Guide to Estimation and Monitoring of Traffic Counting and Traffic Growth

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Traffic Design Group

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An Important Note For The Reader

The research detailed in this report was commissioned by Transfund New Zealand.

Transfund New Zealand is a Crown entity established under the Transit New Zealand Act 1989. Its principal objective is to allocate resources to achieve a safe and efficient roading system. Each year Transfund New Zealand invests a portion of its funds on research that contributes to this objective.

Contents

Executive Summary

Following the completion of the Transfund NZ project to revise earlier work ("Upgrade and enhancement of traffic count guide". *Transfund New Zealand Research report 202)* the report presented here updates the guide itself (third revision).

This revision results from an update of the original research, using continuous traffic count data for 1998 and 1999 (and part of year 2000 in some cases). In addition to the previous analysis, classified vehicle flows were examined as well as flows for partial weekdays. The latter have been included in this analysis for four particular periods.

The revision also reflects the changes to a four term school year and shift to weekend retailing.

As the research indicated that heavy vehicle flows generally mirrored the pattern of all vehicles together, apart from December and January, week factors for heavy vehicles are not included but are available in Transfund New Zealand Research report 202.

The guide also incorporates additional suggestions for traffic count monitoring programmes, drawing on the Transit New Zealand's regular traffic monitoring strategy.

The procedures in this report are primarily based on typical **one-week traffic counts**, and provides the likely **accuracy** of traffic counts upon which further objective decisions can be based.

Abstract

This report investigates traffic patterns and estimation of annual average daily traffic, and suggests a basis for a traffic count monitoring programme based on Transit New Zealand's regular traffic monitoring strategy.

1 Introduction

At the time of issue (29 April 1994) of the first version of the guideline for Transit New Zealand, it was recognised that the traffic pattern control group characteristics identified in Table 1 did not clearly differentiate between the control groups for every situation.

Futher the descriptor labels for the control groups were just labels: i.e., the traffic pattern for a road in a commercial area does not necessarily fit the *urban arterial* control group 2 but may best be described by another control group, particularly as the traffic pattern derived for some of the control groups came from a small sample size.

Following further research work, these issues were addressed to a limited extent in the first revision (11 November 1994). The second (unpublished) revision consisted generally of only minor corrections and some changes in the comments, undertaken as part of the Transit NZ traffic monitoring strategy documentation project undertaken by Dave Wanty of Traffic Design Group Ltd.

2 Estimation of Annual Average Daily Traffic and Traffic Growth

This section enables the annual average daily traffic (AADT) and the annual traffic growth to be estimated, along with associated errors.

2.1 Identifying the Traffic Pattern Control Group

The procedure to identify the traffic pattern control group, in order to estimate the Annual Average Daily Traffic (AADT), is given in Table 1. Note that this procedure is unchanged from the original guide, apart from the removal of the previous single site group 4, since it appears (at least for Auckland City) that the traffic pattern on *urban residential* streets emulates that on *urban arterials*.

Step	Action
1	• Determine a typical weekday interpeak/peak ratio, where the interpeak is the 12-1 pm hourly flow • Determine the interpeak - time "gap" between morning & afternoon peak hour flows (e.g. 17.15 – 08.45 = 8.5 hours)
2	Examine Table 1 below to determine the correct group(s) based primarily on the two attributes determined above, with the group descriptor label as an initial guide only.
3	If it is still unclear what the control group is then : • Plot the hourly flows for each day of the week (and perhaps average Monday – Thursday) • Compare with typical plots (Appendix C) and choose a control group as appropriate
4	If it is still unclear what the control group is then : • Repeat the count, and/or • Try each possible group when estimating the AADT, AADT error etc (average the results)

2.2 Estimating the Vehicle Axle Factor

The procedure to estimate the vehicle factor for axle sensor only counts (e.g. single tube), in order to estimate the Annual Average Daily Traffic (AADT), is described below.

