1996 TRANSPORTATION TOMORROW SURVEY

DISCRETIONARY TRAVEL

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Executive Summary

Discretionary travel is defined as all trips other than home-based work and home-based school. For the purpose of this report discretionary trips are divided into three sub-categories – home-based shopping, home-based other and non home-based. The definition of a home-based trip is one that either starts or finishes at home. This report addresses three topics:

- The under reporting of discretionary travel in the 1996 TTS and the appropriate methods of correction.
- The analysis of discretionary trips and trip making characteristics.
- Issues that need to be addressed with respect to the formulation of p.m. peak period and 24-hour travel demand models.

It is concluded that the primary source of under reporting in the TTS stems from the use of third-party respondents to report the trips made by other household members. Previous studies have established that home-based work and school trips are reported with a high degree of accuracy for both respondents and other household members. Under reporting of discretionary travel is significant with respect to both auto driver and public transit trips.

The use of the following factors is recommended to correct for under reporting caused by the use of third-party respondents:

	Auto Driver	Public Transit (Excl. GO Train use)
Home-based Shopping	1.34	1.39
Home-based Other	1.27	1.31
Non Home-based	1.41	1.36
Combined totals	1.33	1.34

There is no evidence of any under reporting of auto passenger trips in the TTS database. Discretionary travel is of minor importance with respect to GO Train operations accounting for 12%, or less, of daily trips.

The adjustment factors may be applied to most subsets of the TTS data after extraction from the TTS database. The adjustment made to auto driver trips give daily traffic volumes which, in total, are 5% to 10% less than observed cordon counts. It is not possible to say if this difference is due to other sources of under reporting, traffic that is not represented in the TTS or problems in the method of comparison. There is no valid basis for making further adjustment.

Discretionary travel in the GTA and Hamilton-Wentworth is estimated at 64% of total daily auto driver trips and 34% of the trips made by public transit excluding GO Train use. The characteristics of discretionary travel are such that these proportions will likely increase in the future. Discretionary travel volumes are significant between the hours of 7:30 a.m. and 10.30 p.m.

Trip generation rates based on TTS data, adjusted to correct for under reporting, should produce peak hour traffic volumes that are 10% to 15% higher in the afternoon than in the morning. The afternoon peak also extends over a longer period of time. Simulations of the p.m. peak period are likely to be more complex than the a.m. peak, because of the greater diversity of trip characteristics, but other factors are identified which favour simulation of the p.m. peak period. As a result it should be possible to develop a p.m. peak period model that is at least as reliable and robust as the current a.m. peak models. Chapter 5 contains suggestions as to how both the Full and Simplified GTA modelling procedures might be modified to produce p.m. peak and 24-hour simulations.

Contents

Tables & Figures

1.0 Introduction

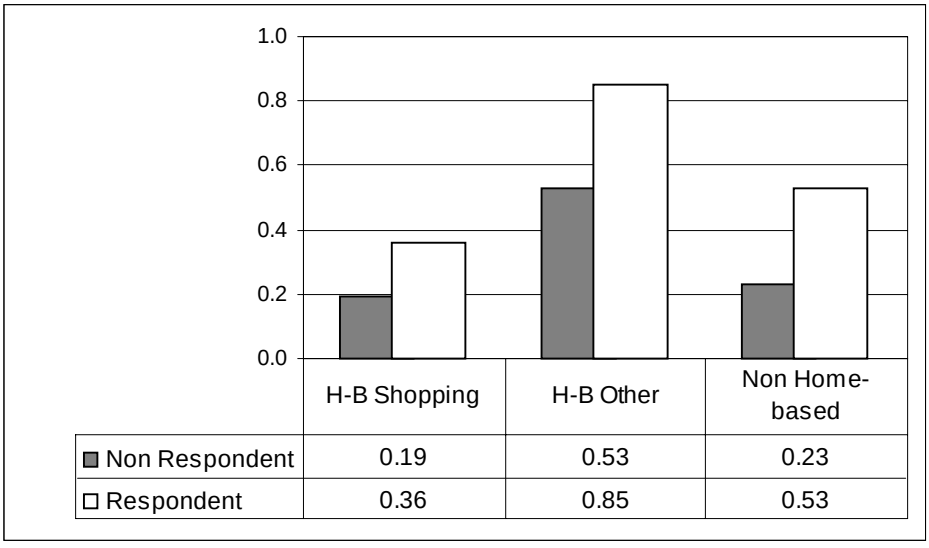
Extensive analysis and validation of the TTS data from 1986, 1991 and 1996[1] have produced no evidence of any under reporting, or other biases, with respect to work and school trips. Comparisons with census data, cordon counts, GO Transit surveys and other transit ridership counts provide a close match to the TTS data with respect to total population, employment and travel by all modes in the a.m. peak period. Differences of 25% to 30% between total daily travel reported in the TTS compared to cordon counts imply that off-peak road travel could be under reported by as much as 50%. These differences need to be explained and accounted for if the TTS data is to be used in the estimation of off-peak and total daily travel.

The scope of this report, and the analysis contained in it, is restricted to the Greater Toronto Area (GTA) and the Regional Municipality of Hamilton-Wentworth. The 1996 TTS covered a larger geographic area but the data for areas external to the GTA and Hamilton-Wentworth have been excluded both in the calculation of correction factors and the subsequent analysis. The few exceptions are noted in the related text.

1.1 Under Reporting of Non Respondent Trips

The TTS methodology relies on the ability of a single member of each household, the respondent (also referred to as the informant in other studies), being able to accurately report the trip movements of all members of the household on the previous day. Figure 1.1 compares the average reported daily trip rates for respondents and non respondents. The comparison is based on persons 11 and older and shows the daily trip rates for the three sub categories (home-based shopping, home-based other and non home-based) of discretionary travel used in this report. Discretionary travel, by definition, excludes home-based work and home-based school trips. The lower trip rates reported for non respondents is a major factor in the apparent under reporting of trips in the TTS database relative to observed traffic and transit ridership counts. Some of the difference in reported trip rates may be due to differences in the sample population between respondents and non respondents. It is essential that differences in sample population be identified and taken into account before adjustments are made to correct for under reporting. Analysis of the 1986 TTS data by Hassounah and Cheah[2] resulted in the recommended correction factors shown in Table 1.1(a). These correction factors, when applied to the subset of trips made by non respondents, produce the same overall trip rate as in the same subset for respondents

Figure 1.1 – Difference Between Respondent and Non Respondent Reported Daily Trip Rates – 1996 TTS Persons 11 & Older



[1] Transportation Tomorrow Survey 1996: Data Validation. Data Management Group. December 1997.
[2] Analysis of TTS Data Bias: Bias Due to Use of Informants. Data Management Group. April 1991.

Table 1.1(a) – Trip Rate Correction Factors - 1986 TTS (Hassounah and Cheah)

Type of trip	Household size	Correction Factor
Non home-based auto trips < 5km	All	3.134
Home-based non work, non school **auto** trips < 5 km	2 persons	1.404
	3 persons	2.142
	4-5 person	2.780
	>5 persons	3.625
Home-based non work, non school **transit** trips < 5 km	2 persons	1.502
	3 persons	2.018
	4-5 person	1.983
	>5 persons	2.469

A similar analysis of the 1996 TTS data by Badoe [3] resulted in the recommended correction factors shown in Table 1.1(b). The results are similar in that they show it is primarily short trips by automobile and local transit that are under reported. The 1986 analysis did not distinguish between auto driver and auto passenger trips whereas the 1996 analysis showed that it is predominantly auto driver trips that are under reported.

Applying correction factors to the trips recorded for non respondents is only one of several methods of correcting for under reporting of non respondent trips. A second method is to apply the correction factors to all the reported trips in a defined subset – not just the trips made by non respondents. A third approach is to expand the data for respondents to match the population of the total survey. A fourth approach would be to do a supplemental survey of non respondents. Each of these approaches has its strengths and weaknesses. There is no "right" or "wrong" method.

It can be argued that applying correction factors to the non respondent trip data is likely to provide for the most accurate spatial distribution of adjusted trip data. Conversely the method probably offers the greatest potential for distortion of other trip making characteristics. The stratification used to identify the subsets to which correction factors are applied must reflect both differences in the survey population (respondents vs. non respondents) that have different trip rates as well as differences in the level of under reporting. The number of factors and combinations of factors that can be included is severely limited by the amount of data available. The problem is further complicated by the inter-dependence of attributes and the need to pre-stratify continuous variables, such as trip maker's age, trip length and trip start time, into discrete intervals.

It was decided that the objectives of this study would more likely be achieved by only using the discretionary trip data collected from respondents. The approach taken was therefore to expand the data collected from respondents to represent the total population of the survey. It must be recognized at the outset that survey respondents do not constitute a random selection of trip makers. The expansion process, described in Section 1.3, corrects for obvious differences in the overall distribution of household size, age, gender and driver's license status but there are many other potential sources of bias. Chapter 2 provides comparisons made between the expanded respondent data, the original TTS data and independent count information. The analysis leads to the conclusion that the use of respondents to report non respondent trip information is the major cause of under reporting of trip data in the TTS.

The second method described above, i.e.- application of correction factors to global subsets, also has its advantages. The required correction factors can be applied to complete trip tables after they have been extracted from the TTS database. The required adjustments are smaller in relative magnitude offering less potential for creating anomalies associated with single records. Chapter 3 contains recommendations as to the correction factors that should be used.

[3] Investigation into the Under Reporting of Trips Due to the Use of Informants in the 1996 Transportation Tomorrow Survey. Daniel A. Badoe. Assistant Professor, Department of Civil and Environmental Engineering, Tennessee Technological University. March 1998 (Draft).

Table1.1(b) – Trip Rate Correction Factors – 1996 TTS (Badoe)

Trip Purpose	Trip Length	Mode	License Status	Start Time	Vehicles avail.	Gender	Adj. Factor	Resp. Trip rate
HBD	Short	Driver	Yes	6-9 am	all	Both	1.479	0.082
				9-3.30			1.910	0.295
				3:30-6:30			1.774	0.179
				6:30-9 pm			1.603	0.148
	Medium			6-9 am			1.246	0.028
				9-3.30			1.850	0.110
				3:30-6:30			1.658	0.073
				6:30-9 pm			1.581	0.062
	Short	Pass.	No	All			1.039	0.231
			Yes			*	1	0.077
		Transit	All	6-9 am	0		2.709	0.012
					1		1.807	0.0016
					2+	*	1	0.0002
				9-3.30	0		2.124	0.0134
					1		1.589	0.016
					2+		1.072	0.0031
				3:30-6:30	0		1.765	0.057
					1		1.321	0.008
					2+		1.159	0.0021
				6:30-9 pm	0		1.448	0.029
					1	*	1	0.0035
					2+		1.361	0.0013
NHB		Driver	Yes	6-9 am	all		1.595	0.028
				9-3.30			2.938	0.158
				3:30-6:30		Male	2.203	0.056
						Female	3.467	0.068
				6:30-9 pm		Male	2.087	0.028
						Female	3.732	0.028
	Medium			6-9 am		Both	1.374	0.024
				9-3.30			2.611	0.090
				3:30-6:30			2.025	0.056
				6:30-9 pm			2.001	0.017
	Short	Transit	All	6-9 am	0		4.082	0.0029
					1		1.117	0.0007
					2+		1.379	0.0004
			Yes	9-3.30	all		3.248	0.006
			No				3.431	0.022
			All	3:30-6:30	0		2.030	0.022
					1		1.288	0.005
					2+		1.078	0.0015
				6:30-9 pm	0		2.691	0.005
					1		1.281	0.001
					2+	*	1	0.0001

* Non respondent trip rate higher than respondent - No adjustment recommended

The use of supplemental surveys to fill in data gaps, or to obtain more accurate measurement of non response rates, has been tried in other surveys with limited success. The TTS trip diary survey in 1986 is one example. Supplemental surveys are time consuming and costly – clearly not an option for this study.

1.2 Differences in Respondent and Non Respondent Populations

The most obvious difference between respondent and non respondent population is in household size distribution. One hundred percent of 1-person households are, of necessity, survey respondents, 50% of 2-person households, one third of 3-person households, etc. Figure 1.2(a) compares the age distribution of the survey respondent population with that of non respondents. Not surprisingly there is a significant difference with respect to the younger age groups with a negligible number of respondents below the age of 13. Figure 1.2(b) shows the ratio of survey respondents to total population by age and gender. There is a higher proportion of women than men respondents in all age groups, predominantly so in the older age groups. The highest probability of a survey participant being a respondent occurs in the 83 to 87 age group as a result of household size distribution. Figure 1.2(c) shows that the majority of people over the age of 60 live in 1- and 2-person households and are therefore more likely to be survey respondents than those living in larger households. The number of elderly respondents living in large households is small.

Figure 1.2(a) – Age Distribution of Respondent & Non Respondent Populations

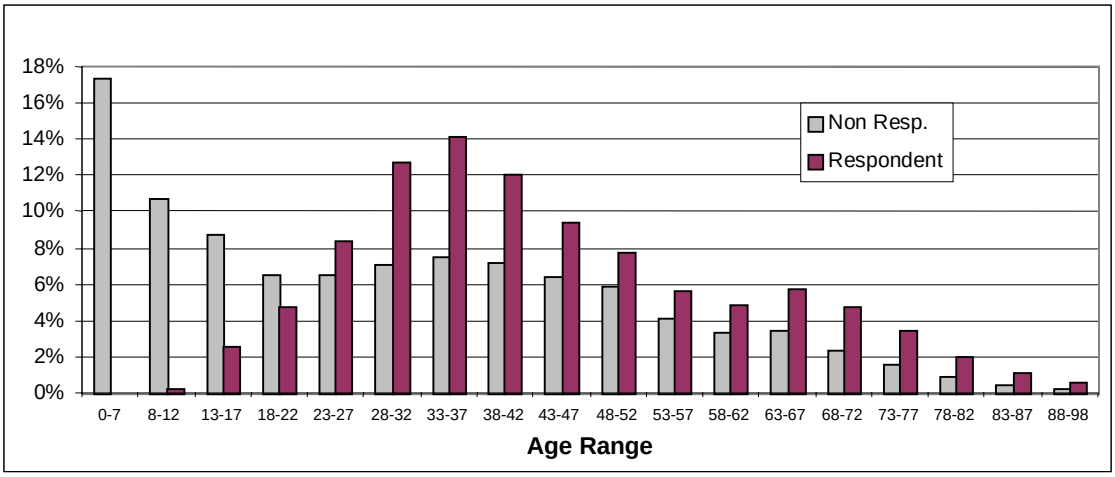


Figure 1.2(b) – Ratio of Respondents to Total Survey Population by Age & Gender

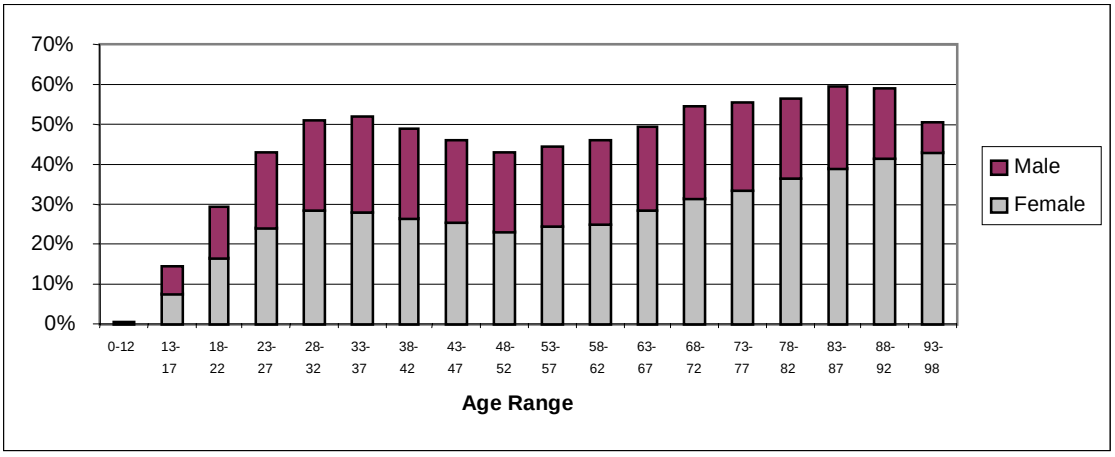
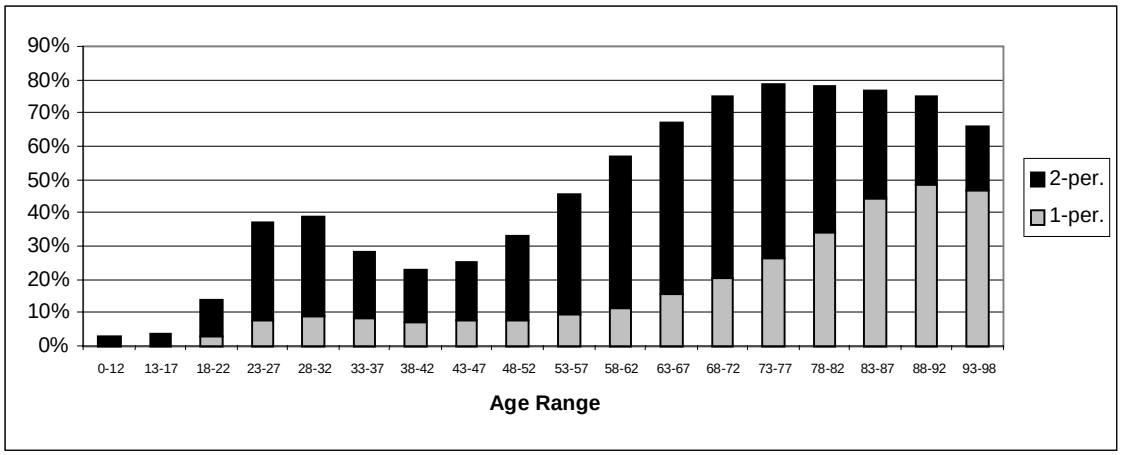


Figure 1.2(c) – Proportion of Survey Population Living in 1- and 2-person Households



Subsequent analysis also revealed that female respondents are more likely to be licensed to drive than are female non respondents. The apparent difference appears to be independent of age and household size.

1.3 Expansion of Respondent Data to Represent the Total Survey Population

Table 1.3(a) shows the factors used to expand the respondent trip data to represent the total population of the TTS survey. The factors have been calculated by dividing the expanded total TTS population in each category by the expanded number of respondents in the same category. The factors are multiplied by the existing expansion factor for each person in that category. The combined factor is used as the expansion factor for all of the discretionary trips made by that person. The expansion factors for discretionary trips made by non respondents in that same category are set to zero.

The adjustments are not applied to home-based work or home-based school trips because there is no evidence to suggest that these trips are under reported. Modifying the expansion factors for work and school trips, together with the exclusion of non respondent data, would almost certainly result in a deterioration in the quality of the data for those two categories. The expansion factors for discretionary trips made by persons for which the age question was refused, those under the age of 18, those 78 and older living in 3-person households or aged 63 and older living in households of four persons or more, are not modified. There is insufficient respondent data in these categories to generate reliable factors. In addition it would seem likely that there could be significant genuine differences in travel behaviour between respondents and non respondents in these categories, particularly the elderly. With no valid basis on which to make adjustments it was considered best to leave the factors unchanged. The total number of trips in these categories is small accounting for 3% of total survey trip records.

The adjustment factors have been calculated using the data for residents of the GTA and Hamilton-Wentworth but have been applied to all survey records to facilitate the calculation of external trip generation rates and trip data if required. A person database, containing the revised expansion factors, has been created for the purpose of calculating discretionary trip rates. The expansion factors in both the trip and person databases have been rounded to one decimal place instead of the two decimal places used for the original TTS data. The change in rounding is not likely to produce any measurable difference in tabulated results. Table 1.3(b) provides a summary of the number of records with non-zero expansion factors in the modified databases.

Table 1.3(a) – Expansion Adjustment Factors

Male age	Number of persons 16 or older in household 1	2	3	4	5+
18	1.000	2.698	3.724	5.157	6.055
19	1.000	2.384	4.038	4.592	4.074
20	1.000	2.430	3.783	5.173	7.086
21	1.000	2.371	3.492	4.514	5.427
22	1.000	2.303	3.473	5.001	7.072
23-27	1.000	2.146	3.256	4.026	5.303
28-32	1.002	2.139	3.020	3.609	4.973
33-37	1.004	2.178	2.843	3.502	4.380
38-42	1.008	2.166	3.158	3.919	5.915
43-47	1.015	2.204	3.088	3.764	5.186
48-52	1.005	2.133	3.241	3.900	4.862
53-57	1.002	2.068	3.242	4.075	6.091
58-62	1.003	2.076	2.984	4.680	7.206
63-67	1.000	2.059	3.176	n/a	n/a
68-72	1.000	1.934	3.041	n/a	n/a
73-77	1.000	2.042	3.930	n/a	n/a
78-82	1.000	2.239	n/a	n/a	n/a
83-87	1.000	2.223	n/a	n/a	n/a
88-98	1.000	2.658	n/a	n/a	n/a

Female	Driver					Non Driver				
	Number of persons 16 or older in household					Number of persons 16 or older in household				
age	1	2	3	4	5+	1	2	3	4	5+
18	1.147	2.611	3.353	3.745	4.177	1.000	2.601	3.735	4.031	6.010
19	1.000	1.953	2.882	4.228	6.064	1.000	2.662	4.619	3.785	5.410
20	1.000	1.982	3.601	3.857	4.454	1.000	2.563	4.589	4.665	4.557
21	1.000	1.975	3.241	4.130	4.008	1.000	2.193	3.781	4.258	7.749
22	1.000	1.952	2.926	3.684	4.264	1.000	2.181	3.511	5.558	4.953
23-27	1.000	1.898	3.082	3.558	3.977	1.000	2.194	3.561	4.613	6.703
28-32	1.005	1.847	2.415	2.808	3.810	1.010	2.207	3.238	3.896	5.508
33-37	1.022	1.863	2.308	2.542	3.379	1.026	2.308	2.871	5.208	8.165
38-42	1.034	1.891	2.304	2.672	3.149	1.064	2.147	3.162	4.709	8.422
43-47	1.024	1.826	2.254	2.909	3.253	1.041	1.996	3.201	4.368	6.379
48-52	1.004	1.794	2.474	3.043	3.315	1.032	2.042	3.552	5.988	8.434
53-57	1.006	1.775	2.495	3.207	5.063	1.000	2.151	3.647	6.582	12.361
58-62	1.000	1.897	2.404	3.699	6.072	1.005	2.039	4.510	7.957	14.602
63-67	1.000	1.769	2.641	n/a	n/a	1.002	2.157	4.972	n/a	n/a
68-72	1.000	1.798	2.535	n/a	n/a	1.003	2.185	5.228	n/a	n/a
73-77	1.000	1.772	2.460	n/a	n/a	1.002	2.329	7.082	n/a	n/a
78-82	1.000	1.789	n/a	n/a	n/a	1.000	2.526	n/a	n/a	n/a
83-87	1.010	1.999	n/a	n/a	n/a	1.000	2.686	n/a	n/a	n/a
88-98	1.000	1.937	n/a	n/a	n/a	1.000	4.232	n/a	n/a	n/a

Table 1.3(b) – Number of Records in the Modified Database

	Respondent database	Original TTS database
Person records	193,736	312,781
Non transit trip records	460,863	587,676
Transit trip records	65,584	70,295
Min. expansion factor	11.1	11.10
Max. expansion factor	326.8	82.56

1.4 Validation of Expansion Process

The expansion process adjusts for biases in the selection of respondents that relates solely to age, gender and household size. There are other factors, including attributes not in the TTS database, that might affect the probability of a person becoming a survey respondent. Tables 1.4(a) and 1.4(b) compare the expanded

Table 1.4(a) – Age Distributions - TTS & Respondent Databases

age	TTS	Resp.	Difference		age	TTS	Resp.	Difference	
0	34215	34219	4	0%	50	107415	104649	-2766	-3%
1	73704	73706	2	0%	51	37389	38680	1291	3%
2	77548	77553	5	0%	52	52125	52046	-79	0%
3	72611	72616	5	0%	53	44341	45005	664	1%
4	72954	72955	1	0%	54	38968	36778	-2190	-6%
5	71420	71423	3	0%	55	71228	71871	643	1%
6	69245	69248	3	0%	56	39471	39213	-258	-1%
7	68807	68807	0	0%	57	33591	34736	1145	3%
8	69690	69690	0	0%	58	37697	39540	1843	5%
9	66710	66711	1	0%	59	29928	32861	2933	10%
10	73217	73219	2	0%	60	64597	58658	-5939	-9%
11	61470	61468	-2	0%	61	25660	26146	486	2%
12	65414	65415	1	0%	62	33183	33855	672	2%
13	64743	64743	0	0%	63	34881	35391	510	1%
14	63341	63342	1	0%	64	31582	31151	-431	-1%
15	64113	64112	-1	0%	65	80358	79235	-1123	-1%
16	64496	64495	-1	0%	66	28835	29599	764	3%
17	61629	61632	3	0%	67	33751	34037	286	1%
18	63019	63015	-4	0%	68	30810	30292	-518	-2%
19	53174	53175	1	0%	69	25780	26038	258	1%
20	57149	57150	1	0%	70	52611	51424	-1187	-2%
21	58249	58246	-3	0%	71	21454	22187	733	3%
22	56180	56159	-21	0%	72	28995	29718	723	2%
23	61455	59749	-1706	-3%	73	23967	24294	327	1%
24	63397	63795	398	1%	74	20758	20776	18	0%
25	85048	85831	783	1%	75	34992	34678	-314	-1%
26	70787	69914	-873	-1%	76	18722	18753	31	0%
27	73132	74465	1333	2%	77	12976	12930	-46	0%
28	85137	81874	-3263	-4%	78	14175	14531	356	3%
29	70589	73522	2933	4%	79	10820	10802	-18	0%
30	119185	117614	-1571	-1%	80	20061	19730	-331	-2%
31	75242	76160	918	1%	81	7764	7965	201	3%
32	99726	100720	994	1%	82	11111	10904	-207	-2%
33	91911	91205	-706	-1%	83	8185	8131	-54	-1%
34	91186	91641	455	0%	84	7162	7242	80	1%
35	135821	137158	1337	1%	85	8344	8434	90	1%
36	90727	90673	-54	0%	86	5915	5986	71	1%
37	78737	77738	-999	-1%	87	4159	3973	-186	-4%
38	88274	89087	813	1%	88	4137	4340	203	5%
39	70195	70093	-102	0%	89	2706	2786	80	3%
40	138820	136912	-1908	-1%	90	3459	3237	-222	-6%
41	57819	61352	3533	6%	91	1382	1422	40	3%
42	83261	80959	-2302	-3%	92	1236	1227	-9	-1%
43	71850	71076	-774	-1%	93	991	969	-22	-2%
44	54309	54029	-280	-1%	94	678	638	-40	-6%
45	122261	120888	-1373	-1%	95	803	734	-69	-9%
46	61414	61538	124	0%	96	518	508	-10	-2%
47	56527	58784	2257	4%	97	324	306	-18	-6%
48	67021	67142	121	0%	98+	502	551	49	10%
49	54826	56214	1388	3%	Ref.	14113	14113	0	0%
					Total	4926367	4926298	-69	0%

totals from the respondent database with those from the original TTS database for selected person attributes. Significant differences could be an indication of uncorrected biases in the respondent database.

