1.   PURPOSE

The purpose of this note is to describe the trip distribution methodology adoptee for the study, and to report on the calibration and validation of the distribution functions.

2.   INTRODUCTION

2.1   Trip Distribution Model Form

The gravity model form chosen for this model was

$$T_{ij} = P_i.K_i\, A_j.L_j\, f(c_{ij})$$

subject to the double constraints of

$$K_i = \frac{P_i}{\Sigma_j\, T_{ij}}$$

$$L_j = \frac{A_j}{\Sigma_j\, T_{ij}}$$

Where:

T_{ij}	=	Trips between zones i and j
P_i	=	Productions at zone I
A_j	=	Attractions at zone j
$f(c_{ij})$	=	Some function of the impedance between zones i and j
$K_i\, L_j$	=	Balancing factors

The balancing factors are successively applied until there is convergence. The notation has been ignored in the rest of this note as it can be shown that ΣK_i and ΣL_j equals 1 over the balancing iterations.

2.2   The Distribution Function

The distribution function can be approximated to an exponential line of the form:

$$f(c_{ij}) = e^{-\alpha c_{ij}}$$

Where:

|		
$f(c_{ij})$	=	function of cost of travel between zone i and zone j
C_{ij}	=	generalised cost of travel between zones i and j and is usually of the form $\beta t_{ij} + \gamma d_{ij} +$ tolls + parking charges
t_{ij}	=	time to travel between zone i and zone j (minutes)

d_{ij}	=	distance between zone i and zone j (kilometres)
β	=	generalised cost of travel per minute
γ	=	generalised cost of travel per kilometre
α	=	distribution model exponent to be calibrated

3. CALIBRATING THE GENERALISED COST COEFFICIENTS

The first step in the calibration is to evaluate the generalised cost coefficients, *β* and *γ*, for each purpose and time period. The time cost coefficient has been established using the values published in Table A4.1 of the New Zealand Transport Agency's (NZTA) Economic Evaluation Manual (EEM).

Only part of the running costs for cars is considered to be a perceived cost. It is assumed that most car drivers, when deciding to make a trip by car, consider as their vehicle operating costs only the cost of fuel. This is consistent with the guidelines for private vehicle operating costs in "Travel Behaviour Change Evaluation Procedures" prepared for Transfund NZ (now part of NZTA) in December 2004 by Maunsells Australia Pty Ltd.

Data from the Ministry of Economic Development of fuel prices over the past four years is shown on the diagram below. The trend line shows a price of around $1.70 for mid 2008 – the time when the HIS survey was carried out.

Regular petrol Pump price
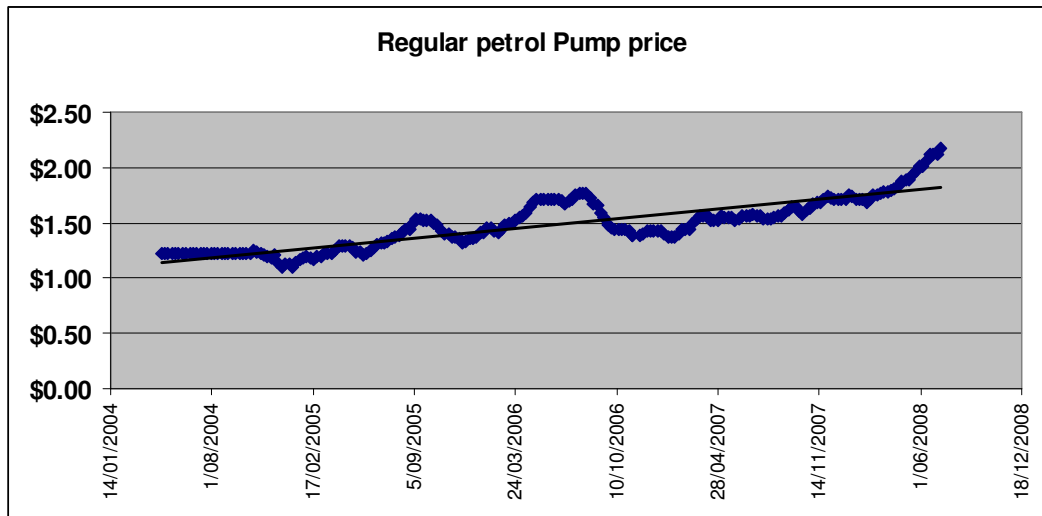
Accordingly, the distance cost for cars has been calculated as 17 cents per kilometre, which corresponds to 10 kilometres per litre at $1.70 per litre.

TRAFFIC DESIGN GROUP   **GABITES PORTER**

The resulting time and distance costs are detailed in **Table 1**.

Perceived Costs of Travel by Vehicle Class						Table 1
Vehicle Class	Work Travel Purpose		Commuting to/from work		Other Non-Work Travel Purposes	Distance Cost
	$/Hour	Cents/min	$/Hour	Cents/min	$/Hour	Cents/min	Cents/km
Car	23.85	39.75	7.80	13.00	6.90	11.50	17.00

The non-work time values need to be factored by 1.15 to convert to perceived costs (Table A11.1 of EEM), and then by 1.19 to bring into mid 2008 values from 2002 (Table A12.2 of EEM).

The next stage was to determine the percentage of trips which fall into the broader work travel, commuting and non-work travel purposes by time of day for each modelled trip purpose, the average occupancy per vehicle, and then for assignment, the weighting of each purpose to form an overall generalised cost. It should be noted that Heavy Goods Vehicles have been dealt with separately as that model has been imported from the recent Christchurch Transport Model project.

A literature search to determine source the percentage breakdowns proved fruitless and in the absence of any such guidelines, the proportions in **Table 2** of trips classified as work, non work, and commuting have been assumed for this analysis. These proportions have been used in numerous New Zealand applications since the early 1980s including public transport models in North Shore, Hamilton, Christchurch, Timaru and Dunedin.

Proportion of Work and non work Trips				Table 2
	Period	*Work*	*Non Work*	*Commuting*
Home Based Work	All	0.0	0.0	1.0
Home Based Ed	All	0.0	1.0	0.0
Home Based Business	All	0.8	0.2	0.0
Home Based Shop	All	0.0	1.0	0.0
Home Based soc/rec	All	0.0	1.0	0.0
Home Based Other	All	0.2	0.8	0.0
Non Home Based	All	0.5	0.5	0.0

Table 3 includes the car occupancy values as calibrated from the Home Interview Survey. There is one anomaly in that Home Based Education is a trip to an education facility for the purpose of study. The car driver trip for the purpose of dropping a person off at school is classed as a Home Based Other trip.

For the purpose of calculating occupancies, the Home Based Work occupancy has been assumed for Home Based Education car drivers, and the Home Based Education passengers have been included in the home based other purpose.

TRAFFIC DESIGN GROUP

GABITES PORTER

Car Occupants by Time Period			Table 3
	Morning Peak	**Inter Peak**	**Evening Peak**
Home Based Work	1.08	1.05	1.09
Home Based Ed	1.08	1.05	1.09
Home Based Business	1.13	1.24	1.26
Home Based Shop	1.08	1.11	1.22
Home Based soc/rec	1.60	1.31	1.76
Home Based Other	2.33	2.92	1.90
Non Home Based	1.41	1.31	1.39
Total	**1.49**	**1.31**	**1.35**

Table 4 has the proportion of trips by purpose for the private purposes for each time period.

Purpose proportions by Time Period			Table 4
	Morning Peak	**Inter Peak**	**Evening Peak**
Home Based Work	24.48	11.38	27.19
Home Based Ed	21.25	2.66	3.66
Home Based Business	2.26	5.79	3.31
Home Based Shop	2.82	13.93	12.18
Home Based soc/rec	4.36	9.04	16.04
Home Based Other	23.49	9.76	12.74
Non Home Based	21.34	47.44	24.88
Total	**100.00**	**100.00**	**100.00**

Table 5 contains the resulting generalised costs coefficients for time and distance. The time costs are evaluated by multiplying the cost in **Table 1** out by the proportions in **Table 2**, adjusting for perceived costs (1.15 factor for non work-related), scaling up to July 2008 dollars (1.19 factor for all) and then multiplying each by the occupancy rates in **Table 3**. Subsequently it represents the aggregated perceived time cost for all vehicle occupants.

Generalised Costs by Time Period					Table 5	
	Morning Peak		**Inter Peak**		**Evening Peak**	
	Time(c)	**Dist(c)**	**Time(c)**	**Dist(c)**	**Time(c)**	**Dist(c)**
Home Based Work	19.18	17.00	18.73	17.00	19.45	17.00
Home Based Ed	19.18	17.00	18.73	17.00	19.45	17.00
Home Based Business	46.37	17.00	57.71	17.00	51.76	17.00
Home Based Shop	16.96	17.00	17.53	17.00	19.16	17.00
Home Based soc/rec	25.22	17.00	20.64	17.00	27.75	17.00
Home Based Other	51.36	17.00	68.61	17.00	38.94	17.00
Non Home Based	44.53	17.00	45.82	17.00	43.86	17.00
Total	**32.96**	**17.00**	**38.71**	**17.00**	**30.37**	**17.00**

4. CALIBRATING THE DISTRIBUTION FUNCTIONS

The surveyed trip matrices were derived from the Household Interview Survey data for each purpose and time period. The purpose used were:

- Home to work
- Home to education
- Home to business
- Home to shop
- Home to soc/rec
- Home to other
- Non home based

- Work to home
- Education to home
- Business to home
- Shopping to home
- Soc/rec to home
- Other to home

The TRACKS program DISCAL has been used to calculate the distribution function coefficients. DISCAL uses as inputs a time and distance matrix with corresponding generalised cost coefficients (as derived above) and a trip matrix. To start the process the time and distance matrices were derived from the all day assignment of the surveyed trips matrix used to determine expansion factors (see Technical note 4).

The calibration process involves inverting the gravity model so that it is expressed in terms of the distribution function

$$f(C_{ij}) \quad = \quad T_{ij} \: / \: P_i \, A_j$$

The function value is calculated for each origin/destination pair, and allocated to a cost band k. The final value of the function in each cost band is the weighted average of the individual cells in that band.

The natural log of this average is then calculated and plotted against cost to calibrate the alpha value for use in the negative exponential function form.

It should be noted that the cost function can also be a function of travel time between zones rather than cost, and is the form that was adopted for the vehicle driver (three step) models. The person models (four step) have used generalised cost because of the need to bring in the public transport travel cost components.

The **first** stage in the process was to calibrate the alpha exponent using the surveyed matrices and the period time and distance matrices derived from assignment of the surveyed matrices. The results from this analysis for each purpose and time period are shown in the Figures below, including the number of trips in each of the matrices and the regression r^2 values.

The results of the calibration for the vehicle driver model (time based) are included in **Figures 1a-3c** respectively. Where a purpose is not included, the number of observations for that purpose and time period is insufficient for calibration purposes.

Please see Table One of Technical Note 10 for a breakdown of the total number of expanded HIS trips for each purpose. This and the relevant discussion in the corresponding section of Technical Note 10 provides some perspective regarding the level of sampling for each.

The goal is to produce R-squared values of greater than 0.8 where possible, which implies that the calibrated function coefficient explains at least 80% of the surveyed

TRAFFIC DESIGN GROUP

GABITES PORTER

data. In some cases this has not been possible due to the low number of sampled and expanded households at a trip purpose by period level.

Note that the total expanded trips are included on each plot, with the number of sampled trips being approximately 1% of these values based on an average expansion factor of approx 100.

The second stage is to apply the gravity model using modelled trip ends, and confirm that the modelled and observed trip length frequencies still match. There is an iterative process between assignment and distribution that will eventually converge. Throughout this process the alpha values published in Figure 1 though Figure 3 are successively 'tuned' such that the modelled trip lengths match the HIS trip lengths as closely as possible. As such the alpha values in Figure 1 through Figure 3 are treated as a 'starting point' and the final validated alpha values, which are the outcome of this process are reported in **Table 7**.

Figure 4a though 9e show the results of using the calibrated functions in the AM/INT/PM 2006 models. These figures show the trip length frequency plots for time and distance for each statistically significant trip purpose. For each purpose, both the modelled and HIS frequency plots have been provided along with statistical measures for both.

Again, in instances where the number of observations for a purpose was too small, plots have not been provided. A full table of HIS and modelled averages and standard deviations has been included here to summarise the results published in **Figure 4a though 9e** as **Table 6**.
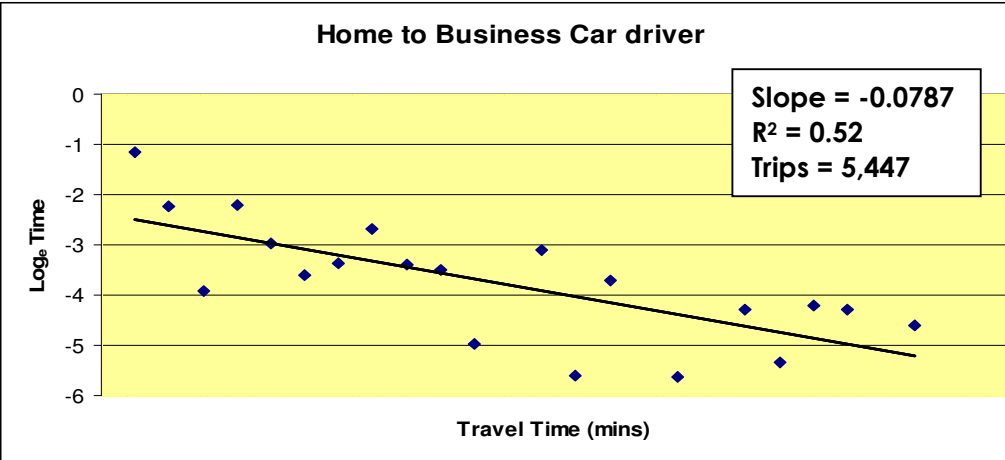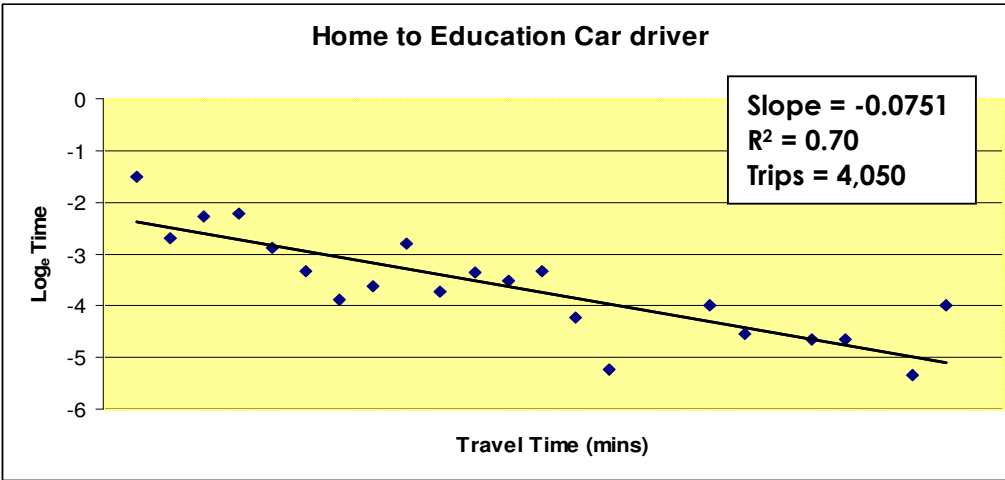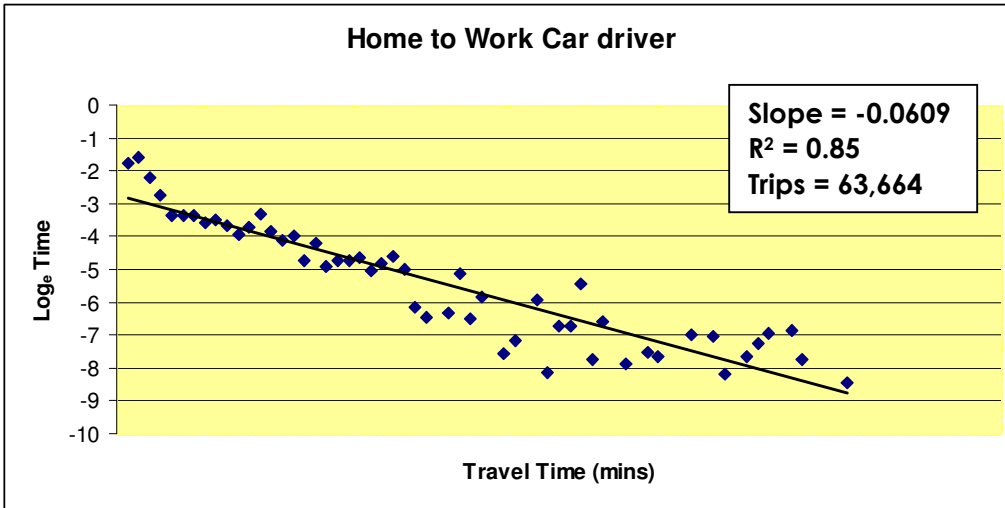
Note that trip chaining has not been taken into account in this analysis. The analysis focuses on trip legs only. This is consistent with all interpretation and analysis of the WRTM Household Interview Survey data.

Validated Distribution Model Coefficients			Table 6
	Morning Peak	*Inter Peak*	*Evening Peak*
Home To Work	0.103	0.117	0.112
Home To Ed	1.910	0.950	0.950
Home To Business	0.950	0.098	0.950
Home To Shop	0.382	0.333	0.950
Home To soc/rec	0.158	0.094	0.127
Home To Other	0.195	0.236	0.530
Non Home Based	0.115	0.111	0.115
Work To Home	0.204	0.137	0.101
Ed To Home	0.358	0.950	0.950
Business To Home	0.132	0.940	0.360
Shop To Home	0.950	0.365	0.350
Soc/rec To Home	0.245	0.140	0.103
Other To Home	0.223	0.196	0.176

TRAFFIC DESIGN GROUP

GABITES PORTER

Comparison of HIS and Modelled Trip Lengths											Table 7
Period	Purpose	Figure	Trip Time				Figure	Trip Distance			
			HIS		Model			HIS		Model	
			Mean	SD	Mean	SD		Mean	SD	Mean	SD
Morning Peak	Home to Work	4A	13.68	13.93	13.88	12.58	5A	13.39	17.94	13.69	16.38
	Home to Education	4A	11.27	9.19	10.65	13	5A	9.54	10.93	11.11	17.54
	Home to Business	4A	11.25	8.16	10.82	12.93	5A	10.41	10.46	10.54	16.54
	Home to Shop	4B	10.34	9.98	9.88	11.47	5B	9.55	12.79	9.39	14.93
	Home to Social/Rec	4B	9.33	16.01	9.29	9	5B	8.8	20.66	8.46	11.14
	Home to Other	4B	8.39	8.27	8.43	8.07	5B	7.18	9.41	7.45	9.81
	Non Home Based	4C	9.87	12.18	10.25	10.11	5C	9.21	15.74	9.42	12.62
	Other to Home	4C	7.67	8.14	7.54	7.39	5C	6.57	8.86	6.62	8.99
	Work to Home	4C	8.23	10.85	8.47	8	5C	7.53	12.86	7.51	9.9
	Education to Home	4D	10.98	3.71	12.68	15.45	5D	12	5.67	13.66	21.24
	Business to Home	4D	13.96	24.6	15.2	15.26	5D	15.72	35.57	15.62	20.38
	Shop to Home	4D	6.11	5.83	7.65	9.97	5D	5.17	7.72	7.42	13.2
	Soc/Rec to Home	4E	7.71	6.76	6.7	6.81	5E	6.2	6.36	5.74	8.29
Interpeak	Home to Work	6A	11.47	12.47	11.87	10.85	7A	11.07	15.98	11.71	14.04
	Home to Education	6A	11.69	10.93	11.58	16.15	7A	9.54	10.56	12.89	21.98
	Home to Business	6A	17.6	26.88	17.23	17.54	7A	19.42	35.62	18.41	23.54
	Home to Shop	6B	10.43	10.52	9.91	11.64	7B	10.2	13.43	9.8	15.34
	Home to Social/Rec	6B	13.97	14.72	14.1	13.38	7B	14.69	18.56	14.62	17.67
	Home to Other	6B	7.45	7.47	7.08	6.93	7B	6.46	8.6	6.22	8.39
	Non Home Based	6C	10.55	16.08	11.15	11.3	7C	10.86	21.45	11.32	14.5
	Other to Home	6C	8.32	7.13	7.97	7.61	7C	7.3	8.15	7.16	9.32
	Work to Home	6C	10.22	11.59	10.51	9.56	7C	9.64	14.87	9.98	12.14
	Education to Home	6D	11.82	9.41	11.62	15.49	7D	10.58	9.43	12.78	21.14
	Business to Home	6D	10.61	8.54	9.75	12.26	7D	9.85	9.7	9.71	15.74
	Shop to Home	6D	10.26	12.65	9.74	11.53	7D	9.93	15.96	9.59	15.14
	Soc/Rec to Home	6E	9.89	11.13	10.03	9.52	7E	9.32	14.68	9.53	12.05
Evening Peak	Home to Work	8A	12.6	11.67	12.88	11.7	9A	12.81	17.09	12.49	15.13
	Home to Education	8A	11.54	7.78	12.16	17.04	9A	10.19	11.1	13.56	23.16
	Home to Business	8A	9.83	8.73	9.8	12.04	9A	7.23	8.52	9.58	15.23
	Home to Shop	8B	7.67	7.08	8.03	10.12	9B	5.92	7.13	7.68	13.29
	Home to Social/Rec	8B	10.84	13.42	11.12	10.37	9B	10.01	16.65	10.4	13.01
	Home to Other	8B	8.84	8.11	7.62	9.03	9B	6.98	9.77	6.98	11.3
	Non Home Based	8C	9.65	12.63	9.71	9.95	9C	8.47	15.32	8.52	12.12
	Other to Home	8C	11	12.95	11.28	11.33	9C	10.27	17.13	10.26	14.17
	Work to Home	8C	13.95	13.11	14.32	12.84	9C	13.55	16.8	13.77	16.52
	Education to Home	8D	12.2	6.97	11.85	15.28	9D	9.41	8.12	12.49	20.5
	Business to Home	8D	13.47	9.81	12.57	14.14	9D	12.23	11.73	11.91	17.9
	Shop to Home	8D	10.42	9.41	10.29	11.77	9D	9.48	12.03	9.54	15.22
	Soc/Rec to Home	8E	13.45	17.99	13.54	12.44	9E	12.91	23.26	13.05	15.86

