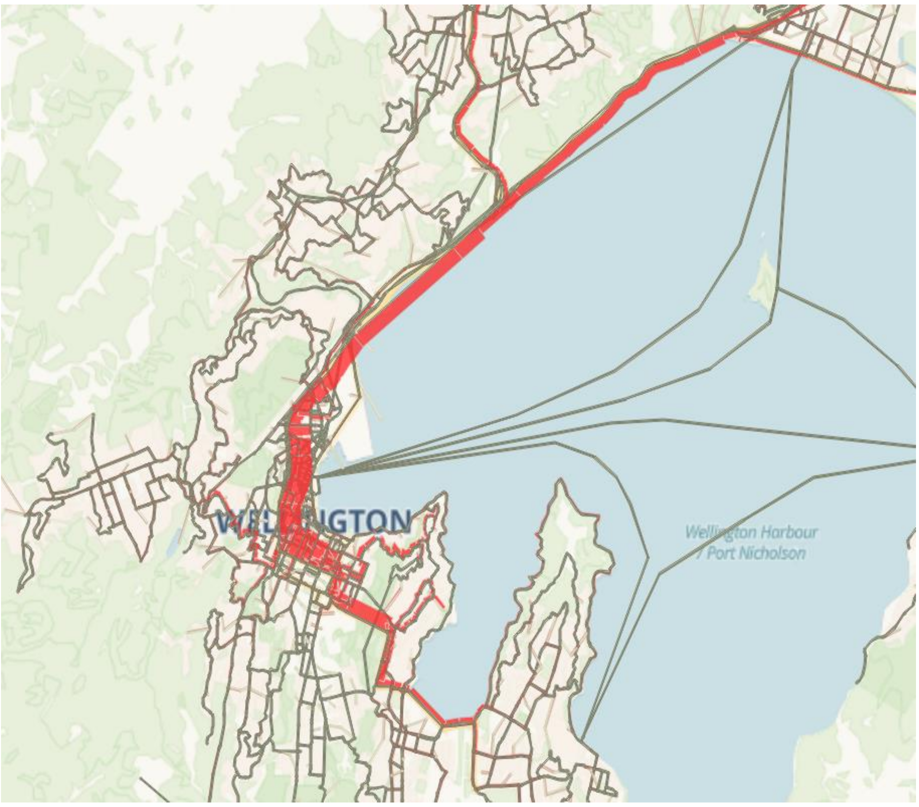


Figure E 13: Vivian St (SB)

Figure E 14: Karo Drive (NB)

Appendix F Client Comment and Consultant Response

Below are comments and responses on the base model.

No.	Comment By	Comment	Response
1	Andrew Ford	It does need an exec summary, but that can wait until comments addressed.	Noted. Executive Summary placeholder added.
2	Andrew Ford	3.2 – peak hour proportions seem intuitive, higher % the closer to Wellington CBD (and lower further away), and a lower % in the PM peak.	Agreed.
3	Andrew Ford	The trip end change charts are good, but I wonder whether instead of absolute change at a trip end level we look at percentage change, or even some GEH composite? I suppose what I am saying is that a high % change but low absolute change might be ok, and a high absolute change but low % change might be ok, but would be useful to see what % of zones have had both a high absolute and high % change.	Table added for the AM peak hour with this analysis. This time period has the biggest changes in terms of percentage and absolute.
4	Andrew Ford	4.3 – demand adjustment has mainly changed the distribution.	More text added in this section to note shape of demands has changed, particularly within CBD, and inbound or outbound to CBD depending on the period.
5	Andrew Ford	You note in section 4 that there are significant changes to / from / within CBD – knowing this is a weakness of the current model, it would be good to capture some of the discussions / analysis we had around comparing WTAM against the current version of WTSM, which suggested (if I remember correctly) that adjusted WTAM intra-CBD car trips were still significantly lower than current WTSM intra-CBD car trips which we believe are an over-estimate? Note: from the numbers in the appendices, I believe they are significantly lower than current WTSM, but as above would be useful to note if this is indeed the case.	Table 4-3 (now Table 4-4) shows this comparison, with CBD trips for Qrious Raw, Qrious Adjusted, and WTSM 2018. This shows that the Qrious adjusted CBD trips lie between the raw Qrious and WTSM 2018.
6	Andrew Ford	Table 5.1 – some conditional formatting would help draw attention to the different levels of achievement?	Done
7	Andrew Ford	5.16 – travel time graph seems to have gone a bit awry.	Legend fixed.
8	Andrew Ford	With travel times, do we have a feel for whether the model shows any bias? Is it "generally" a bit too fast or too slow?	Have added rows at the end of table to indicate percentage of routes which are Faster, Same or Slower than observed.