2.2.1 Definitions

Vehicle factor is defined here as *2.00 divided by the axle factor*, where axle factor is defined as *the average number of axles per vehicle*. It does not apply to sites counted with vehicle detectors such as loops.

Table 1: Traffic Pattern Control Group Characteristics

Group, descriptor label	12-1 pm/peak ratio		Interpeak	%AADT
	Mon – Thu 2-way	Friday 1-way	Mon – Thu 2-way	Sun Peak 2-way
1a *Urban Arterial (a)*	0.45 - 0.60	0.30 - 0.55	8.5 - 10.0	5.5 - 7.5
1b *Urban Arterial (b)*	0.60 - 0.85	0.50 - 0.90	6.0 - 9.0	5.0 - 9.0
2 *Urban Commercial*	0.80 - 0.85	0.70 - 1.00	2.0 - 4.0	5 - 9
3 *Urban Industrial*	0.65 - 0.90	0.55 - 1.00	4.0 - 9.0	0 - 5
5 *Rural Urban Fringe*	0.50 - 0.70	0.30 - 0.80	8.0 - 10.0	10 - 24
6a *Rural Strategic (a)*	0.65 - 0.90	0.40 - 0.95	4.0 - 8.0	7 - 14
6b *Rural Strategic (b)*	0.80 - 0.95	0.45 - 0.95	4.0 - 7.0	9 - 17
7a *Rural 'Summer' Recr.*	0.85 - 1.00	0.50 - 1.00	2.0 - 4.0	10 - 19
7b *Rural 'Winter' Recr.*	0.90 - 1.00	0.35 - 1.00	2.0 - 4.0	10 - 30

2.2.2 Visual survey

The traditional way of deriving the vehicle or axle factor is to undertake a one-hour visual survey, usually during normal weekday business hours. [A longer survey is recommended where traffic flows are light in order to get a reasonable sample size of say at least 200 vehicles].

The advantage of a visual survey is that it is easy to carry out using a simple form, so as to obtain the number of vehicles in each vehicle class in accordance with the Transfund NZ Project Evaluation Manual vehicle class obtained (which is very useful for scheme appraisals and project evaluations).

The disadvantage is that because it is a weekday business hours veh/axle factor, which is then assumed to apply throughout the whole week or year, it is biased. Typically it would appear that this short-term sampling introduces an error on average of around 2 - 3 %.

2.2.3 Vehicle classifier survey

An alternative way of deriving the veh/axle factor at a tube count site is, every so often, to survey at the site using a vehicle classifier.

The advantage of using a classifier is that usually a week-long survey is possible (producing a more reliable estimate) and it is easier to get a sufficient sample of vehicles for lightly trafficked sites.

The disadvantage is that some of the classes combine vehicles with different number of axles, and the Transit NZ Project Evaluation Manual light commercial vehicles and bus classes are not derived. However, by undertaking a short visual survey at the same time, these limitations can usually be overcome.

2.2.4 Indirect survey means

A third method of estimating the veh/axle factor is to derive the factor at say a nearby Transit NZ dual-loop continuous site and assume that the same veh/axle factor applies.

The advantage is that, given that Transit NZ has derived the calibrated axle factor(s) at its nearby site, the veh/axle factor can be estimated without the need for a survey.

The disadvantage is that it is not known how reasonable the assumption is that the axle factors at the different sites are similar.

2.2.5 Formula

The basic formula used to estimate the axle factor from any survey is:

$$\text{axle factor} = \Sigma\, n_i\, a_i \,/\, \Sigma\, n_i$$

where $i = 1, 2, \ldots$, number of vehicle classes
n_i = number of class i vehicles observed
a_i = average number of axles per class i vehicle

Example 1

Suppose that in a one-hour visual survey, 270 cars and 30 three-axle coaches were observed. The veh/axle factor is calculated as

$$\text{axle factor} = (270 \times 2 + 30 \times 3) / (270 + 30) = 2.10$$
$$\text{veh. factor} = 2.00 / 2.10 = 0.95$$

Example 2

Suppose that an estimate for the veh/axle factor for a tube site counted in March near the Transit NZ Milton continuous site was required, and that the calibrated axle factors for the Transit NZ site were 2.0, 3.0, 4.0 and 7.0 for the short, medium, long, and very long vehicle classes respectively. Suppose also that the respective average daily flows for each of these respective vehicle classes for the period were 1960, 165, 30 and 45 (total 2200).