TRAFFIC DESIGN GROUP

GABITES PORTER

Home to Work Car driver

Slope = -0.0609
R² = 0.85
Trips = 63,664

Log_e Time

Travel Time (mins)

Home to Education Car driver

Slope = -0.0751
R² = 0.70
Trips = 4,050

Log_e Time

Travel Time (mins)

Home to Business Car driver

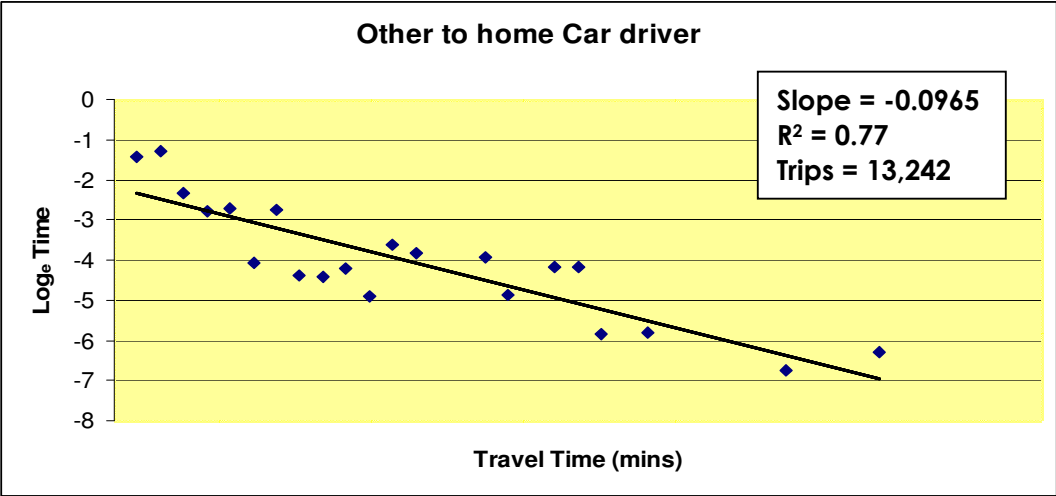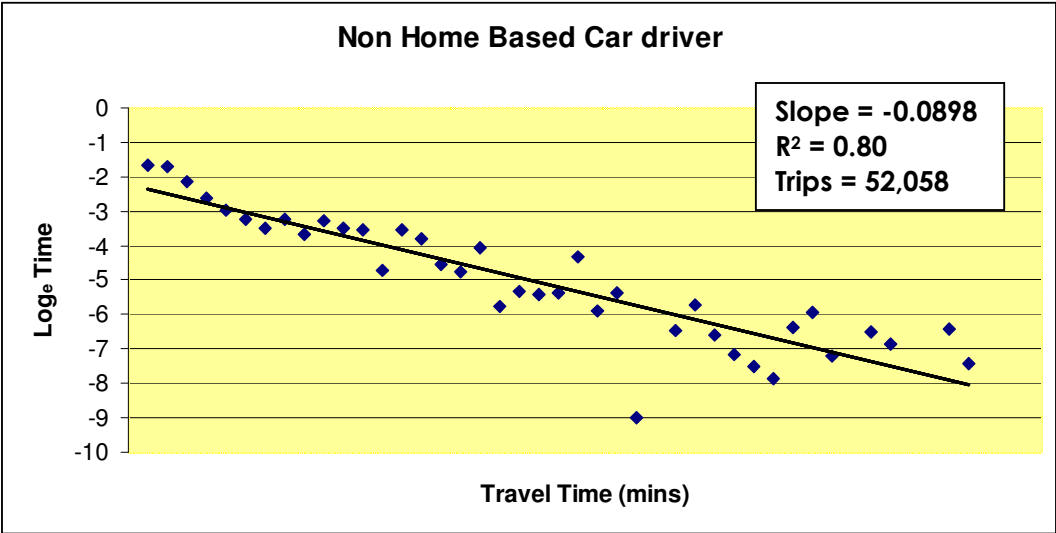Slope = -0.0787
R² = 0.52
Trips = 5,447

Log_e Time

Travel Time (mins)

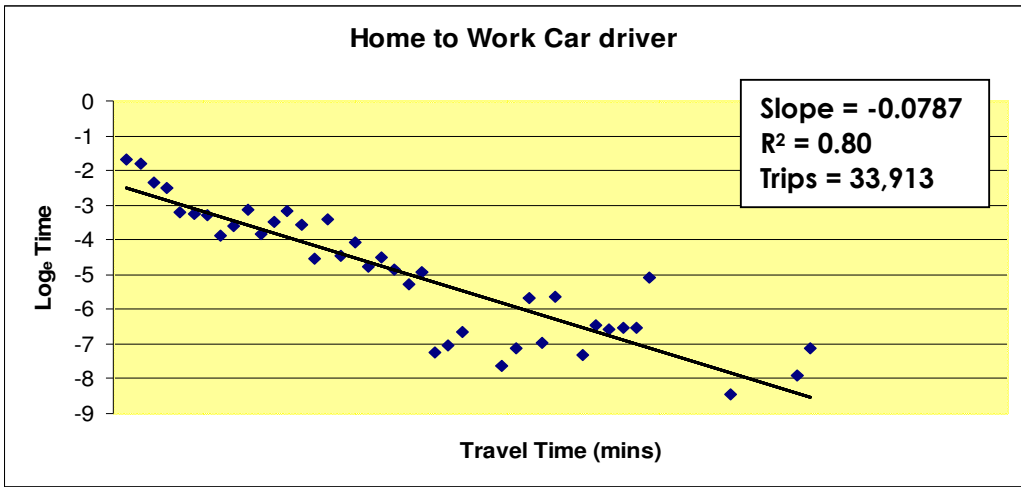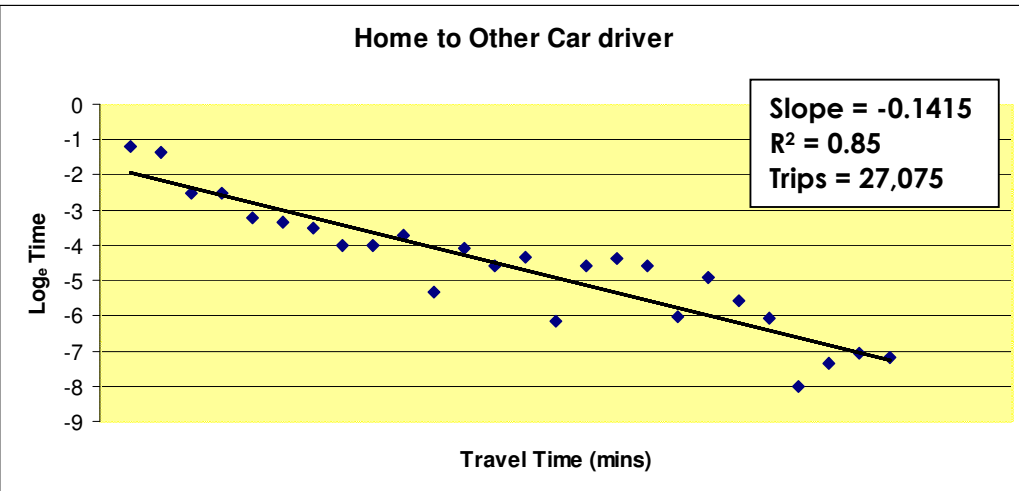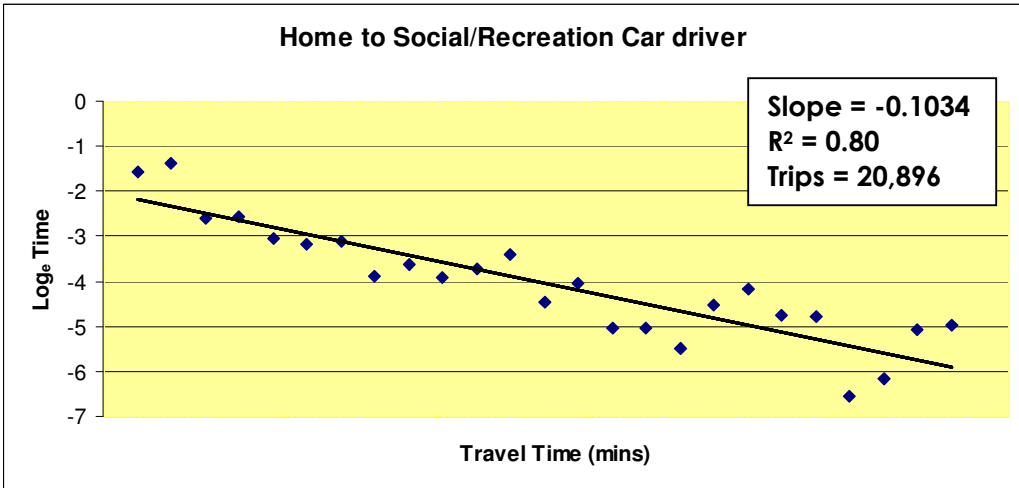| Waikato Regional Model	Distribution Functions Morning Peak Car Drivers	Figure 1a
Trip Distribution		

TRAFFIC DESIGN GROUP

GABITES PORTER

Home to Shop Car driver

Slope = -0.066
R^2 = 0.34
Trips = 5,714

Home to Social/Recreation Car driver

Slope = -0.1177
R^2 = 0.78
Trips = 5,360

Home to Other Car driver

Slope = -0.0957
R^2 = 0.77
Trips = 40,234
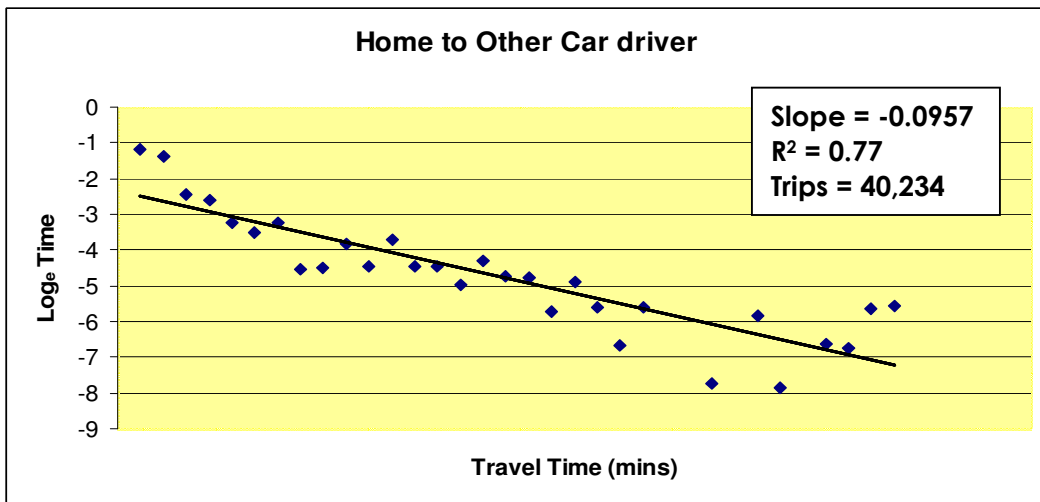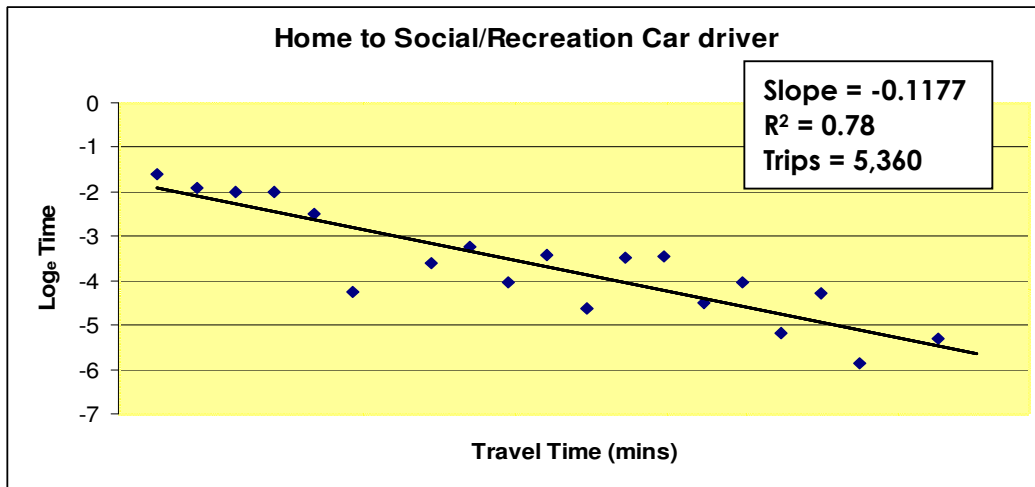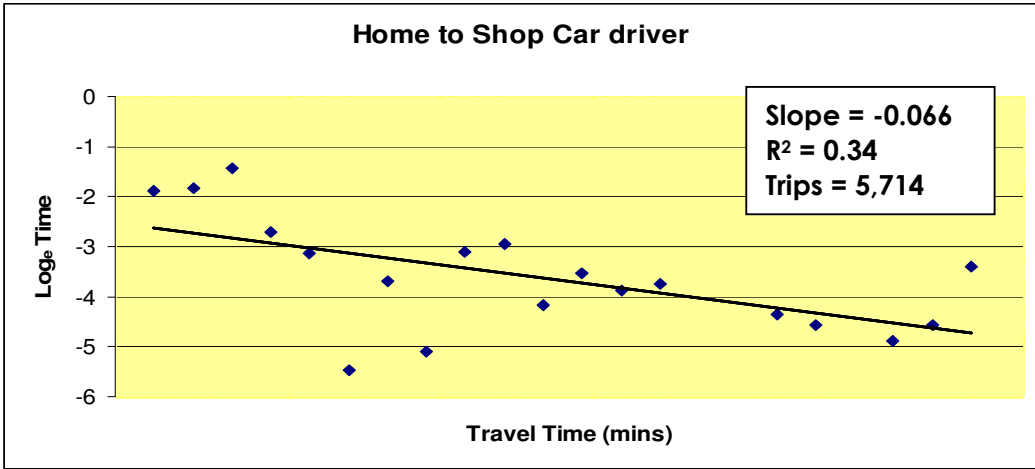
Waikato Regional Model	**Distribution Functions** **Morning Peak Car Drivers**	**Figure 1b**
Trip Distribution		

TRAFFIC DESIGN GROUP

GABITES PORTER

Non Home Based Car driver

Slope = -0.0898
R² = 0.80
Trips = 52,058

Log_e Time

Travel Time (mins)

Other to home Car driver

Slope = -0.0965
R² = 0.77
Trips = 13,242

Log_e Time

Travel Time (mins)

Waikato Regional Model	Distribution Functions	Figure 1c
Trip Distribution	Morning Peak Car Drivers	

TRAFFIC DESIGN GROUP   GABITES PORTER

Home to Work Car driver

Slope = -0.0787
R^2 = 0.80
Trips = 33,913

Home to Education Car driver

Slope = -0.0874
R^2 = 0.24
Trips = 2,296

Home to Business Car driver

Slope = -0.0787
R^2 = 0.69
Trips = 18,699
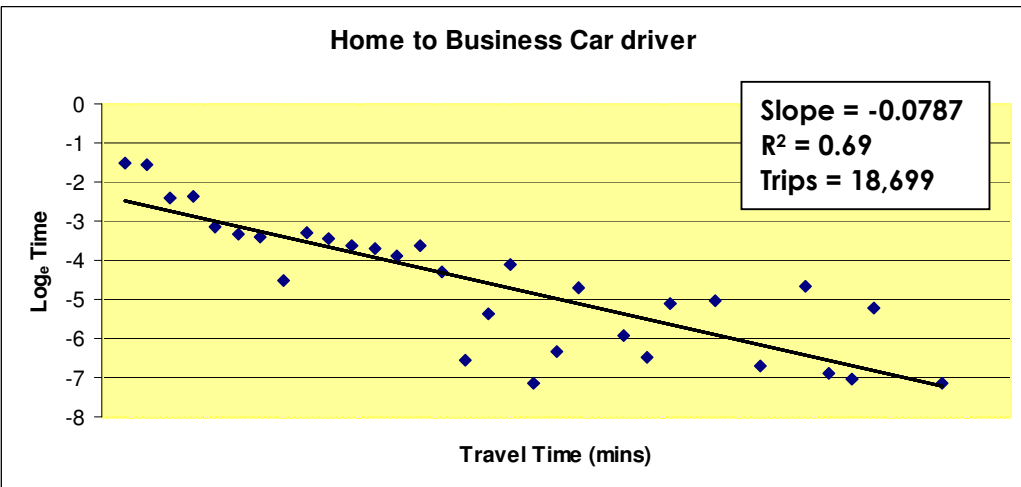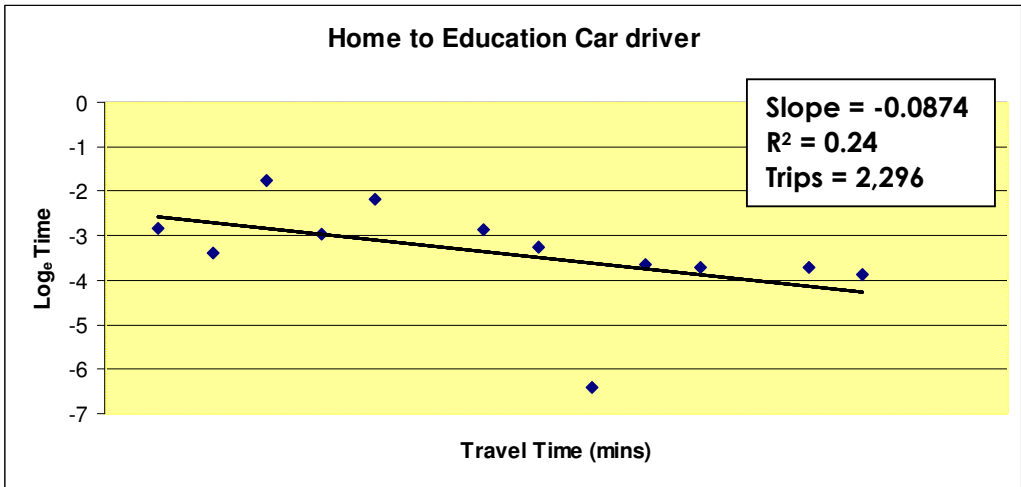
Waikato Regional Model	**Distribution Functions**	**Figure 2a**
Trip Distribution	**Inter Peak Car Drivers**	