The age distribution of the respondent database has less pronounced peaks on the 10 year increments (30, 40, 50, 60, 70, 80 and 90) suggesting that respondents are less likely to round their own age than they are the reported ages of other household members. If that is the correct explanation the respondent database may be the more precise of the two.

Table 1.4(b) – Distribution of Person Attributes – TTS & Respondent databases

gender	TTS	Resp.	Difference	
Don't know	2905	2854	-51	-2%
Female	2515203	2515115	-88	0%
Male	2408260	2408331	71	0%
Total	4926368	4926299	-69	0%

n_person	TTS	Resp.	Difference	
1	390857	393195	2338	1%
2	1084157	1093232	9075	1%
3	977984	990872	12888	1%
4	1371820	1358575	-13245	-1%
5+	1101549	1090425	-11124	-1%
Total	4926368	4926299	-69	0%

reg_hhld	TTS	Resp.	Difference	
Toronto	2305558	2317240	11682	1%
Durham	450354	449084	-1270	0%
York	567689	561369	-6320	-1%
Peel	812512	809921	-2591	0%
Halton	328264	326019	-2245	-1%
Hamilton-W	461990	462666	676	0%
Total	4926368	4926299	-69	0%

n_vehicle	TTS	Resp.	Difference	
0	546582	567859	21277	4%
1	1838470	1855589	17119	1%
2	1977185	1961322	-15863	-1%
3	433437	419216	-14221	-3%
4	104004	96932	-7072	-7%
5	18457	17337	-1120	-6%
6	5655	5422	-233	-4%
7	1373	1364	-9	-1%
8	219	229	10	5%
9	406	478	72	18%
10	43	46	3	7%
11	99	92	-7	-7%
13	112	99	-13	-12%
21	129	124	-5	-4%
30	36	35	-1	-3%
31	79	83	4	5%
32	40	38	-2	-5%
33	40	36	-4	-10%
Total	4926368	4926299	-69	0%

driv_lic	TTS	Resp.	Difference	
Unknown	436	188	-248	-57%
No	1879150	1844822	-34328	-2%
yes	3046782	3081289	34507	1%
Total	4926368	4926299	-69	0%

stu_sta	TTS	Resp.	Difference	
Don't know	1220	562	-658	-54%
Not a studer	3724527	3700121	-24406	-1%
Part time	141305	162311	21006	15%
Student	1059315	1063305	3990	0%
Total	4926368	4926299	-69	0%

pd_hhld	TTS	Resp.	Difference	
PD1-Metro	146644	149181	2537	2%
PD2-Metro	199591	202859	3268	2%
PD3-Metro	232683	236232	3549	2%
PD4-Metro	192125	191639	-486	0%
PD5-Metro	112235	111417	-818	-1%
PD6-Metro	207286	210906	3620	2%
PD7-Metro	55044	55249	205	0%
PD8-Metro	177910	178520	610	0%
PD9-Metro	84725	84046	-679	-1%
PD10-Metro	144539	146254	1715	1%
PD11-Metro	142836	142522	-314	0%
PD12-Metro	78665	77133	-1532	-2%
PD13-Metro	197646	200126	2480	1%
PD14-Metro	58575	57876	-699	-1%
PD15-Metro	75577	75127	-450	-1%
PD16-Metro	199475	198153	-1322	-1%
Brock	11432	11473	41	0%
Uxbridge	14668	14614	-54	0%
Scugog	18887	18678	-209	-1%
Pickering	74177	74070	-107	0%
Ajax	64879	64433	-446	-1%
Whitby	72207	72046	-161	0%
Oshawa	133507	133529	22	0%
Clarington	60597	60240	-357	-1%
Georgina	34019	33822	-197	-1%
East Gwillin	18826	18550	-276	-1%
Newmarket	54198	53805	-393	-1%
Aurora	34786	34550	-236	-1%
Richmond H	97400	96212	-1188	-1%
Whit.-Stouff	19126	18963	-163	-1%
Markham	163484	161301	-2183	-1%
King	18018	17694	-324	-2%
Vaughan	127833	126473	-1360	-1%
Caledon	38146	38241	95	0%
Brampton	255656	253694	-1962	-1%
Mississauga	518710	517985	-725	0%
Halton Hills	39503	38823	-680	-2%
Milton	30997	30868	-129	0%
Oakville	123640	122928	-712	-1%
Burlington	134124	133401	-723	-1%
Flamboroug	33106	32639	-467	-1%
Dundas	21955	21826	-129	-1%
Ancaster	23479	23136	-343	-1%
Glanbrook	10856	10689	-167	-2%
Stoney Cree	52036	51376	-660	-1%
Hamilton	320559	323001	2442	1%
Total	4926368	4926298	-70	0%

emp_sta	TTS	Resp.	Difference	
Don't know	1939	2017	78	4%
Full time	1915490	1906589	-8901	0%
Work at hor	80442	87456	7014	9%
WAH part ti	22159	24050	1891	9%
Not employe	2504676	2466701	-37975	-2%
Part time	401661	439487	37826	9%
Total	4926368	4926299	-69	0%

The gender and household size distribution are almost identical, as would be expected given the expansion procedure. There is no evidence of any significant difference in the geographic distribution of the expanded populations at either the regional or municipal level.

In terms of the remaining person attributes shown in Table 1.4(b) the most significant differences are:

- 38,000 (2%) reduction in the number of people reported as not employed
- 38,000 (9%) increase in the number of people reported as employed part time
- 35,000 (1%) increase in the number of people reported as licensed to drive with a corresponding 2% reduction in the number of people reported as not licensed to drive.
- 21,000 (15%) increase in the number of people reported as part time students with a corresponding 24,000 (1%) reduction in the number of people reported as not being students.

These differences may reflect biases in the attributes of survey respondents relative to non respondents the reasons for which are not readily apparent. It could also be that the data pertaining to these attributes is more accurate for respondents than for non respondents. No attempt has been made to correct for these differences between the two databases. The differences are not expected to result in any major change in discretionary trip rates and distribution of characteristics.

1.5 Comparison of Adjusted Trip Totals

Table 1.5 compares the results of applying the factors recommended by Badoe (refer to Section 1.1) with the results obtained by expanding the respondent data to represent the total survey population.

The most significant absolute adjustments occur in the number of auto driver trips and are very similar in magnitude by both methods. The two methods produce adjusted trip totals that match within 7% in each of the 10 largest categories. The overall auto driver trip total matches within 1% for the categories for which adjustments were recommended by Badoe. The magnitude of the adjustments produced by expansion of the respondent database are more uniform, ranging in magnitude from 22% to 49%, compared with 11% to 65% from the application of the adjustment factors to non respondent trips. The greater variation resulting from the factors applied to non respondent trips may be the result of differences in the respondent and non respondent population characteristics that are not adequately reflected in the stratification of trip and person characteristics. Expanding the respondent database to represent the total population results in an increase in long (over 25 km) auto driver trips whereas no adjustments were recommended by Badoe for this category. Although the number of trips involved is small, the effect on traffic assignment will be proportionately much more significant because of the length of the trips involved.

The same general observations apply to local transit trips. The differences between the two methods are proportionately greater than for auto drivers but involve much smaller trip totals. Expansion of the respondent database results in a 34% increase in the number of discretionary trips made by local transit compared to a 13% obtained by applying the adjustment factors to non respondent trips. The larger increase in the respondent database is mostly attributable to higher trip rates for medium and long trips.

In the one category (short HBD with no driver's license) of auto passenger trip, for which a non respondent adjustment factor was recommended, the expansion of the respondent database resulted in a 4% higher trip total. No adjustment factor was recommended for licensed trip makers because the non respondent trip rate was higher than the respondent trip rate. Expansion of the respondent database resulted in a 16% reduction in the number of trips in that category and a 3% reduction in other categories for which no adjustments were recommended. The higher reported trip rates for non respondents than respondents could result from differences in the demographic characteristics of the two groups not being adequately reflected in the stratification. It could also reflect difference in travel behaviour directly related to respondent status (e.g.: who is most likely to be home to answer the survey). It is highly unlikely that non respondent auto passenger trips would be over reported. The differences are small in the context of the total number of trips.

Table 1.5 – Comparison of Adjusted Trip Totals

Auto Driver

Trip Purpose	Trip Length	License status	Start Time	Veh. avail.	Gender	Original trip tot.	Trips added by adjustment: Badoe		Trips added by adjustment: Resp. Database		Difference in Trip Total	
HBD	Short	Yes	6-9 am	all	Both	196790	39989	20%	44956	23%	4967	3%
			9-3.30			602902	199388	33%	161823	27%	-37565	-6%
			3:30-6:30			374217	110588	30%	102904	27%	-7684	-2%
			6:30-9 pm			329756	79806	24%	94600	29%	14794	4%
	Medium		6-9 am			87972	10095	11%	19470	22%	9375	11%
			9-3.30			262493	81783	31%	82229	31%	446	0%
			3:30-6:30			188301	48310	26%	57968	31%	9658	5%
			6:30-9 pm			169414	39567	23%	50954	30%	11387	7%
NHB	Short	Yes	6-9 am	all		60705	14515	24%	18060	30%	3545	6%
			9-3.30			263222	133425	51%	120512	46%	-12913	-5%
			3:30-6:30		Male	62650	29674	47%	21945	35%	-7729	-12%
					Female	74190	44752	60%	26060	35%	-18691	-25%
			6:30-9 pm		Male	31537	13664	43%	11514	37%	-2150	-7%
					Female	30563	19721	65%	11771	39%	-7951	-26%
	Medium		6-9 am		Both	73356	12088	16%	18030	25%	5942	8%
			9-3.30			202352	93941	46%	98663	49%	4721	2%
			3:30-6:30			142881	50382	35%	49748	35%	-634	0%
			6:30-9 pm			44165	14856	34%	16882	38%	2026	5%
			Sub-total			**3197466**	**1036543**	**32%**	**1008087**	**32%**	**-28455**	**-1%**
			Other Categories			603174	0	0%	196415	33%	196415	33%
			Total			**3800640**	**1036543**	**27%**	**1204502**	**32%**	**167959**	**4%**

Local Transit

HBD	Short	all	6-9 am	0	Both	4574	1214	27%	807	18%	-407	-9%
				1		2161	634	29%	857	40%	223	10%
				2+	*	552	0	0%	47	9%	47	9%
			9-3.30	0		49781	11572	23%	9052	18%	-2521	-5%
				1		22167	5035	23%	10635	48%	5600	25%
				2+		6953	307	4%	3554	51%	3247	47%
			3:30-6:30	0		22427	4074	18%	5144	23%	1070	5%
				1		12029	1664	14%	4946	41%	3282	27%
				2+		4129	382	9%	2638	64%	2256	55%
			6:30-9 pm	0		13179	1582	12%	3899	30%	2318	18%
				1	*	6102	0	0%	1778	29%	1778	29%
				2+		2287	470	21%	1462	64%	992	43%
NHB			6-9 am	0		1108	387	35%	336	30%	-51	-5%
				1		938	46	5%	426	45%	380	41%
				2+		482	110	23%	272	56%	162	34%
		yes	9-3.30	all		14485	7698	53%	5498	38%	-2200	-15%
		No				13508	12352	91%	4474	33%	-7879	-58%
		all	3:30-6:30	0		8647	1885	22%	1680	19%	-205	-2%
				1		6935	846	12%	2735	39%	1890	27%
				2+		3259	147	5%	2098	64%	1950	60%
			6:30-9 pm	0		1940	571	29%	476	25%	-95	-5%
				1		1684	206	12%	724	43%	519	31%
				2+	*	557	0	0%	-161	-29%	-161	-29%
			Sub-total			**199883**	**51181**	**26%**	**63377**	**32%**	**12196**	**6%**
			Other Categories			186694	0	0%	68408	37%	68408	37%
			Total			**386577**	**51181**	**13%**	**131785**	**34%**	**80604**	**21%**

Auto Passenger

HBD	Short	No	6am-9pm	all	both	193149	5194	3%	12626	7%	7432	4%
		Yes			*	205483	0	0%	-32584	-16%	-32584	-16%
			Sub-total			**398632**	**5194**	**1%**	**-19958**	**-5%**	**-25152**	**-6%**
			Other Categories			636562	0	0%	-20850	-3%	-57736	-9%
			Total			**1035194**	**5194**	**1%**	**-40808**	**-4%**	**-82888**	**-8%**

* Non respondent trip rate higher than respondent - No adjustment made

2.0 Comparison of Respondent and Original TTS Trip Data

Tables 2.0(a) and (b) show the difference in expanded discretionary trip totals between the adjusted respondent database and the original TTS database. Table 2.0(a) provides comparisons stratified by selected person and household attributes. Table 2.0(b) provides similar comparisons by trip attribute. In total the expanded number of discretionary trips is 24% higher in the respondent database.

2.1 Household Size

Significant differences in the percentage increase in discretionary trip totals exist between single person households, 2-person households and households of 3 or more persons (refer to Table 2.0(b)). This variation was to be expected, given the nature of the under reporting, and is consistent with Hassounah and Cheah's findings with respect to the 1986 TTS. The variations are relatively minor for households of more than 3 persons. The 1% increase for 1-person households results from the exclusion of household members under the age of 16 in the stratification used for expansion. There are a few isolated incidences of 2-person households with a respondent under the age of 16.

2.2 Age

The greatest increase in the number of reported discretionary trips is in the 18 to 24 age range as would be expected given the high proportion of survey non respondents in that age range. There is no change in the refused age category or in the 11 to 17 age range because the data has not been modified. The increase in the number of trips becomes progressively smaller above age 60 because of the high proportion of respondents in the original database and the data from larger households were not modified.

2.3 Gender

The slightly larger increase in the proportion of trips made by males is consistent with the higher proportion of male non respondents than female.

2.4 Employment and Student Status

The above average increase in the number of discretionary trips made by part time students and employed persons reflects the unexplained differences between the expanded respondent and TTS populations. It could be an indication of a hidden bias in the adjustment procedure.

2.5 Geographic Distribution of Trips by Household Location

The non respondent correction produces a larger proportional increase in the number of discretionary trips made by households in Peel and York than in the other regions. Peel and York have the largest average household size and therefore the largest percentage of non respondents. At the municipal level the largest variation in the percentage increase is in the rural municipalities, ranging from a low of 13% for Uxbridge to a high of 33% for Whitchurch-Stouffville. The urban municipalities have increases ranging from 18% to 31% without any obvious pattern to the variations.

2.6 Driver's License Status

The data on driver's license status is included in Table 2.0(b). The below average (12%) increase in the number of discretionary trips made by people without driver's licenses reflects two factors: a) under reporting of auto driver trips is much more significant than of auto passenger trips (see Section 2.7), and b) the apparent under representation of non drivers in the respondent database.

Table 2.0(a) – Discretionary Trip Totals by Person Attribute

age	TTS	Resp.	Difference	
11	38532	38533	1	0%
12	38290	38291	1	0%
13	36119	36119	0	0%
14	32336	32337	1	0%
15	33214	33213	-1	0%
16	39016	39016	0	0%
17	46853	46853	0	0%
18	53110	75545	22435	42%
19	47488	67108	19620	41%
20	48960	77404	28444	58%
21	56672	85015	28343	50%
22	53441	76413	22972	43%
23	61365	88650	27285	44%
24	64290	90640	26350	41%
25	86589	110384	23795	27%
26	79895	101501	21606	27%
27	82507	108559	26052	32%
28	102808	125231	22423	22%
29	88100	110640	22540	26%
30	143164	174846	31682	22%
31	104045	121913	17868	17%
32	143578	175427	31849	22%
33	133970	159634	25664	19%
34	133746	157274	23528	18%
35	193396	234375	40979	21%
36	144493	177542	33049	23%
37	131047	155010	23963	18%
38	142944	175205	32261	23%
39	119666	149271	29605	25%
40	207586	261871	54285	26%
41	101804	131024	29220	29%
42	135110	166351	31241	23%
43	119831	145392	25561	21%
44	87045	109422	22377	26%
45	182576	240956	58380	32%
46	95369	129334	33965	36%
47	89934	121967	32033	36%
48	99329	135792	36463	37%
49	80970	110428	29458	36%
50	136550	173557	37007	27%
51	52790	69841	17051	32%
52	69480	90382	20902	30%
53	58487	79252	20765	36%
54	50932	60624	9692	19%
55	92431	128091	35660	39%
56	54784	71786	17002	31%
57	46178	57195	11017	24%
58	50998	69120	18122	36%
59	41204	52722	11518	28%
60	87943	106845	18902	21%
61	38572	47885	9313	24%
62	51222	62560	11338	22%
63	51836	59790	7954	15%
64	52045	57045	5000	10%
65	121215	136100	14885	12%
66	49534	58142	8608	17%
67	54169	62244	8075	15%
68	47976	54316	6340	13%
69	45436	49131	3695	8%
70	76461	81912	5451	7%
71	39103	44457	5354	14%
72	42156	48030	5874	14%
73	36045	41787	5742	16%
74	31210	32874	1664	5%
75	48562	53479	4917	10%
76	26901	28254	1353	5%
77	17470	19126	1656	9%
78	18011	19585	1574	9%
79	14465	17365	2900	20%
80+	75585	78613	3028	4%
Refused	16584	16581	-3	0%
Total	5375522	6643167	1267645	24%

gender	TTS	Resp.	Difference	
Don't know	138	57	-81	-59%
Female	2879983	3512383	632400	22%
Male	2495400	3130728	635328	25%
	5375522	6643168	1267646	24%
emp_sta	TTS	Resp.	Difference	
Don't know	2059	3172	1113	54%
Full time	2413139	3007219	594080	25%
Work at hom	148110	204980	56870	38%
WAH part tin	48039	63613	15574	32%
Not employed	2186781	2577383	390602	18%
Part time	577394	786802	209408	36%
	5375522	6643168	1267646	24%
stu_sta	TTS	Resp.	Difference	
Not a student	4656889	5749518	1092629	23%
Part time	214977	294907	79930	37%
Student	503012	598099	95087	19%
	5374878	6642525	1267647	24%
reg_hhld	TTS	Resp.	Difference	
Toronto	2342303	2884350	542047	23%
Durham	540905	657102	116197	21%
York	643635	817255	173620	27%
Peel	852707	1079616	226909	27%
Halton	431379	520294	88915	21%
Hamilton-We	564592	684551	119959	21%
	5375522	6643169	1267647	24%
pd_hhld	TTS	Resp.	Difference	
PD1-Metro	124145	149836	25691	21%
PD2-Metro	177179	221819	44640	25%
PD3-Metro	200833	251494	50661	25%
PD4-Metro	247132	292060	44928	18%
PD5-Metro	128865	156285	27420	21%
PD6-Metro	212153	257270	45117	21%
PD7-Metro	62144	76163	14019	23%
PD8-Metro	222571	266258	43687	20%
PD9-Metro	72847	92017	19170	26%
PD10-Metro	112340	146709	34369	31%
PD11-Metro	166521	205113	38592	23%
PD12-Metro	81297	102089	20792	26%
PD13-Metro	195619	245370	49751	25%
PD14-Metro	71421	83962	12541	18%
PD15-Metro	81053	102003	20950	26%
PD16-Metro	186182	235900	49718	27%
Brock	13932	16207	2275	16%
Uxbridge	18285	20674	2389	13%
Scugog	20516	23410	2894	14%
Pickering	89077	112242	23165	26%
Ajax	72043	86316	14273	20%
Whitby	88661	105871	17210	19%
Oshawa	168282	207412	39130	23%
Clarington	70110	84969	14859	21%
Georgina	37668	47474	9806	26%
East Gwillimb	22597	28489	5892	26%
Newmarket	68517	83557	15040	22%
Aurora	45428	56530	11102	24%
Richmond Hil	108412	137675	29263	27%
Whit.-Stouff.	23549	31355	7806	33%
Markham	185206	234842	49636	27%
King	21483	27414	5931	28%
Vaughan	130776	169920	39144	30%
Caledon	42224	51960	9736	23%
Brampton	264962	340007	75045	28%
Mississauga	545521	687649	142128	26%
Halton Hills	49493	58930	9437	19%
Milton	38271	46046	7775	20%
Oakville	154590	192488	37898	25%
Burlington	189025	222830	33805	18%
Flamborough	44570	52951	8381	19%
Dundas	32655	40813	8158	25%
Ancaster	30609	37288	6679	22%
Glanbrook	12630	16131	3501	28%
Stoney Creek	61951	74719	12768	21%
Hamilton	382178	462650	80472	21%
	5375521	6643169	1267648	24%

Table 2.0(b) – Discretionary Trip Totals by Trip Attribute

Person attribute
(Continued from Table 2.1)

driv_lic	TTS	Resp.	Difference	
No	695920	782501	86581	12%
yes	4679463	5860608	1181145	25%
Total	5375383	6643109	1267726	24%

n_person	TTS	Resp.	Difference	
1	582667	586203	3536	1%
2	1514813	1763828	249015	16%
3	1043028	1383574	340546	33%
4	1348961	1744715	395754	29%
5	607580	829273	221693	36%
6	199618	288709	89091	45%
7	53123	76481	23358	44%
8	15667	21106	5439	35%
9	10064	13934	3870	38%
	5375522	6707823	1332301	25%

mode_prim	TTS	Resp.	Difference	
Unknown	1108	1095	-13	-1%
Bicycle	31111	40926	9815	32%
Auto driver	3800640	5005141	1204501	32%
Motorcycle	2411	3086	675	28%
Other	10398	10561	163	2%
Auto passenç	1035194	994386	-40808	-4%
School Bus	5736	7162	1426	25%
Taxi	35597	44612	9015	25%
Walk	57344	72051	14707	26%
Transit (Ex. C	386577	518361	131784	34%
GO Train	5814	6506	692	12%
GO Train + T	3592	3935	343	10%
Total	5375522	6707822	1332300	25%

trip_purp	TTS	Resp.	Difference	
H-B Shoppinç	1090758	1329529	238771	22%
Non home ba	1500794	2002281	501487	33%
H-B Other	2783968	3311359	527391	19%
Total	5375522	6643168	1267646	24%

purp_dest	TTS	Resp.	Difference	
Don't know	372	427	55	15%
2nd school	20905	25562	4657	22%
Day care	56434	66878	10444	19%
Serve passer	532925	649892	116967	22%
Home	1970956	2372342	401386	20%
Shopping	809236	1020183	210947	26%
Other	1473976	1813096	339120	23%
2nd work	316682	466760	150078	47%
1st school	27258	34124	6866	25%
1st work	166775	193905	27130	16%
Total	5375522	6643169	1267647	24%

pd_orig	TTS	Resp.	Difference	
PD1-Metro	339547	421859	82312	24%
PD2-Metro	153946	189954	36008	23%
PD3-Metro	181136	227406	46270	26%
PD4-Metro	225828	276106	50278	22%
PD5-Metro	116767	145761	28994	25%
PD6-Metro	164594	198941	34347	21%
PD7-Metro	45948	56915	10967	24%
PD8-Metro	224341	274480	50139	22%
PD9-Metro	91397	117743	26346	29%
PD10-Metro	131646	170108	38462	29%
PD11-Metro	171809	209561	37752	22%
PD12-Metro	79713	99240	19527	24%
PD13-Metro	227704	282626	54922	24%
PD14-Metro	49039	56411	7372	15%
PD15-Metro	59590	72943	13353	22%
PD16-Metro	173026	218796	45770	26%
Brock	9744	11313	1569	16%
Uxbridge	15566	17746	2180	14%
Scugog	16656	19130	2474	15%
Pickering	83832	104341	20509	24%
Ajax	62938	75129	12191	19%
Whitby	82945	98861	15916	19%
Oshawa	171391	209455	38064	22%
Clarington	50152	60242	10090	20%
Georgina	25900	32318	6418	25%
East Gwillimt	13200	16415	3215	24%
Newmarket	76613	93182	16569	22%
Aurora	36404	44595	8191	23%
Richmond Hil	100951	129880	28929	29%
Whit.-Stouff.	18615	24173	5558	30%
Markham	198670	250305	51635	26%
King	14763	18129	3366	23%
Vaughan	133697	174258	40561	30%
Caledon	28470	34372	5902	21%
Brampton	242245	311882	69637	29%
Mississauga	547479	680800	133321	24%
Halton Hills	40796	47517	6721	16%
Milton	34558	41482	6924	20%
Oakville	151917	189211	37294	25%
Burlington	186462	217432	30970	17%
Flamborough	28194	32805	4611	16%
Dundas	27363	32317	4954	18%
Ancaster	25654	31619	5965	23%
Glanbrook	7530	9298	1768	23%
Stoney Creek	48009	58478	10469	22%
Hamilton	391004	474091	83087	21%
	5307749	6559626	1251877	24%

2.7 Primary Mode

The increase in the auto driver mode (32%) accounts for 90% of the total increase in discretionary trips. Local transit shows a similar percentage increase (34%) but for a much smaller trip total. The expanded auto passenger discretionary trip total in the respondent database is lower than in the original TTS database. The difference can be attributed, in part, to the under representation of non drivers in the respondent database. Previous studies, including Badoe, showed no evidence of any under reporting of auto passenger

trips. An explanation could be that since auto passenger trips require co-ordination with another person (the driver) they are more likely to be accurately reported by a third party person than are trips made alone. The absolute changes in the magnitude of the trip totals for other modes, including GO Rail, are not very significant.