The estimated veh/axle factor is calculated as follows:

$$\text{axle factor} = (1960\times2.0 + 165\times3.0 + 30\times4.0 + 45\times7.0) / 2200 = 2.20$$
$$\text{veh. factor} = 2.00 / 2.20 = 0.91$$

2.3 Estimating the Annual Average Daily Traffic

The procedure to estimate the Annual Average Daily Traffic (AADT), on the basis of undertaking one-week count surveys, is given in the table on the next page. Note that the same procedure can be followed for estimating the AADT for heavy vehicles, using instead the week factors given in Appendix B1.

2.3.1 Note

No week factors have been given for the Christmas/New Year period (weeks 53 and 1) because of lack of quality data, and the high variability depending on when Christmas fell. If it is planned to count the Christmas/New Year holiday period then it is recommended to also count weeks 52 and 2 so that an estimate of the AADT can be obtained.

Step	Action
1	Determine the count weeks (in the range 2-51 and based on a Monday-Sunday week where week 2 begins the Monday after the first Sunday of the year)
2	Determine the average ADT for the week counted (WADT)
3	Multiply the WADT by the week average factor (refer Appendix A1) for the appropriate control group(s), multiply by the veh. factor (if applicable), and multiply by the holiday factor (if applicable) to determine the provisional AADT estimates <u>Formula</u> AADT = (WADT × week factor × *veh. factor*) × *hol. factor*
4	Average the AADT estimates for each week (and then round)

There is usually no need to apply a holiday factor since the week factors incorporate holiday effects. If Easter is counted then it is recommended to also count an adjacent week and compute the AADT from the latter only, since the factors for weeks 12-17 exclude Easter.

Cognisance should be given to the likely AADT error so that false accuracy is not inferred when quoting AADT. For example, if the AADT is 1967 and the AADT error 10%, quoting the AADT to the nearest 50 (quarter the error) is acceptable, while to the nearest 5 is not.

2.3.2 Short Term Counts

If a count survey is undertaken for a whole day, the average week ADT (WADT) can first be estimated by multiplying the daily flow by the appropriate *day factor* given in Table 2a.

If a count survey is undertaken for part of a day, then for the 2 or 3 hour periods, 7-9 am, 9-12, 1-4 and 4-6 pm on a non-Friday weekday, then average week ADT (WADT) can first be estimated by multiplying the measured two or three hour flow so obtained by the appropriate *partday factor* given in Table 2b (*page* 16).

Local factors for other short survey periods might be able to be estimated using information available from Transit NZ in certain circumstances. Generally however the error in the AADT from surveys of only a few hours duration is very high (greater than 30%).

Table 2a: Day Factors

Group Day	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1a1 *Urb Art a (Auck)*	0.98	0.95	0.93	0.92	0.88	1.17	1.37
1a2 *Urb Art. a (non Ak)*	1.01	0.98	0.95	0.94	0.89	1.09	1.24
1b1 *Urb Art b (Auck)*	0.99	0.96	0.95	0.93	0.89	1.13	1.31
1b2 *Urb Art. b (non Ak)*	1.00	0.97	0.94	0.93	0.88	1.11	1.30
2 *Urb CBD (Auck)*	1.02	1.00	0.97	0.94	0.86	1.07	1.34
3 *Urb Ind'l (Auck)*	0.85	0.85	0.84	0.84	0.84	1.84	2.66
5 *Rur Urb Fringe*	1.14	1.14	1.10	1.07	1.07	0.94	0.86
6a *Rur Strategic (a)*	1.05	1.01	0.99	0.97	0.97	1.09	1.10
6b *Rur Strategic (b)*	1.11	1.14	1.10	1.05	1.05	1.03	0.91
7a *Rur Rec Summer'*	1.07	1.17	1.13	1.05	1.05	1.11	0.88
7b *Rur Rec Winter*	1.15	1.25	1.21	1.12	1.12	1.03	0.82