TRAFFIC DESIGN GROUP

GABITES PORTER

Home to Shop Car driver

Slope = -.0856
R² = .81
Trips = 30,797

Home to Social/Recreation Car driver

Slope = -0.1034
R² = 0.80
Trips = 20,896

Home to Other Car driver

Slope = -0.1415
R² = 0.85
Trips = 27,075
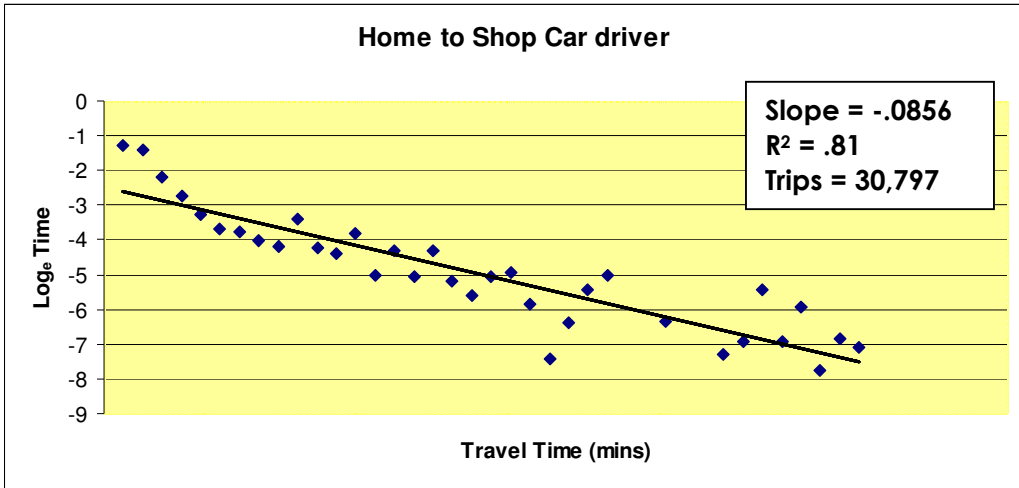
Waikato Regional Model	**Distribution Functions** **Inter Peak Car Drivers**	**Figure 2b**
Trip Distribution		

TRAFFIC DESIGN GROUP

GABITES PORTER

Non home based Car driver

Slope = -0.0799
R² = 0.92
Trips = 218,317

Log_e Time / Travel Time (mins)

Work to home Car driver

Slope = -0.0823
R² = 0.88
Trips = 37,092

Log_e Time / Travel Time (mins)

Education to home Car driver

Slope = -0.0787
R² = 0.40
Trips = 4,321

Log_e Time / Travel Time (mins)
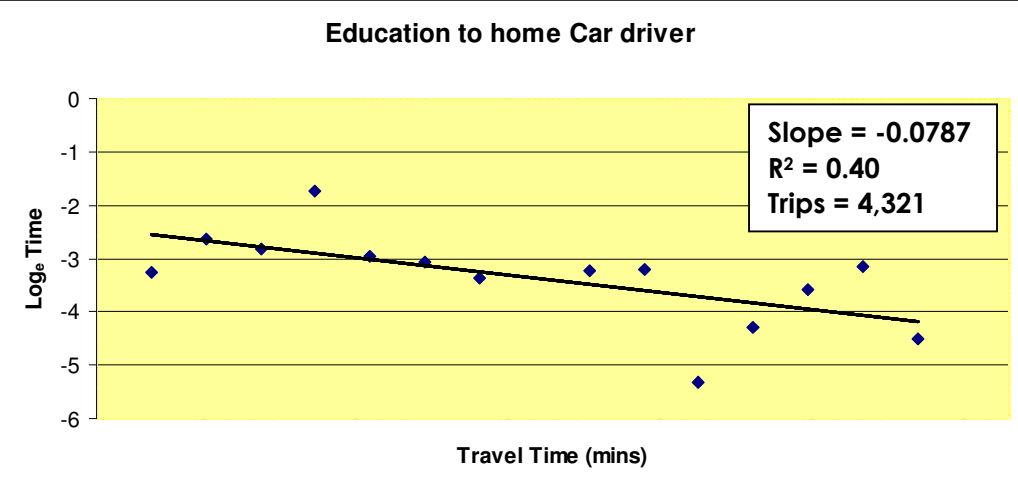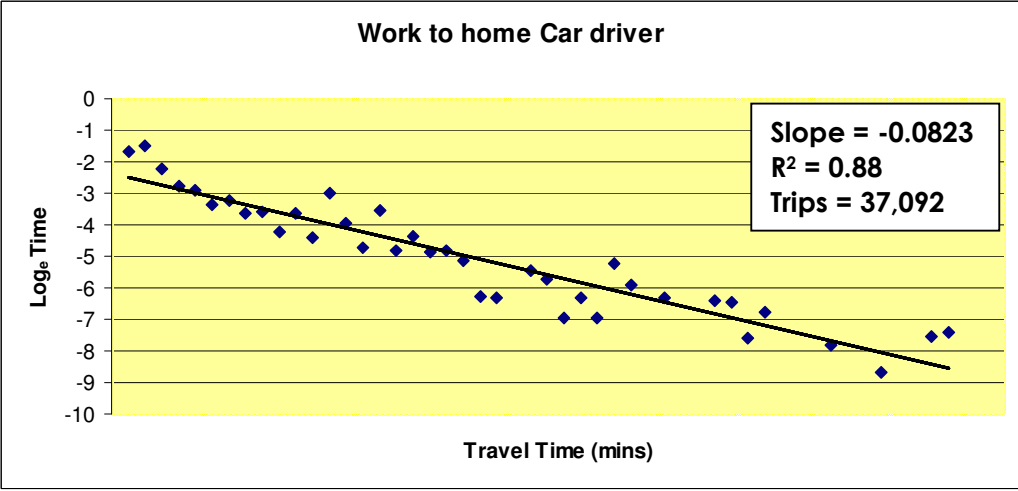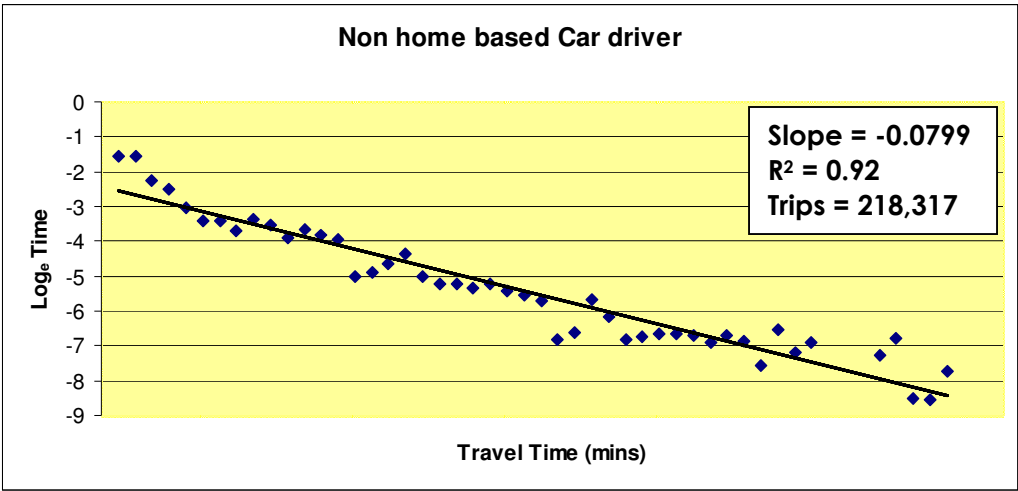
Waikato Regional Model	**Distribution Functions**	**Figure 2c**
Trip Distribution	**Inter Peak Car Drivers**	

TRAFFIC DESIGN GROUP   **GABITES PORTER**

Business to home Car driver

Slope = -0.1404
R² = 0.87
Trips = 14,763

Shop to home Car driver

Slope = -0.1018
R² = 0.85
Trips = 40,692

Social/Recreation to home Car driver

Slope = -0.1230
R² = 0.78
Trips = 40,692
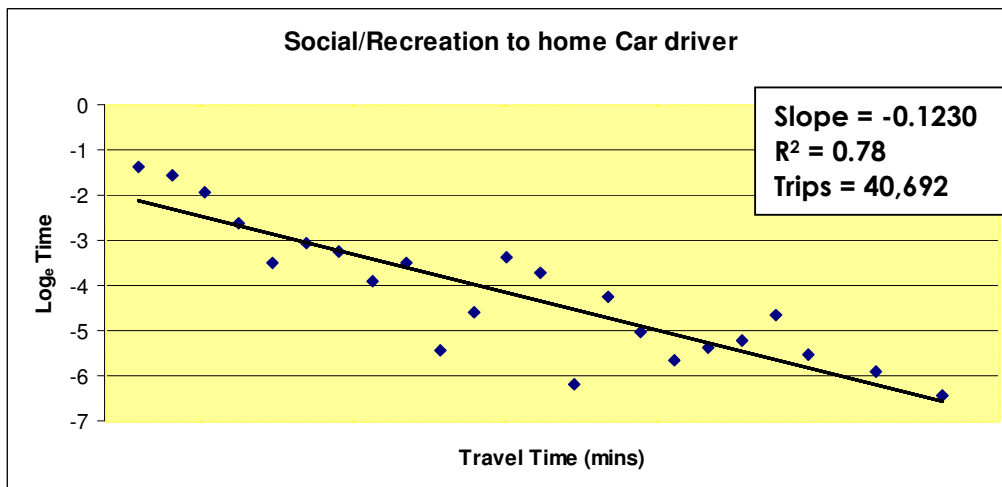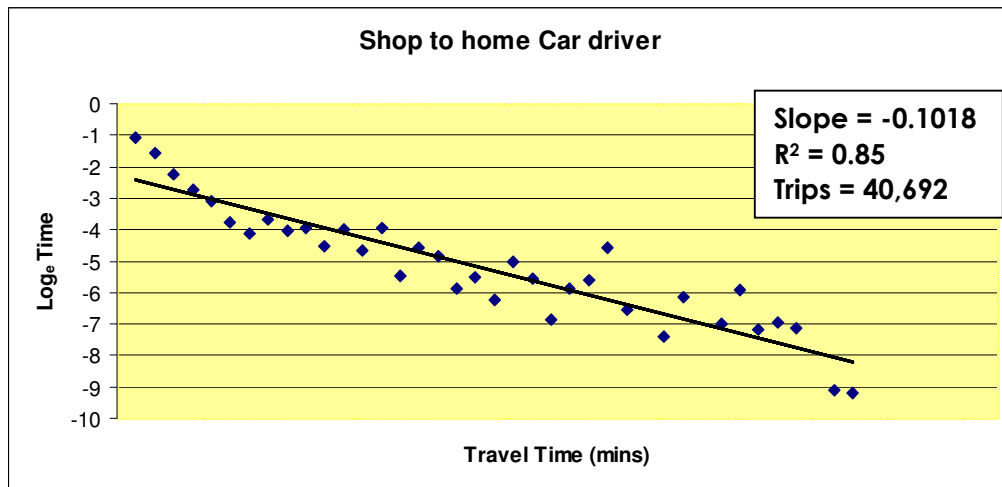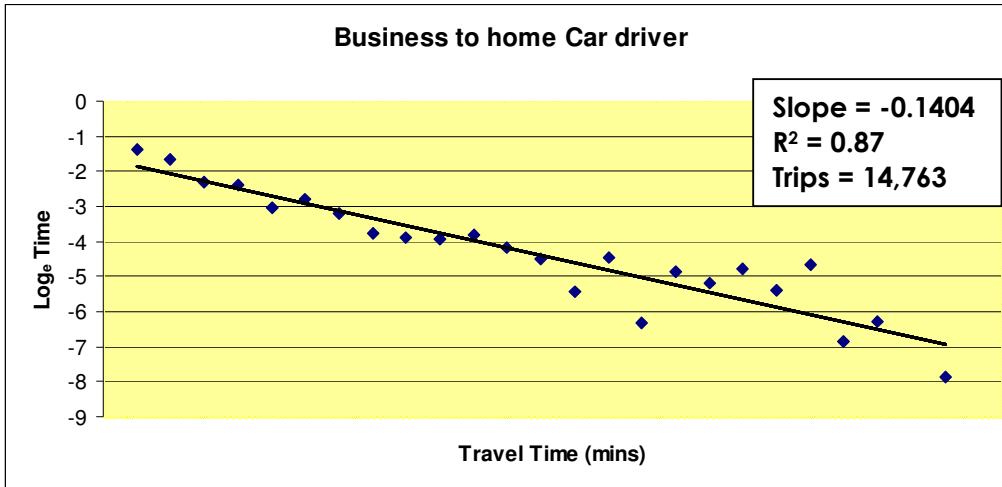
Waikato Regional Model	**Distribution Functions Inter Peak Car Drivers**	**Figure 2d**
Trip Distribution		

TRAFFIC DESIGN GROUP

GABITES PORTER

Other to home Car driver

Slope = -0.1303
R² = 0.85
Trips = 30,029
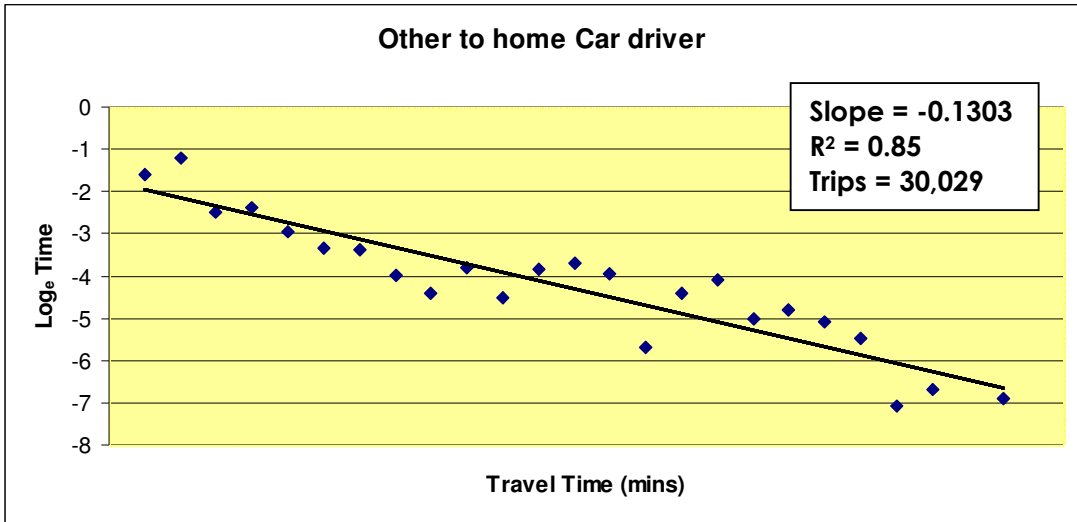
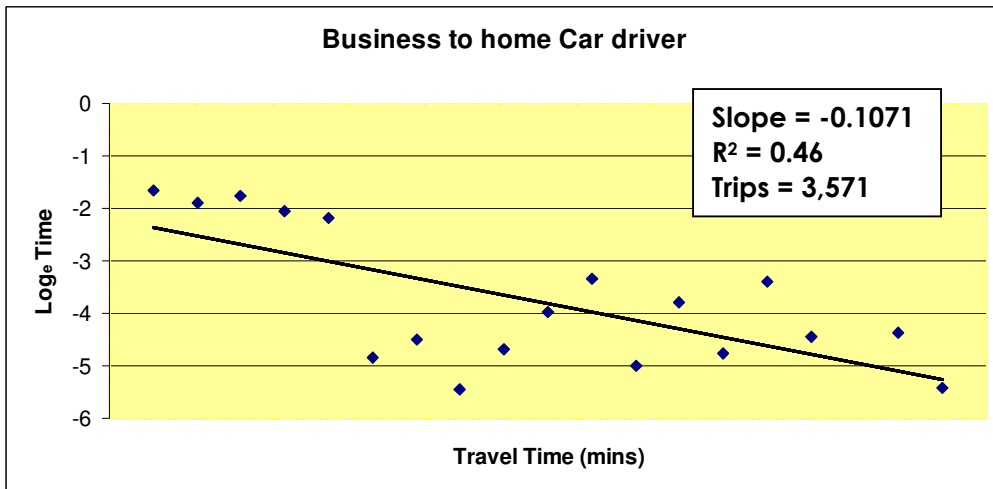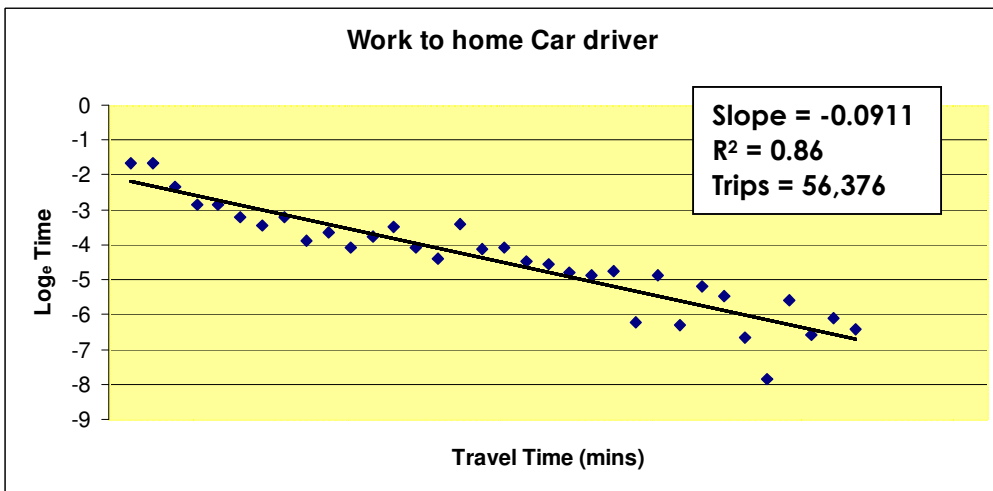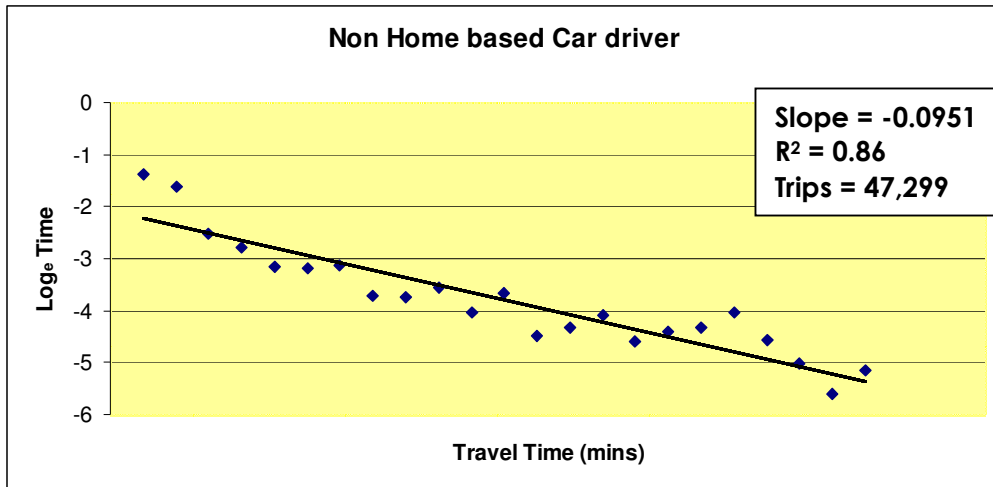| Waikato Regional Model	Distribution Functions Inter Peak Car Drivers	Figure 2e
Trip Distribution		