2.8 Trip Purpose

The largest absolute increase (507,000) is in the number of home-based other trips. The largest relative increase (33%) is in the number of non home-based trips. The tabulation by destination purpose shows a 47% increase in the number of second work trips many of which are likely to be non home-based trips made at lunch time. The fact that non home-based trips have the highest level of under reporting is consistent with those trips being the ones of which a third-party respondent is least likely to have knowledge. The number of first trips to work from non home locations shows the smallest increase (16%).

2.9 Trip Origin Location

The percentage increase in trips by municipality of trip origin is similar in magnitude and distribution to the increases by municipality of residence.

2.10 Trip Start Time

Table 2.10 gives a comparison of discretionary trip totals by time of day. The differences between the respondent and TTS databases are shown as percentages of both the discretionary trip totals and the overall totals including home-based work and school trips. Figure 2.10 shows the difference in trip totals for a continuously moving 1-hour time window.

The most significant increase, in both absolute and percentage terms, occurs in the middle of the day, as would be expected with the identified nature of the under reporting. The difference in the total number of trips reported prior to 9 a.m. is relatively small suggesting that a person's first trip of the day is the most likely to be accurately reported by a third party. The correction for the p.m. peak period (3:30 to 6:30) is more than twice as significant than the a.m. peak period, 11% compared to 5% of total trips.

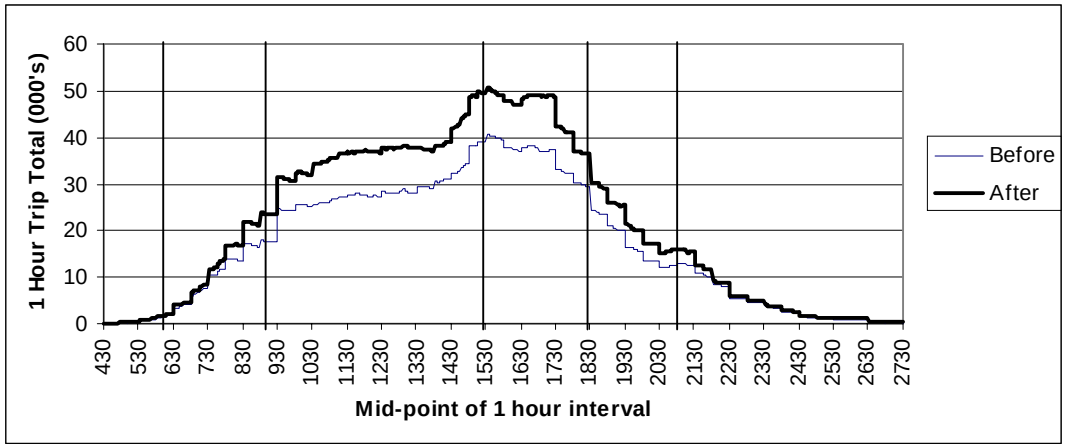
Table 2.10 – Discretionary Trips by Trip Start Time

Start time	TTS database	Respondent database	Difference		Work & School Trips	Total Difference
4:00-5:59	13,351	17,458	4,107	31%	96,298	4%
6:00-8:59	530,778	636,254	105,476	20%	1,800,072	5%
9:00-15:29	1,969,569	2,516,724	547,155	28%	865,691	19%
15:30-18:29	1,281,545	1,574,556	293,011	23%	1,403,765	11%
18:30-20:59	965,659	1,153,477	187,818	19%	275,259	15%
21:00-27:59	614,617	744,719	130,102	21%	288,843	14%
Total	5,375,519	6,643,188	1,267,669	24%	4,729,929	13%

2.11 Auto Trip Length

Figure 2.11(a) compares the auto driver discretionary trip length distributions from the TTS and respondent databases. Contrary to expectations there is little variation in the magnitude of the difference. It was expected that there would be a larger difference for short trips than for long trips. The median auto driver discretionary trip length in the respondent database is 5.6 km compared to 5.9 km in the original TTS database. The adjustment to short trips (under 5 km) dominates the change in the total number of daily trips, accounting for almost 60% of the total increase, but it is the adjustment to the longer trips that has the greatest impact on traffic flows. Figure 2.11(b) shows that half of the increase in auto trip km comes from the increase in trips over 17 km in length.

Figure 2.10 – 1-hour Discretionary Trip Total Before and After Correction



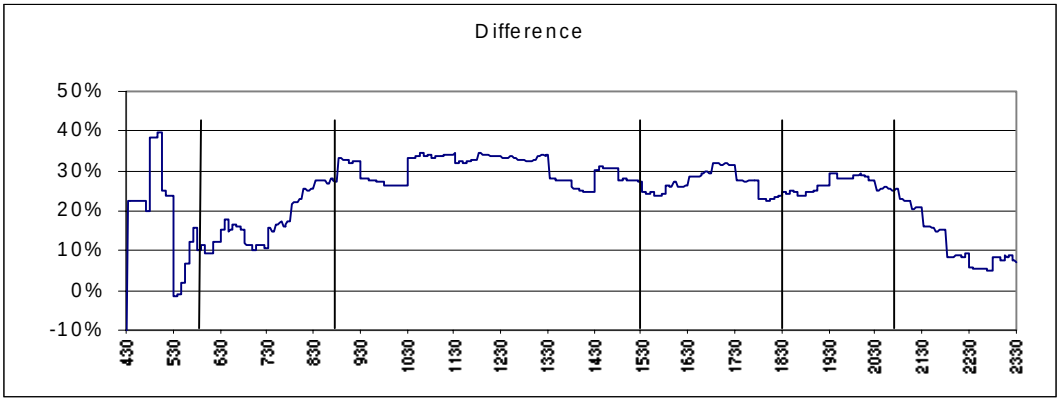
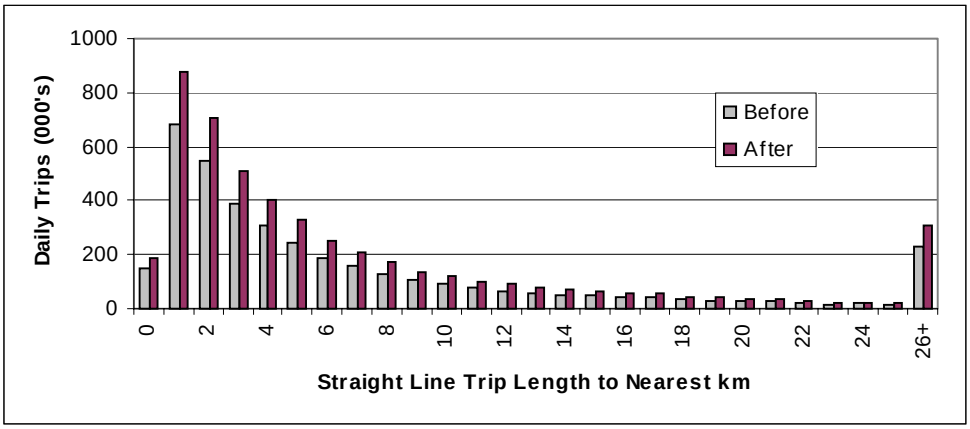


Figure 2.11(a) – Discretionary Auto Driver Trip Lengths Before and After Correction



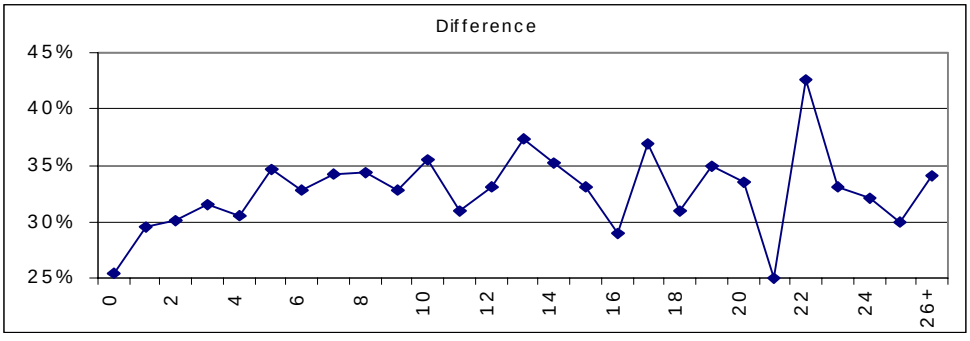
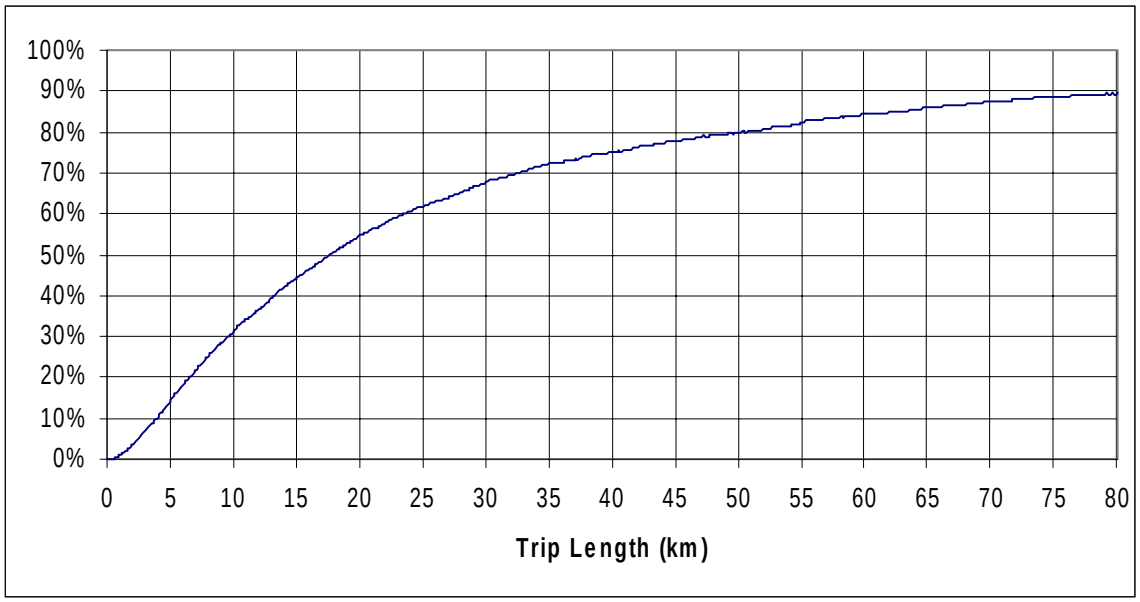


Figure 2.11(b) – Cumulative Distribution of Additional Auto Driver Trip Km



2.12 Cordon Counts

Tables 2.12(a), (b) and (c) give comparisons between Cordon Counts and assigned traffic volumes for selected screen lines in the four regions (Toronto, Peel, York and Durham) for which cordon count information was collected in 1995 or 1996. Figures 2.12(a) through (d) provide a summary by region referenced to the mean hourly count for that region. The comparisons were obtained by performing EMME/2 assignments of auto driver trip matrices extracted from the TTS and respondent databases. A number of problems have to be recognized when making comparisons between TTS and cordon count data:

1. Difference in timing. The Cordon Count Data were collected in the early summer of 1995 (1996 in Durham), the TTS in the fall of 1996. Natural growth, economic recovery and seasonal variations are all factors that would likely contribute to higher traffic volumes at the time of the TTS relative to the cordon counts.
2. The TTS data represents a 3-month average. The cordon counts consist mostly of one day counts at each location. Substantial day to day variations in traffic volumes are possible.
3. Vehicle classification. The comparison is between auto drivers, taken from the TTS database and private vehicles taken from the cordon counts. The TTS database does not identify the type of vehicle. It is often difficult for the cordon count survey crews to distinguish between private and light commercial vehicles. Many pickup trucks, small vans and SUV's could belong to either category.
4. Time distribution. The cordon count data is based on the times at which vehicles are observed on the street whereas the TTS data consists of reported trip start times. The cordon count information is collected in 15 minute time intervals. The TTS database contains the exact time that each trip is reported as starting but most survey respondents give approximate times – usually to the nearest 10, 15 or 30 minutes. As a result, the TTS database contains sharp peaks that generally coincide with the dividing lines between count periods. With the exception of the evening and 15-hour counts for Toronto, the count data has been extracted for time periods that are 15 minutes later than trip start time ranges used for the TTS data. The Toronto cordon count program did not collect data after 9 p.m., hence the need to use the same time intervals as for the TTS in order to cover the same length of time. Shifting the cordon count time period by 15 minutes produces counts that are slightly higher in the a.m. peak but has negligible impact on the counts for the other time periods.

Table 2.12(a) – Peak Period Cordon Count Comparisons

	Morning Peak (6:00 - 8:59)					Evening Peak (3:30 - 6:29)				
	95 count	TTS	Diff.	Resp.	Diff.	95 count	TTS	Diff.	Resp.	Diff.
Peel > Toronto	88296	106407	21%	116256	32%	76487	77207	1%	88123	15%
York > Toronto	94231	100144	6%	106098	13%	89469	72964	-18%	89197	0%
Durham > Toronto	31714	35175	11%	36411	15%	14476	11915	-18%	13651	-6%
Toronto in	**214241**	**241726**	**13%**	**258765**	**21%**	**180432**	**162086**	**-10%**	**190971**	**6%**
Toronto > Peel	62269	72021	16%	76836	23%	91704	104593	14%	120069	31%
Toronto > York	63922	66238	4%	75142	18%	106885	99378	-7%	112268	5%
Toronto > Durham	9934	9220	-7%	9925	0%	31004	33952	10%	36459	18%
Toronto out	**136125**	**147479**	**8%**	**161903**	**19%**	**229593**	**237923**	**4%**	**268796**	**17%**
Humber R West	80671	93901	16%	103263	28%	76673	76696	0%	90417	18%
401 South	146084	156290	7%	167712	15%	166923	152153	-9%	179377	7%
Uxb. Sub East	66388	68703	3%	75672	14%	52334	37582	-28%	43987	-16%
Humber R. East	61018	69600	14%	78845	29%	79834	94255	18%	109207	37%
401 North	142364	140091	-2%	155462	9%	175459	162960	-7%	186558	6%
Uxb. Sub West	33269	30357	-9%	33517	1%	70280	66645	-5%	77595	10%
Internal	**236651**	**240048**	**1%**	**267824**	**13%**	**325573**	**323860**	**-1%**	**373360**	**15%**
Toronto total	**587017**	**629253**	**7%**	**688492**	**17%**	**735598**	**723869**	**-2%**	**833127**	**13%**
Peel > York	11053	11811	7%	13562	23%	7463	6345	-15%	8282	11%
Durham > York	7782	12139	56%	13592	75%	3540	3703	5%	4299	21%
S. York South	41067	43737	7%	45965	12%	14332	14202	-1%	16449	15%
York > Peel	6587	4990	-24%	5397	-18%	11289	11879	5%	14834	31%
York > Durham	2125	2714	28%	3485	64%	8445	13036	54%	15723	86%
S. York North	10613	10287	-3%	11393	7%	38697	41184	6%	46655	21%
York total	**79227**	**85678**	**8%**	**93394**	**18%**	**83766**	**90349**	**8%**	**106242**	**27%**
Toronto > Peel	60125	66488	11%	70978	18%	89094	98917	11%	112793	27%
Halton > Peel	47640	50955	7%	54296	14%	31434	26251	-16%	29432	-6%
York > Peel	6645	5380	-19%	5345	-20%	12623	12153	-4%	13938	10%
Credit R. West	28420	32517	14%	36934	30%	69037	75996	10%	85242	23%
401 South	33535	36265	8%	40537	21%	44957	42178	-6%	48785	9%
QEW South	9604	7015	-27%	7961	-17%	16640	11687	-30%	13591	-18%
Peel >Toronto	86326	101558	18%	110226	28%	73795	74306	1%	84300	14%
Peel > Halton	22467	22536	0%	24695	10%	51319	50252	-2%	56801	11%
Peel > York	12760	12518	-2%	13891	9%	8823	6049	-31%	8043	-9%
Credit R. East	62942	76676	22%	80896	29%	42686	40312	-6%	46888	10%
401 North	40816	42438	4%	48057	18%	37975	39315	4%	46111	21%
QEW North	13509	12062	-11%	13063	-3%	13500	8258	-39%	9044	-33%
Peel total	**424789**	**466408**	**10%**	**506879**	**19%**	**491883**	**485674**	**-1%**	**554968**	**13%**
York>Durham	1883	2453	30%	2929	56%	6965	13009	87%	14056	102%
Durham>York	6201	12112	95%	12647	104%	2531	3259	29%	3577	41%
Hwy 401 N	23194	19690	-15%	21454	-8%	43189	31848	-26%	35533	-18%
Hwy 401 S	32079	24573	-23%	25749	-20%	35595	23376	-34%	27679	-22%
Hwy 2 N	22339	19036	-15%	21550	-4%	53216	46995	-12%	52742	-1%
Hwy 2 S	44186	39800	-10%	42259	-4%	41383	31436	-24%	36569	-12%
P/Ajax>Whitby	10391	8638	-17%	9564	-8%	24249	27698	14%	29955	24%
Whitby>P/Ajax	22161	26863	21%	27644	25%	11973	10580	-12%	12216	2%
Durham total	**162434**	**153165**	**-6%**	**163796**	**1%**	**219101**	**188201**	**-14%**	**212327**	**-3%**
Total	**1253467**	**1334504**	**6%**	**1398263**	**12%**	**1530348**	**1488093**	**-3%**	**1648930**	**8%**

Table 2.12(b) – Off-peak Cordon Count Comparisons

	Midday (9:00 a.m. to 3:29 p.m.)						Evening (6:30 to 8:59 p.m.)				
	95 count	TTS	Diff.	Resp.	Diff.		95 count	TTS	Diff.	Resp.	Diff.
Peel > Toronto	115990	75430	-35%	100308	-14%		39241	31287	-20%	37856	-4%
York > Toronto	132883	72120	-46%	96456	-27%		48798	31514	-35%	35527	-27%
Durham > Toronto	29176	20934	-28%	24600	-16%		8863	5657	-36%	6911	-22%
Toronto in	**278049**	**168484**	**-39%**	**221364**	**-20%**		**96902**	**68458**	**-29%**	**80294**	**-17%**
Toronto > Peel	118658	75438	-36%	101104	-15%		47568	38555	-19%	43311	-9%
Toronto > York	133116	71058	-47%	97512	-27%		54848	38490	-30%	41688	-24%
Toronto > Durham	27105	19318	-29%	25328	-7%		15119	11777	-22%	11210	-26%
Toronto out	**278879**	**165814**	**-41%**	**223944**	**-20%**		**117535**	**88822**	**-24%**	**96209**	**-18%**
Humber R West	115810	73450	-37%	97364	-16%		40021	31455	-21%	38369	-4%
401 South	245913	153834	-37%	197840	-20%		99305	69372	-30%	79675	-20%
Uxb. Sub East	93727	51240	-45%	65778	-30%		33577	18068	-46%	21605	-36%
Humber R. East	107064	72808	-32%	98510	-8%		41508	35140	-15%	39344	-5%
401 North	258799	151262	-42%	196208	-24%		100453	71780	-29%	79654	-21%
Uxb. Sub West	94838	47922	-49%	64618	-32%		39834	26445	-34%	28095	-29%
Internal	**460701**	**271992**	**-41%**	**359336**	**-22%**		**181795**	**133365**	**-27%**	**147093**	**-19%**
Toronto total	**1017629**	**606290**	**-40%**	**804644**	**-21%**		**396232**	**290645**	**-27%**	**323596**	**-18%**
Peel > York	10085	6084	-40%	7754	-23%			1843		1767	
Durham > York	5987	3988	-33%	5872	-2%			1214		1577	
S. York South	29503	21350	-28%	27990	-5%			5529		5813	
York > Peel	10088	5540	-45%	7718	-23%			3213		3389	
York > Durham	5755	3898	-32%	5158	-10%			1998		2236	
S. York North	28406	20284	-29%	27906	-2%			13161		11878	
York total	**89825**	**61144**	**-32%**	**82398**	**-8%**			**26958**		**26660**	
Toronto > Peel	115879	72556	-37%	96532	-17%		44075	37019	-16%	41457	-6%
Halton > Peel	55858	34422	-38%	45334	-19%		17062	11286	-34%	13627	-20%
York > Peel	11335	4118	-64%	6116	-46%		4406	2143	-51%	2231	-49%
Credit R. West	69833	46144	-34%	60518	-13%		34465	28294	-18%	30426	-12%
401 South	53486	27570	-48%	37976	-29%		18633	13714	-26%	15559	-16%
QEW South	22745	9834	-57%	11914	-48%		11204	5005	-55%	6098	-46%
Peel >Toronto	112953	73962	-35%	97836	-13%		35852	30729	-14%	37106	3%
Peel > Halton	51629	32388	-37%	43424	-16%		22602	19233	-15%	20296	-10%
Peel > York	12789	4452	-65%	6038	-53%		3636	1573	-57%	1493	-59%
Credit R. East	75273	49654	-34%	63780	-15%		25244	17310	-31%	20992	-17%
401 North	56423	26968	-52%	35746	-37%		16907	12502	-26%	13764	-19%
QEW North	22412	11220	-50%	13920	-38%		9038	4385	-51%	5821	-36%
Peel total	**660615**	**393288**	**-40%**	**519134**	**-21%**		**243124**	**183193**	**-25%**	**208870**	**-14%**
York>Durham	5354	3774	-30%	4880	-9%			2024		2290	
Durham>York	4726	3968	-16%	5680	20%			1188		1596	
Hwy 401 N	59964	26232	-56%	32416	-46%			11832		14231	
Hwy 401 S	55195	20210	-63%	25586	-54%			8617		10407	
Hwy 2 N	68137	39144	-43%	47518	-30%			20533		24641	
Hwy 2 S	72335	42670	-41%	51650	-29%			15879		20386	
P/Ajax>Whitby	23400	15500	-34%	19254	-18%			8091		9103	
Whitby>P/Ajax	23504	16924	-28%	20494	-13%			4517		5261	
Durham total	**312615**	**168422**	**-46%**	**207478**	**-34%**			**72681**		**87915**	
Total	**2080684**	**1229144**	**-41%**	**1552340**	**-25%**		**639356**	**473838**	**-26%**	**671725**	**5%**
								(Toronto and Peel)			