No.	Comment By	Comment	Response
			Comment added that model tends to be slightly faster than observed.
9	Andrew Ford	It would be useful to have the names for the routes (not just 1,2,3 etc).	Route names added.
10	Andrew Ford	And ideally the scale would be in minutes, however if the names are added to the labels that will suffice along with comment saying, "all times are in minutes".	This is noted at the beginning of the appendix (time in seconds, distance in meters).
11	Andrew Ford	Select link analysis at key points on the network – i.e. Ngauranga to Aotea Quay SH1, Tawa, Kelson, Vivian St, karo Dr – to confirm that the distribution of trips is plausible?	Added as Appendix E.
12	Andrew Ford	Perhaps a simple thematic map showing traffic volumes by different bands (say 0 – 500, 500 – 1000, 1000 – 1500 etc….) again just to give a visual feel for whether we are broadly seeing the highest traffic volumes in the areas where we'd expect to see them?	Figure 4-4 and Figure 4-14 has been added for AM and PM peak hour.
13	Ian Clark	Page 2. I am interested in HCVs having a lower PCU value than buses, and I recall seeing an Austroads research report on the greater effects of large trucks, particularly in areas with gradients, which is very relevant to parts of Wellington.	The PCU value is applied to the matrix, so cannot be different by link. To model slower truck speeds on a steep road, it would seem more appropriate to change the speed-flow relationship rather than the PCU value, which is not straightforward (links would need to be split for HCV vs car). We suggest that at this level of detail, an operational model should be also used for the assessment.
12	Ian Clark	Page 3: validation criteria. In hindsight I wonder whether validation of the shoulders is a step too far, when most attention will be on the peak hours	Noted. Although the WTAM hour and shoulder demands were used to produce the proportions for WTSM to split the three hour AM and PM period demands to hour and shoulder. The HTS was used initially but was too sparse to produce robust proportions.
13	Ian Clark	Pages 5-6: I agree with Andy that the shape of the peak period to peak hour proportions makes sense, but the high "peakiness" is surprising, when the peak periods are three hours – the HTS info indicates that 62-72% of the three hour AM peak totals occur within the one hour. However, the report continues, to say that the Qrious info reduces these proportions, and lower proportions still have been tested (pages 7-8). (As a comparison, for Auckland (and I know we are not talking about Auckland), some 55% of the **two** hour AM peak period totals occur in the peak hour)	This split was largely informed by the screenline validation and we found that the HTS split was giving the peak hour very high volumes. Hence why a flat global factor was applied. The HTS range was between 39%-72% and averaged 55% so the global factor (40%) was 15% lower than HTS.
14	Ian Clark	While these adjustments make good sense, I've previous referred to a difficulty in establishing accurate profiles, where there are several areas	Matching demand to supply for highly congested roads over relatively short time periods is indeed difficult in a static model. To address this, the AM and PM

No.	Comment By	Comment	Response
		with extensive queueing in the peaks, meaning that any observed profiles do not represent demand profiles	periods were extended from two to three hours. So there could be the need to manually move demand from the hour to the shoulder if existing bottlenecks are removed.
15	Ian Clark	Pages 9-21. I agree with Andy that it would be useful to know the significance of the % changes – are the cells with low or high absolute numbers being changed?	Table with absolute and percentage differences for the AM peak hour added. This has the biggest changes in terms of % and totals so is considered representative.
14	Ian Clark	Pages 22 to 30. The traffic flow validation for light vehicles and total vehicles is generally good, based on the GEH statistics, while the medium/heavy vehicle results are less good. The medium/heavy vehicle validation is also not looking good when considering differences of less than 10% across screenlines, but the individual counts within 100 vph are good. These results are all probably as expected – indeed from memory the North Wellington Saturn Model showed very similar overall validation patterns, and we accepted the comment, repeated here on page 30, that good GEH validation for HCVs is not really expected for large area general use traffic models of this nature.	Noted.
15	Ian Clark	Traffic flow validation scatterplots are provided at Appendix C, and it could be worthwhile adding some text on some of the outliers – particularly HCVs. (eg pointing out where is the case of observed v modelled = 50 v 450 HCVs, and where the total (observed) flows are constrained by capacity (eg Mt Vic Tunnel and Ngauranga Gorge)	Comments added. Northbound on Jervois Quay shows as an issue across all periods as having much less HCV volumes.
16	Ian Clark	By the way, I'm mildly bothered by the statement on page 22, that all data has been used in calibration, so there is no real validation	The screenlines are strategic in nature, and each pick up demand from very large areas. Excluding some of these screenlines from the calibration would have resulted in poor validation. As an example, initial tests excluded the inner CBD screenlines from the calibration. The resulting flows within the CBD were way too low, so the inner CBD screenlines were included in the calibration. A much larger traffic count dataset would be required to retain some traffic counts for validation only.
17	Ian Clark	Pages 30-36. The travel time results look "generally good", although the cumulative travel time graphs indicate that the shape of the observed v modelled travel times is not always that good. This is probably to be expected	Yes, delays will be shown at nodes where they are along the road in reality. Confirmed that there is no capacity restraint, in that the modelled flows can exceed capacity.