TRAFFIC DESIGN GROUP

GABITES PORTER

Home to Shop Car driver

Slope = -0.2373
R^2 = .86
Trips = 5,293

Home to Social/Recreation Car driver

Slope = -0.1110
R^2 = 0.64
Trips = 9,152

Home to Other Car driver

Slope = -0.0828
R^2 = 0.49
Trips = 6,581
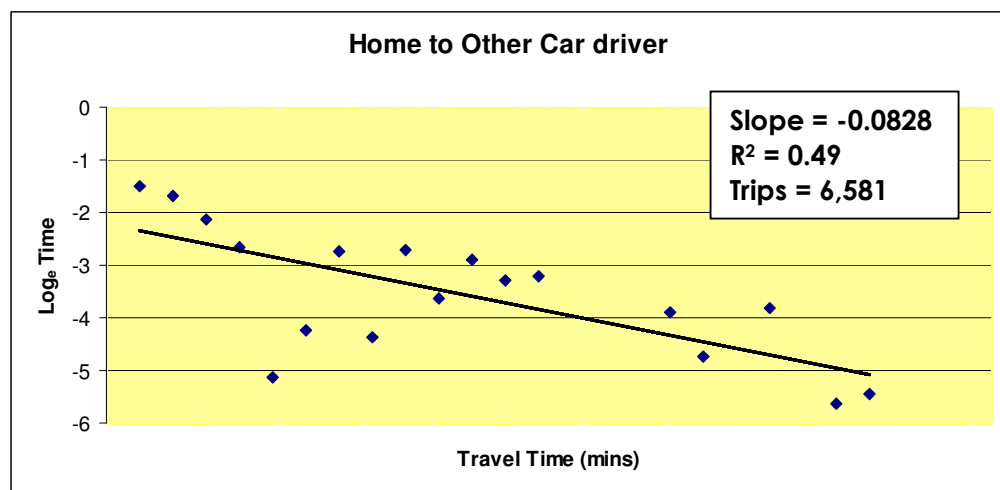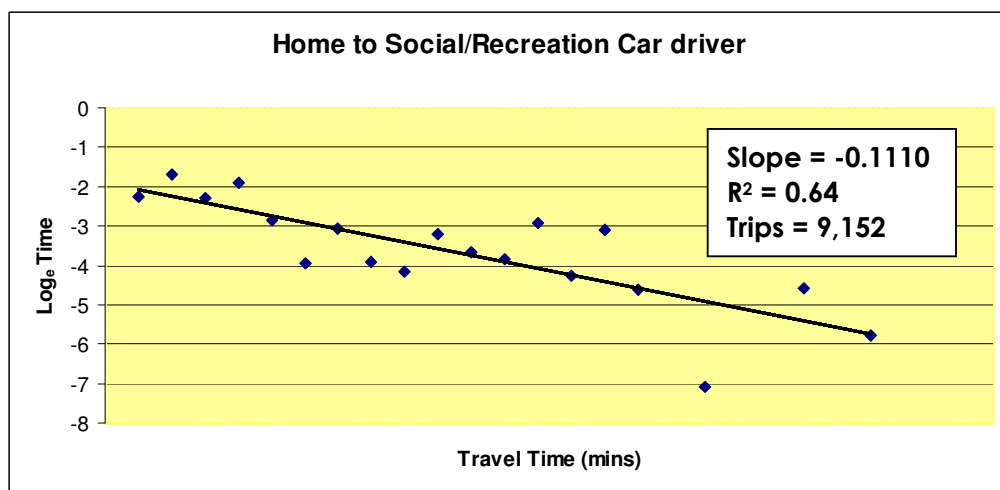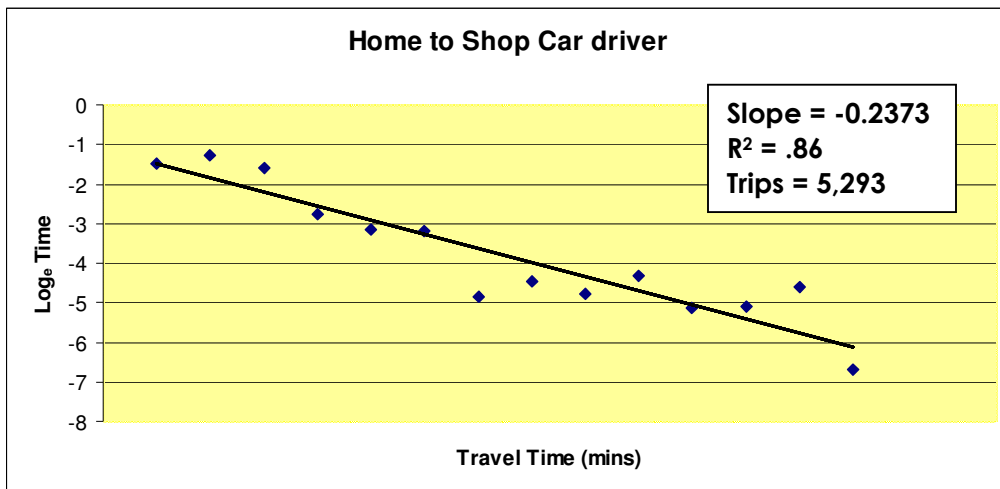
Waikato Regional Model	**Distribution Functions Evening Peak Car Drivers**	**Figure 3a**
Trip Distribution		

TRAFFIC DESIGN GROUP

GABITES PORTER

Non Home based Car driver

Slope = -0.0951
R² = 0.86
Trips = 47,299

Work to home Car driver

Slope = -0.0911
R² = 0.86
Trips = 56,376

Business to home Car driver

Slope = -0.1071
R² = 0.46
Trips = 3,571

Waikato Regional Model	**Distribution Functions** **Evening Peak Car Drivers**	**Figure 3b**
Trip Distribution		
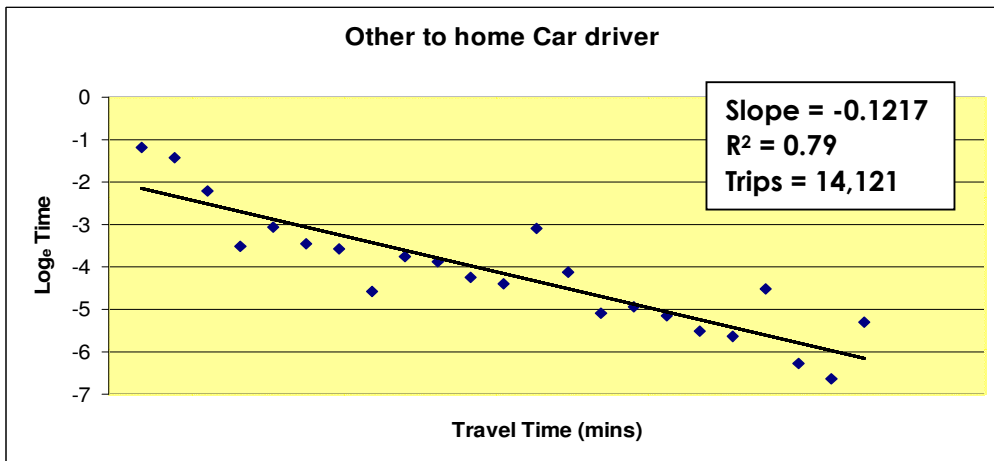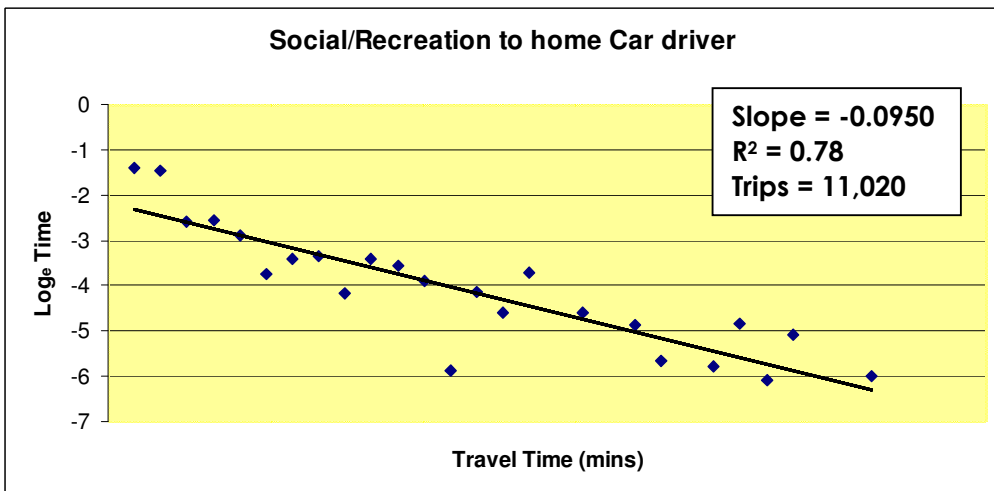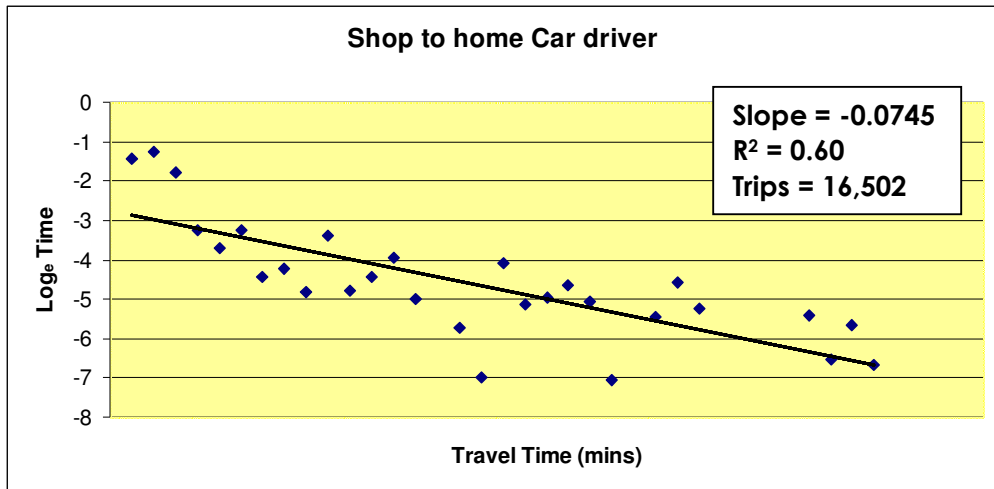
TRAFFIC DESIGN GROUP

GABITES PORTER

Shop to home Car driver

Slope = -0.0745
R² = 0.60
Trips = 16,502

Social/Recreation to home Car driver

Slope = -0.0950
R² = 0.78
Trips = 11,020

Other to home Car driver

Slope = -0.1217
R² = 0.79
Trips = 14,121

Waikato Regional Model	**Distribution Functions**	**Figure 3c**
Trip Distribution	**Evening Peak Car Drivers**	

TRAFFIC DESIGN GROUP

GABITES PORTER

Home to Work Trip Time frequency

	Mean	SD
HIS	13.68	13.93
Model	13.88	12.58

Home to Education Trip Time frequency

	Mean	SD
HIS	11.27	9.19
Model	10.65	13.00

Home to Business Trip Time frequency

	Mean	SD
HIS	11.25	8.16
Model	10.82	12.93
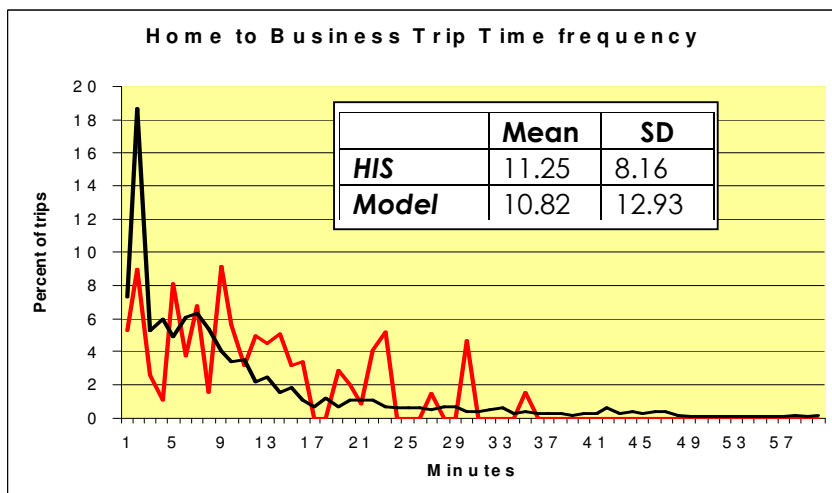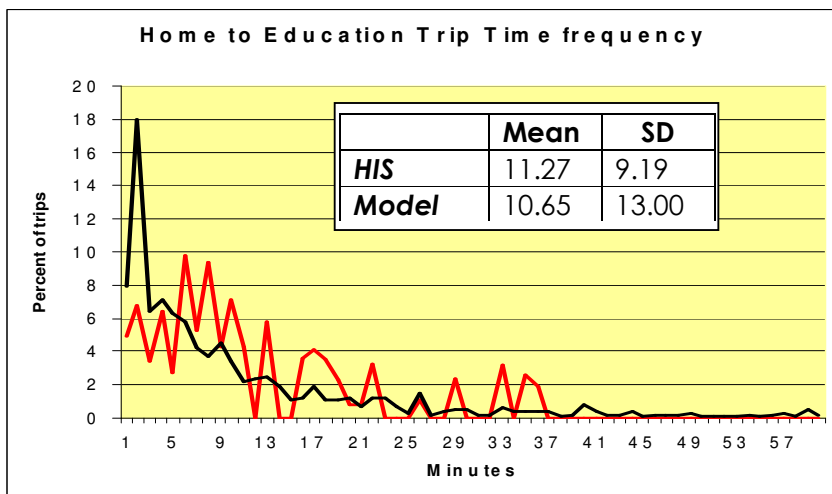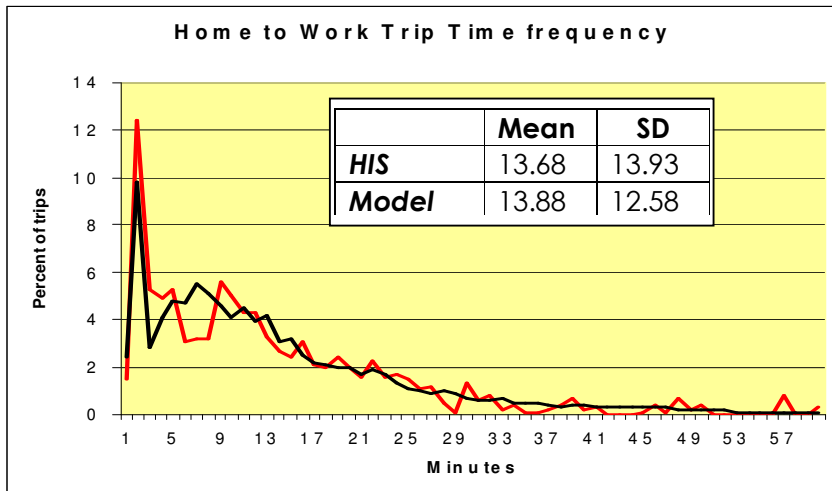
Waikato Regional Model	**Trip Time Frequency Plots (HTW/HTEd/HTB) Morning Peak Car Drivers**	**Figure 4a**
Trip Distribution		

TRAFFIC DESIGN GROUP

GABITES PORTER

Home to Shop Trip Time frequency

	Mean	SD
HIS	10.34	9.98
Model	9.88	11.47

Home to Soc/Rec Trip Time frequency

	Mean	SD
HIS	9.33	16.01
Model	9.29	9.00

Home to Other Trip Time frequency

	Mean	SD
HIS	8.39	8.27
Model	8.43	8.07
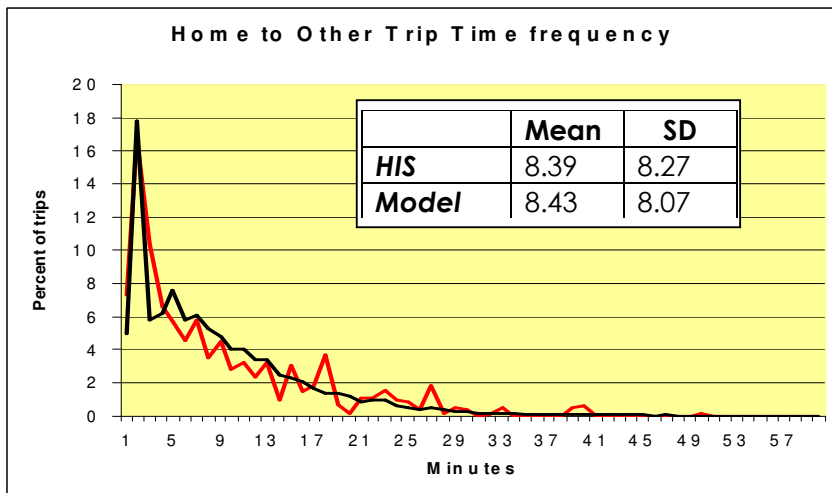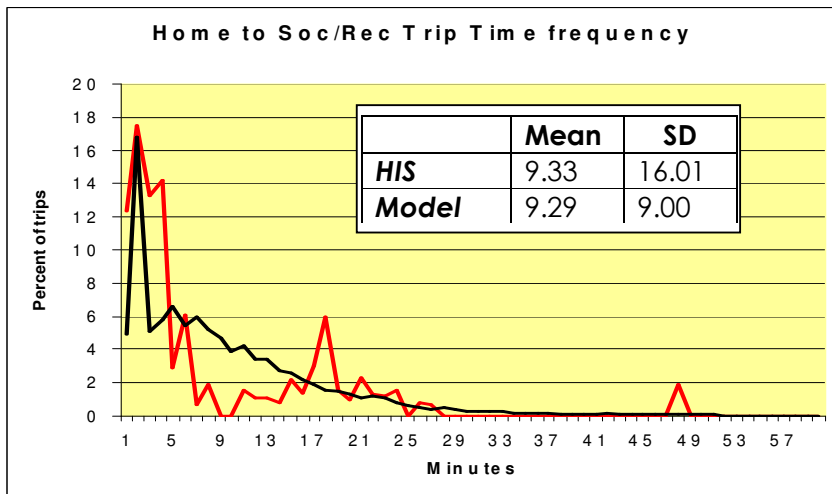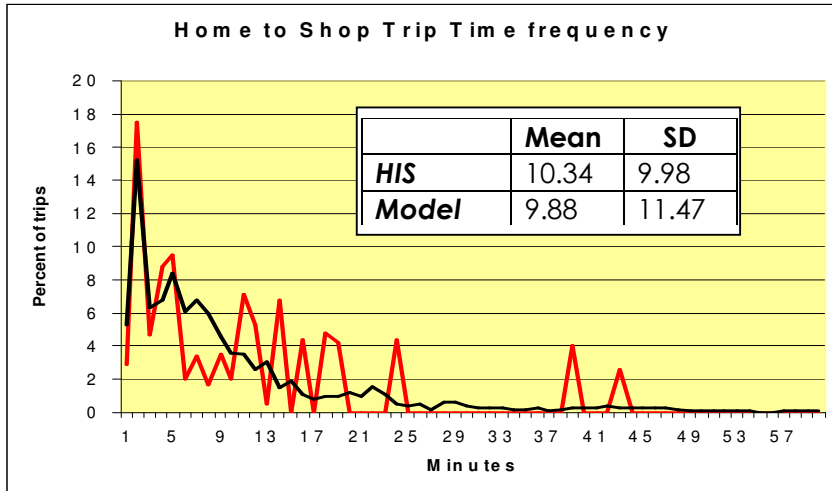
Waikato Regional Model	**Trip Time Frequency Plots (HTS/HSR/HTO) Morning Peak Car Drivers**	**Figure 4b**
Trip Distribution		

TRAFFIC DESIGN GROUP

GABITES PORTER

Non Home Based Trip Time frequency

	Mean	SD
HIS	9.87	12.18
Model	10.25	10.11

Other to Home Trip Time frequency

	Mean	SD
HIS	7.67	8.14
Model	7.54	7.39

Work to Home Trip Time frequency

	Mean	SD
HIS	8.23	10.85
Model	8.47	8.00

Waikato Regional Model	**Trip Time Frequency Plots (NHB/OTH/WTH)**	
Trip Distribution	**Morning Peak Car Drivers**	**Figure 4c**

TRAFFIC DESIGN GROUP   **GABITES PORTER**

Education to Home Trip Time frequency

	Mean	SD
HIS	10.98	3.71
Model	12.68	15.45

Business to Home Trip Time frequency

	Mean	SD
HIS	13.96	24.6
Model	15.2	15.26

Shop to Home Trip Time frequency

	Mean	SD
HIS	6.11	5.83
Model	7.65	9.97

Waikato Regional Model	**Trip Time Frequency Plots (ETH/BTH/STH)**	
Trip Distribution	**Morning Peak Car Drivers**	**Figure 4d**