Table 2.12(c) – Total Daily (15/12.5-hr) Cordon Count Comparisons

	15 hours (12.5 hours for York & Durham)				
	95 count	TTS	Diff.	Resp.	Diff.
Peel > Toronto	318147	290331	-9%	342543	8%
York > Toronto	361173	276742	-23%	327278	-9%
Durham > Toronto	84703	73681	-13%	81573	-4%
Toronto in	**764023**	**640754**	**-16%**	**751394**	**-2%**
Toronto > Peel	316047	290607	-8%	341320	8%
Toronto > York	352730	275164	-22%	326610	-7%
Toronto > Durham	81442	74267	-9%	82922	2%
Toronto out	**750219**	**640038**	**-15%**	**750852**	**0%**
Humber R West	310280	275502	-11%	329413	6%
401 South	649451	531649	-18%	624604	-4%
Uxb. Sub East	244083	175593	-28%	207042	-15%
Humber R. East	286192	271803	-5%	325906	14%
401 North	668830	526093	-21%	617882	-8%
Uxb. Sub West	233895	171369	-27%	203825	-13%
Internal	**1188917**	**969265**	**-18%**	**1147613**	**-3%**
Toronto total	**2703159**	**2250057**	**-17%**	**2649859**	**-2%**
Peel > York	28602	24240	-15%	29598	3%
Durham > York	17309	19830	15%	23763	37%
S. York South	84903	79289	-7%	90404	6%
York > Peel	27963	22409	-20%	27949	0%
York > Durham	16324	19648	20%	24366	49%
S. York North	77717	71755	-8%	85954	11%
York total	**252818**	**237171**	**-6%**	**282034**	**12%**
Toronto > Peel	309173	274980	-11%	321760	4%
Halton > Peel	151994	122914	-19%	142689	-6%
York > Peel	35009	23794	-32%	27630	-21%
Credit R. West	201755	182951	-9%	213120	6%
401 South	150611	119727	-21%	142857	-5%
QEW South	60193	33541	-44%	39564	-34%
Peel >Toronto	308926	280555	-9%	329468	7%
Peel > Halton	148017	124409	-16%	145216	-2%
Peel > York	38008	24592	-35%	29465	-22%
Credit R. East	206145	183952	-11%	212556	3%
401 North	152121	121223	-20%	143678	-6%
QEW North	58459	35925	-39%	41848	-28%
Peel total	**1820411**	**1528563**	**-16%**	**1789851**	**-2%**
York>Durham	14202	19236	35%	21865	54%
Durham>York	13458	19339	44%	21904	63%
Hwy 401 N	126347	77770	-38%	89403	-29%
Hwy 401 S	122869	68159	-45%	79014	-36%
Hwy 2 N	143692	105175	-27%	121810	-15%
Hwy 2 S	157904	113906	-28%	130478	-17%
P/Ajax>Whitby	58040	51836	-11%	58773	1%
Whitby>P/Ajax	57638	54367	-6%	60354	5%
Durham total	**694150**	**509788**	**-27%**	**583601**	**-16%**
Total	**5470538**	**4525579**	**-17%**	**5153486**	**-6%**

Figure 2.12(a) – Cordon Count Summary - Toronto

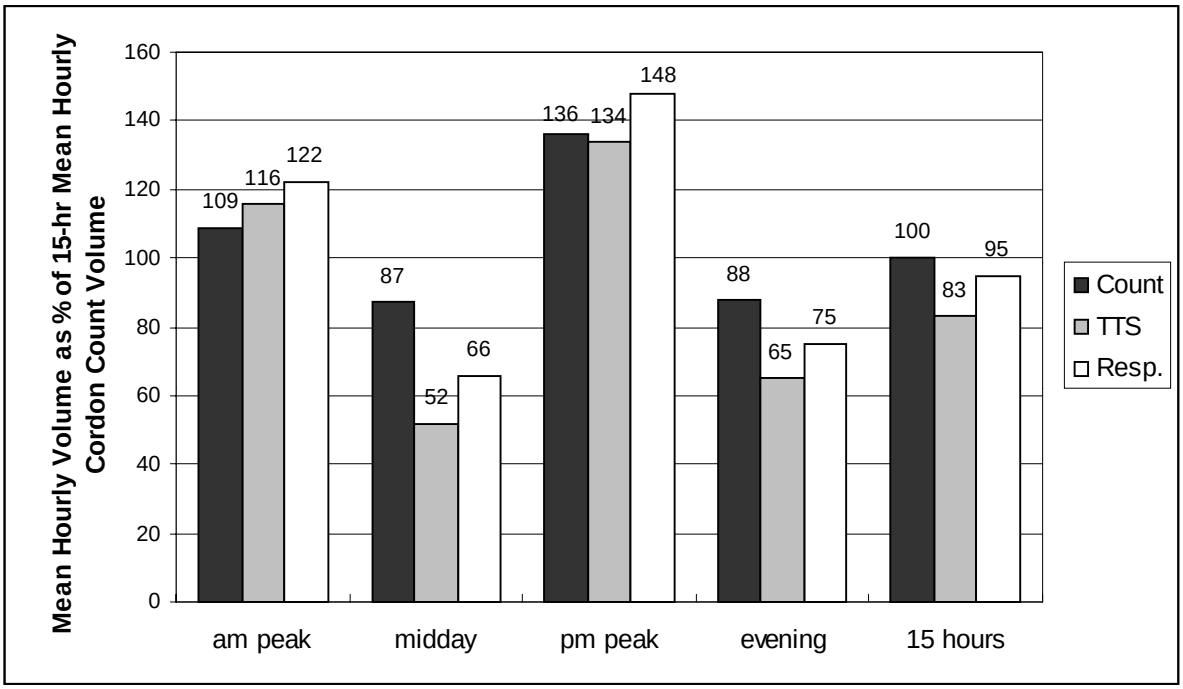


Figure 2.12(b) – Cordon Count Summary – Peel Region

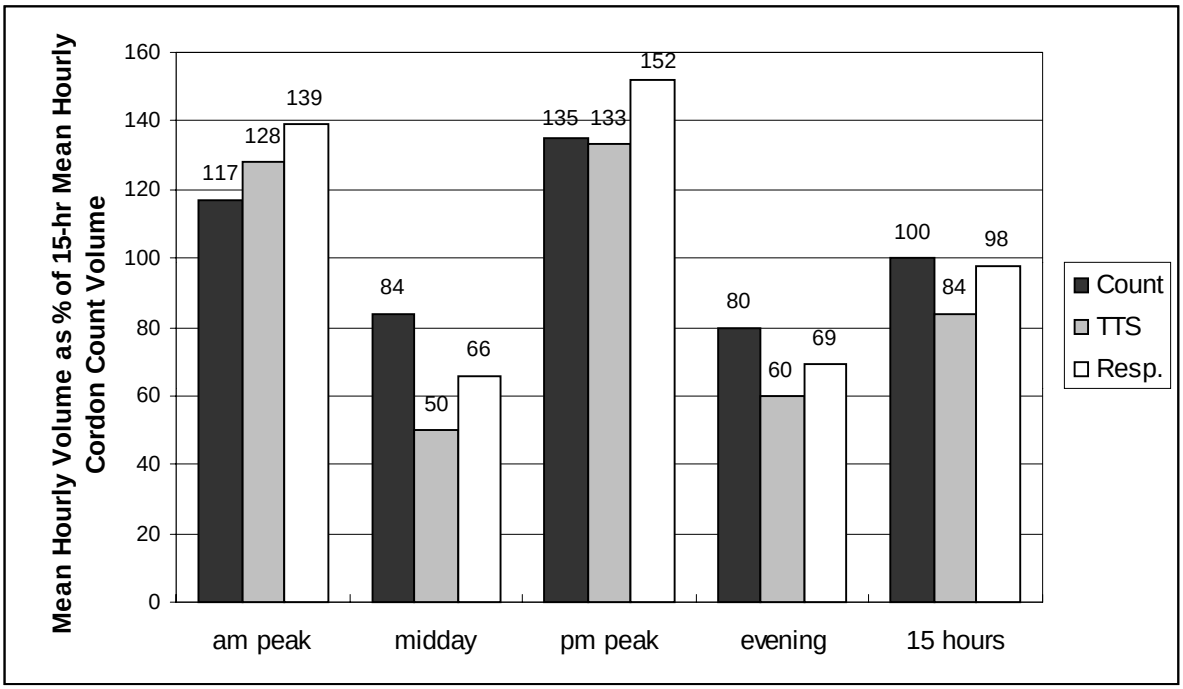


Figure 2.12(c) – Cordon Count Summary – York Region

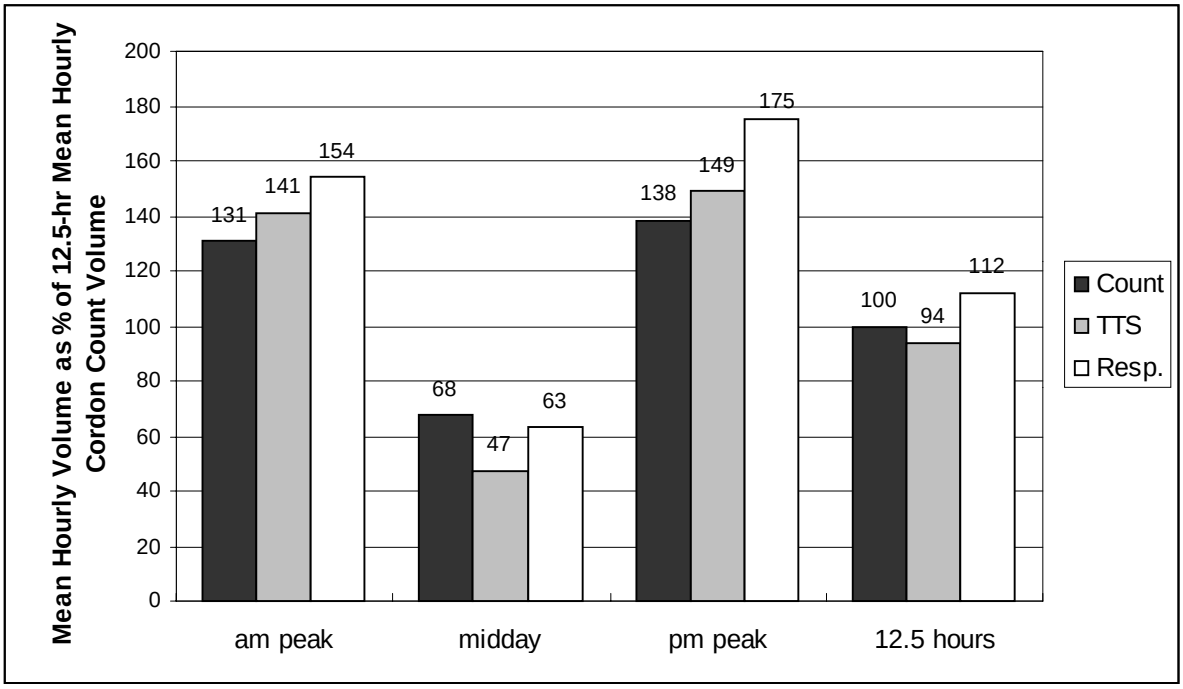
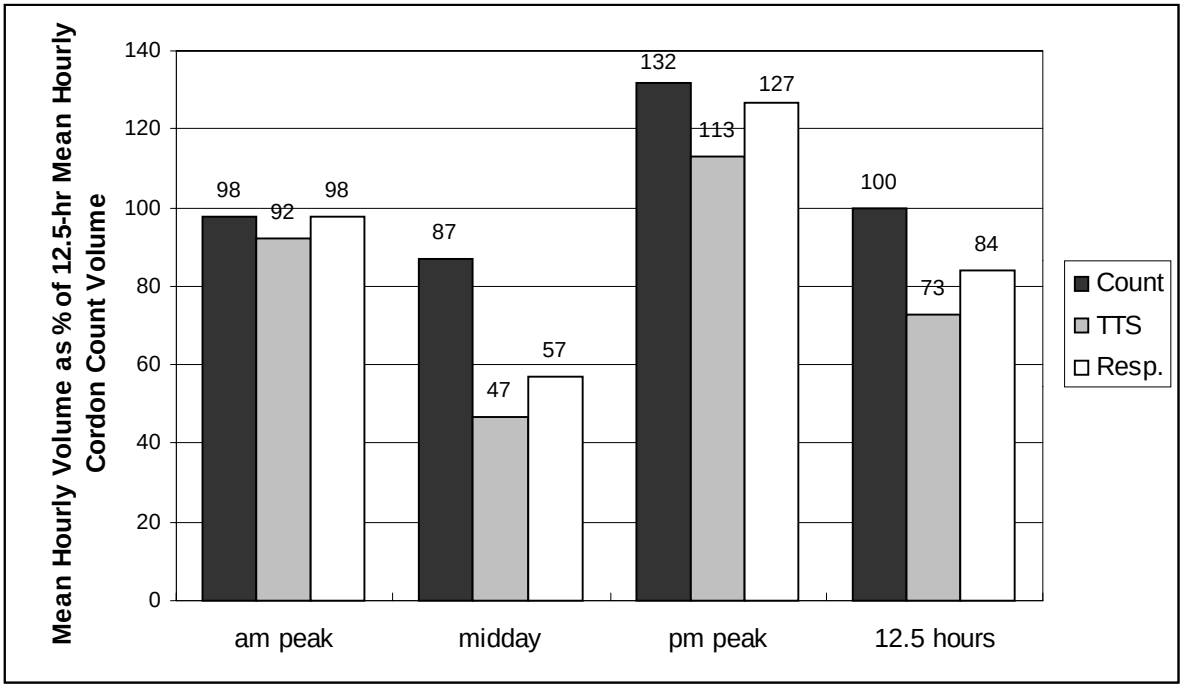


Figure 2.12(d) – Cordon Count Summary – Durham Region



5. Trip length. The TTS should, in theory, contain a representative sample of all trip lengths whereas it is the vehicles making long trips that are most likely to be counted in the cordon count program. The difference is significant. A select link EMME/2 assignment of total daily auto driver trips produced a median trip length of 21.2 km for trips crossing the Toronto boundary compared to a median length of 5.4 km for all trips.
6. Network simulation. The aggregation of TTS data to screenlines relies on a network simulation of the routes taken between origin and destination. The accuracy with which the routes correspond with actual routings depends on how well the network is represented. The location of centroid connectors, particularly in locations where the screen line does not follow a natural barrier such as a river or railway line, is of particular importance.

The above concerns make it difficult to draw definitive conclusions from comparisons made between cordon counts and TTS data.

The 15-hour assigned volumes from the respondent database give a reasonably close match to the observed counts in both Toronto and Peel when combined across all screen lines (95% for Toronto and 98% for Peel). The volumes are significantly closer than those obtained from the original TTS database (83% and 84%). Given the difference in timing, the under representation of actual traffic volumes is likely to be greater but it may be concluded that the respondent database gives volumes that are more accurate than the original TTS database. Compared to the cordon counts both the original TTS and the respondent databases would appear to over represent the a.m. and p.m. periods relative to off peak travel. It is unlikely that the TTS would over-represent trips, for either respondents or non respondents, or that any hidden bias, related to the selection of respondents, would create differences of this magnitude. It is more likely the assignment procedures and the definition of compatible time intervals that are the problem.

For York Region the 12.5-hour screenline volumes from the respondent database were, on average, 12% higher than the count whereas the TTS data gave volumes 6% lower than the counts. The differences, relative to Toronto and Peel, are consistent with the exclusion of evening travel from the comparison and more pronounced peaks associated with the high proportion of commuter travel to and from Toronto.

Durham is the only region that has cordon count data for 1996, the same year as the survey, but shows the greatest discrepancies between the cordon count and survey data. The original TTS data produced volumes averaging 73% of the counts and the respondent database 84%. Much of the under representation is of volumes crossing Highway 401 suggesting that there might be a problem specific to that screenline, possibly in the way it is represented in the assignment relative to real life.

When the results from the four regions are taken together it would appear that the correction for the under reporting of non respondent trips account for 65% of the apparent under reporting of total daily traffic. The level of under reporting that remains is hard to assess because of the previously mentioned limitations in making comparisons with the cordon counts. There is also no valid basis on which to base any further adjustment of the data. The correction for under reporting has a greater impact in the p.m. peak than in the a.m. peak providing a more realistic representation of the relative magnitudes of the two peak periods. Over representation of the peak period travel, relative to off-peak, appears to be a problem and is addressed in more detail in Chapter 5.

2.13 Transit Ridership Counts

Table 2.13 compares the number of transit boardings recorded in the TTS and respondent databases with the transit ridership counts used in the original validation of the 1996 TTS data.

The under reporting adjustment increased the discretionary trip boardings for TTC buses by 38% producing an almost exact match with the ridership counts obtained from the TTC. Streetcar ridership is still significantly under represented but by a smaller amount than in the original TTS database (25% vs. 33%). The 1996 TTS did not collect information on transfers between subway lines or between the subway and the Scarborough RT. In order to obtain a comparable number, the TTC boarding counts were adjusted using information from the 1986 TTS. The subway and SRT count numbers are therefore less reliable than for bus and streetcar. There is no obvious explanation as to why the TTS would over represent subway

ridership in either the TTS or respondent databases. It should be noted that the TTC ridership counts were taken at a different time on each route over a two year period.

Discretionary trips are not a significant factor in either GO Rail or GO Bus Ridership. The adjustment for under reporting therefore has little effect on total ridership, which closely matches the observed ridership counts in both the TTS and respondent databases.

The respondent database also gives total ridership figures that are very close to the observed daily ridership counts for Mississauga Transit. In the other municipalities for which counts were available at the time of the validation, the reported ridership in the TTS was significantly higher (20% to 59%) than the counts. The correction for under reporting increases those differences. However both the ridership totals and the differences are small in absolute terms.

The TTS validation included comparisons between TTS and annual ridership data for the Hamilton Street Railway, which suggested that bus ridership in the City of Hamilton was under reported by 10% to 15%. The respondent database would correct for that difference.

Table 2.13 – Daily Transit Boardings

Operator	Discretionary			Work & School	Total Change	Count	Difference	
	TTS	Resp.	Change				TTS	Resp.
TTC Bus	271421	375675	38%	735505	10%	1150377	-12%	-3%
TTC Streetcar	65497	83090	27%	108752	10%	254822	-32%	-25%
TTC Subway/SRT*	203780	272571	34%	499969	10%	669950	5%	15%
TTC Sub-total	**540698**	**731336**	**35%**	**1344226**	**10%**	**2075149**	**-9%**	**0.02%**
GO Rail	9405	10441	11%	82015	1%	94142	-3%	-2%
GO Bus	5054	6275	24%	22921	4%	27156	3%	8%
GO Sub-total	**14459**	**16716**	**16%**	**104936**	**2%**	**121298**	**-2%**	**0.3%**
Mississauga	22669	32657	44%	70152	11%	100392	-8%	2%
Brampton	3946	6344	61%	18538	11%	18709	20%	33%
Peel Sub-total	**26615**	**39001**	**47%**	**88690**	**11%**	**119101**	**-3%**	**7%**
Vaughan	504	770	53%	3329	7%	2989	28%	37%
Markham	1563	2624	68%	6867	13%	7044	20%	35%
Whitby	548	691	26%	3259	4%	2388	59%	65%
Hamilton	31695	42838	35%	43515	15%	n/a		
Other	12637	16799	33%	36965	8%	n/a		
Total	**628720**	**850775**	**35%**	**1631788**	**10%**			

*Excludes transfers between lines.

3.0 Global Adjustment Factors

A primary reason for expanding the respondent database to represent the total survey population was to avoid the distortion of trip characteristics that might be introduced by applying constant adjustment factors to trip categories that might contain a variation in the level of under reporting. The concern related primarily to trip start time and trip length. The comparisons between the expanded respondent data and the original TTS data showed no evidence of any significant variation in the implied level of under reporting associated with trip length (Figure 2.11(a)). The implied level of under reporting was almost constant between 9 a.m. and 9 p.m. (Figure 2.10). Of the total daily discretionary trips, 79% are made between 9 a.m. and 9 p.m. Under reporting of discretionary trips that start before 7:30 a.m. or after 10 p.m. would appear to be minimal but the number of trips affected is very small.

Household size is the most significant demographic factor affecting the magnitude of under reporting but household size has not been identified as a major factor with respect to other trip characteristics nor are variations in household size distribution likely to have a significant effect on the overall level of under reporting. Other demographic factors, primarily gender, age, and possession of a driver's license, would appear to correlate more with overall trip rates and the probability of a person being a respondent than they do with levels of under reporting for non respondent. The analysis also produced little evidence of geographic variations in levels of under reporting.

The two most significant factors affecting the levels of under reporting are trip purpose and mode of transport. Global under reporting correction factors based on these two attributes may well produce trip rates and trip distributions that are as reliable and robust as any other method of adjusting the TTS data. Table 3.0 provides a summary of the differences in expanded discretionary trip totals between the respondent and TTS trip databases. The data are sorted in order of the relative magnitude of the daily trip totals. The comparison is restricted to persons in the age range 18 to 62. No adjustments, or only partial adjustments, were made in other age categories due to insufficient data for respondents.

The figures shown in bold type, for auto drivers and local transit trips, are recommended as correction factors that can be applied to any subset of the 1996 TTS data extracted using those trip attributes. The significance of non respondent under reporting of discretionary trips is greatest with respect to auto driver trips largely because they account for 64% of total daily auto trips. The relative magnitude of the under reporting of discretionary trips made by local transit is similar to auto drivers (34% vs. 33%). The difference is less significant, however, because discretionary trips only account for 34% of total daily transit trips. Transit planning generally focuses on peak period demand where discretionary travel is even less of a factor.

Adjustments to other modes are not recommended for the following reasons:

a) Auto passengers are the second most significant mode in terms of total daily discretionary travel but there is no evidence of under reporting. The fact that the trip rates for non respondents is higher than for respondents in many sub categories is most likely due to unidentified biases in the two populations.

b) Information on discretionary walk trips should only have been collected for connecting links between trips made by other modes. Discretionary walk trip information in the TTS database is meaningless for most purposes and should not be used.

c) The total numbers of trips made by taxi and bicycle are small and of minor importance to most transportation planning issues. The adjustment factors are consistent with those for auto drivers and local transit and could be used if there is a need. It is interesting to note that 75% of the adjusted daily taxi trip total consists of discretionary trips.

d) The number of discretionary trips made on the other modes, including GO Train, is too small for the adjustment factors to have any statistical reliability or significance.

The global adjustment factors should not be applied to subsets of the TTS data that are heavily biased in their selection criteria in respect to the relative proportions of respondents and non respondents (e.g.- trip makers under the age of 18). Similarly, it would be inappropriate to apply the factors to trip selections that include a high proportion of trips made between 10 p.m. and 8 a.m.

Table 3.0 – Global Trip Adjustment Factors

Primary Mode	Ratio of Adjusted to Original Trip Totals				Total Discretionary trips after adjustment	Proportion of total daily trips (incl. Work & school)
	Home-based		Non Home	All		
	Shopping	Other	Based	Discretionary		
Auto driver	**1.34**	**1.27**	**1.41**	**1.33**	4,315,737	64%
Auto passenger	0.95	0.94	1.08	0.97	594,491	61%
Local Transit	**1.39**	**1.31**	**1.36**	**1.34**	364,213	34%
Walk	1.36	1.30	1.35	1.33	54,689	22%
Taxi	1.33	1.27	1.32	1.29	34,553	75%
Bicycle	1.42	1.38	1.38	1.39	33,711	49%
Other	1.00	1.14	0.96	1.02	7,129	76%
GO Train	1.23	1.34	1.02	1.11	5,814	10%
School Bus	2.09	1.47	1.84	1.78	3,169	25%
GO Train + Transit	0.75	1.03	1.16	1.08	2,930	10%
Motorcycle	0.83	1.46	2.26	1.49	2,833	62%
Unknown	1.28	0.77	1.17	0.98	712	49%
Total	1.27	1.22	1.37	1.28	5,419,980	59%

4.0 Analysis of Discretionary Travel

The following analysis has been performed using the respondent data expanded to match the demographic characteristics of the TTS population terms of the distribution of age, gender, household size and driver's license status for women. The analysis is based on residents of the GTA and Hamilton-Wentworth. Sections 4.1 through 4.7 deal with the characteristics of discretionary trips and Sections 4.8 through 4.10 with the characteristics of the trip makers. Section 4.11 provides a summary. For the purpose of this analysis, discretionary travel has been divided into three sub-categories:

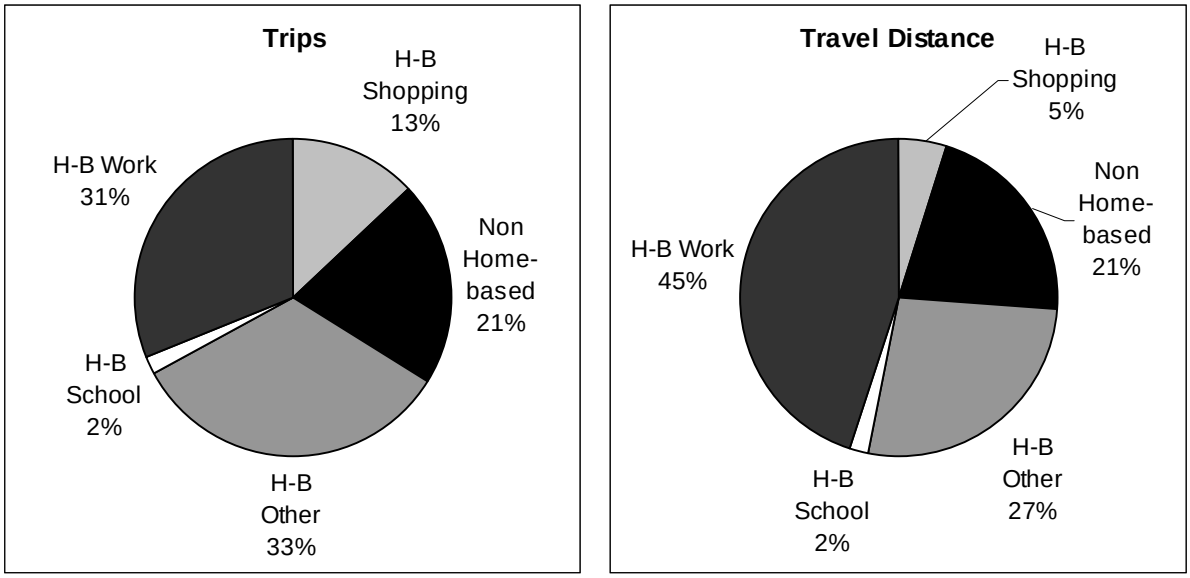
- Home-based shopping - trips with one end (origin or destination) at home and the other at a location where the destination purpose of the current, or the previous trip, was given as shopping.
- Home-based other - trips with one end at home and the other at a location where the purpose was given as something other than work, school or shopping.
- Non home-based - all trips where neither the origin nor the destination is given as home.