Table 2b: Partday Factors for Typical Monday – Thursday

Partday Group	1a	1b	2	3	5	6a	6b	7a	7b
7am - 9am (2 hours)	5.63	7.31	7.86	5.57	8.61	8.40	10.2	16.9	13.8
9am - 12pm (3 hours)	5.66	5.17	5.77	4.13	5.59	4.74	5.17	4.84	5.24
1pm - 4pm (3 hours)	5.10	4.60	5.22	3.72	5.49	4.41	4.89	4.08	4.76
4pm - 6pm (2 hours)	5.78	6.00	6.36	5.97	6.64	5.99	6.88	7.77	7.91

2.4 Estimating the Annual Average Daily Traffic Error

The procedure to estimate the AADT error is given in the following table.

Step	**Action**
1	Multiply the AADT estimates for each week by the *t* value (taken as 2.0) and the overall standard deviation from Appendix A2. These are the provisional AADT errors. <u>Typical Formula</u> AADT error (95% conf.) = 2.0 × week std dev × AADT
2	Average the provisional AADT errors and then round
3	Note that the lower and upper bounds of the 95% confidence range in AADT can be calculated as follows AADT lower bound = (week factor – 2×std dev) × WADT AADT upper bound = (week factor + 2×std dev)× WADT where WADT has been adjusted by the veh. factor if need be

As a guideline the likely % AADT error is given in Table 3 below. The values for 1 one-week count per year are based on the updated median/mean of the group average relative 95% errors for each week

Table 3: Likely % AADT Error for Week Counts (Loop Sites) (95% confidence error)

Counts Group	1a	1b	2	3	5	6a	6b	7a	7b
S1: 1 week /yr	13	12	13	12	9	14	11	15	22
S2: 2 weeks/yr	7	6	7	10	7	11	9	13	19
S3: 4 weeks/yr	4	3	4	7	4	8	6	10	11
S4: 12 weeks/yr	3	2	3	5	3	4	3	6	8

Note: The % AADT error for tube count sites will usually be 3-5% greater (1% random error, 2-4% non-random error)

2.4.1 Day count errors

For a one-day count, the likely % AADT error is given in Table 4a below. The values have been derived by adding the average day factor 95% relative error to the median week factor 95% relative error, based on weeks 2 to 51 and excluding the Easter effect.

Table 4a: Likely % AADT Error For Day Counts (Loop Sites)

Day Group	1a	1b	2	3	5	6a	6b	7a	7b
Mon to Thur	16	16	19	20	16	21	16	25	38
Friday	16	16	19	21	15	20	19	28	36
Saturday	20	18	25	35	18	22	17	27	34
Sunday	22	20	37	37	20	24	22	34	40

2.5 Estimating the Traffic Growth

2.5.1 Single site

The procedure to estimate the annual % traffic growth for a single site is given in the following table.

Step	Action
1	Determine the base year (e.g. current year) AADT estimate
2	Subtract an earlier years AADT from the base year AADT and divide by the number of years between AADTs to obtain the annual arithmetic change (in vehicles per year)
3	Divide the annual arithmetic change by the base year AADT and multiply by 100%
4	Round the annual % traffic growth (e.g., nearest 0.5 or 1%)
5	If there are 4 or more AADT estimates in the last 6 years (or 7+ in the last 10 etc) then it is better to alternatively: (a) Determine the equation of the best fit line using linear regression – the slope is the annual arithmetic change (vehicles per year) (b) Compute the best fit estimate of AADT for the base year (c) Divide the annual arithmetic change by the computed base year AADT & multiply by 100%

2.5.2 Combined sites

There are two basic ways to estimate the annual traffic growth for several sites combined (e.g. screenline or area-wide). They are :

- Sum the AADTs for each site and from the total sums derive the annual traffic growth, or
- Determine the growth for each site and then simply average.