TRAFFIC DESIGN GROUP   **GABITES PORTER**

Soc/Rec to Home Trip Time frequency

	Mean	SD
HIS	7.71	6.76
Model	6.7	6.81
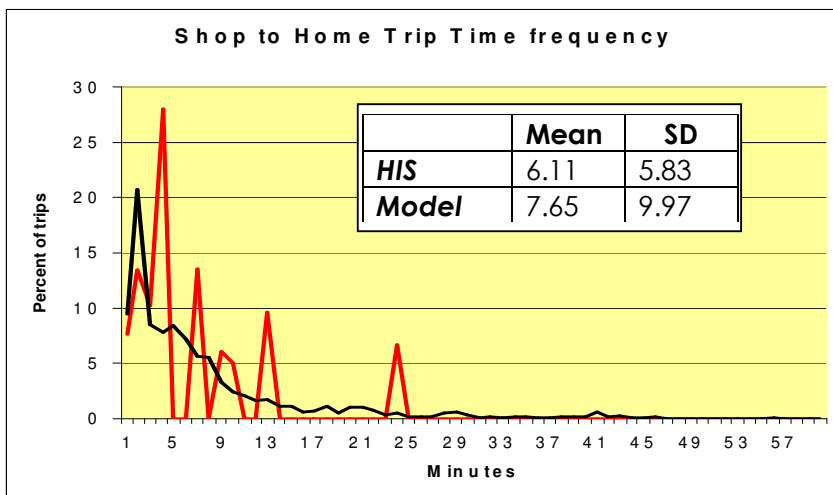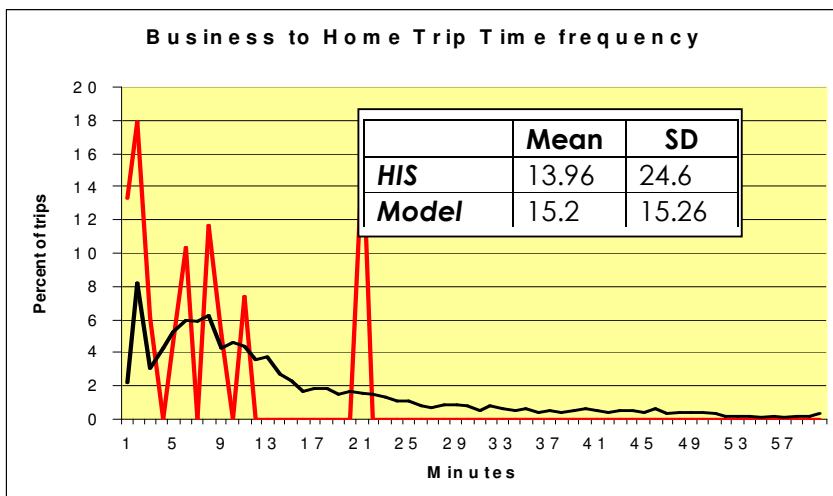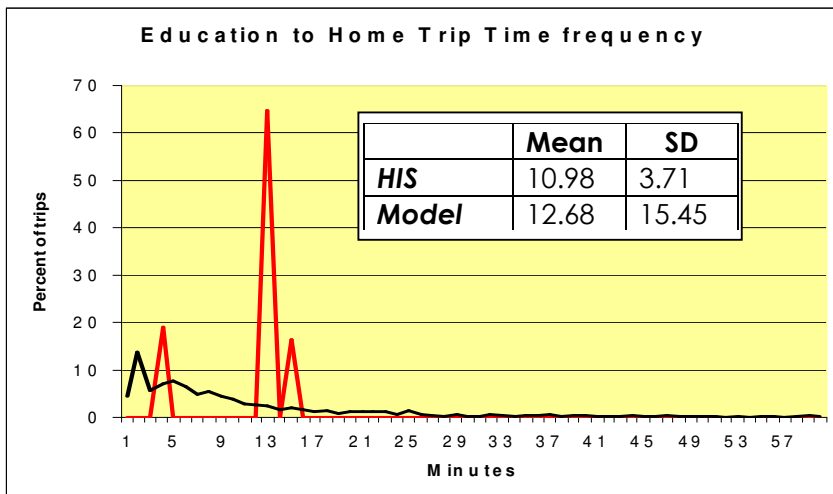
Waikato Regional Model	Trip Time Frequency Plots (SRH)	
	Morning Peak Car Drivers	**Figure 4e**
Trip Distribution		

TRAFFIC DESIGN GROUP

GABITES PORTER

Home to Work Trip Distance frequency

	Mean	SD
HIS	13.39	17.94
Model	13.69	16.38

Home to Education Trip Distance frequency

	Mean	SD
HIS	9.54	10.93
Model	11.11	17.54

Home to Business Trip Distance frequency

	Mean	SD
HIS	10.41	10.46
Model	10.54	16.54
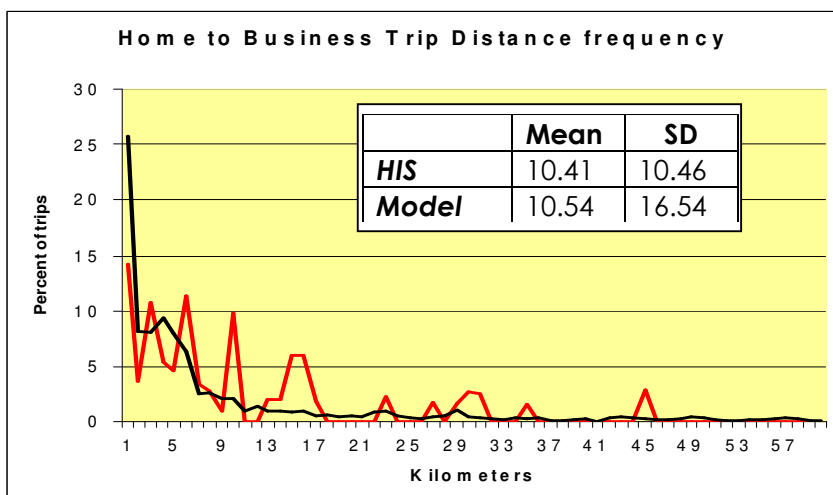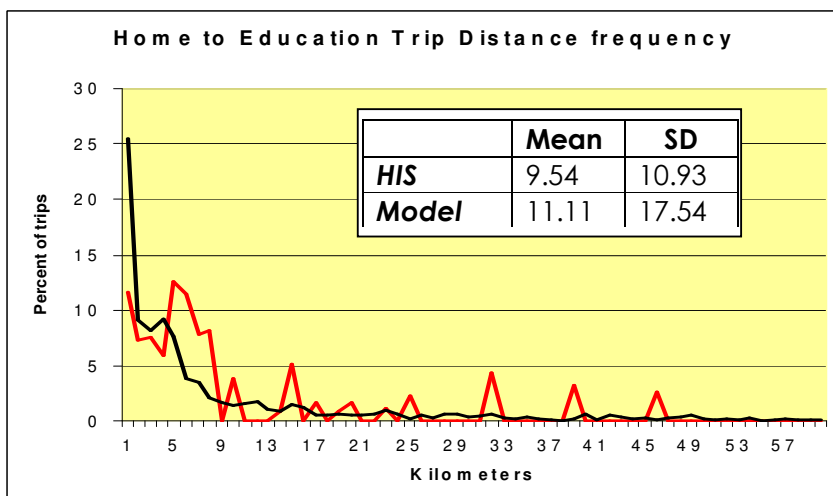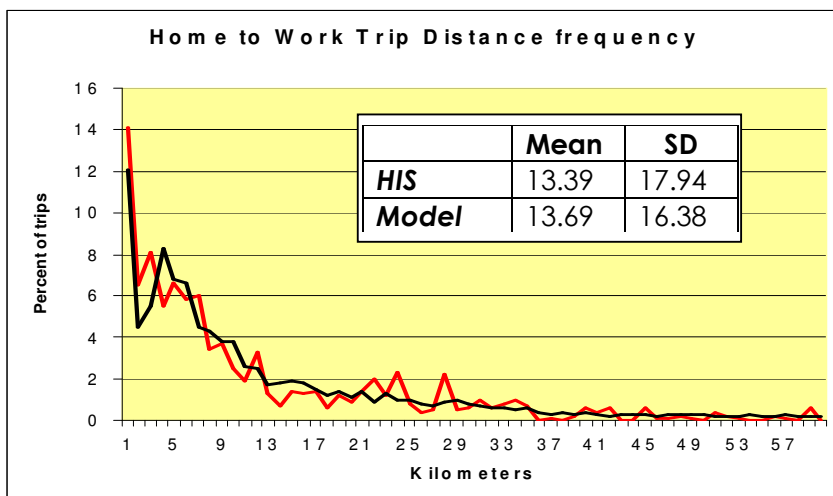
Waikato Regional Model	**Trip Distance Frequency Plots (HTW/HTE/HTB) Morning Peak Car Drivers**	**Figure 5a**
Trip Distribution		
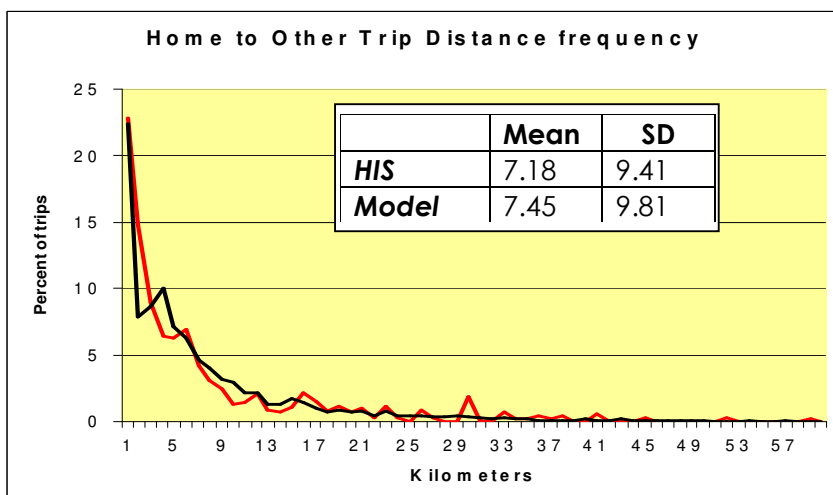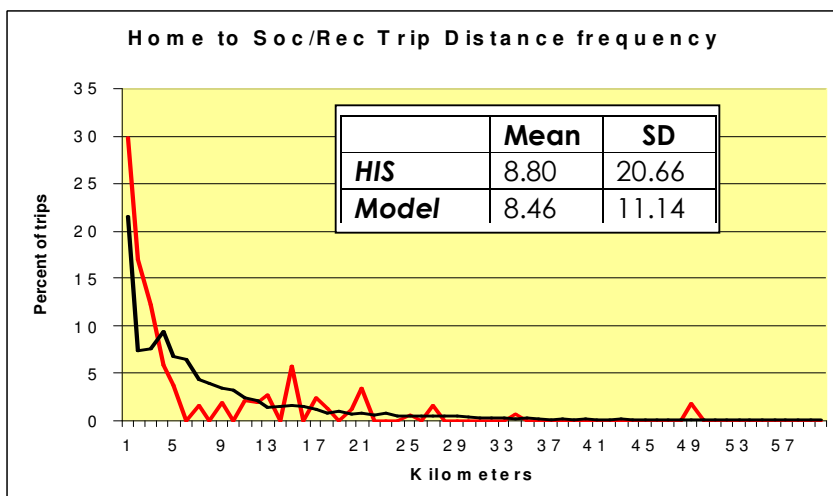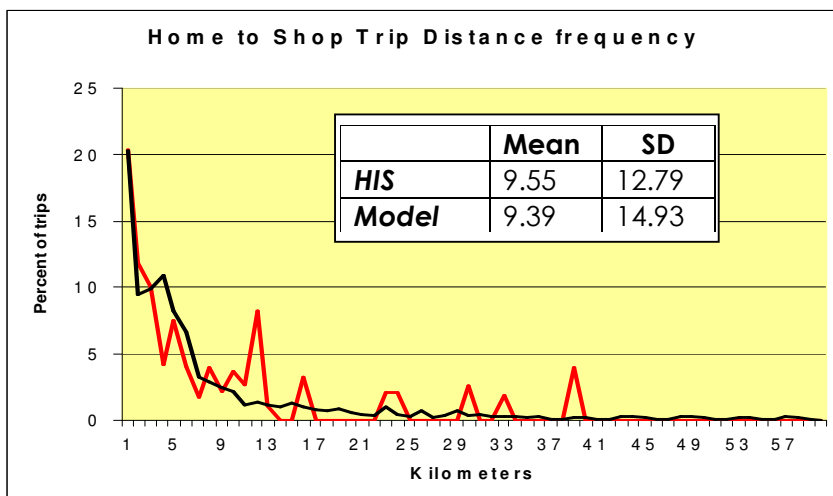
TRAFFIC DESIGN GROUP

GABITES PORTER

Home to Shop Trip Distance frequency

	Mean	SD
HIS	9.55	12.79
Model	9.39	14.93

Home to Soc/Rec Trip Distance frequency

	Mean	SD
HIS	8.80	20.66
Model	8.46	11.14

Home to Other Trip Distance frequency

	Mean	SD
HIS	7.18	9.41
Model	7.45	9.81

Waikato Regional Model	**Trip Distance Frequency Plots (HTS/HSR/HTO) Morning Peak Car Drivers**	**Figure 5b**
Trip Distribution		

TRAFFIC DESIGN GROUP   **GABITES PORTER**

Non Home Based Trip Distance frequency

	Mean	SD
HIS	9.21	15.74
Model	9.42	12.62

Other to Home Trip Distance frequency

	Mean	SD
HIS	6.57	8.86
Model	6.62	8.99

Work to Home Trip Distance frequency

	Mean	SD
HIS	7.53	12.86
Model	7.51	9.90
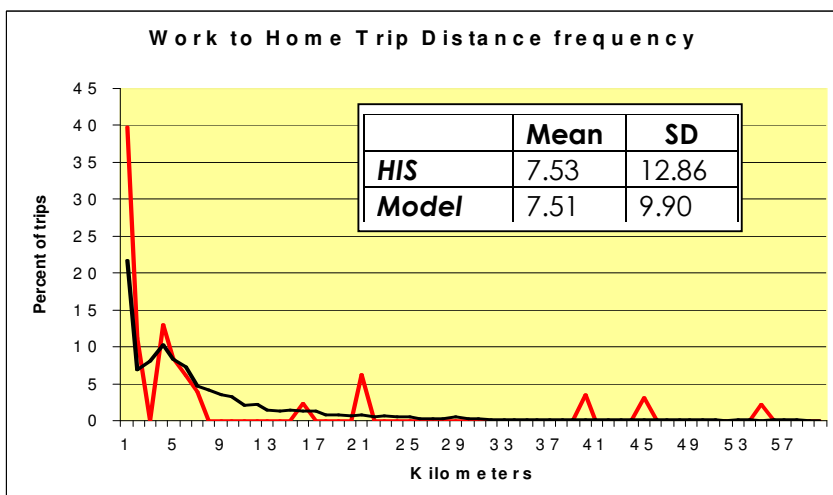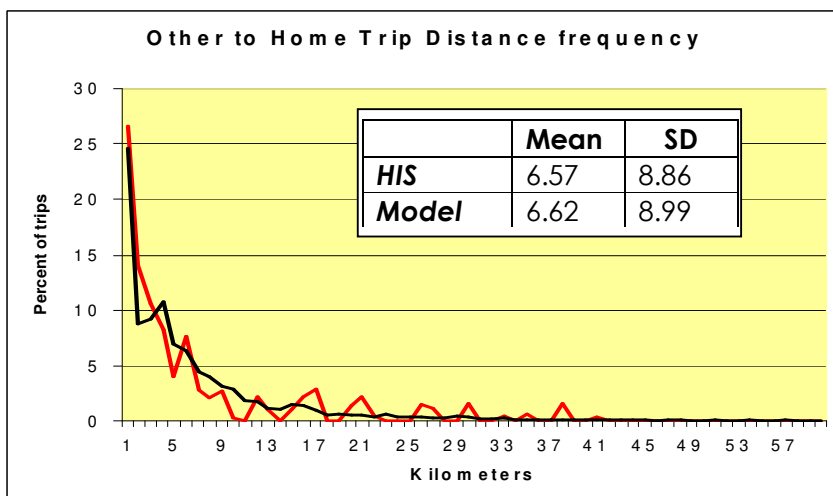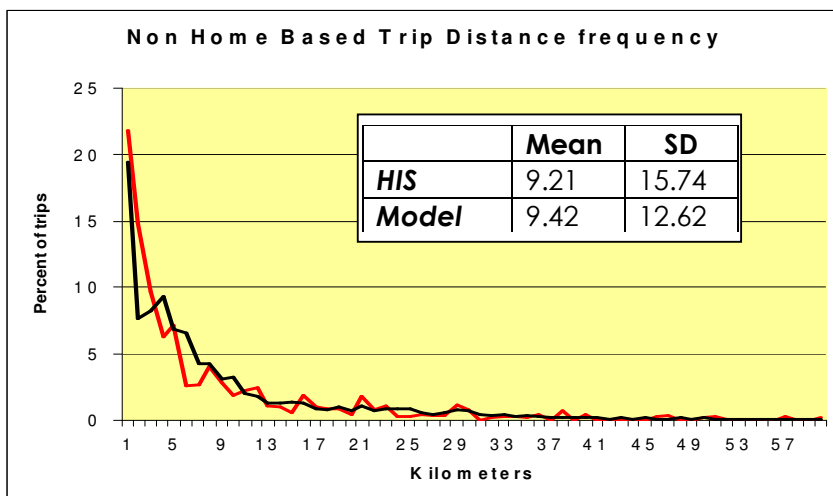
Waikato Regional Model	**Trip Distance Frequency Plots (NHB/OTH/WTH) Morning Peak Car Drivers**	**Figure 5c**
Trip Distribution		

TRAFFIC DESIGN GROUP

GABITES PORTER

Education to Home Trip Distance frequency

	Mean	SD
HIS	12.00	5.67
Model	13.66	21.24

Business to Home Trip Distance frequency

	Mean	SD
HIS	15.72	35.57
Model	15.62	20.38

Shop to Home Trip Distance frequency

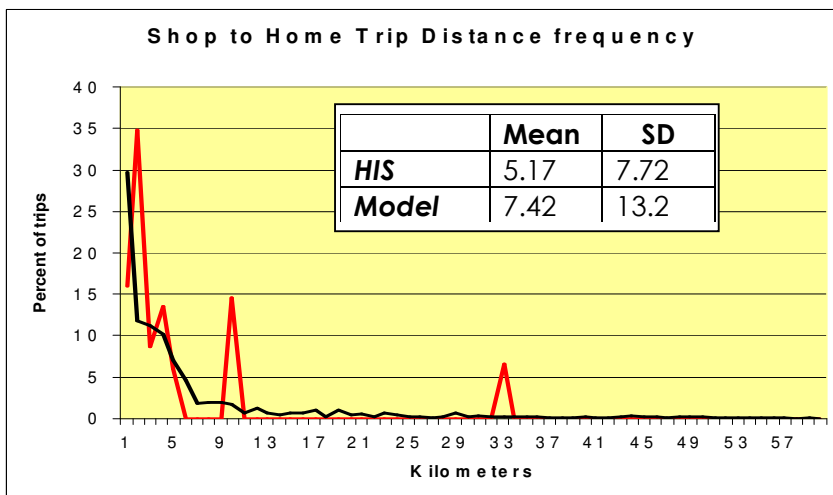|	Mean	SD
HIS	5.17	7.72
Model	7.42	13.2
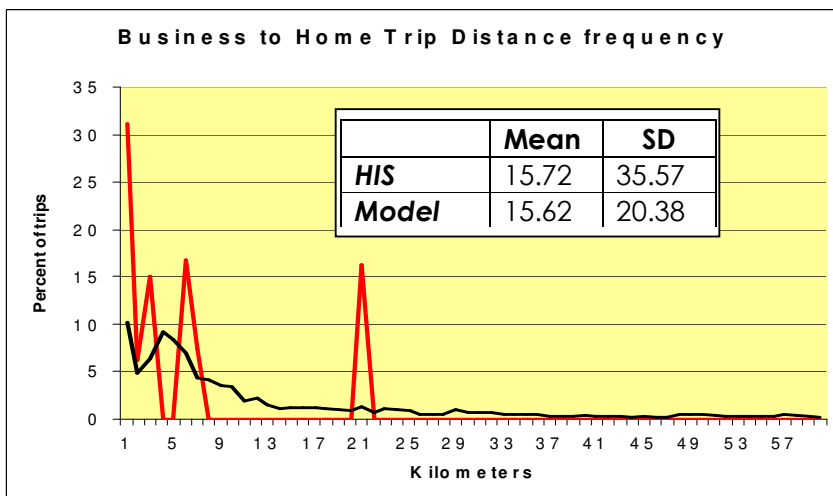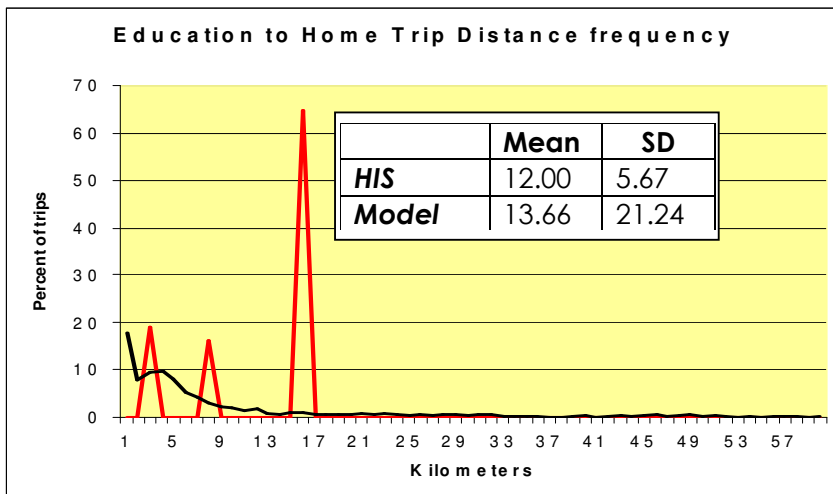
Waikato Regional Model	**Trip Distance Frequency Plots (ETH/BTH/STH) Morning Peak Car Drivers**	**Figure 5d**
Trip Distribution		