The above trip purposes, together with home-based work and home-based school, define the total travel market covered by the TTS survey. While the focus of this analysis is on discretionary travel some comparisons with home-based work and school trips are included for the purpose of highlighting the differences.

4.1 Total Travel

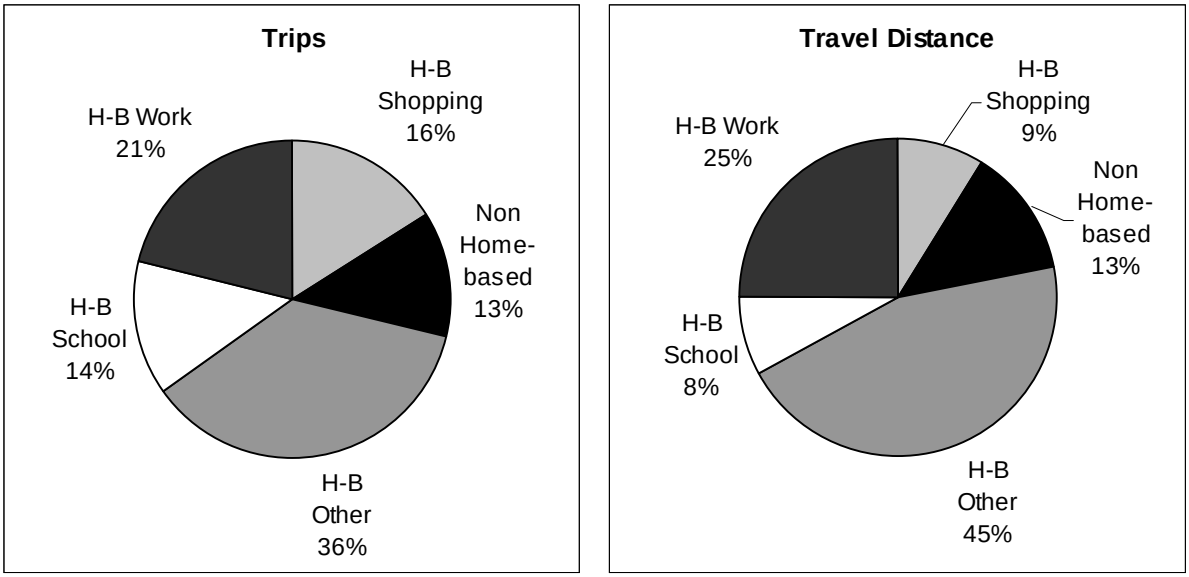
Figures 4.1(a), (b), (c) and (d) show the relative significance of the 5 trip purposes for the four main modes of travel. The Figures show the relative magnitude both in terms of the number of daily trips made and the total distance travelled measured in a straight line from origin to destination.

Figure 4.1(a) – Auto Driver Trip Purpose Distribution



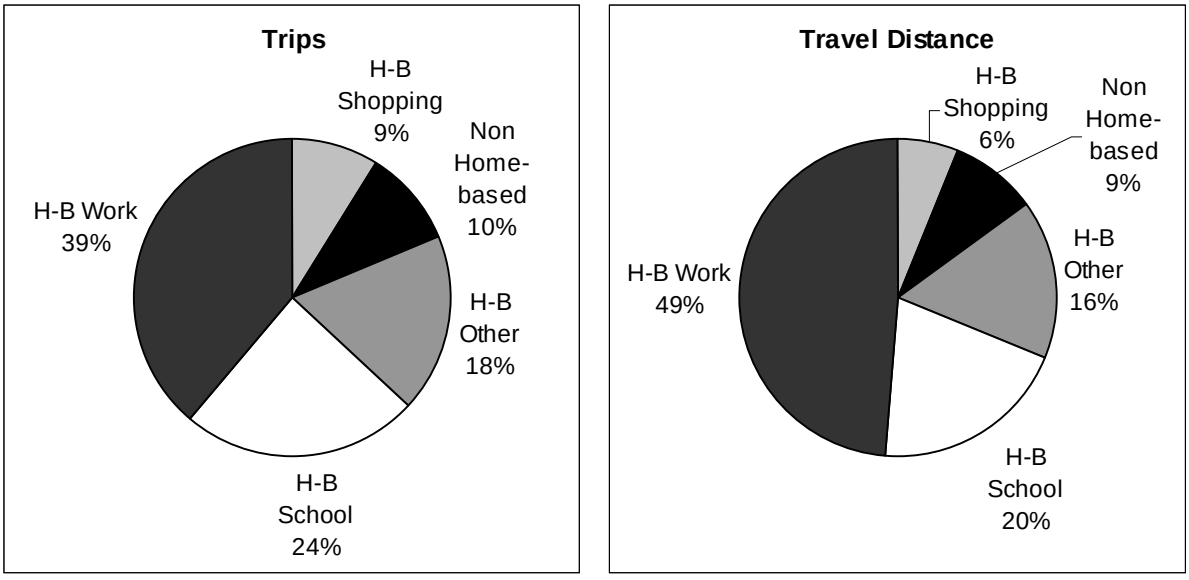
Total discretionary travel accounts for 67% of total daily auto driver trips and 53% of total daily auto travel distance. Home-based shopping is the least significant of the three discretionary trip purposes accounting for 13% of daily trips but only 5% of daily travel distance for the auto driver mode.

Figure 4.1(b) – Auto Passenger Trip Purpose Distribution



Discretionary travel accounts for about the same proportion of daily auto passenger trips (65%) as for auto drivers and a higher proportion of total daily passenger travel distance (67%).

Figure 4.1(c) – Local Transit Trip Purpose Distribution

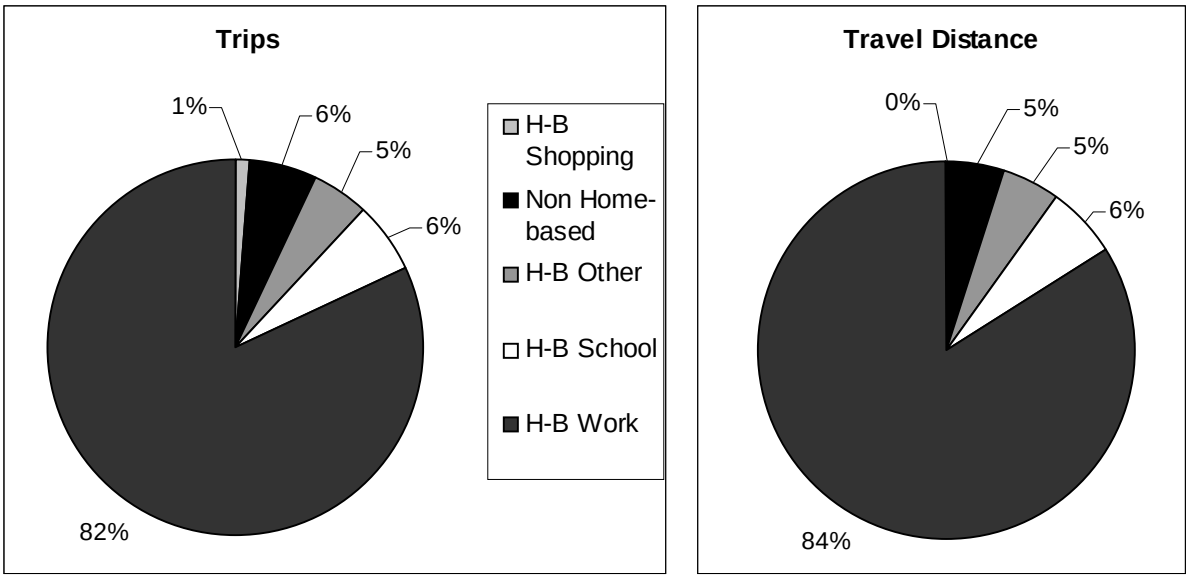


Discretionary travel is less significant for local transit use than it is for either auto drivers or auto passengers. In total, discretionary travel accounts for 37% of the total daily trips made by local transit and 31% of the passenger travel distance.

The amount of discretionary travel reported on GO Rail, at 12% of trips and 10% of travel distance, is significantly higher than the 3% reported in the 1995 GO Rail survey. The GO Rail survey, however, had a 31% non response rate for that question. Differences in methodology, sampling and response rates make it difficult to draw conclusions as to the relative reliability of the two surveys. The one conclusion that can

be drawn is that discretionary travel is of relatively minor importance to GO Rail operations. The remainder of this analysis is restricted to the automobile and local transit modes.

Figure 4.1(d) – GO Rail Trip Purpose Distribution



Home-based other is the most significant of the three discretionary trip purposes accounting for 33% of total daily auto driver trips, 36% of auto passenger trips and 18% of daily local transit trips. Non home-based is the second most important discretionary purpose accounting for 21% of auto driver trips, 13% of auto passenger trips and 10% of local transit use. Table 4.1 gives a further breakdown of non home-based trips by origin and destination purposes. It shows that 50% of non home-based trips have a place of work as either their origin or destination. Seventeen percent are totally work related (work to work), 13% are to work from other origins and 20% from work to other destinations.

Table 4.1 – Origin & Destination Purpose of Total Daily Non Home-based Trips – All Modes

Origin Purpose	Destination Purpose Other	Work	School	Shopping	Total
Other	484564	216766	27402	154188	882920
Work	285117	342048	10202	108538	745905
School	50485	15043	5859	11276	82663
Shopping	114677	27484	2924	145176	290262
Total	934843	601341	46387	419178	2001749

Origin Purpose	Destination Purpose Other	Work	School	Shopping	Total
Other	24%	11%	1%	8%	44%
Work	14%	17%	1%	5%	37%
School	3%	1%	0%	1%	4%
Shopping	6%	1%	0%	7%	15%
Total	47%	30%	2%	21%	100%

Home-based shopping is the least significant of the three trip purposes accounting for 13% of auto driver trips, 16% of auto passengers and 9% of local transit trips. The proportion of total daily travel distance is significantly lower, at 5%, 9% and 6% respectively.

4.2 Mode Splits

Figures 4.2(a) and (b) compare the local transit and auto passenger mode splits for the three discretionary trip purposes with those for home-based work trips. Transit mode splits for discretionary travel are about one half of what they are for work trips. The auto passenger mode shares are higher than for work trips. Outside Toronto and Hamilton the local transit mode shares for discretionary travel are in the 0 to 3% range. Auto passenger mode shares are lower for non home-based trips (11%) then for home-based shopping (18%) or home-based other (17%). Auto passenger mode shares are higher in Hamilton-Wentworth than in the other regions including Toronto. It should be remembered, however, that the TTS did not collect data on walk trips other than to work and school. Walk and cycle trips for all trip purposes have been excluded for the purpose of this comparison.

Figure 4.2(a) – Local Transit Mode Shares

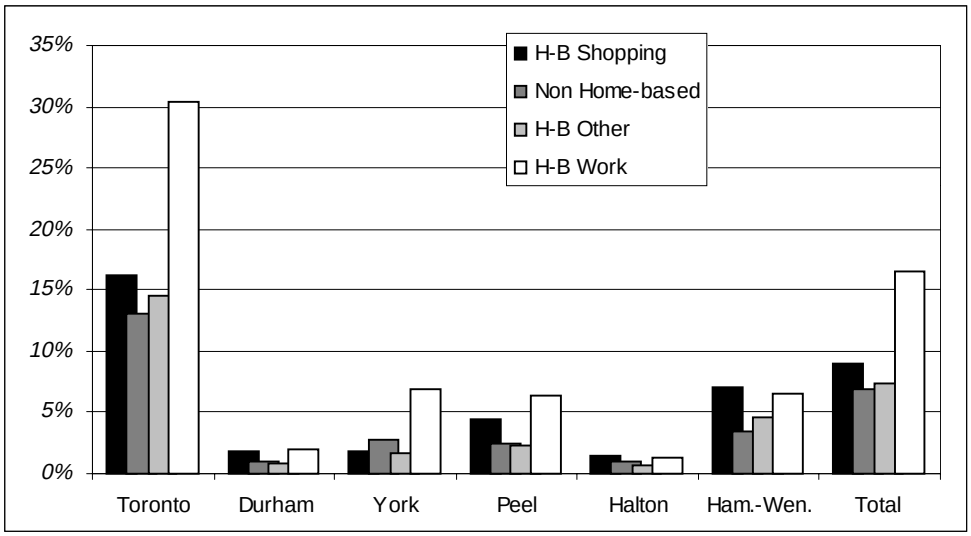
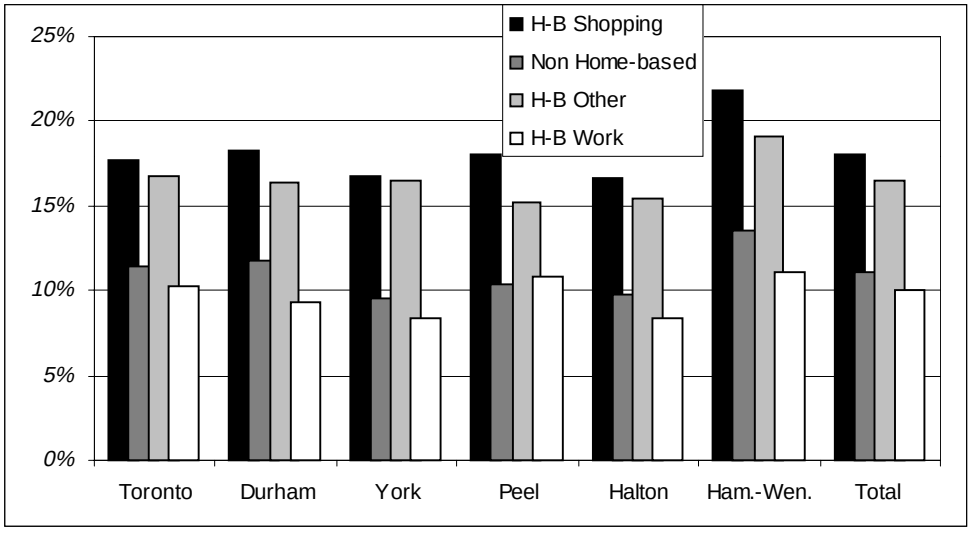


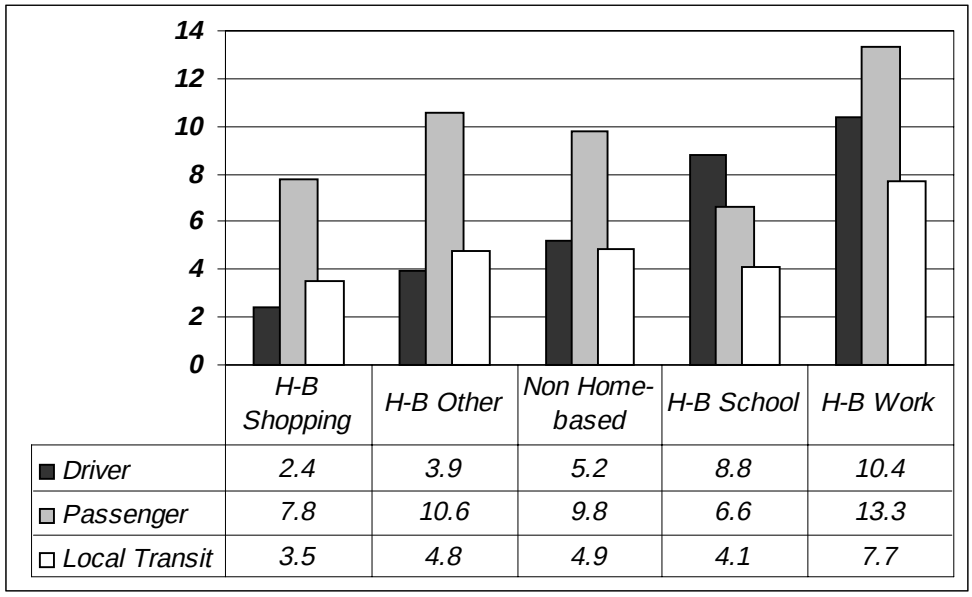
Figure 4.2(b) – Auto Passenger Mode Shares



4.3 Trip Length

Figure 4.3 gives a comparison of median trip lengths for each combination of mode and trip purpose. Trip length is measured in a straight line and therefore likely under represents median road travel distances by 15% to 20% on a consistent basis. Discretionary trips are generally much shorter than work related trips. The trip category with the shortest median trip length is auto driver home-based shopping. At 2.4 km, the median is less than one quarter of that for auto driver work trips. The short length of shopping trips explains the differences in the proportion of travel distance relative to number of trips in the previous section. The median trip length is longer for auto passengers than it is for either auto drivers or local transit in all but the school trip purpose category. For shopping trips it is more than three times the median for auto driver trips. This difference in median trip length implies that short distance local trips are the most likely to be made by a lone driver without passengers. The exception is serve-passenger trips where the median trip length is 3.2 km.

Figure 4.3 – Median Trip Length (km)



	H-B Shopping	H-B Other	Non Home-based	H-B School	H-B Work
Driver	2.4	3.9	5.2	8.8	10.4
Passenger	7.8	10.6	9.8	6.6	13.3
Local Transit	3.5	4.8	4.9	4.1	7.7

4.4 Auto occupancy

It is not possible to obtain reliable estimates of auto occupancy from the TTS data because there is no information on who rides with whom and no trip information for children under age 11 - the most likely people to be auto passengers. Comparisons by trip purpose are further complicated by the fact that drivers and passengers do not necessarily share the same trip purpose. The fact that home-based shopping trips have the highest proportion of auto passengers suggests that auto occupancy is likely to be higher on shopping trips than for other trip purposes. Dividing the combined total of auto passenger and auto driver trips by the number of auto driver trips gives a reference number that can be used for comparison between trip purposes. Weighting the values by average trip length gives an average travel value that should be more representative of the value one would expect to observe on the street. Table 4.4 shows both the trip and travel values calculated in this manner. The values for discretionary trips, particularly shopping, are significantly higher than for home-based work trips. The mean travel value is the one that should be compared with on street observations such as the cordon counts. Observed auto occupancies from the cordon count program range from 1.15 to 1.4 depending on the location of the screenline and the time of day.

Table 4.4 – Mean Auto Occupancy Indicators by Trip Purpose

	Trip	Travel
Home-based Shopping	1.25	1.8
Non Home-based	1.14	1.25
Home-based Other	1.22	1.6
Home-based Work	1.14	1.18

4.5 Start Time

Figure 4.5(a) shows the distribution of discretionary trip start times for the three main modes of travel. The peak hour for auto driver trips is between 3 and 4 p.m. although there is little change in hourly volume until 7:30 p.m. There is a less significant peak in the morning between 8 and 9 a.m. Discretionary auto passenger trips occur mostly in the evening, between 5 and 10 p.m. The number of discretionary trips made by local transit peaks between 3 and 5:30 p.m.

Figure 4.5(a) – Discretionary Travel Trip Start Times by Mode of Travel

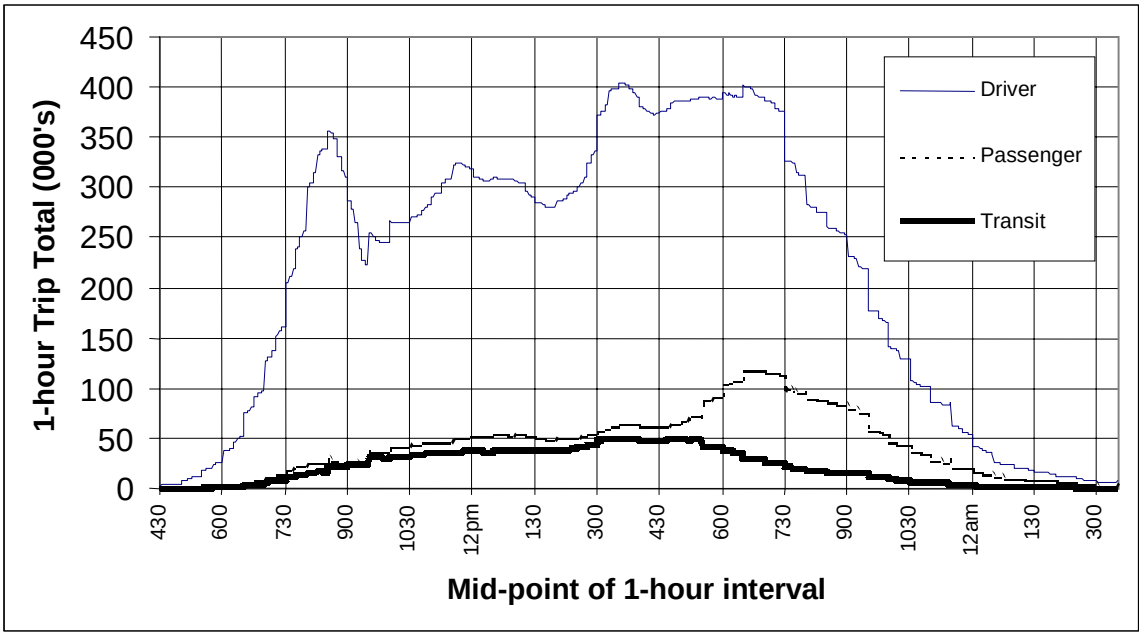


Figure 4.5(b) shows the distribution of start times for auto driver trips broken down by trip purpose. There is a pronounced peak in both home-based other and non home-based trips prior to 9 a.m. Much of that peak can be attributed to serve-passenger trips or detours. Figures 4.5(c) and (d) show the trip start time distributions for serve-passenger origins and destinations. The figures show that of the 130,000 auto driver trips made to a serve-passenger destination during the a.m. peak hour approximately 50,000 of the drivers then return home and 48,000 continue on to work. In total, the serve-passenger component accounts for 76% of the home-based other auto driver trips in the a.m. peak hour and 52% in the p.m. peak hour. Trips between a serve-passenger origin and a work destination account for 39% of the non home-based auto driver trips that start in the a.m. peak hour.