The former is recommended, since this gives a better reflection of the vehicle kilometres of travel (VKT), and can provide a growth "index".

[A good method of achieving this is to compute the traffic growth for each site and then weight each growth by the AADT when averaging (use the SUMPRODUCT and SUM functions if using a spreadsheet). This helps reduce the effect of missing values as well as highlighting the traffic growths for individual sites.]

2.6 Estimating the Traffic Growth Error

Unless there are extenuating circumstances, it is recommended that the estimate of annual % traffic growth error is deduced from the typical values given in Table 5. These have been revised somewhat from the original guide.

Table 5: Annual % Traffic Growth Error
(95% confidence Type I error)

Group **Sampling**	1a,1b *Urb* *Art*	2 *Urb* *CBD*	3 *Urb* *Ind'l*	5 *R/U* *Fringe*	6a *Rur* *Str*	6b *Rur* *Str*	7a *Sum* *Rec*	7b *Win* *Rec*
S1: 1 week/yr								
1 site	18	19	19	12	16	17	24	32
5 sites/years	8	8	8	4	7	8	11	14
25 sites/years	4	4	4	2	3	3	5	6
S2: 2 weeks/yr								
1 site	11	15	17	12	11	13	25	30
5 sites/years	5	7	8	4	5	6	11	13
25 sites/years	2	3	3	2	2	3	5	6
S3: 4 weeks/yr								
1 site	7	9	11	7	8	9	20	22
5 sites/years	3	4	5	3	4	4	9	10
10 sites/years	2	3	3	2	3	3	6	7
S4: 12 weeks/yr								
1 site	5	6	8	5	5	6	14	16
2 sites/years	3	4	6	3	3	4	10	11
5 sites/years	2	3	4	2	2	3	6	7

Notes:
If tubes are used for rural sites then the annual % traffic growth error should usually:

- be increased by 4% if the error is ≤ 7%,
- be increased by 3% if the error is 8-17%,
- be increased by 1-2% if the error is ≥ 18%,

unless several reliable estimates of the veh/axle factor exist.

Values for x sites/years may be derived by dividing the value for 1 site by $\sqrt{x}$, where x = (number of AADTs - 1) per site. So, for example, to compute the average annual % traffic growth from 1995 to 2000 (5 calendar years) for a site (i.e. 5 site/years), then there would be 6 AADTs (1995, 1996, 1997, 1998, 1999, and 2000).

When there is a combination of different sites and/or sampling strategies, then the overall combined error is approximately the average of each component sample error divided by the square root of the number of component samples. For example, the combined error of 1 *urban arterial* site and *1 rural urban fringe* site is the average of their two errors divided by √2.

Example 1

Estimating the AADT and its error

A traffic survey was undertaken on a rural Taranaki highway. From it the following traffic counts were obtained.

What is the estimated AADT and its associated error ?

Flow Period	S/B	N/B	2-way total
average Mon-Thu 12-1 pm	198	218	416
average Mon-Thu peak (16:45)	269	317	586
Sunday peak hour (16:00)	296	291	587
Weekly ADT (12-18 May 2000)	3136	3138	6274

The two-way average Mon-Thu interpeak/peak ratio is 416/586 = 0.71
As the average Mon-Thu peak hour is 11:15 the 'interpeak' is 5.5 hours.
The Sun peak %AADT = 587 / (≈ 0.96 × 6274) × 100% = 9.7 %
From Table 1 the appropriate control group is 6a *Rural Strategic (a)*