TRAFFIC DESIGN GROUP **GABITES PORTER**

Soc/Rec to Home Trip Distance frequency

	Mean	SD
HIS	6.20	6.36
Model	5.74	8.29

Percent of trips

Kilometers

TRAFFIC DESIGN GROUP

GABITES PORTER

Home to Work Trip Time frequency

	Mean	SD
HIS	11.47	12.47
Model	11.87	10.85

Home to Education Trip Time frequency

	Mean	SD
HIS	11.69	10.93
Model	11.58	16.15

Home to Business Trip Time frequency

	Mean	SD
HIS	17.60	26.88
Model	17.23	17.54

Waikato Regional Model	**Trip Time Frequency Plots (HTW/HTE/HTB) Inter Peak Car Drivers**	**Figure 6a**
Trip Distribution		

TRAFFIC DESIGN GROUP   **GABITES PORTER**

Home to Shop Trip Time frequency

	Mean	SD
HIS	10.43	10.52
Model	9.91	11.64

Home to Soc/Rec Trip Time frequency

	Mean	SD
HIS	13.97	14.72
Model	14.10	13.38

Home to Other Trip Time frequency

	Mean	SD
HIS	7.45	7.47
Model	7.08	6.93
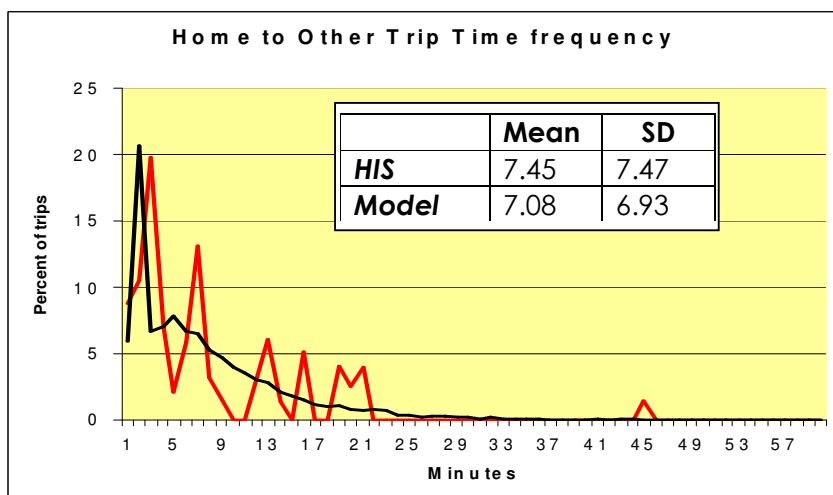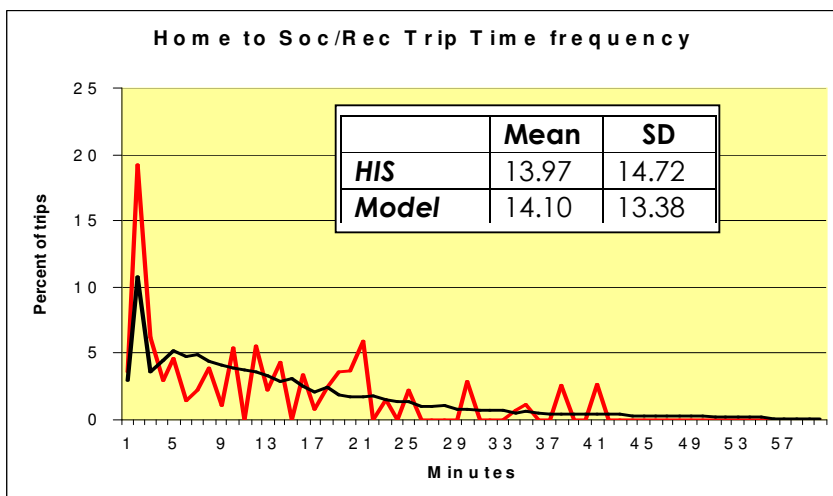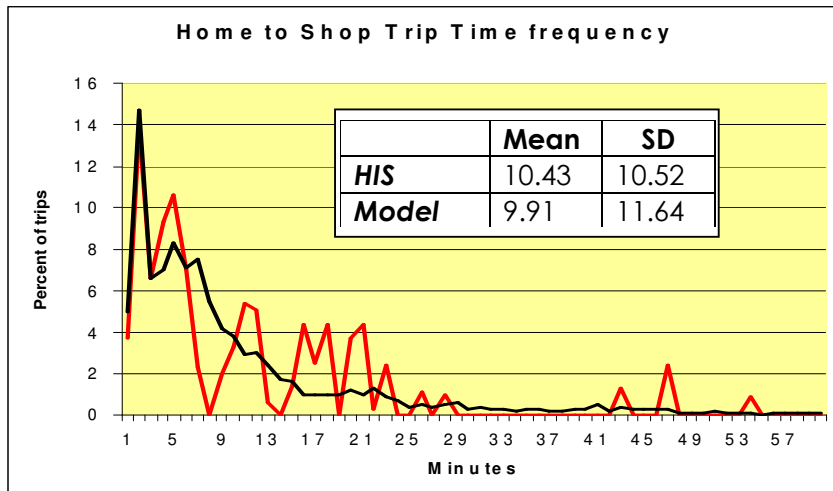
Waikato Regional Model	**Trip Time Frequency Plots (HTS/HSR/HTO)**	
	Inter Peak Car Drivers	**Figure 6b**
Trip Distribution		
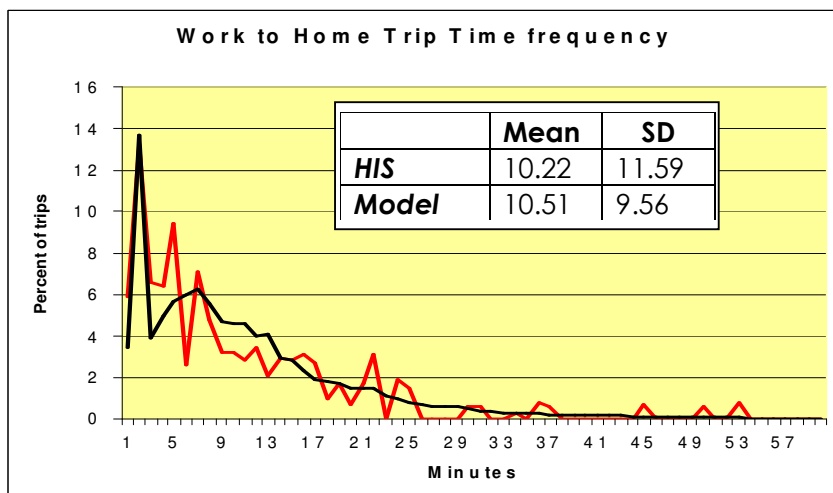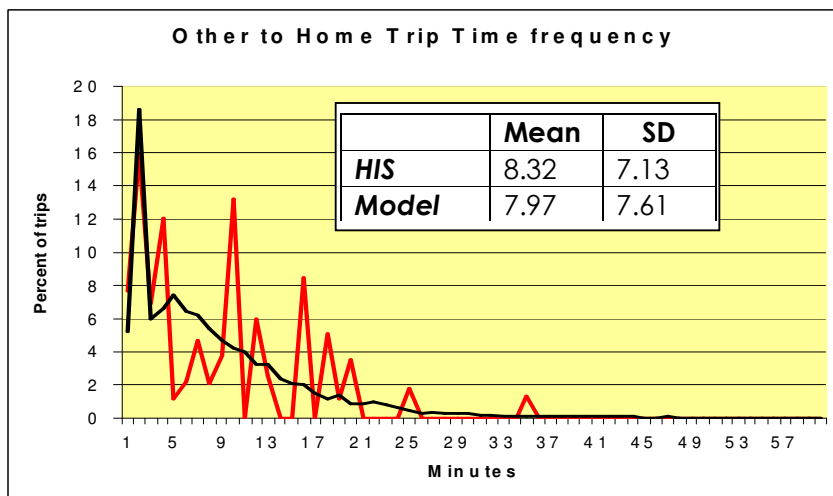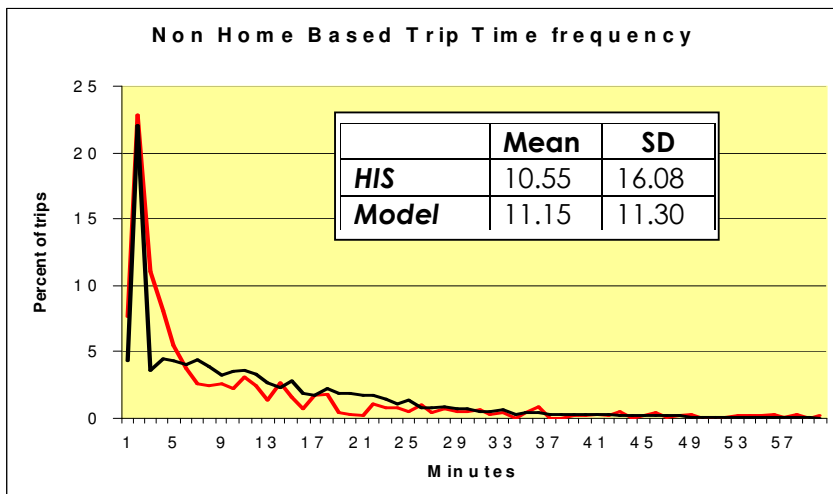
TRAFFIC DESIGN GROUP

GABITES PORTER

Non Home Based Trip Time frequency

	Mean	SD
HIS	10.55	16.08
Model	11.15	11.30

Other to Home Trip Time frequency

	Mean	SD
HIS	8.32	7.13
Model	7.97	7.61

Work to Home Trip Time frequency

	Mean	SD
HIS	10.22	11.59
Model	10.51	9.56

Waikato Regional Model	**Trip Time Frequency Plots (NHB/OTH/WTH)**	**Figure 6c**
Trip Distribution	**Inter Peak Car Drivers**	

TRAFFIC DESIGN GROUP   **GABITES PORTER**

Education to Home Trip Time frequency

	Mean	SD
HIS	11.82	9.41
Model	11.62	15.49

Business to Home Trip Time frequency

	Mean	SD
HIS	10.61	8.54
Model	9.75	12.26

Shop to Home Trip Time frequency

	Mean	SD
HIS	10.26	12.65
Model	9.74	11.53
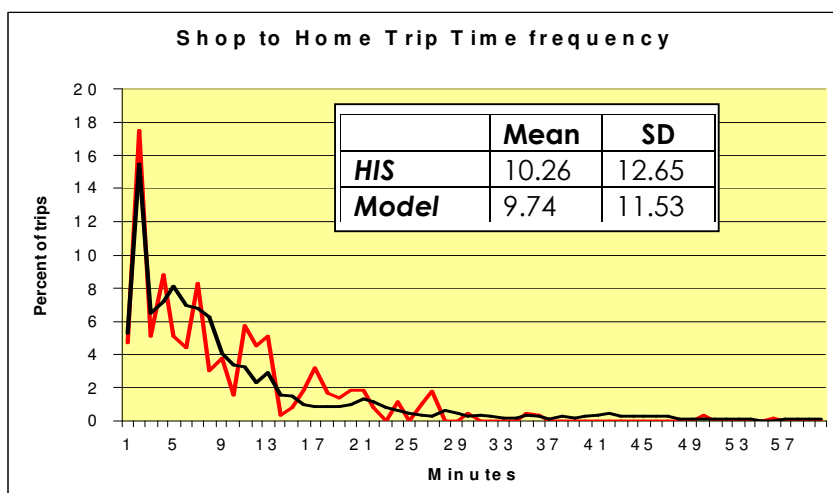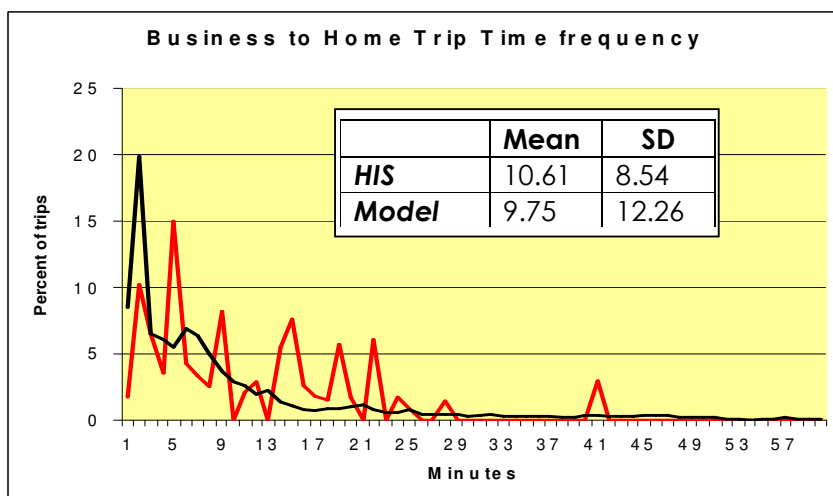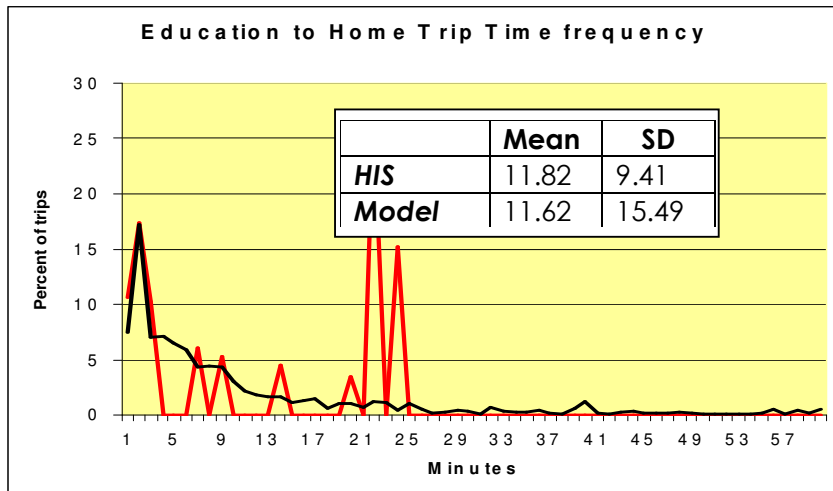
Waikato Regional Model	**Trip Time Frequency Plots (ETH/BTH/STH)**	
	Inter Peak Car Drivers	**Figure 6d**
Trip Distribution		

TRAFFIC DESIGN GROUP

GABITES PORTER

Soc/Rec to Home Trip Time frequency

	Mean	SD
HIS	9.89	11.13
Model	10.03	9.52
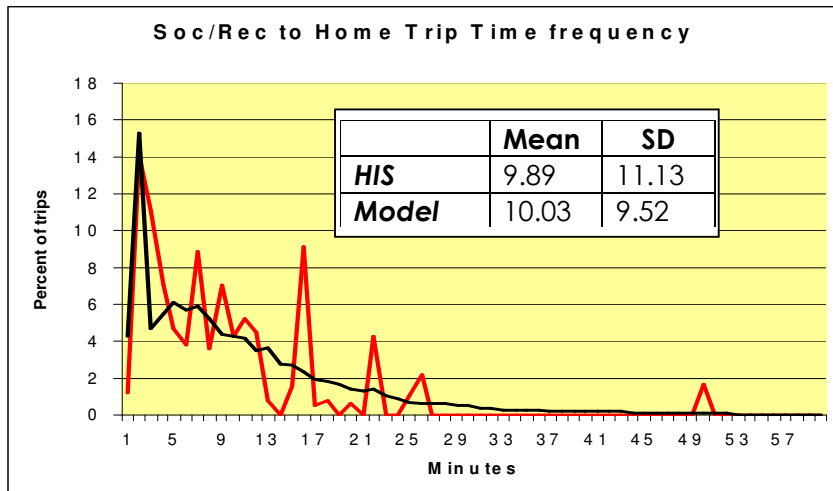
Waikato Regional Model	**Trip Time Frequency Plots (SRH)**	
	Inter Peak Car Drivers	**Figure 6e**
Trip Distribution		

TRAFFIC DESIGN GROUP

GABITES PORTER

Home to Work Trip Distance frequency

	Mean	SD
HIS	11.07	15.98
Model	11.71	14.04

Home to Education Trip Distance frequency

	Mean	SD
HIS	9.54	10.56
Model	12.89	21.98

Home to Business Trip Distance frequency

	Mean	SD
HIS	19.42	35.62
Model	18.41	23.54

Waikato Regional Model	**Trip Distance Frequency Plots (HTW/HTE/HTB)**	**Figure 7a**

Home to Shop Trip Distance frequency

	Mean	SD
HIS	10.2	13.43
Model	9.80	15.34

Home to Soc/Rec Trip Distance frequency

	Mean	SD
HIS	14.69	18.56
Model	14.62	17.67

Home to Other Trip Distance frequency

	Mean	SD
HIS	6.46	8.60
Model	6.22	8.39

| Waikato Regional Model | **Trip Distance Frequency Plots (HTS/HSR/HTO)** | **Figure 7b** |