Figure 4.5(b) – Auto Driver Start Times by Trip Purpose

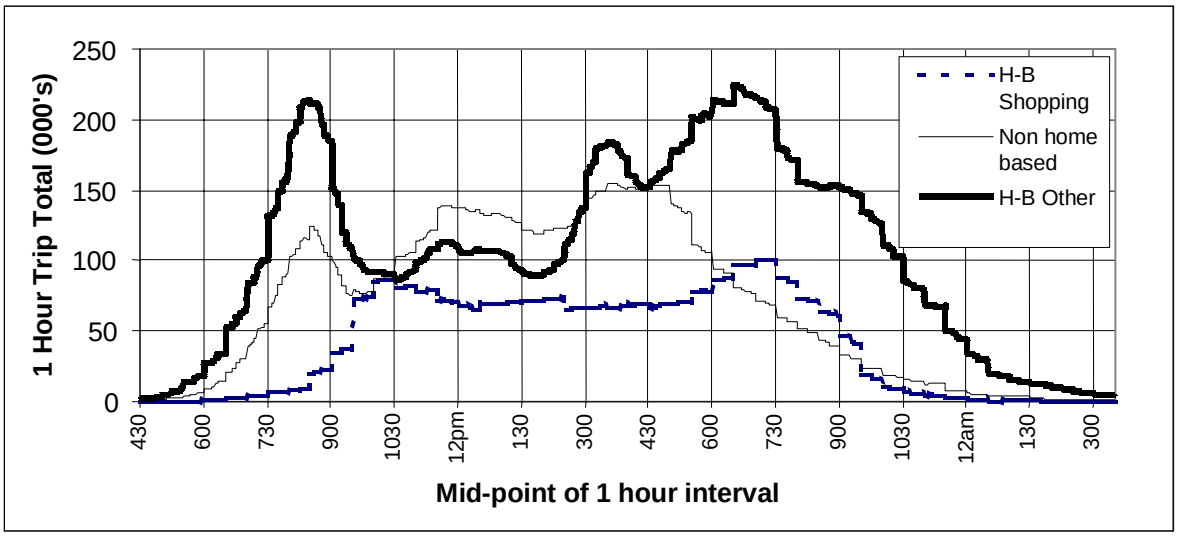


Figure 4.5(c) – Trip Start Times for Serve-passenger Origins

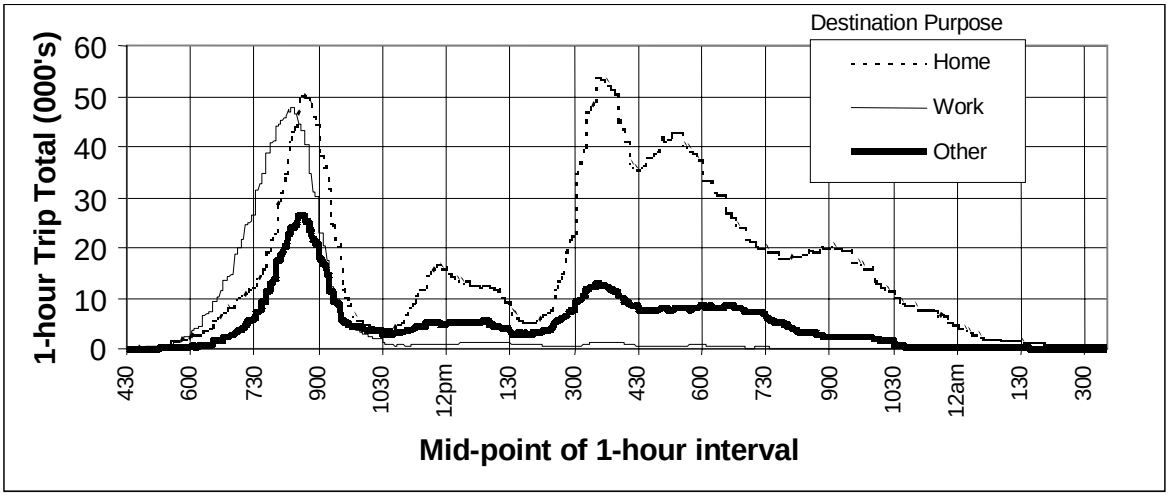
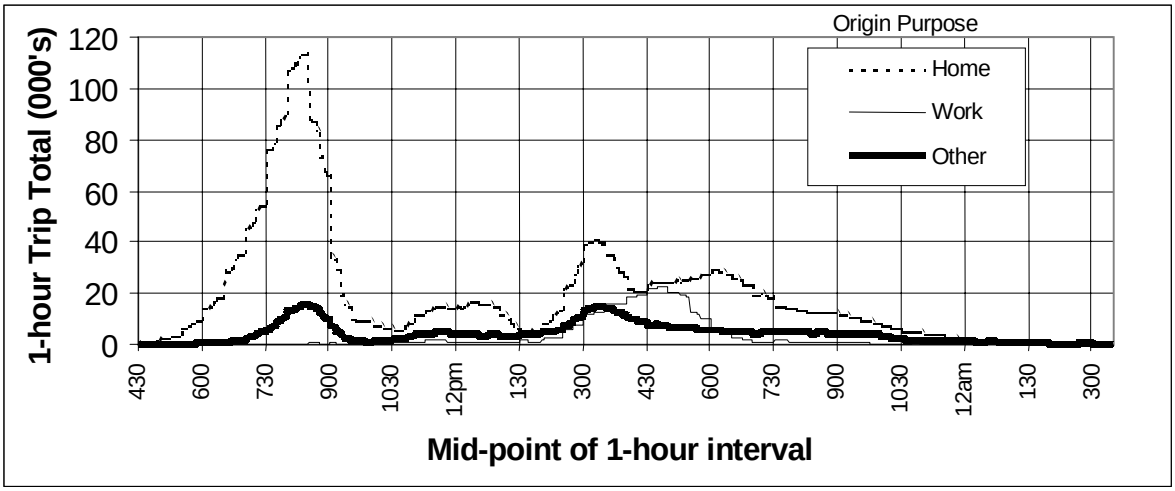


Figure 4.5(d) – Trip Start Times for Serve-passenger Destinations



The TTS does not provide any data as to who the passengers are on serve-passenger trips or their trip purposes. Since the vast majority of serve-passenger trips occur in the peak periods it would seem highly likely that they are either work or school trips. It could be argued that a serve-passenger trip to take someone else to work or school is not discretionary travel. Without those trips there would be no a.m. peak for auto driver discretionary trips. Removing the serve-passenger component would have a much smaller effect in the p.m. peak and virtually none at all in the off peak.

Figures 4.5(e) and (f) show the distribution of trip start times for auto passenger and local transit trips. The most significant component of auto passenger discretionary travel consists of home-based other trips made between 4:30 and 11 p.m. Home-based other trips made on local transit have a significant peak between 3 and 6 p.m. Home-based shopping and non home-based trips are more uniformly distributed throughout the day with the majority of auto passenger trips being made between 10 a.m. and 9 p.m. and local transit trips between 9 a.m. and 8 p.m.

Figure 4.5(e) – Start Times for Auto Passenger Trips

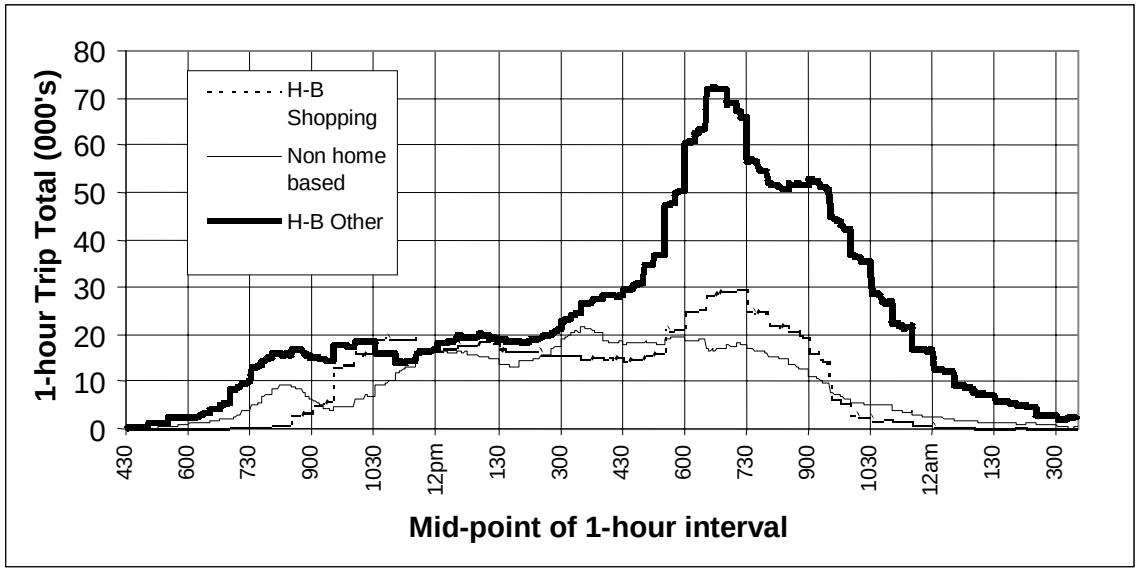
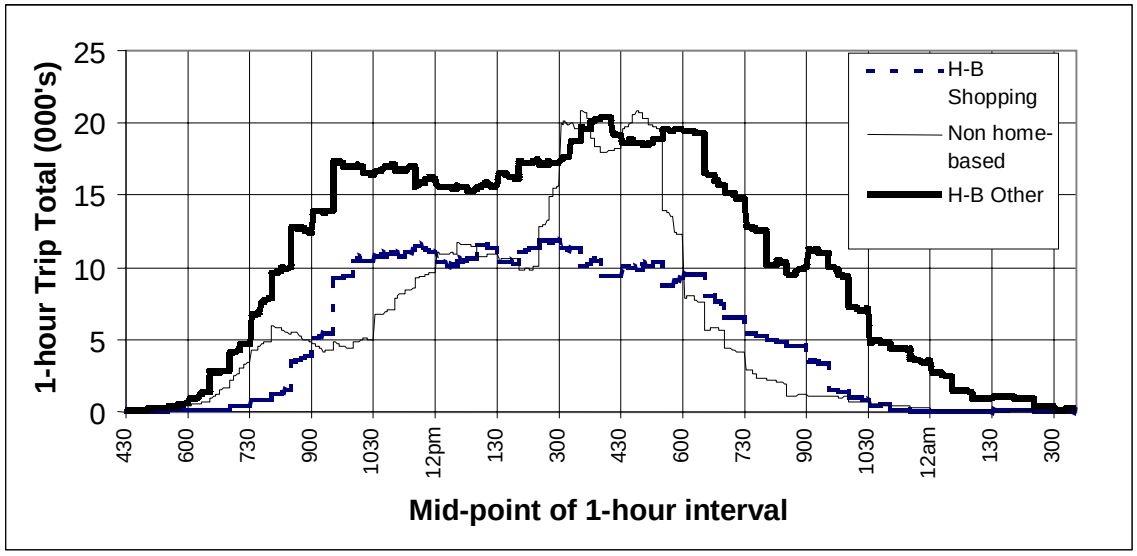


Figure 4.5(f) – Start Times for Local Transit Trips



4.6 Destinations

In the following discussion the new City of Toronto has been divided into 5 aggregations of the old planning districts. These areas are treated as equivalent to municipalities in the other regions for the purpose of analyzing travel patterns. Table 4.6(a) shows that 74% of shopping trips are made to locations within the municipality of residence and 92% within the same region. The downtown of Toronto (PD 1) is not a significant attraction for shopping trips but 25% of the shopping trips from Vaughan and 20% from Markham are made to Toronto.

Table 4.6(a) – Home-based Destinations by Municipality of Residence

	Home-based Shopping						Home-based Other					
Residence/ Origin	Same Municipality	Same Region	Planning District 1	Toronto (Incl. PD 1)	Other Regions	External	Same Municipality	Same Region	Planning District 1	Toronto (Incl. PD 1)	Other Regions	External
PD 1	62%	98%	62%	98%	2%	1%	53%	93%	53%	93%	6%	1%
PD2-6	64%	98%	13%	98%	2%	0%	55%	93%	20%	93%	6%	1%
PD7-9	77%	91%	4%	91%	9%	0%	59%	86%	7%	86%	13%	1%
PD10-12	60%	88%	4%	88%	12%	0%	48%	84%	7%	84%	15%	1%
PD13-16	80%	93%	3%	93%	7%	0%	65%	89%	7%	89%	11%	1%
Brock	49%	74%	0%	0%	12%	15%	56%	69%	0%	3%	10%	17%
Uxbridge	68%	77%	0%	0%	23%	0%	67%	71%	2%	10%	17%	3%
Scugog	64%	90%	0%	3%	1%	6%	66%	86%	4%	8%	0%	6%
Pickering	77%	91%	0%	7%	2%	0%	58%	72%	3%	21%	5%	2%
Ajax	58%	95%	0%	5%	0%	0%	60%	83%	2%	14%	2%	1%
Whitby	67%	99%	0%	1%	0%	0%	60%	90%	2%	6%	3%	1%
Oshawa	86%	98%	0%	1%	1%	0%	76%	93%	1%	3%	2%	2%
Clarington	48%	98%	0%	2%	0%	0%	54%	89%	1%	5%	2%	3%
Georgina	66%	94%	1%	3%	2%	1%	60%	87%	0%	4%	5%	4%
East Gwillimbury	11%	93%	1%	5%	0%	2%	31%	82%	4%	9%	4%	5%
Newmarket	91%	97%	1%	1%	0%	1%	73%	88%	2%	7%	1%	4%
Aurora	54%	95%	2%	4%	0%	1%	56%	86%	3%	10%	2%	2%
Richmond Hill	70%	92%	0%	8%	0%	0%	53%	79%	3%	19%	2%	1%
Whit.-Stouff.	45%	96%	0%	2%	2%	0%	45%	81%	3%	11%	6%	1%
Markham	67%	79%	2%	20%	1%	1%	56%	67%	4%	29%	2%	1%
King	35%	79%	3%	7%	3%	11%	31%	58%	5%	26%	7%	9%
Vaughan	61%	73%	1%	25%	2%	0%	49%	61%	4%	35%	3%	1%
Caledon	53%	80%	0%	3%	8%	10%	44%	68%	2%	13%	8%	10%
Brampton	92%	97%	0%	2%	0%	0%	76%	87%	2%	8%	3%	1%
Mississauga	87%	89%	1%	8%	3%	0%	73%	76%	4%	18%	5%	1%
Halton Hills	92%	92%	0%	1%	6%	1%	67%	75%	1%	4%	17%	4%
Milton	68%	81%	0%	2%	16%	1%	68%	80%	1%	5%	10%	5%
Oakville	80%	85%	1%	3%	12%	0%	77%	82%	2%	6%	9%	2%
Burlington	92%	95%	0%	0%	4%	0%	72%	80%	1%	3%	15%	2%
Flamborough	29%	54%	0%	0%	32%	14%	37%	68%	0%	0%	21%	11%
Dundas	43%	89%	0%	0%	11%	0%	38%	88%	0%	0%	9%	3%
Ancaster	50%	97%	0%	0%	1%	2%	40%	89%	0%	1%	5%	5%
Glanbrook	6%	96%	0%	0%	4%	0%	22%	87%	0%	5%	4%	5%
Stoney Creek	36%	93%	0%	0%	3%	4%	45%	88%	0%	1%	7%	4%
Hamilton	89%	95%	1%	1%	4%	1%	81%	90%	0%	1%	5%	3%
Total	74%	92%	4%	43%	5%	1%	62%	85%	8%	45%	7%	2%

There is less regional self-containment of home-based other trips with 62% of destinations within the same municipality and 85% within the same region. The most significant cross-boundary movements are again from Vaughan to Toronto (35% of the Vaughan total) and Markham to Toronto (29% of the Markham total).

Non home-based trips, as one would expect, are more dispersed than are home-based trips. Table 4.6(b) shows the distribution of destinations by both municipality of residence and trip origin. By trip origin, 53%

are self-contained within the same municipality and 79% within the same region. Downtown Toronto is more significant as a destination for non home-based trips than it is for home-based trips, accounting for 10% of the total from all areas. Vaughan and Markham again show the highest proportion of cross-boundary trips into Toronto at 40% and 37% respectively.

Table 4.6(b) – Non Home-based Trip Destinations

	By Place of Residence						By Trip Origin					
Residence/ Origin	Same Municipality	Same Region	Planning District 1	Toronto (Incl. PD 1)	Other Regions	External	Same Municipality	Same Region	Planning District 1	Toronto (Incl. PD 1)	Other Regions	External
PD 1	52%	90%	52%	90%	8%	1%	45%	87%	45%	87%	12%	1%
PD2-6	46%	89%	23%	89%	10%	1%	49%	89%	17%	89%	10%	0%
PD7-9	52%	82%	10%	82%	17%	1%	50%	73%	6%	73%	25%	1%
PD10-12	40%	81%	9%	81%	18%	1%	35%	76%	8%	76%	23%	1%
PD13-16	54%	87%	9%	87%	13%	1%	59%	84%	5%	84%	16%	1%
Brock	33%	57%	1%	11%	17%	15%	63%	73%	0%	4%	11%	12%
Uxbridge	37%	48%	2%	19%	29%	4%	52%	71%	1%	11%	17%	1%
Scugog	41%	85%	1%	9%	3%	2%	57%	90%	2%	3%	1%	5%
Pickering	39%	53%	6%	37%	10%	1%	52%	77%	3%	17%	6%	0%
Ajax	39%	62%	6%	30%	7%	1%	47%	82%	4%	13%	4%	1%
Whitby	45%	73%	3%	18%	8%	1%	50%	90%	1%	6%	3%	2%
Oshawa	64%	88%	1%	8%	2%	1%	66%	93%	1%	3%	1%	2%
Clarington	33%	85%	2%	9%	3%	3%	49%	89%	1%	5%	1%	6%
Georgina	40%	79%	2%	10%	9%	2%	73%	91%	1%	5%	2%	1%
East Gwillimbury	8%	73%	3%	17%	6%	5%	20%	73%	7%	18%	0%	9%
Newmarket	54%	77%	2%	16%	5%	2%	63%	83%	2%	7%	4%	7%
Aurora	36%	71%	3%	20%	7%	2%	46%	85%	1%	9%	3%	3%
Richmond Hill	41%	66%	6%	30%	3%	1%	41%	69%	3%	25%	5%	1%
Whit.-Stouff.	30%	65%	4%	29%	4%	2%	41%	70%	2%	14%	15%	1%
Markham	44%	55%	7%	41%	3%	1%	42%	58%	4%	37%	5%	1%
King	16%	55%	4%	21%	11%	13%	22%	67%	2%	11%	10%	13%
Vaughan	36%	48%	5%	44%	7%	1%	35%	49%	3%	40%	9%	2%
Caledon	24%	55%	5%	26%	13%	6%	40%	65%	4%	14%	13%	7%
Brampton	57%	73%	3%	19%	7%	2%	63%	78%	2%	13%	7%	2%
Mississauga	60%	64%	6%	27%	8%	1%	59%	66%	5%	23%	9%	2%
Halton Hills	47%	57%	5%	15%	24%	4%	63%	69%	1%	5%	17%	10%
Milton	52%	64%	7%	14%	13%	8%	58%	73%	2%	9%	11%	6%
Oakville	57%	64%	5%	14%	21%	2%	62%	72%	2%	6%	19%	3%
Burlington	65%	75%	1%	4%	17%	3%	68%	76%	1%	3%	18%	3%
Flamborough	19%	52%	2%	5%	24%	20%	35%	68%	0%	1%	25%	7%
Dundas	30%	76%	2%	3%	17%	4%	46%	90%	1%	3%	5%	2%
Ancaster	27%	82%	1%	6%	8%	4%	33%	86%	0%	2%	8%	4%
Glanbrook	12%	86%	2%	3%	1%	10%	22%	78%	1%	5%	5%	12%
Stoney Creek	26%	80%	1%	2%	13%	4%	33%	84%	1%	1%	8%	7%
Hamilton	76%	86%	1%	3%	8%	3%	77%	89%	1%	1%	6%	3%
Total	50%	77%	10%	49%	11%	2%	53%	79%	10%	48%	12%	2%

Table 4.6(c) shows the 12 traffic zones (1996 GTA zone system) that have the most non home destinations for each of the three trip purposes. It shows the extent to which shopping trips are concentrated at the major shopping centres with the top 12 traffic zones accounting for almost 20% of all shopping trips. In comparison, the top 12 zones account for less than 7% of home-based other trips and 4.4% of non home-based trips. Ten of the 12 top traffic zones are the same for both home-based shopping and home-based other trips. Pearson Airport stands out as the number one destination for non home-based trips accounting for 50% more destinations than any other zone.

Table 4.6(c) – Most Common Destinations by Traffic Zone

Home-based Shopping

Rank	Zone	Location	Municipality	Trips	Cum. %
1	1579	Square One	Mississauga	14740	2.5%
2	2586	Limeridge Mall	Hamilton	12662	4.6%
3	425	Scarborough Town Centre	Toronto	12011	6.6%
4	295	Yorkdale	Toronto	11055	8.4%
5	654	Oshawa Centre	Oshawa	10038	10.1%
6	3	Sherway Gardens	Toronto	9492	11.6%
7	228	Eaton Centre	Toronto	9159	13.2%
8	1657	Bramalea City Centre	Brampton	8429	14.6%
9	535	Pickering Town Centre	Pickering	8260	15.9%
10	22	Hwy 27/Dundas	Toronto	8057	17.3%
11	338	Fairview Mall	Toronto	7965	18.6%
12	2063	Burlington Mall	Burlington	6265	19.7%

Home-based Other

Rank	Zone	Location	Municipality	Trips	Cum. %
1	228	Eaton Centre	Toronto	10659	0.8%
2	1579	Square One	Mississauga	9762	1.5%
3	295	Yorkdale	Toronto	9316	2.2%
4	425	Scarborough Town Centre	Toronto	8876	2.9%
5	22	Hwy 27/Dundas	Toronto	8501	3.5%
6	3	Sherway Gardens	Toronto	7154	4.0%
7	535	Pickering Town Centre	Pickering	7111	4.5%
8	324	Bayview Village	Toronto	6786	5.0%
9	2586	Limeridge Mall	Hamilton	6783	5.5%
10	338	Fairview Mall	Toronto	6717	6.0%
11	1657	Bramalea City Centre	Brampton	5796	6.5%
12	1609	Pearson Airport	Mississauga	5553	6.9%

Non Home-based

Rank	Zone	Location	Municipality	Trips	Cum. %
1	1609	Pearson Airport	Mississauga	10162	0.6%
2	1579	Square One	Mississauga	6705	1.1%
3	324	Bayview Village	Toronto	5941	1.4%
4	220	Toronto General/Sick Kids	Toronto	5614	1.8%
5	573	Industrial/Residential	Ajax	5499	2.1%
6	303	Sunnybrook Hospital	Toronto	5486	2.5%
7	4000	External	External	5473	2.8%
8	656	Downtown Oshawa	Oshawa	5328	3.1%
9	215	Mt. Sinai/Q.E. Hospitals	Toronto	5239	3.5%
10	22	Hwy 27/Dundas	Toronto	5195	3.8%
11	535	Pickering Town Centre	Pickering	5024	4.1%
12	307	Yonge/Sheppard	Toronto	4976	4.4%

4.7 Age and Gender

Figure 4.7(a) shows the total daily discretionary trip rate by age and gender of the trip maker. The combined trip rate, for men and women, remains relatively constant at about two trips per day between the ages of 35 and 70. Women make more trips than men below the age of 50 but the reverse is true above age 50.

Figure 4.7(a) – Daily Trip Rates by Gender and Age

Figure 4.7(b) shows the daily trip rates with a further break down by trip purpose. It shows that women make significantly more shopping trips than men do up to age 65 and that there is a noticeable increase in the rate for both genders between ages 60 and 65. The greatest number of non home-based trips are made by people in the 30 to 50 age range. The home-based other trip rates are higher than for either of the other two trip purposes for all age ranges. The rate for women reaches a peak around age 40 at which point it is significantly higher than for men. The rate for men does not peak until after age 60 at which point men are making more trips than women

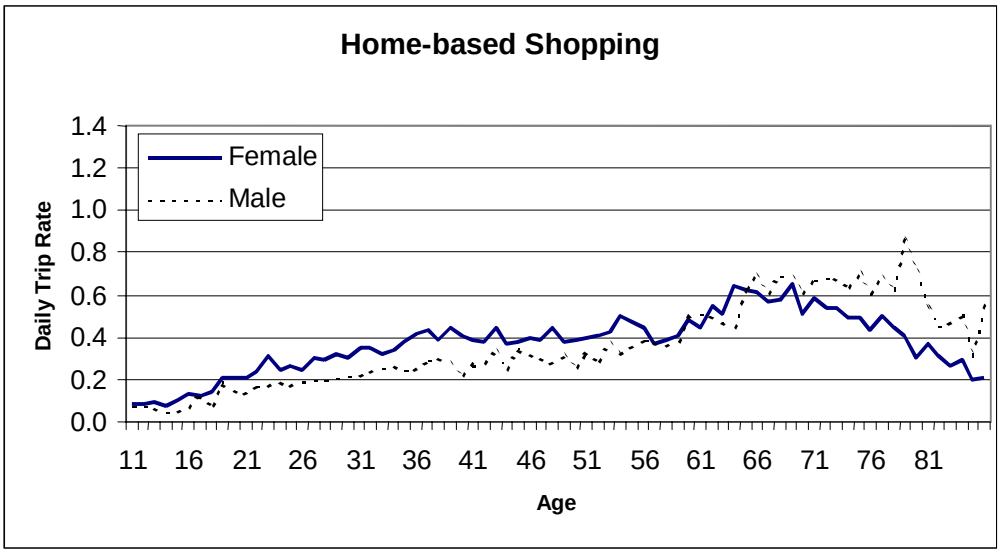
4.8 Employment Status

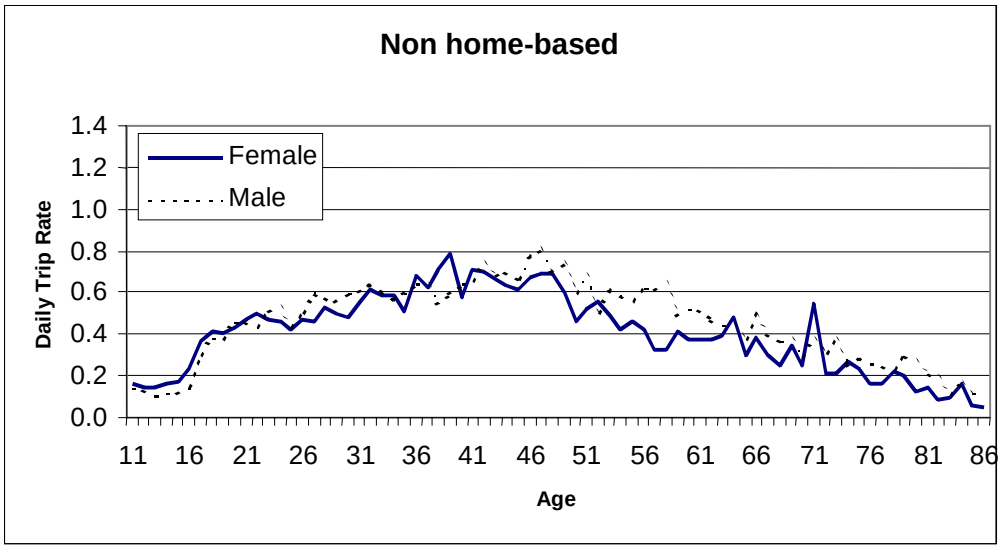
Figures 4.8(a), (b) and (c) give the mean daily trip rates for each of the three trip purposes by age category and employment status. Shopping trips are mostly made by people who are not employed with the average rate for all age groups being almost double that for people who are employed full time. People who work at home, either full time or part time, have the highest trip rate for both non home-based and home-based other trip purposes. People who are not employed make the fewest non home-based trips as would be expected given the high proportion (50%) of non home-based trips that are related to place of employment (Table 4.1). Those employed full time outside the home make the fewest home-based other trips.