Average week (20/21) factor is (1.098 + 1.107)/2 = 1.1025 app A
Overall standard deviation is (0.052 + 0.071)/2 = 0.0615 } Gp 6a

The AADT is 6274 × 1.1025 = 6917 or ≈ 6900
The 95% error of AADT is 2.0 × 0.0615 × 6917 = 851 ≈ 850
Thus the AADT is estimated as 6900 ±.850 (i.e., 12% error)

Example 2

Estimating the traffic growth and its error

Suppose the AADTs for 1995 to 2000 of an *Urban Arterial (a)* site counted 1 week per month were 11500, 12000, 11950, 12250, 13450, and 13200.

What is the annual % traffic growth and likely error for a 2001 base year ?

The best-fit line gives a computed AADT for 2000 of 13331, with a projected AADT for 2001 of 13707 (a 376 annual increase).
Thus the annual traffic growth is 376/13707 × 100% = 2.7% p.a., with a likely error (refer Table 3) of 2%, i.e. annual growth of approximately 2.5 ± 2%.

Example 3

Estimating the traffic growth error

Suppose there were the following traffic counts in 2000 and 2001.

(a) *Urban Arterial (a)* 1 site @ 1 week/month
(b) *Urban Arterial (a)* 9 sites @ 1 week /year
(c) *Urban Arterial (b)* 6 sites @ 2 weeks/year

What is the likely annual % traffic growth error from 2000 to 2001 for (a), (b) and (c) separately and combined ?

From Table 5 the annual % traffic growth error is ≈ 5%, 6% (18/√9), and 6% (15/√6) for (a), (b) and (c) respectively. Overall the error is ≈3% (5.7/√3) with 95% confidence.

3 Suggested Basis for a Traffic Count Monitoring Programme

3.1 Definitions

Control station	A site where the traffic is regularly counted at least one week every month (and preferably on a semi-continuous basis)
Ordinary station	A site where the traffic is occasionally counted for one week, one to four times per year
Special station	A site which is counted for a special purpose as and when the occasion arises
Screenline survey	An imaginary line whereby any road which passes through it is surveyed at that point, traffic often being a primary attribute surveyed

3.2 Suggested Programme Basis

<u>AADT error</u>

Control stations should estimate the AADT within ± 5-7% (preferably better) with 95% confidence error

Ordinary stations should estimate the AADT within ± 10-13% with 95% confidence error

<u>Annual traffic growth error</u>

On an area-wide basis or along a screenline the annual traffic growth should be estimated to within ± 3% with 95% and 80% confidence errors (Type I and II errors respectively).

3.3 Guidelines

3.3.1 Frequency

To assist in achieving the above the following guidelines are given:

- If estimating AADT for a site to within ± 5-7% with 95% confidence, then count:

  Groups 1a, 1b, 2, 5 2 one-week loop counts per year
  Groups 3, 6b 4 one-week loop counts per year
  Groups 6a, 7a, 7b 12 one-week loop counts per year

- If estimating AADT for a site to within ± 10-13% with 95% confidence, then count:

Groups 1a, 1b, 2, 3, 5, 6b	1 one-week loop count per year
Groups 6a, 7a	2 one-week loop counts per year
Groups 6b	2 counts per year
Groups 7b	4 one-week loop counts per year

- If estimating the growth in AADT for a site/area to within ± 3% with 95% confidence, then *in general* count:

Group 1a	*Urban Arterial (a)*	30-40 weeks overall
Group 1b	*Urban Arterial (b)*	35-50 weeks overall
Group 2	*Urban CBD (Auck)*	35-50 weeks overall
Group 3	*Urban Industrial (Auck)*	50-75 weeks overall
Group 5	*Rural Urban Fringe*	15-20 weeks overall
Group 6a	*Rural Strategic (a)*	25-35 weeks overall
Group 6b	*Rural Strategic (b)*	25-40 weeks overall
Group 7a	*Rural 'Summer' Recreational*	65-200 weeks overall
Group 7b	*Rural 'Winter' Recreational*	65-200 weeks overall

3.3.2 Visual surveys

The guidelines above were based on a maximum 2.5% measurement error due to variability of estimating the number of axles per vehicle (axle factor) for tube sites.