No.	Comment By	Comment	Response
		for a fairly coarse model of this nature (and from memory it was stated earlier that this model is not capacity constrained), as it means that congestion/delay is probably assigned to "a node" rather than along a length of road, as happens in reality. Again, it could be worthwhile adding some text on some of the outliers – eg pointing out where the outcome seems good, but the shape is less so (such as Figure D-59), and where are the locations of interest.	
18	Ian Clark	And I agree with Andy, it would be useful for a row to be added to Table 5-8, to indicate if, overall, the modelled times are a bit fast or a bit slow.	Have added rows at the end of table to indicate % pf routes which are Faster, Same or Slower than observed.
19	Ian Clark	Where I can find details of the junction/capacity assumptions – am I right in saying that TN28 only relates to WTSM, not WTAM?	Much of the information in TN28 (road assignment) applies to both WTSM and WTAM. A comment has been added to TN28 to make this clearer. So junction capacity calculations for WTAM are reported in TN28.

Below are comments and responses on the future year model.

No.	Comment By	Comment	Response
1	Ian Clark	No comment required on Section 6. The text acknowledges that I was involved in the discussion about whether or not to completely rewrite this Tech Note to reflect the modest changes in validation results.	N/A
2	Ian Clark	Firstly I acknowledge the point that the four "key issues" identified in Section 7.1 (page 41) are indeed not unusual (as stated in the text).	Agreed.
3	Ian Clark	I'd be interested to see some examples of "cases 3 and 7" in Table 7-1, where development needs to be removed between the base and future model.	For case 3 in the AM peak hour, WTSM has 0.17 trips in total for 2018 and 0.09 for the forecast year. So not including any future year demand for WTAM is considered appropriate. The individual OD values are also inconsequential (maximum of 0.0053). For case 7 in the AM peak hour, WTSM has 0.04 in 2018 and 0.01 for the forecast year. Again, we consider it appropriate to include zero future year demand for WTAM.
4	Ian Clark	I am interested in case 4b, as assuming 0 in the future WTAM (relative to >0 in WTSM) means that we are "missing out on" 15,022 in the AM peak. Could it be that some of this growth should be included, maybe relating to adjacent zones?	If we were to apply the growth on an aggregated zone basis (by sector), then we are diluting the benefit of the refined zoning as the future year WTAM demands would only representative by sector. We have undertaken and supplied checks (AM peak hour) of

No.	Comment By	Comment	Response
			applying the growth at a sector level and it does not result in a significant difference in total, or on an aggregated (12) sector basis.
5	Ian Clark	I am also interested in the broad locations of case 8b, since this case contributes the vast majority of the changes in demand. I normally use an additive method, which based on Table 7-2 would mean + 12,672, whereas the multiplicative method assumed leads to + 14,000. This difference is not massive, but whether it is at all significant depends on the geographical spread.	Given this relates to 265,000 OD pairs, it is difficult to show geographically. We tested changing case 8b to additive (rather than multiplicative), and it made minimal difference for the AM peak hour. Detailed figures were supplied separately by email. The analysis indicates the RAND method (multiplicative for case 8b) is robust and additive would not significantly change the demands.
6	Ian Clark	The above results are provided for the AM peak only, and it may be worthwhile providing results for the other two time periods, to confirm that the patterns/quantum of trips are similar. Having said that, the summary results at Table 7-3 indicates that this is indeed the case, with WTAM growth slightly higher than WTSM growth in all three time periods.	We have checked all five time periods in terms of the trips by case, and the WTSM vs WTAM total growth. We have not reported all time periods as it would make the technical note unwieldy. This can be reported if required.
7	Andy Ford	Regarding 4b, I do wonder as Ian notes whether some of the growth could be applied to adjacent zones. One approach could be loosely reverting to the old WTSM zone system to identify adjacent zones – i.e. if zone 1115 is a case 4b then the growth could be applied to 1110 – 1114?	As per point 4 above, if we apply the growth on an aggregated zone basis (by 225 zone sector), then we are diluting the benefit of the refined zoning as the future year WTAM demands would only representative by sector. We've checked applying the full pivot on a 225 zone sector basis, and the resulting demands for the AM peak hour are very similar in total, and by aggregate 12 sector.
8	Andy Ford	As you note in the summary, we need to monitoring the matrix totals and application of growth when using WTAM to identify and address any funnies that might occur through the growth application process.	Yes.

Christchurch

Hazeldean Business Park, 2 Hazeldean Road
Addington, Christchurch 8024
PO Box 13-052, Armagh
Christchurch 8141
Tel +64 3 366 7449
Fax +64 3 366 7780

Please visit **www.stantec.com** to learn more about how Stantec design with community in mind.

Stantec | JACOBS