4.9 Driver's License Status

Figure 4.9 shows that both men and women who are licensed to drive make two to three times as many discretionary trips as do people of the same gender and age group who are not licensed to drive.

Figure 4.7(b) – Daily trip Rates by Age, Gender and Trip Purpose





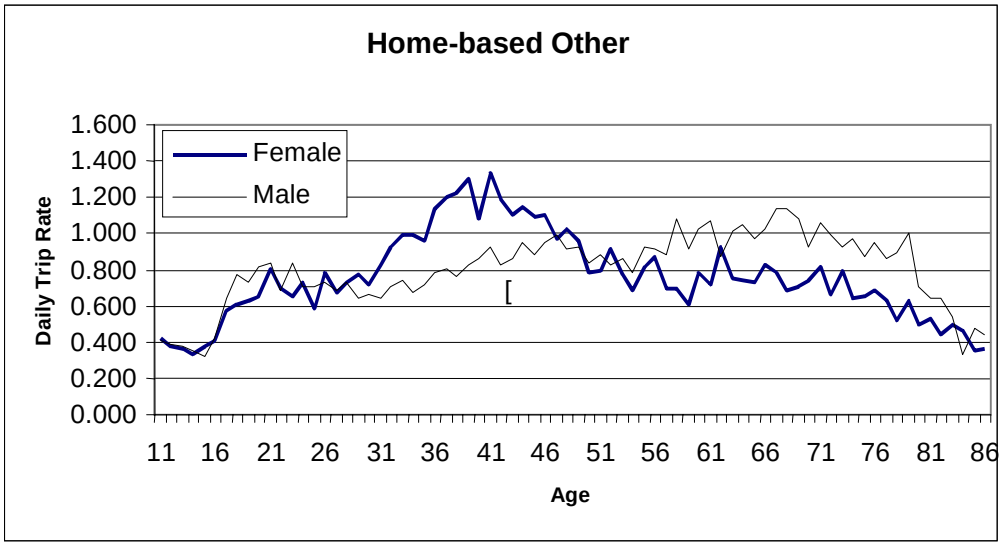
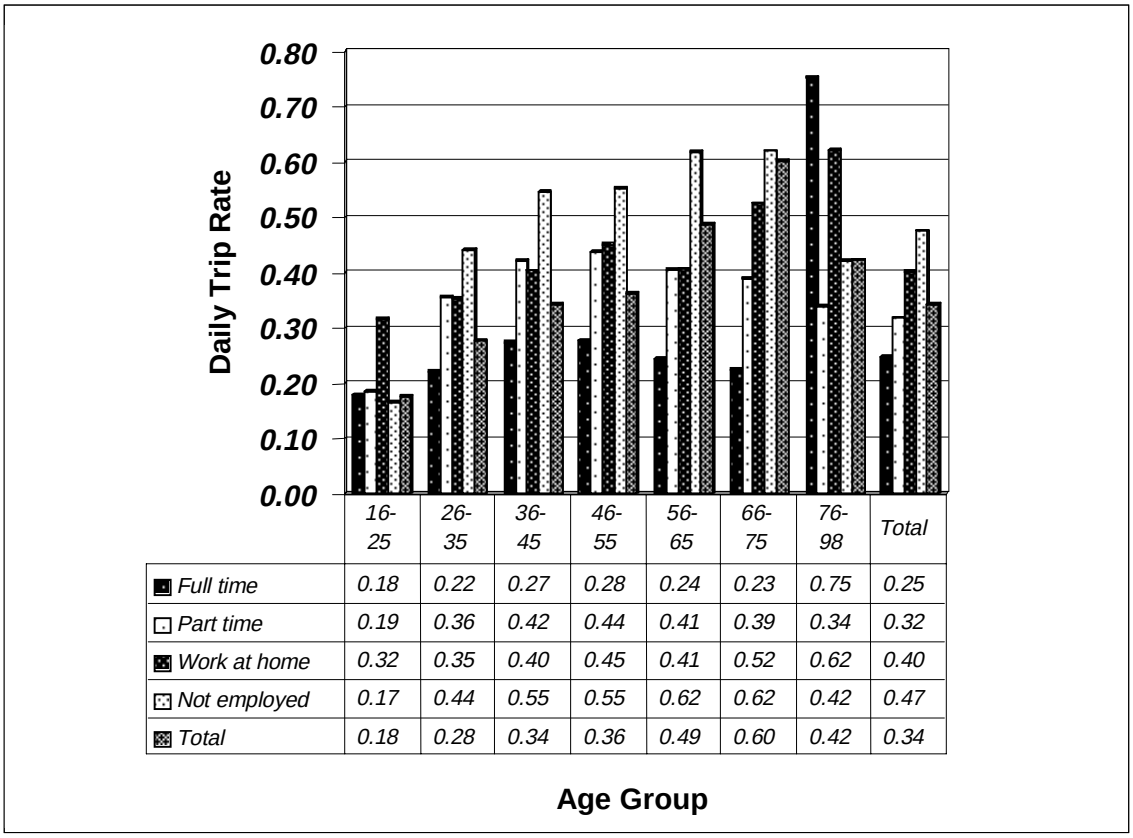
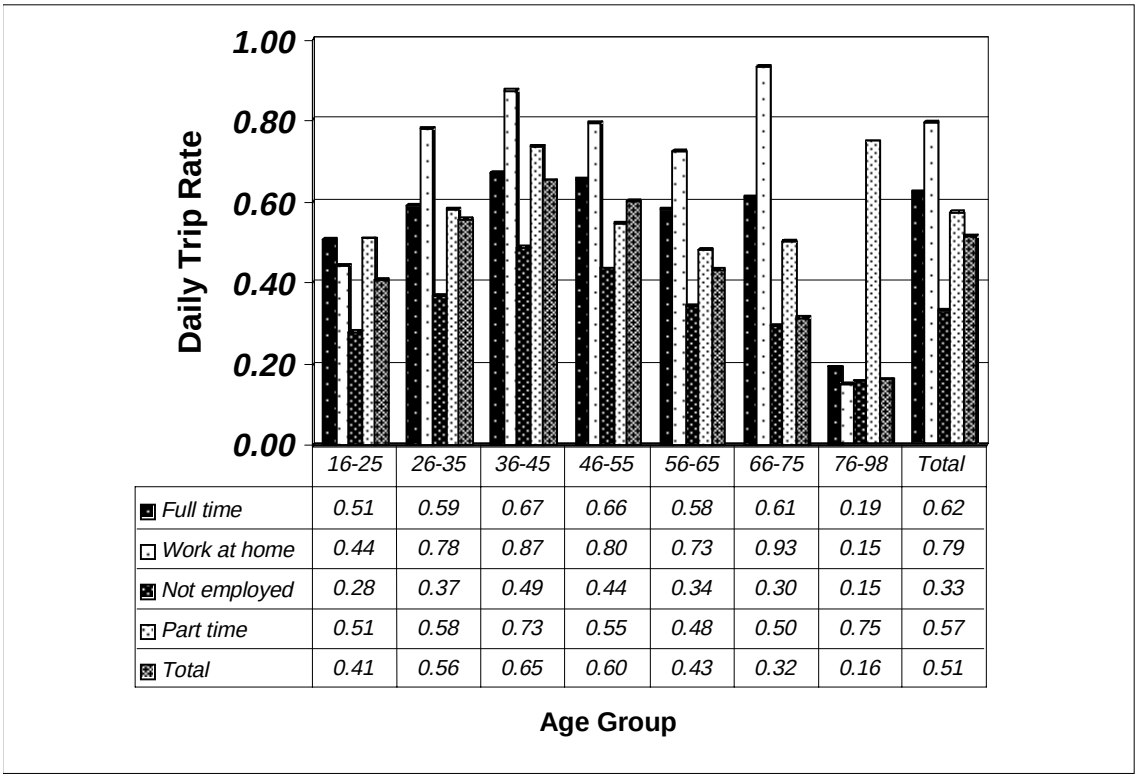


Figure 4.8(a) – Home-based Shopping Trip Rates by Employment Status



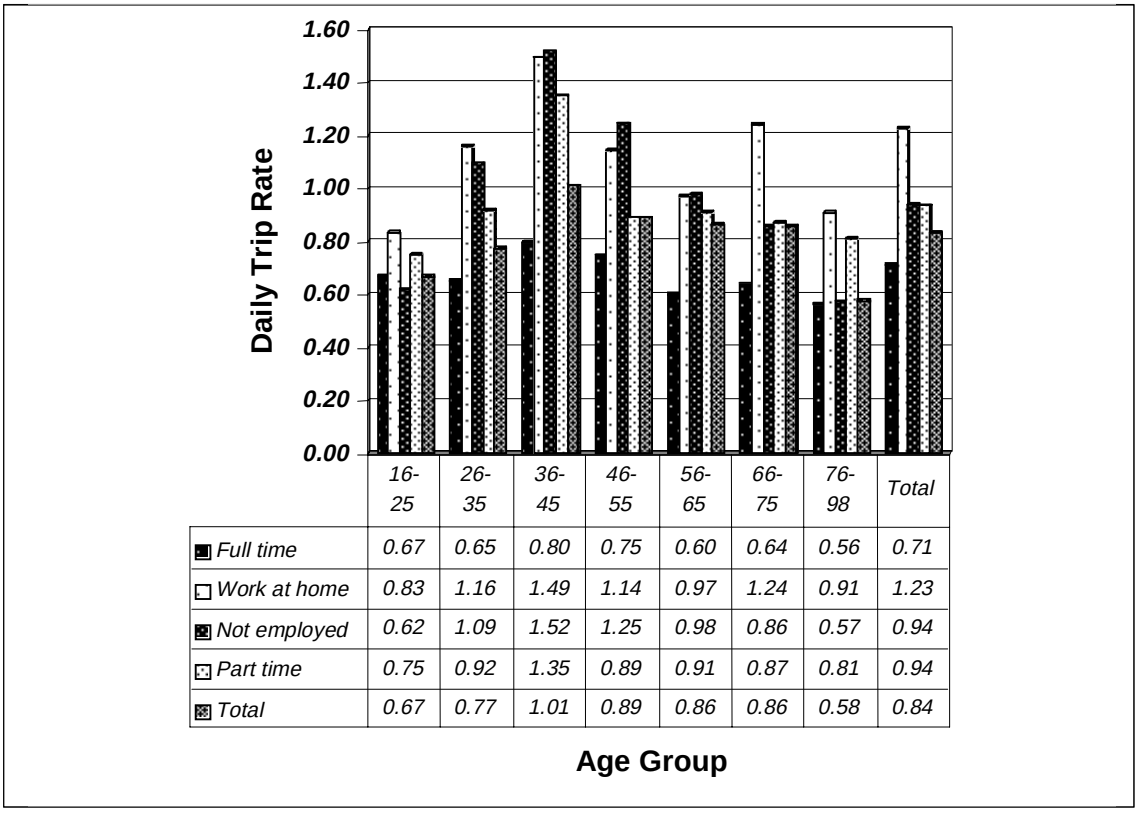
	16-25	26-35	36-45	46-55	56-65	66-75	76-98	Total
Full time	0.18	0.22	0.27	0.28	0.24	0.23	0.75	0.25
Part time	0.19	0.36	0.42	0.44	0.41	0.39	0.34	0.32
Work at home	0.32	0.35	0.40	0.45	0.41	0.52	0.62	0.40
Not employed	0.17	0.44	0.55	0.55	0.62	0.62	0.42	0.47
Total	0.18	0.28	0.34	0.36	0.49	0.60	0.42	0.34

Figure 4.8(b) – Non Home-based Trip Rates by Employment Status



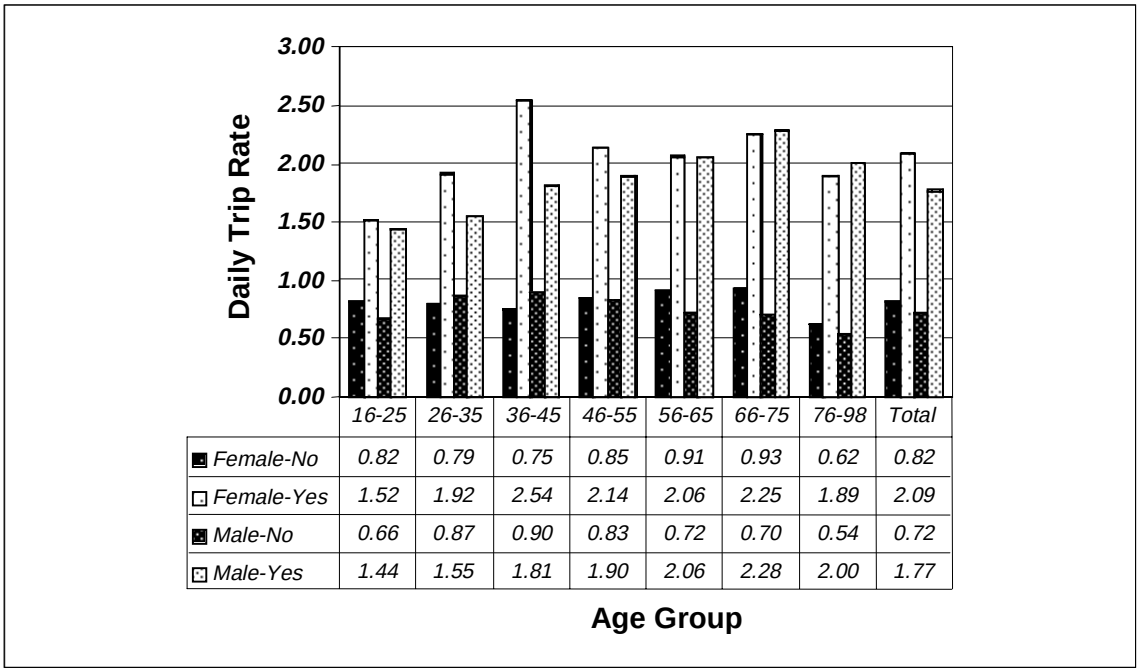
	16-25	26-35	36-45	46-55	56-65	66-75	76-98	Total
Full time	0.51	0.59	0.67	0.66	0.58	0.61	0.19	0.62
Work at home	0.44	0.78	0.87	0.80	0.73	0.93	0.15	0.79
Not employed	0.28	0.37	0.49	0.44	0.34	0.30	0.15	0.33
Part time	0.51	0.58	0.73	0.55	0.48	0.50	0.75	0.57
Total	0.41	0.56	0.65	0.60	0.43	0.32	0.16	0.51

Figure 4.8(c) – Home-based Other Trip Rates by Employment Status



	16-25	26-35	36-45	46-55	56-65	66-75	76-98	Total
Full time	0.67	0.65	0.80	0.75	0.60	0.64	0.56	0.71
Work at home	0.83	1.16	1.49	1.14	0.97	1.24	0.91	1.23
Not employed	0.62	1.09	1.52	1.25	0.98	0.86	0.57	0.94
Part time	0.75	0.92	1.35	0.89	0.91	0.87	0.81	0.94
Total	0.67	0.77	1.01	0.89	0.86	0.86	0.58	0.84

Figure 4.9 – Discretionary Trip Rate by Gender & License Status

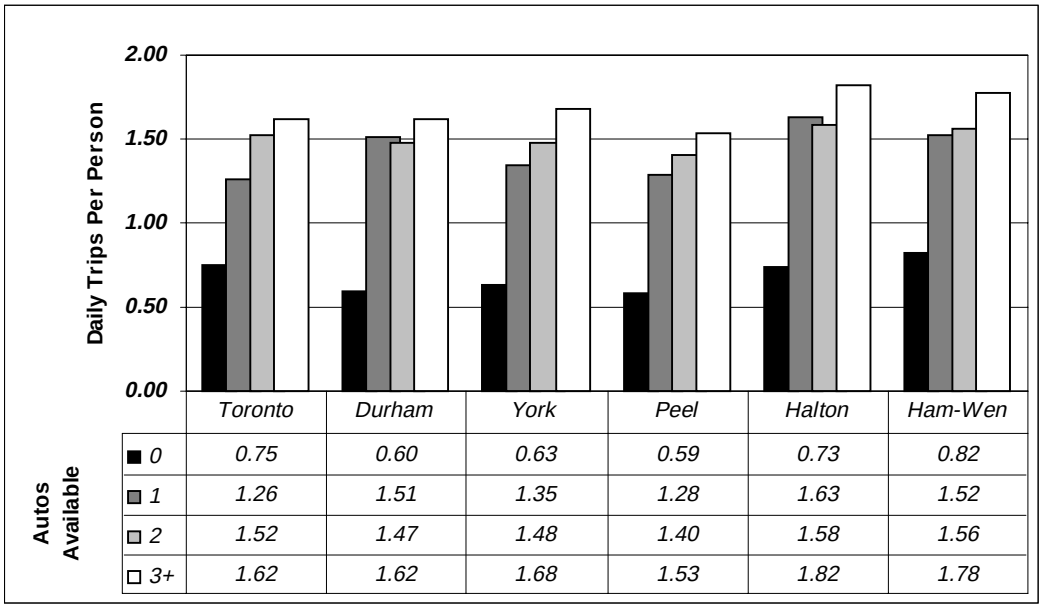


	16-25	26-35	36-45	46-55	56-65	66-75	76-98	Total
Female-No	0.82	0.79	0.75	0.85	0.91	0.93	0.62	0.82
Female-Yes	1.52	1.92	2.54	2.14	2.06	2.25	1.89	2.09
Male-No	0.66	0.87	0.90	0.83	0.72	0.70	0.54	0.72
Male-Yes	1.44	1.55	1.81	1.90	2.06	2.28	2.00	1.77

4.10 Auto Availability

Figure 4.10 shows that, on average, persons living in households with one or more autos available report making two to three times as many discretionary trips as do people living in households with no vehicles available. The number of automobiles available does affect the trip rate but not nearly to the extent that the first automobile does.

Figure 4.10 – Discretionary Trip Rate By Region & Auto Availability



Autos Available	Toronto	Durham	York	Peel	Halton	Ham-Wen
0	0.75	0.60	0.63	0.59	0.73	0.82
1	1.26	1.51	1.35	1.28	1.63	1.52
2	1.52	1.47	1.48	1.40	1.58	1.56
3+	1.62	1.62	1.68	1.53	1.82	1.78

4.11 Summary

Peak period travel consists primarily of home-based work and school trips but discretionary trips account for more than half of total daily travel by automobile. School trips are mostly made by people under the age of 25 and work trip rates diminish rapidly after age 55. In contrast the frequency of discretionary travel remains relatively constant from mid thirties into old age with little evidence of any significant reduction in trip making frequency until age 75 or 80. The significance of discretionary travel is therefore certain to increase as baby boomers approach retirement age. Between 1986 and 1996 the median age of the population in the GTA increased by 2.6 years and the number of people over age 65 increased by 50% (1996 TTS Report 5).

Outside of Toronto and Hamilton, local transit does not currently play a significant role in serving discretionary travel. Local transit mode splits are in the 0 to 3% range. Even in Toronto and Hamilton the transit mode splits are one half, or less, what they are for work trips. The possession of a driver's license and auto availability are clearly the two factors that most determine the frequency of discretionary travel.

The following paragraphs provide a point by point summary of the travel characteristics of each of the three discretionary trip purposes.

Home-based Shopping

- 13% of total daily auto driver trips but only 5% of total auto travel distance.
- Highest transit use of the three discretionary trip purposes (16% transit mode split in Toronto, 3% in the rest of the GTA and 7% in Hamilton-Wentworth).
- Trips are short (median trip length 2.7 km).

- High proportion of auto passengers, particularly for longer trips (mean auto occupancy estimated at 1.8 persons).
- Trips are generally made between 9 a.m. and 7 p.m. with no significant peak period.
- Highest trip rates are for persons over age 35 who are not employed.
- Significant concentrations of the non home end in the zones containing major shopping centres.
- Not a significant factor in over all network congestion.
- May be a source of local problems with respect to parking and ease of access onto the road network.

Non Home-based

- 21% of total daily auto travel
- Least likely of all trip purposes to use local transit (13% transit mode split in Toronto, 2% in the rest of the GTA and 3% in Hamilton-Wentworth).
- Highest auto driver mode share (81%) of any trip purpose.
- Trips are mostly made between 10 a.m. and 6 p.m.
- Highest trip rates are for persons employed outside the home.
- Secondary peak, prior to 9 a.m., results from detours to serve auto passengers on the way to work.
- 50% of trips have one, or both, ends at a work location.

Home-based Other

- 33% of total daily auto driver trips and 27% of total auto travel distance.
- Mode split characteristics fall midway between home-based shopping and non home-based trips.
- Majority of trips are made after 2 p.m. with the peak, for both auto drivers and passengers, occurring at around 7 p.m.
- A secondary peak, for auto drivers only, occurs before 9 a.m. consisting almost entirely of trips made to serve-passengers travelling to work and/or school.
- People who work at home have the highest daily trip rate, those working full time outside the home the lowest.

5.0 Modeling Issues

In recent years modeling efforts in the GTA, including both the full and simplified GTA models, have focused mainly on the a.m. peak period. Reasons for that include ease of simulation and the fact that the number of trips reported in the 1986 TTS was higher in the a.m. peak than in the p.m. peak, significantly so for public transit. Most travel in the a.m. peak consists of trips from home to work or school made on a regular daily basis. Future trip generation and attraction totals can be projected, with reasonable confidence, from estimates of population, employment and school enrolment. Travel behaviour relationships in the p.m. peak period, and in the off-peak, are more complex.

Figure 5.0(a) shows the reported start time distribution of auto trips in the 1996 TTS after adjustment for under reporting of non respondent trips. Figure 5.0(b) shows the resulting start time distribution of travel distances measured in a straight line from origin to destination. Both Figures show the p.m. peak 1 hour for auto drivers to be 5% to 10% higher than the a.m. peak 1 hour. The p.m. peak also extends over a much longer period of time. Cordon and other on-street count information generally show larger differences (10% to 15%) in the a.m. and p.m. peak period volumes. The TTS may also under state the difference between a.m. and p.m. peaks for reasons which are discussed in the following sections.