Based on limited research, this 2.5% measurement error can typically be achieved with tube sites by undertaking:

Urban site		1 one-two hour visual survey
Rural site	AADT > 5000	2 one-two hour visual surveys
Rural site	AADT < 5000	4 one-two hour visual surveys

Instead of, or supplementary to, undertaking visual surveys, a portable classifier may be used for a period of a week in order to improve the confidence of the axle factor.

Alternatively, loops can be used to eliminate this source of error (introduced when converting axle pair counts to vehicle counts).

3.3.3 When to use loops

Formerly Transit NZ considered that when the AADT exceeds 10,000 then loops rather than tubes should be used. When the AADT is 7500 - 10,000 the use of loops should be seriously considered (also at sites where there are sight distance restrictions). However Transit NZ have been installing loops in some areas for all sites with more than 4000-5000 vehicles per day.

Control sites are prime candidates for using loops in order to improve the count accuracy, as well as reduce the data collection and analysis costs.

Recreational sites, because they need to be counted more frequently to achieve the same level of accuracy as other sites, may also be suitable for loops.

3.4 Comments

Regarding the location of traffic counting sites, there are too many factors involved to be able to provide a "recipe" to follow. However, some general comments can be given:

For example, to help with transportation planning, regular counts each year along screenlines as recommended by transportation studies would be beneficial — too often this is not done. Counts (especially classified counts of different vehicle types) on access roads to major ports would also be useful for strategic planning. For scheme appraisals, classified counts on different types of roads (i.e., different traffic patterns) could prove useful and may negate the need to undertake special counts or use the national defaults in the Transfund NZ Project Evaluation Manual.

Regarding the appropriate number of control stations, it is typical to expect around 10-12 ordinary stations for every control station. Transit NZ has over sixty-five telemetry (continuous control) sites throughout the state highway network for which high quality and accurate traffic data are available. Transit NZ Head Office will generally be happy to supply any reasonable request for information for appropriate sites in the areas of interest.

With the increased battery and data storage capacity and reliability, it is becoming increasingly easier and more efficient to operate key (loop) sites on a continuous basis. Furthermore count loops can often be installed and connected to signal controllers and hence regular counts obtained using SCATS or the Harding system (note that the use of SCATS detectors is not recommended for monitoring purposes).

It is apparent that to statistically detect the annual % traffic growth to say $\pm$ 0.5% (i.e. the annual % traffic growth is $x - 0.5$ to $x + 0.5$), then if continuous sites are not used numerous (loop) counts will be necessary using data over several years wherever possible. Thus a systematic traffic counting programme is highly recommended.

It should also be noted that the method used in the Transit NZ Hamilton "State Highway Traffic Volumes 1970 - 199*x*" booklet of computing the traffic growth on the basis of the AADT over five calendar years (moving average linear regression), is more or less equivalent to an estimate of the increase of AADT with 5 sites/years. That is, it is like averaging the annual traffic growth over the five-year period to derive a more reliable estimate, given that the growth is reasonably linear (and small). Given that traffic growth has been fairly constant since the early 1980's and all other things are equal, using linear regression is a sensible approach. Thus while it may seem that it is difficult to statistically reliably estimate the annual traffic growth to any great degree of accuracy, by having a systematic traffic count monitoring programme operating over several years, the appropriate targets may be reached.

3.5 Additional Comments

3.5.1 Transit NZ regular monitoring strategy

The above comments are largely unchanged from the previous guide, and accordingly some additional notes are provided.

This section of the guide is intended to provide some suggestions to assist territorial local authorities and consultants in revising the process for monitoring the traffic on their local roads.