TRAFFIC DESIGN GROUP   *GABITES PORTER*

Non Home Based Trip Distance frequency

	Mean	SD
HIS	10.86	21.45
Model	11.32	14.50

Other to Home Trip Distance frequency

	Mean	SD
HIS	7.30	8.15
Model	7.16	9.32

Work to Home Trip Distance frequency

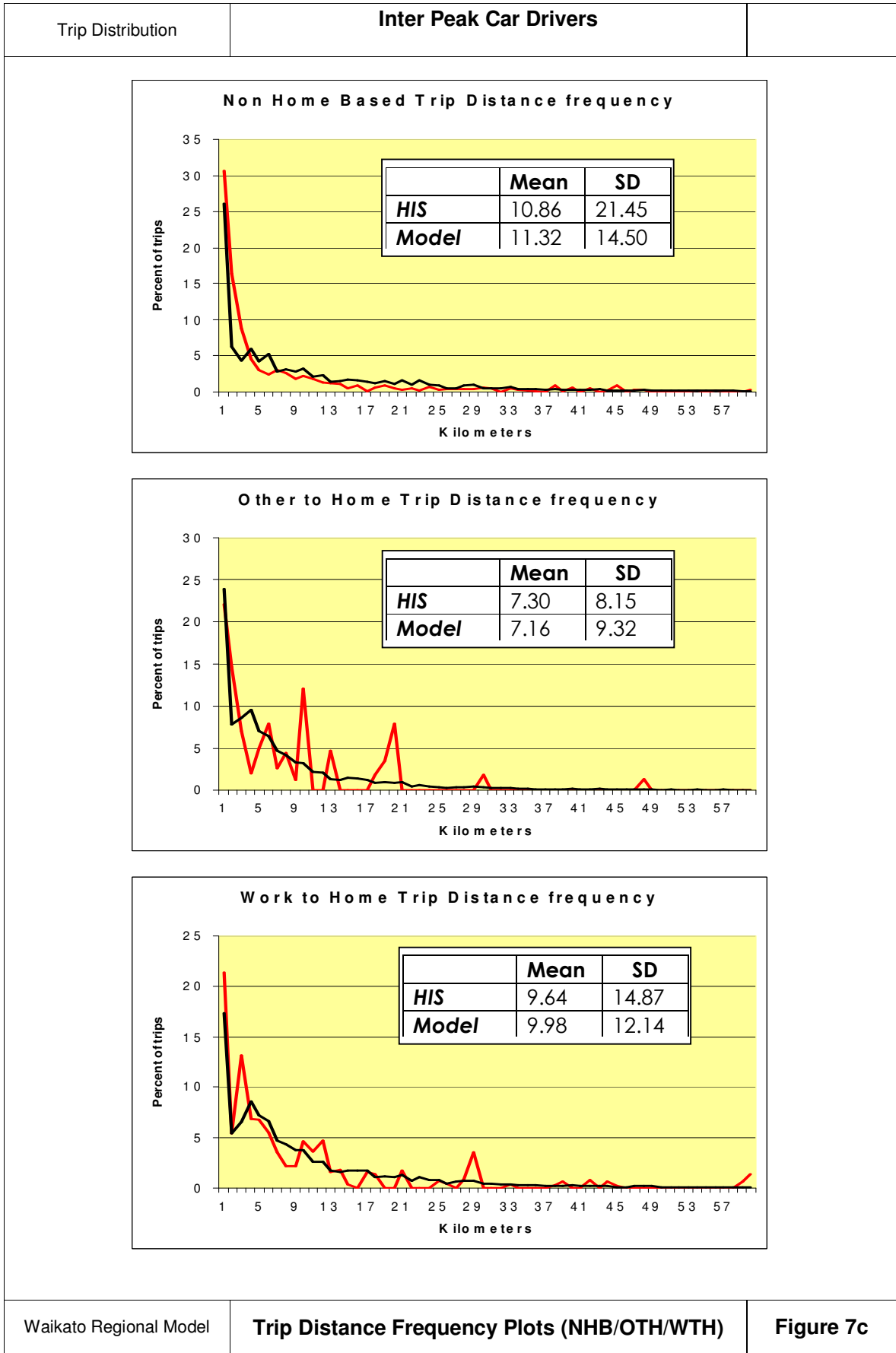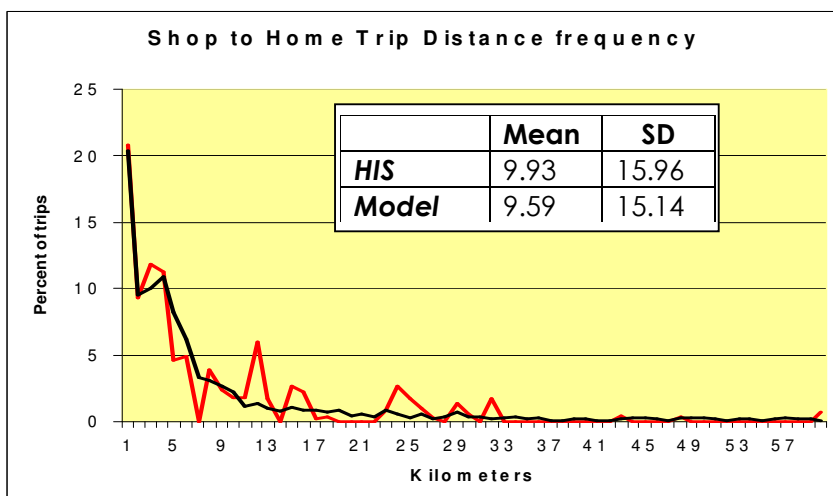|	Mean	SD
HIS	9.64	14.87
Model	9.98	12.14

| Waikato Regional Model | **Trip Distance Frequency Plots (NHB/OTH/WTH)** | **Figure 7c** |

TRAFFIC DESIGN GROUP *GABITES PORTER*

Education to Home Trip Distance frequency

	Mean	SD
HIS	10.58	9.43
Model	12.78	21.14

Business to Home Trip Distance frequency

	Mean	SD
HIS	9.85	9.70
Model	9.71	15.74

Shop to Home Trip Distance frequency

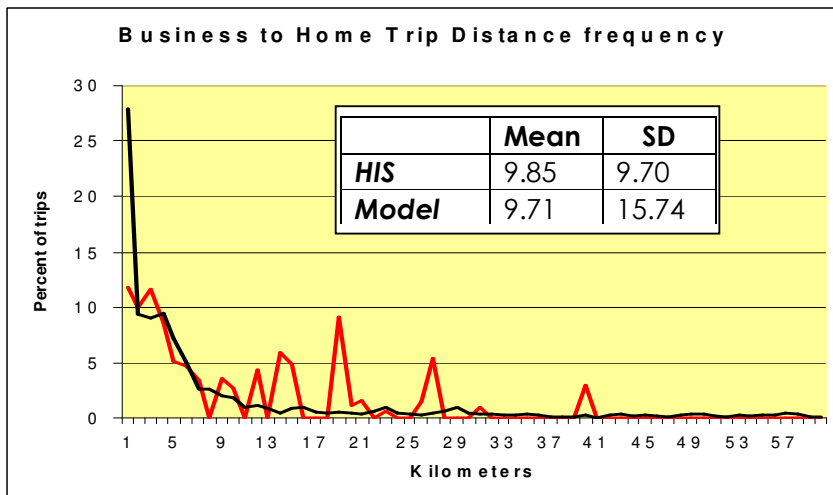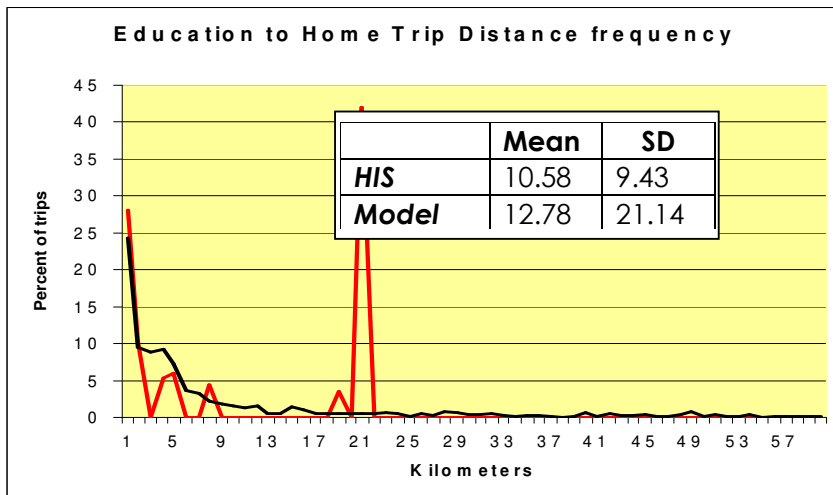|	Mean	SD
HIS	9.93	15.96
Model	9.59	15.14

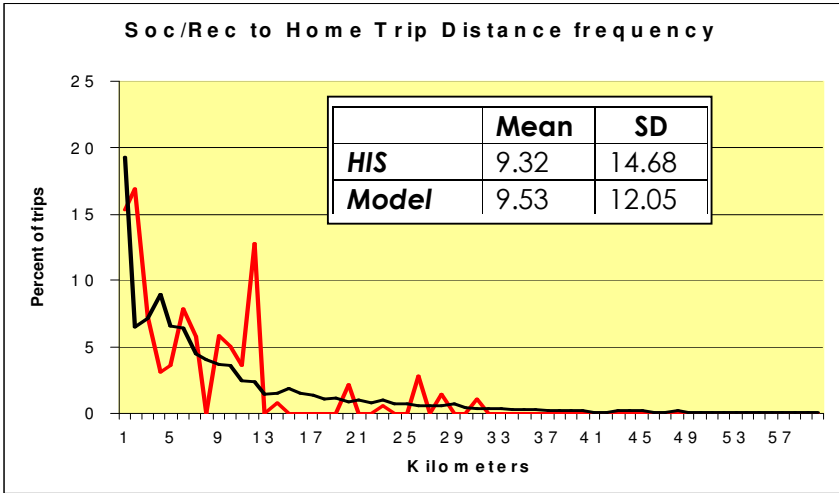| Waikato Regional Model | **Trip Distance Frequency Plots (ETH/BTH/STH)** | **Figure 7d** |

TRAFFIC DESIGN GROUP

GABITES PORTER

Soc/Rec to Home Trip Distance frequency

	Mean	SD
HIS	9.32	14.68
Model	9.53	12.05

TRAFFIC DESIGN GROUP

GABITES PORTER

Home to Work Trip Time frequency

	Mean	SD
HIS	12.60	11.67
Model	12.88	11.70

Home to Education Trip Time frequency

	Mean	SD
HIS	11.54	7.78
Model	12.16	17.04

Home to Business Trip Time frequency

	Mean	SD
HIS	9.83	8.73
Model	9.80	12.04

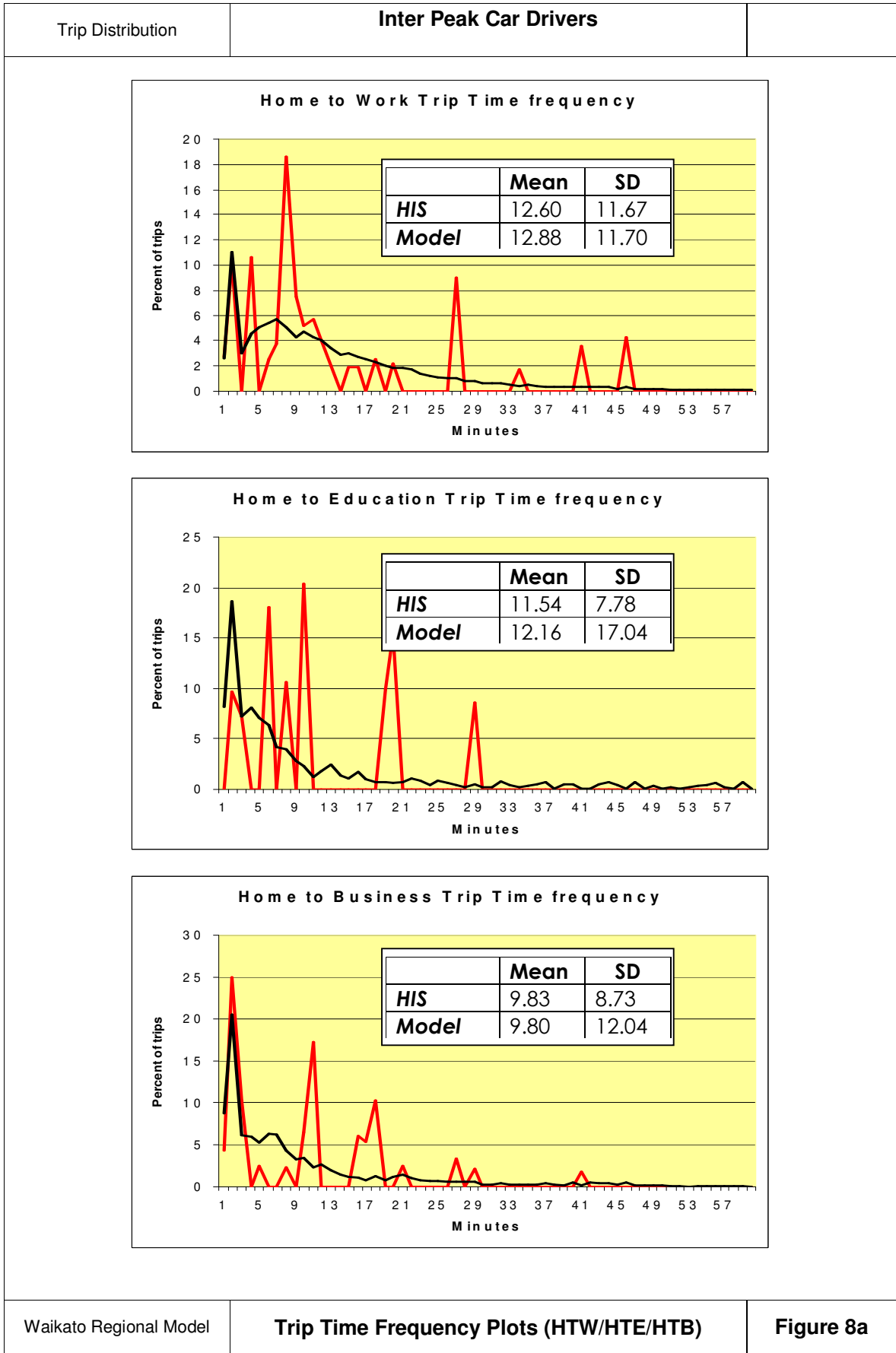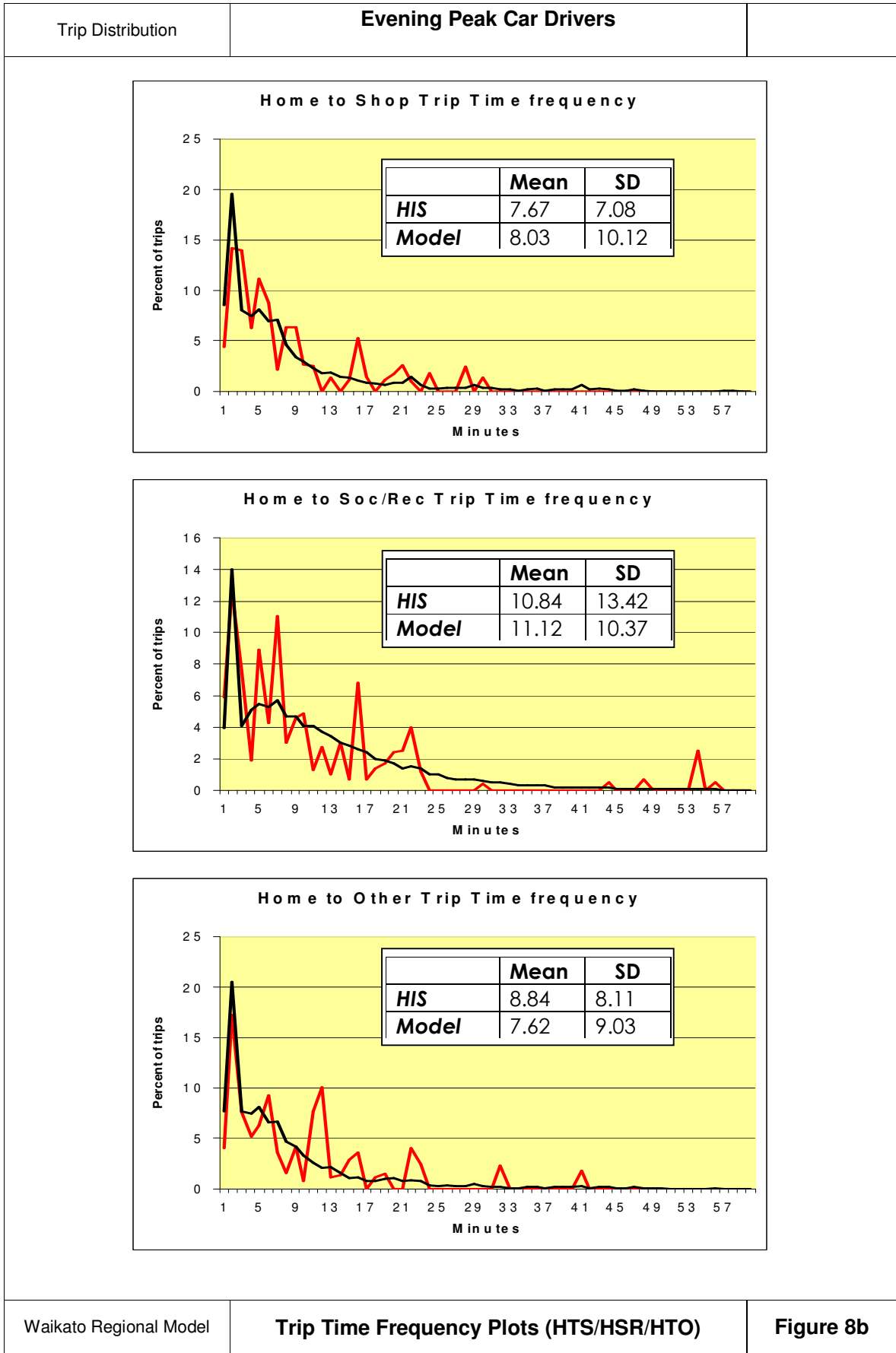| Waikato Regional Model | **Trip Time Frequency Plots (HTW/HTE/HTB)** | **Figure 8a** |

TRAFFIC DESIGN GROUP

GABITES PORTER

Home to Shop Trip Time frequency

	Mean	SD
HIS	7.67	7.08
Model	8.03	10.12

Home to Soc/Rec Trip Time frequency

	Mean	SD
HIS	10.84	13.42
Model	11.12	10.37

Home to Other Trip Time frequency

	Mean	SD
HIS	8.84	8.11
Model	7.62	9.03

| Waikato Regional Model | **Trip Time Frequency Plots (HTS/HSR/HTO)** | **Figure 8b** |

TRAFFIC DESIGN GROUP   *GABITES PORTER*

Non Home Based Trip Time frequency

	Mean	SD
HIS	9.65	12.63
Model	9.71	9.95

Other to Home Trip Time frequency

	Mean	SD
HIS	11.00	12.95
Model	11.28	11.33

Work to Home Trip Time frequency

	Mean	SD
HIS	13.95	13.11
Model	14.32	12.84

Waikato Regional Model	**Trip Time Frequency Plots (NHB/OTH/WTH) Evening Peak Car Drivers**	**Figure 8c**
Trip Distribution		

Tech Note 11 Trip Distribution Final.doc

TRAFFIC DESIGN GROUP

GABITES PORTER

Education to Home Trip Time frequency

	Mean	SD
HIS	12.20	6.97
Model	11.85	15.28

Business to Home Trip Time frequency

	Mean	SD
HIS	13.47	9.81
Model	12.57	14.14

Shop to Home Trip Time frequency

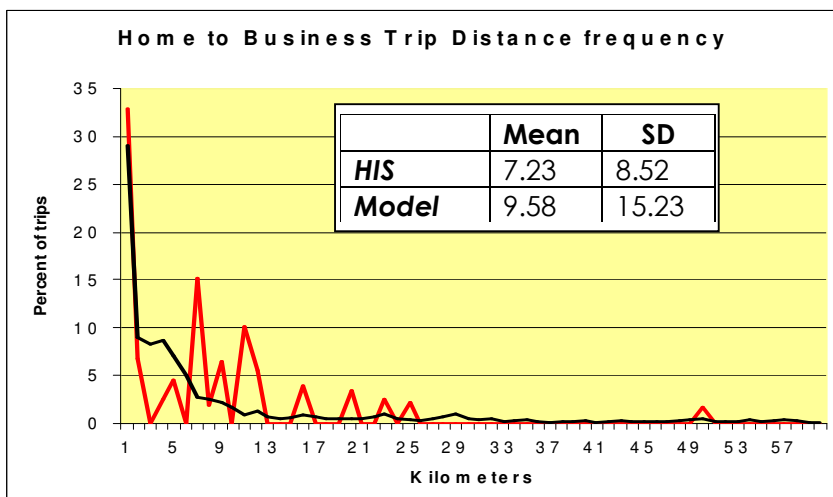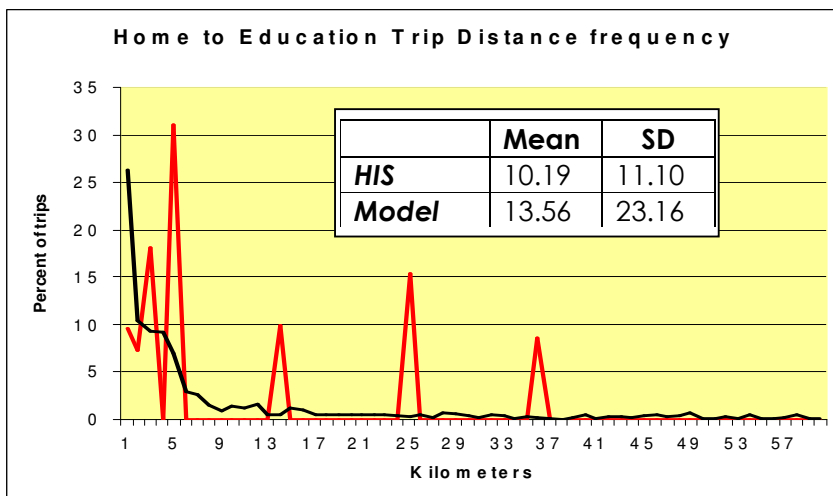|	Mean	SD
HIS	10.42	9.41
Model	10.29	11.77