Figure 5.0(a) – Auto Driver & Passenger Trip Start Time Distribution

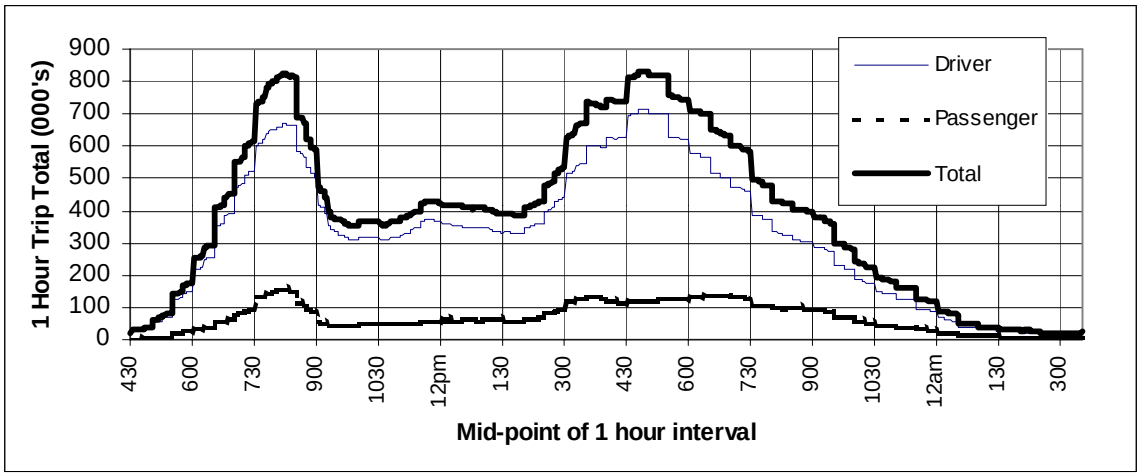
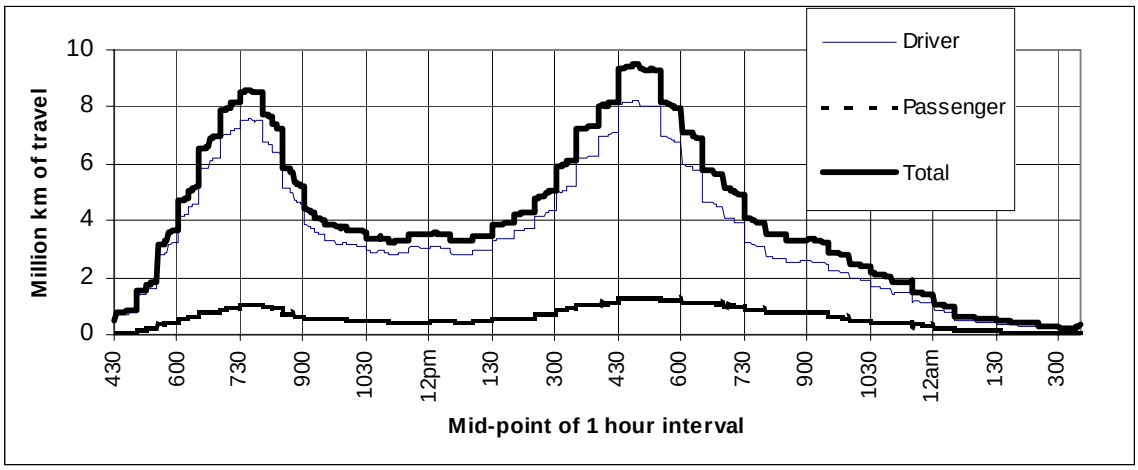


Figure 5.0(b) – Auto Travel Start Time Distribution



Since the highest demands on the road network occur in the p.m. peak period it is necessary to have p.m. peak period simulation models to determine the peak demand. It is also necessary to simulate total daily and annual traffic for the economic justification of new facilities, the calculation of total consumption of non renewable fossil fuels and the analysis of air quality. The analysis in Chapter 4 showed that the majority of total daily automobile travel is not directly related to work or school and that the proportion of off-peak non work and non school travel is likely to increase in the future.

In addressing the need to simulate total daily travel one needs to be clear as to the limitations of the TTS data. Section 5.1 discusses some of these limitations. The remainder of this chapter is devoted to identification of specific modeling issues. While some potential solutions are suggested the actual testing of these ideas, and the associated model development, are beyond the scope of this project and report.

5.1 TTS Data Limitations

The TTS is a survey of the typical weekday travel patterns of private households. As a general rule it does not provide information concerning:

- Weekend and vacation travel.
- Commercial travel (goods movement, couriers, salesmen, taxi drivers, emergency vehicles, etc.)
- Travel by visitors staying in hotels.
- External and through travel from households outside the survey area.

Other sources of information must be used in order to estimate the amount of travel associated with each of these components of total daily and annual travel.

The TTS is also of limited value in addressing the transportation implications of special generators and associated events (e.g.: the CNE, sports events, concerts, etc.). The TTS may be able to provide information on background traffic levels but the trips actually associated with the facility or event must be estimated using other information.

The traffic zone containing Pearson International Airport according to the TTS is the most frequent destination for non home-based trips and is the 12th most frequent destination zone for home-based other trips. However, the expanded total of 16,000 non work trips represents only a fraction of the daily movement through the airport of passengers, greeters and well-wishers.

While the TTS does contain a substantial amount of information on shopping trips, the peak demand at most shopping centres occurs on weekends and is seasonal in nature. These peaks are not adequately reflected in the TTS data. The TTS may provide useful information on background travel levels to be used in the planning of new plazas and as an indication of the average week day loading that shopping trips place on the road network. The analysis in Chapter 4 shows that shopping trips account for a relatively small proportion (5%) of total daily auto travel and an even smaller proportion of peak period travel.

5.2 Other Home-based Trips

Other home-based trips, including shopping, account for 44% of total daily vehicular trips (excluding walk, cycle and school bus). Population based trip production rates can be used to predict trip productions at the home end with a reasonable degree of confidence. This approach is taken in both the full and simplified GTA models. The problem is in selecting appropriate zonal factor, or factors, on which to base forecasts of trip attractions. Retail floor area can be used as a predictor for shopping trip attractions but the previous analysis shows that shopping trips only account for 5% of total daily automobile use and 6% of local transit use. Given the significance of shopping, relative to the other trip purposes, and the discussion at the end of the previous section, the development of a separate trip generation model for shopping trips may not be justified.

In the development of the full GTA model it was concluded that zonal population was the best predictor of non work and non school a.m. peak period trip attractions. Employment and a combination of population and employment were also tested. Planning district (municipal) based average trip attraction rates are

applied at the traffic zone level to obtain spatial variability. Trip distribution is performed using the "Fratar" technique.

In the simplified GTA model, the existing distribution of trips is factored to match the change in population at the home end. The same approach as is used to forecast home-based school trips in both the full and simplified GTA models.

In the absence of a proven alternative either of the above approaches can be adapted for application to the p.m. peak or on a total daily basis. Both models use a seeding procedure to eliminate zeros from the observed TTS data thus enabling the factoring procedures to be applied in areas that do not currently have any population.

5.3 Non Home-based Trips

Figures 4.1(a) and (c) show that non home-based trips account for 21% of daily automobile travel and 10% of daily transit trips. Table 5.3(a) gives a further breakdown of the total non home-based trips by all modes.

Table 5.3(a) – Non Home-based Trip Categories

	Daily Trips	
1st trip to work or last trip from work	619,753	32%
Other trips to/from work	401,220	21%
Non work related trips	927,037	48%
Total NHB	1,948,011	
2nd & subsequent home-based work trips	102,202	
Total incl. second HBW trips	2,050,213	

Many of the first trips to work and last trips from work are likely the result of combining a trip to or from work with other trip purposes forming a series of linked trips that start at home and finish at work or vice versa. The way work trips are usually modeled is to assume that all trip productions occur at the home location and trip attractions at the work end in effect substituting a single home to work trip for a series of linked trips. Table 5.3(b) shows the effect this substitution has on total vehicle-km of auto travel.

Table 5.3(b) – Total Daily First/Last Trips To/From Work

	Matrix Definition		Selection Criteria		Trips		Km of travel *	
	From	To	Origin Purpose	Dest. Purpose			Total	Mean
(1)	Origin	Destination	Home	1st Work	1,540,473		26,968,496	17.5
(2)	Origin	Destination	Not home	1st Work	203,592		2,642,550	13.0
	Estimated total daily travel to work				(1)+(2)		**29,611,046**	
(3)	Home	Destination	All	1st Work	1,745,203	(a)	30,173,914	17.3
(4)	Home	Usual Work	All	1st Work	1,687,317	(b)	27,006,676	16.0
	Simulated total daily travel to work				(4)*(a)/(b)		**27,933,181**	
(5)	Home	Origin	Not home	1st Work	203,967		1,914,285	9.4
(6)	Origin	Destination	Last work	Home	1,429,390		24,975,800	17.5
(7)	Origin	Destination	Last work	Not home	336,292		4,371,060	13.0
	Estimated total daily travel from work				(7)+(8)		**29,346,860**	
(8)	Origin	Home	Last work	All	1,767,067	(d)	30,272,866	17.1
(9)	Usual work	Home	Last work	All	1,708,669	(e)	27,216,190	15.9
	Simulated total daily travel from work				(9)*(d)/(e)		**28,146,371**	
(10)	Destination	Home	Last work	Not home	336,974		3,743,595	11.1

* Minimum distance paths on the 1996 emme/2 road network

Daily travel to work is broken down into two components; those trips that start at home (1), and those that start at other locations (2). It is assumed, in the simulation, that travel to work will occur only between the home location and the usual place of work. The total number of trips in the home to usual place of work matrix (3) has been adjusted by applying a global factor to match the total observed first work trip destinations matrix (4). The difference occurs because not all people have a usual place of work. It is assumed that the work trip production and attraction rates used in a simulation model will be based on all first trips to work, not just those to the usual place of work. The resulting total travel distance is 1.7 million km (6%) lower than the observed total. The difference, however, is due primarily to the substitution of the usual place of work for actual work destination, which increases mean home to work trip length by 8%. Substituting home for non home locations reduces the net change in mean trip length by only 1%.

The trips and travel totals do not include the other home-based component of linked trips to work since they would normally be included in the other home-based component of the model. No attempt has been made to identify home to work trip "chains" in the TTS database. The home to origin link for non home to work trips (5) is included in the table as an approximation to show the relative significance of that component of total daily travel.

Rows 6 through 10 provide a similar comparison for last trips from work. The discrepancy between estimated and simulated travel daily distances is 1.2 million km (4%). Approximately 20% of the last trip from work are non home-based compared to 12% of the first trips to work.

Table 5.3(b) includes trips in the GTA and Hamilton-Wentworth made by non residents of that area, hence the minor variations in trip totals and possible differences from other tables in this report.

The second sub-component of non home-based travel shown in Table 5.3(a) is trips to and from work other than the first trip of the day to work and the last trip of the day from work. This sub-component includes trips made at lunch time and business travel between work locations. The average trip length is short with a median straight line distance of 7 km. In total this sub-component therefore accounts for about 3% of total daily auto travel. The trips occur predominantly in the off peak period and can likely be ignored for most design purposes. A global adjustment factor can be applied, if required, for other purposes such as fuel consumption and air quality standards.

The third sub-component of non home-based travel consists of trips that do not relate to work at either end. This is the most difficult component of daily travel to simulate because of the absence of an obvious trip generation predictor for either end of the trip. The approach taken in the existing simplified and full GTA models is to include these trips with home-based other trips using population as the predictor (both ends in the full model, origins only in the simplified model). In the short term it is recommended that the same approach be adopted for p.m. peak and all day modeling but that the testing of alternative approaches, such as continuum modeling, be a high priority for further research. This sub-component accounts for about 10% of total daily auto travel (48% of 21%).

The number of subsequent home to work trips and previous to last work to home trips is included in Table 5.3(a) because, although home-based, they are not usually included in home-based work trip rates. These trips differ significantly in characteristics from first trips to work/last trips from work both in the time of day they occur and trip length. The median trip length is 5 km. The amount of automobile travel involved is less than 0.5% of the daily total. It does not really matter whether these trips are included in home-based work, home-based other, non home-based or ignored provided that the trip generation and distribution components of the model are consistent.

5.4 Over Simulation of Peak Period

There is evidence that the use of TTS data, together with existing network simulation techniques, can lead to over representation of the peak period and peak hour traffic volumes with a corresponding under representation of off-peak travel. The existence of the problem may have been masked in the past by the under representation of non work trips. The problem can be attributed in part to the trip assignment technique currently used in EMME/2 and most other traffic simulation software packages. An underlying assumption is that the network is in a steady state condition over an extended period of time sufficient for

the rates of flow represented by the trip matrices to extend throughout the network. In real life steady state conditions never exist. Trips take different amounts of time to reach different parts of the network. Queuing situations are developing and dissipating all the time. Traffic volumes will be over represented if the amount of traffic still in transit in the system is greater at the end of the simulation period, than at the beginning, as is the case in the a.m. peak period model.

The scope for distortion depends on trip lengths. The median trip length, about 5 km for auto drivers, is not a good reference because it is long trips that produce most of the load on the network. Approximately 50% of total traffic volume are created by the 14% of trips that are over 21 km in length (straight line distance). Cordon and other on-street counts reflect the composition of the traffic flow, not the universe of trips. For example a select link assignment of TTS data to the EMME/2 road network produced a median trip length of 24.2 km (minimum distance path on the network) for auto driver trips crossing the Toronto boundary compared with a median of 5.4 km for all auto driver trips. This is one reason why many simulation models tend to over simulate volumes on freeways relative to other roads. The problem is most noticeable in the a.m. peak, covering the transition from lightly loaded conditions at 6 a.m. through the period of peak traffic generation, the congestion effects of which are not fully dissipated until well after the peak period of trip generation is over. An advantage of simulating the p.m. peak period is to reduce the transitional effects. The p.m. peak extends over a longer period of time and represents less of a contrast relative to traffic volumes before and after the peak.

The ideal solution to the problem would be to use a real time simulation in which each vehicle is moved through the system in small increments of time with facility to represent queue delays at points of congestion. EMME/2 does not currently have this capability nor is it practical since individual departure times would have to be predicted for every trip. The practical alternative is to apply adjustment factors to either the trip table or the assigned link volumes. The choice of appropriate adjustment factors is complicated due to the fact that every link in the network is unique with respect to its relationship to specific origins and destinations and the time it takes to reach that particular link. It is suggested that the adjustment be incorporated into the peak hour factor as discussed in the next section.

5.5 Peak Hour Factor

Both the full and the simplified GTA models use a 3-hour peak period for mode split calculations and 1-hour road capacities for trip assignment. Reasons for basing the mode split calculation on the 3-hour volumes include the amount of data available and clear evidence that trip start time is related to mode of transport. Within the 3-hour period GO Rail has the most pronounced peak (80% of the 3-hour total occurs in the peak one hour) and road travel the lowest (40% of the 3-hour total occurring in the peak one hour).

The two models differ slightly in the conversion from 3-hour to 1-hour volumes. The full GTA model uses a global factor of .405 applied to the 3-hour trip matrix. The simplified model produces a 3-hour trip assignment with differential factors applied to the 1-hour link capacities to obtain a 3-hour “capacity”. The same factors (.35 for freeways, .4 for arterials and .5 for local streets) are applied to the link volumes after assignment if peak hour link volumes are required as an output.

A third alternative would be to apply O-D specific conversion factors to the trip matrix. Figure 5.5(a) shows the relationship between the peak hour and peak 3-hour periods based on trip start times for auto drivers as given in the TTS database. The peak periods have been taken as 6:00 to 8:59 a.m. and 3:30 to 6:29 p.m. The peak hours are 7:45 to 8:44 a.m. and 4:30 to 5:29 p.m. The peak hour factor for trips longer than 20 km is less than one third of the 3-hour total because the peak hour for longer trips starts at about 6:45 a.m. (Figure 5.5(b)). The factor for short trips is also slightly under stated at 60% because the peak hour for trips of less than 5 km does not start until 8 a.m. The p.m. peak hour is clearly far more consistent in that there is little variation with trip length in either the time at which the peak hour occurs or the factor relative to the peak 3-hour total. A global factor would appear to fit the p.m. peaking characteristics better than it does the a.m. peak. A factor in the .35 to .4 range is consistent with the observed ratio for short trips and allows for some disbursement of longer trips relative to the concentration of start times as discussed in Section 5.2. In the a.m., a factor of 0.3 or less applied to long trips or assigned volumes on freeways can be justified on the basis of the over representation discussed in Section 5.2.

Figure 5.5(a) – Peak Hour to Peak Period Auto Driver Trip Ratios

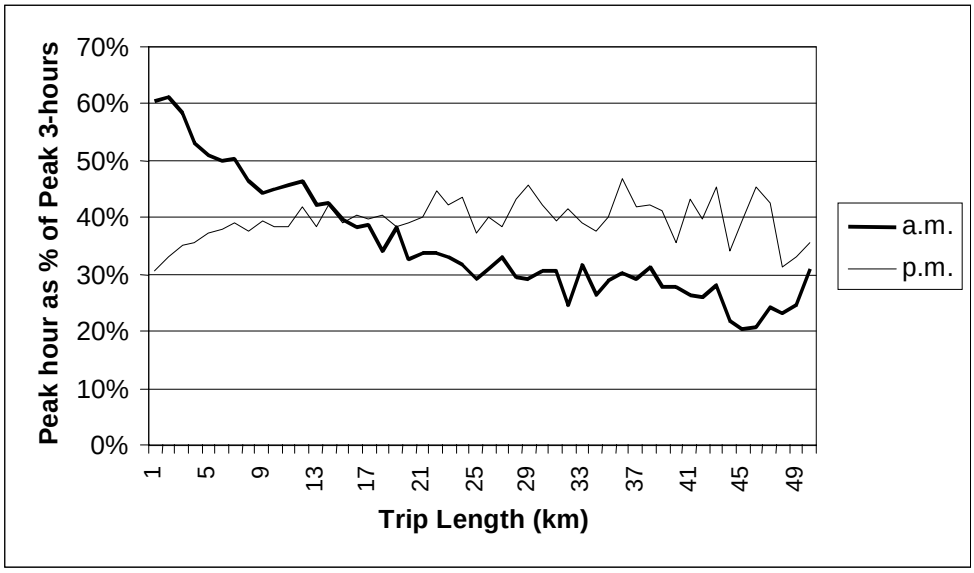
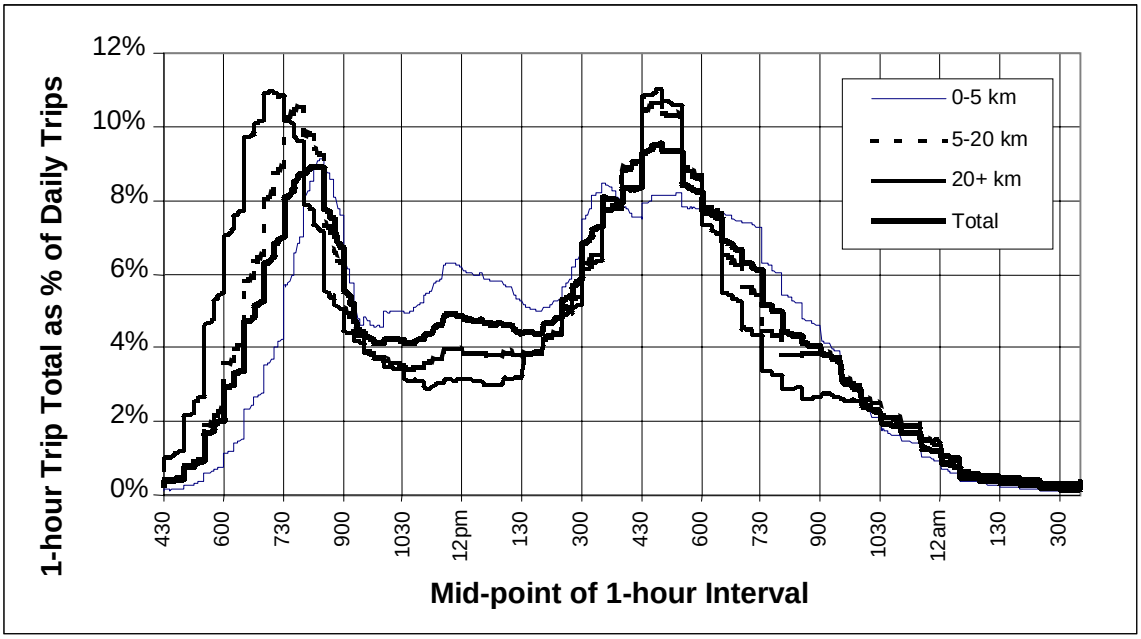


Figure 5.5(b) – Peak Hour to Daily Trip Ratios by Trip Length



5.6 P.M. Peak Simulation Models

Higher hourly traffic volumes and a longer peak period than in the a.m. dictate that forecasts of p.m. peak travel should be used for the planning of roads. In most areas the highest demand on public transit is in the a.m. because school trips tend to be made at the same time as work trips in the morning but are made earlier than work trips in the afternoon. In order to adapt the existing GTA model (both full and simplified) the following changes are recommended as first steps for development and testing.

- The peak period be defined as 3:30 to 6:29 p.m. for the extraction of TTS data
- It is essential that the reported TTS non work and non school trip rates be adjusted to correct for under reporting. The use of global factors, stratified by mode and trip purpose, may be sufficient for most planning purposes.
- Work and school trip generation need to be reversed, i.e., population based trip rates should be used to calculate trip destinations and, in the case of work trips, employment based rates used to calculate origins. The origin work trip rates and peak period factors need to be based on all last trips from work regardless of destination purpose. Destination rates from TTS will need to be adjusted to reflect the non home component.
- Home-based other and non home-based other (not work or school) trips continue to be treated as a single purpose using trip generation rates based on population. Those rates should exclude all work origins and destinations. The simplified GTA model differs from the full GTA model in that non work and non school trip generation is based on changes in population at the origin end. For the p.m. peak it will be desirable to separate the trips with home as their destination and apply the same procedure with population-based trip destination rates. The full GTA model uses population to forecast both origins and destinations, so a single category and matrix may suffice.
- Mode split factors and formulae need to be re-calibrated for the p.m. peak.
- A global factor may be used to convert peak period auto trip tables, or assigned traffic volumes, to 1-hour totals. An initial value of .38 is suggested pending further validation against cordon counts.

One might expect a p.m. peak model to be less reliable than an a.m. peak model because of the difficulties in forecasting non work and non school travel and the greater variation in day to day behaviour. The information contained in this report should help to address this problem. Although more people go directly to work in the morning than go directly home in the evening the proportion of direct to home travel is still high at about 80% (compared to 88% in the morning). Simulating the p.m. peak does have advantages relative to the a.m. particularly in regard to the uniform spatial and time distribution of trips before, during and after the peak period.

5.7 24-hour Simulations

The simplest approach to forecasting 24-hour travel is to apply 24-hour adjustment factors, stratified spatially and/or by road type, to one of the peak period (a.m. or p.m.) simulations. While adequate for global forecasts of vehicle-km of travel etc., such factoring is not likely to produce reliable estimates of usage on specific facilities.

Another option for simulating total daily travel is to have separate models for each time period (a.m. peak, mid-day, p.m. peak, evening and night) and to combine the results to give total traffic volumes. The primary advantage of this approach, relative to a single 24-hour model, is that variations in transit levels of service and road congestion by time of day on different parts of the network can be taken into account in the mode split and assignment procedures. The disadvantages are the increased complexity and the need to address the issue of trip start times and peaking factors in considerable detail.

A single 24-hour model is recommended as a practical alternative capable of generating facility specific traffic volumes that are realistic. The model would likely have the same trip components as recommended for a p.m. peak model. Mode split calculations should be based on peak period transit level of service since over 80% of all transit trips are work or school related.

An appropriate factor, or factors, will need to be selected to convert 1-hour capacities to 24-hour capacities, or conversely 24-hour trip tables to 1-hour volumes. A factor close to, but less than the observed peak hour proportion of daily volumes, is recommended as appropriate. The selected number can be a design hour standard or target. Figure 5.5(b) shows that a value of 9.5% would reflect the average conditions across the GTA network in 1996. A lower target (say 9%) might be appropriate for the future given the expected continuation in the trend towards an increase in the proportion of discretionary travel relative to peak period work and school related travel.

APPENDIX – Definitions Used in Cordon Count Comparisons

Screenline Definitions

Toronto

- Peel boundary
- York boundary
- Durham boundary
- Humber River between Lake Ontario & Steeles Avenue
- Highway 401 between Peel & Durham boundaries
- Uxbridge Rail sub-division from Steeles Avenue and extended south to Lake Ontario

Peel

- Toronto boundary
- York boundary
- Halton boundary
- QEW between Toronto and Halton boundaries
- Highway 401 between Toronto and Halton boundaries
- Credit River between Lake Ontario and Highway 401

York

- Peel boundary
- Durham boundary
- South York Cordon as defined in 1995 York Region Cordon Count Report

Durham

- York boundary
- Highway 401 between Toronto and the east boundary of Oshawa
- Highway 2 between Toronto and the east boundary of Oshawa
- West boundary of Whitby

The same boundary (e.g. Peel/York) may be counted in two different locations depending on which agency is taking the counts. The links in the EMME/2 network have been selected to represent the locations as accurately as possible but do not always provide an exact match.

Time Period Definitions

TTS data

- Morning peak 6:00 to 8:59 a.m.
- Midday 9:00 a.m. to 3:29 p.m.
- Afternoon peak 3:30 to 6:29 p.m.
- Evening 6:30 to 8:59 p.m.

Cordon Count Data

- Morning peak 6:15 to 9:15 a.m.
- Midday 9:15 a.m. to 3:45 p.m.
- Afternoon peak 3:45 to 6:45 p.m.
- Evening 6:45 to 9:15 p.m.

Vehicle/Mode Definitions

TTS – Auto driver
Cordon count – Private vehicles