Waikato Regional Model	**Trip Time Frequency Plots (ETH/BTH/STH)**	
	Evening Peak Car Drivers	**Figure 8d**
Trip Distribution		

TRAFFIC DESIGN GROUP   **GABITES PORTER**

Soc/Rec to Home Trip Time frequency

	Mean	SD
HIS	13.45	17.99
Model	13.54	12.44
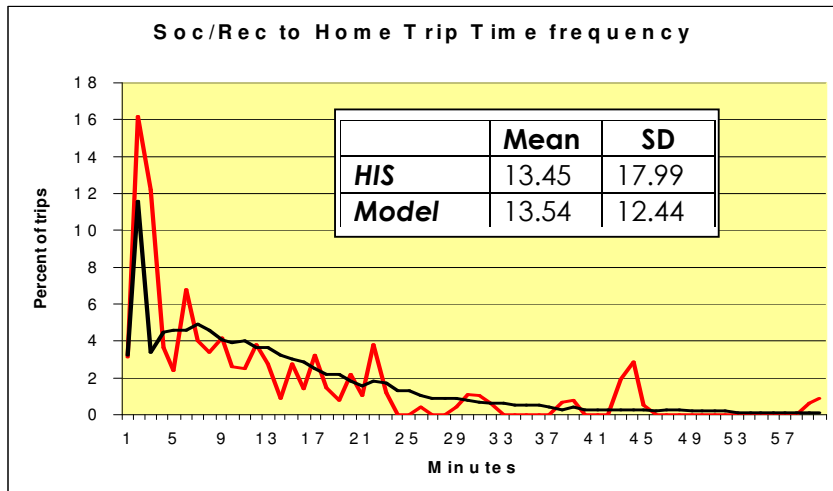
Waikato Regional Model	**Trip Time Frequency Plots (SRH)** **Evening Peak Car Drivers**	**Figure 8e**
Trip Distribution		

TRAFFIC DESIGN GROUP   **GABITES PORTER**

Home to Work Trip Distance frequency

	Mean	SD
HIS	12.81	17.09
Model	12.49	15.13

Home to Education Trip Distance frequency

	Mean	SD
HIS	10.19	11.10
Model	13.56	23.16

Home to Business Trip Distance frequency

	Mean	SD
HIS	7.23	8.52
Model	9.58	15.23
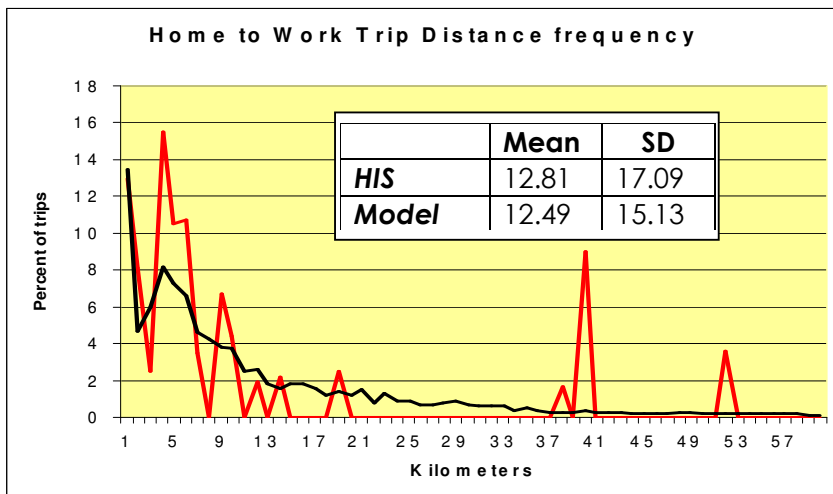
Waikato Regional Model	**Trip Distance Frequency Plots (HTW/HTE/HTB) Evening Peak Car Drivers**	**Figure 9a**
Trip Distribution		

TRAFFIC DESIGN GROUP

GABITES PORTER

Home to Shop Trip Distance frequency

	Mean	SD
HIS	5.92	7.13
Model	7.68	13.29

Home to Soc/Rec Trip Distance frequency

	Mean	SD
HIS	10.01	16.65
Model	10.40	13.01

Home to Other Trip Distance frequency

	Mean	SD
HIS	6.98	9.77
Model	6.98	11.30
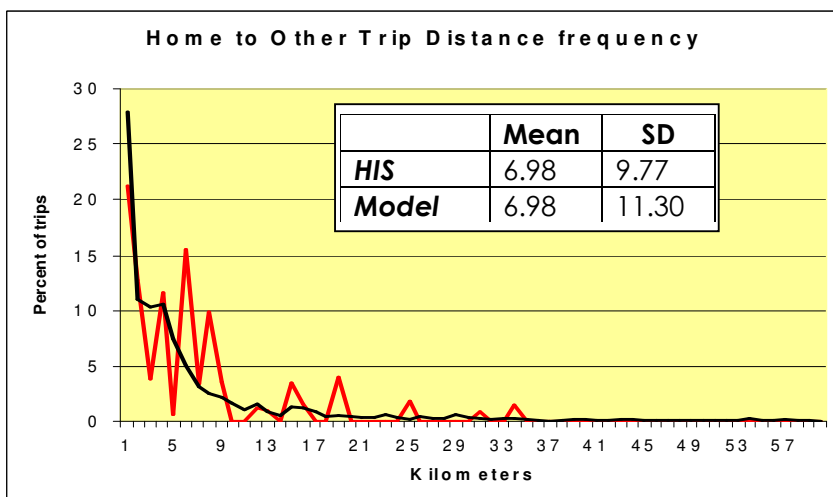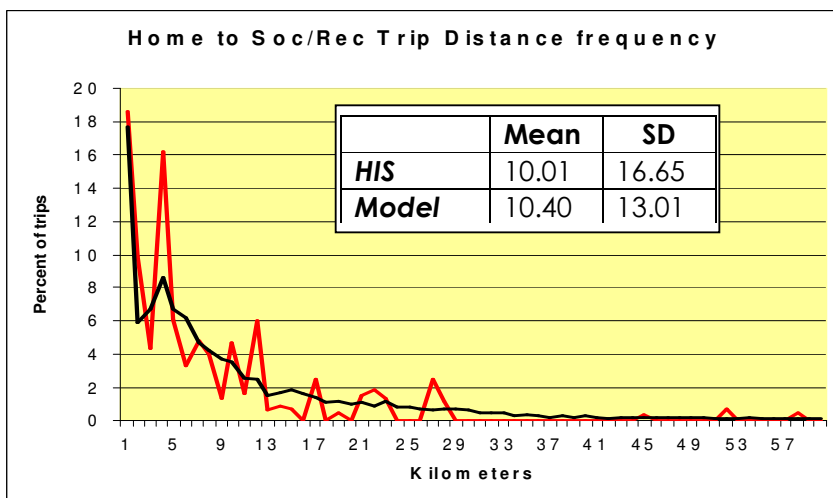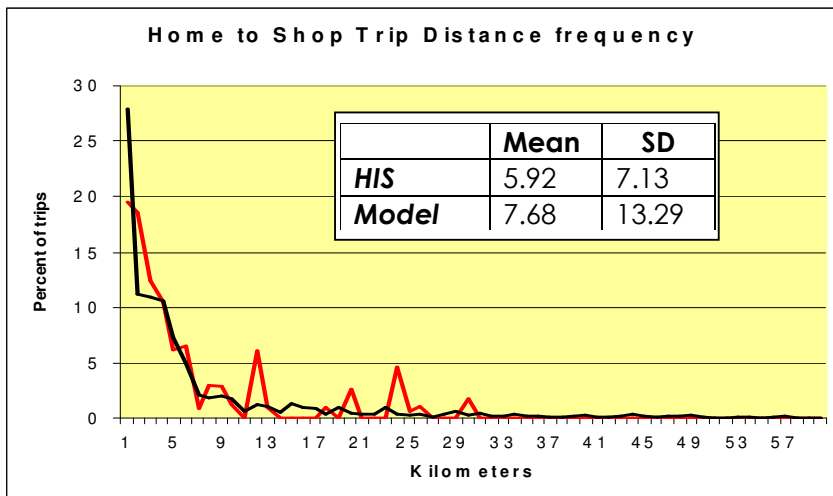
Waikato Regional Model	**Trip Distance Frequency Plots (HTS/HSR/HTO) Evening Peak Car Drivers**	**Figure 9b**
Trip Distribution		
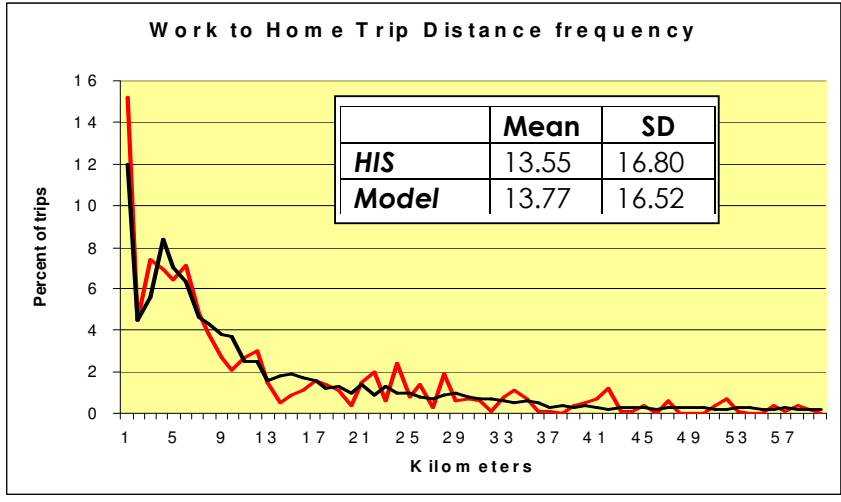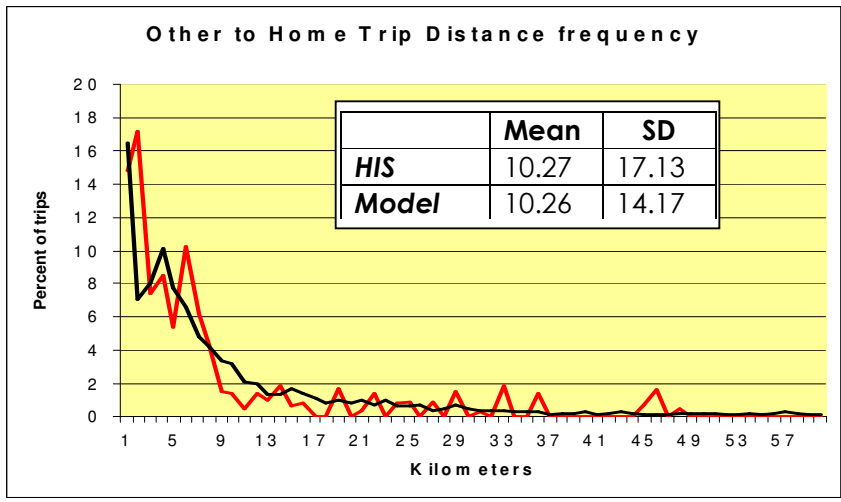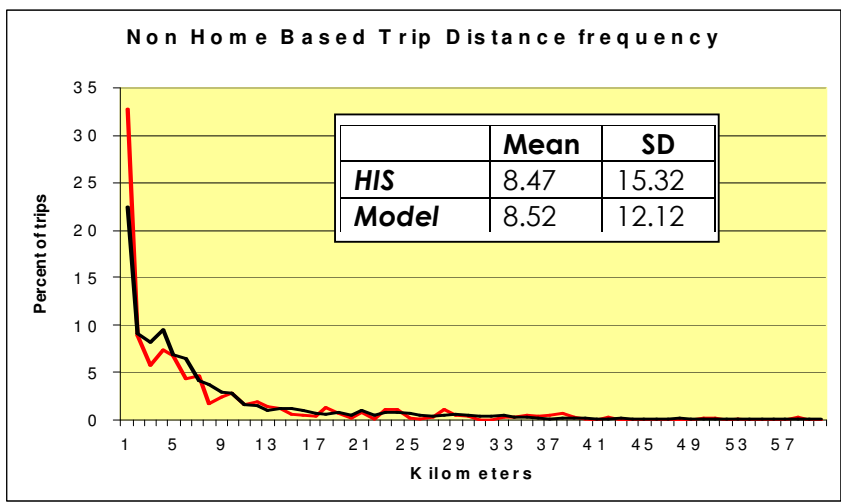
TRAFFIC DESIGN GROUP

GABITES PORTER

Non Home Based Trip Distance frequency

	Mean	SD
HIS	8.47	15.32
Model	8.52	12.12

Other to Home Trip Distance frequency

	Mean	SD
HIS	10.27	17.13
Model	10.26	14.17

Work to Home Trip Distance frequency

	Mean	SD
HIS	13.55	16.80
Model	13.77	16.52

Waikato Regional Model	**Trip Distance Frequency Plots (NHB/OTH/WTH) Evening Peak Car Drivers**	**Figure 9c**
Trip Distribution		
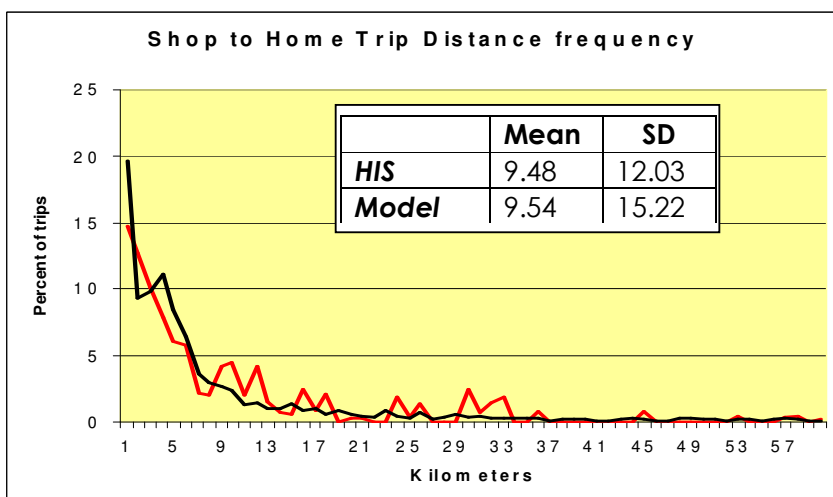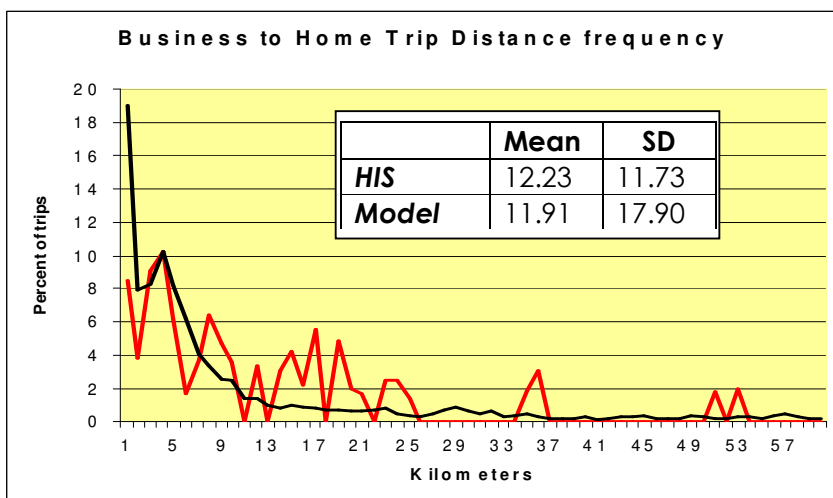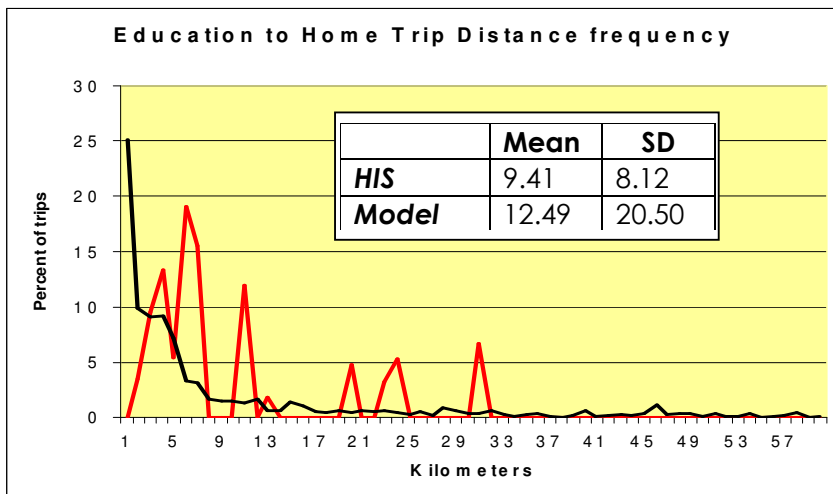
TRAFFIC DESIGN GROUP

GABITES PORTER

Education to Home Trip Distance frequency

	Mean	SD
HIS	9.41	8.12
Model	12.49	20.50

Business to Home Trip Distance frequency

	Mean	SD
HIS	12.23	11.73
Model	11.91	17.90

Shop to Home Trip Distance frequency

	Mean	SD
HIS	9.48	12.03
Model	9.54	15.22

Waikato Regional Model	**Trip Distance Frequency Plots (ETH/BTH/STH) Evening Peak Car Drivers**	**Figure 9d**
Trip Distribution		
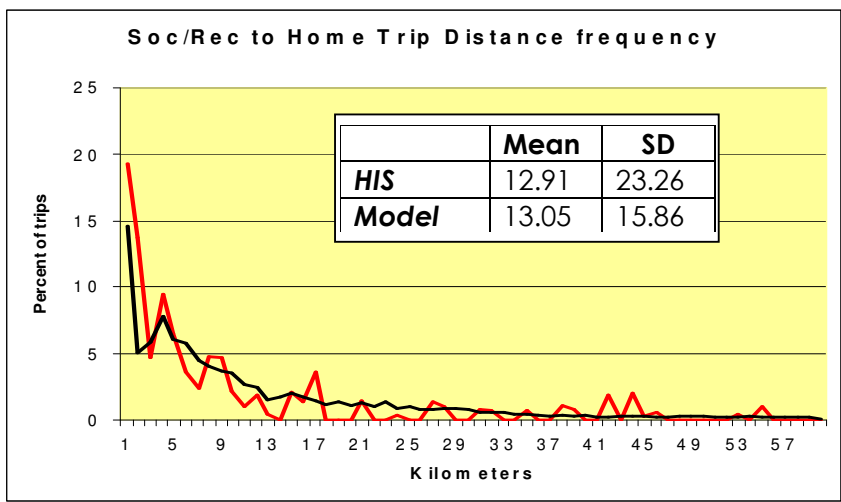
TRAFFIC DESIGN GROUP

GABITES PORTER

Soc/Rec to Home Trip Distance frequency

	Mean	SD
HIS	12.91	23.26
Model	13.05	15.86

Waikato Regional Model	**Trip Distance Frequency Plots (SRH)** **Evening Peak Car Drivers**	**Figure 9e**
Trip Distribution		

TRAFFIC DESIGN GROUP

GP **GABITES PORTER**