By way of background, the approach adopted by Transit NZ for their regular monitoring of the state highways is initially reported. Note that special or *ad hoc* surveys were not included as part of this strategy.

Background

Traffic Design Group was engaged by Transit NZ to provide advice on a number of key issues in relation to their traffic monitoring programme. These included the precision and accuracy of surveys and intended targets, developing an overall strategy for monitoring, examining the traffic data quality within RAMM, documenting the strategy approach then adopted by Transit NZ, and finally giving advice on the implementation of a traffic information database.

The Transit NZ traffic monitoring strategy is outlined in a condensed manner as follows.

Monitoring links

The state highway network was divided up into a series of reasonably homogeneous traffic monitoring links. This was generally achieved by writing a BASIC computer program that examined the traffic, length and urban/rural characteristics for each of the RAMM sections (links), and aggregated the latter accordingly to a number of (objective) criteria. The resulting computer output traffic links (nodes) were then manually checked. The nodes at each end of the links were sometimes adjusted to tie in with intersections rather than roading/pavement features. The use of RAMM was considered a weakness in this respect, but the use of the developed program and the ability to slightly vary the parameter criteria appropriate to each Transit region shortened the process considerably.

The number of traffic links so derived was a trade-off between the level of precision in determining the vehicle kilometres of travel (VKT) for the state highways in each region, and the practicality of monitoring each link over a 1 or 3 year programme. In general for the Transit situation, more counts (links) were required in the urban areas and some minor redistribution of counts in the rural areas. The policy for the motorway networks was to monitor between every interchange, and similarly for the major urban networks (expressways) to monitor between every major intersection.

Initially the strategy was to monitor between 3-5% of the traffic links on a continuous basis, with around a third monitored every year, and the remainder monitored once every three years with the AADT for the intervening years estimated from the annual traffic growth for the sites monitored annually. However, largely for administrative reasons, each region decided to monitor all sites on an annual basis, rather than triennially.

The strategy also incorporated a number of policy decisions relating to the type of count undertaken as follows.

Policies

Transit intend phasing out all axle pair counts, replacing these with either loops or with classifier surveys. All busy sites were to be monitored using loops, and the use of a single classifier to monitor both directions of travel was restricted to low flow sites. All control sites were to be monitored continuously, and preferably be dual loop sites possibly also with axle sensors. The short term sites were to be monitored for a one week period 1, 2, 3 or 4 times a year as appropriate to achieve a nominal 10% level of precision. All classifier surveys were to use the Austroads classification scheme or the Transit approved classification scheme. It was also intended that either a one-hour visual survey would be undertaken at least once a year at each axle pair site prior to their elimination (or alternatively a one-week classifier(s) survey undertaken instead if practical) and at each continuous site. Visual surveys were to use the standard form with the results for the dual loop telemetry sites promptly forwarded to Head Office.

Note that *busy* sites were defined as links with AADT exceeding 4000-5000 vpd, a level reasonably consistent with the National State Highway Strategy, and reflecting policy initiatives over the years that loops be used at all sites with AADT > 7,500-10,000 vpd, and at all sites with poor sight distance.

Low flow sites were defined as links with daily flows less than 4000 vpd such that the accuracy of using a single classifier would not be impaired to any great extent; otherwise a classifier would be required for each direction.

Accordingly, additional loops have been progressively installed on the state highway network over the past few years. Regions were also given the opportunity to request funding from Head Office for the installation of dual loop telemetry sites where either the 3% target was not met, it was fiscally warranted, or there were a number of nearby short-term sites for which there was no suitably representative control site.

The Transit policy to standardise all sites to record at 15 minute intervals meant that some of the older equipment in the telemetry sites with limited storage capacity would ideally require upgrading in order to avoid the inconvenience of the need for more regular retrieval of the data. The policy to continue to record the standard four vehicle length bins (0.5–5.5m; 5.5–11m; 11–17m; 17–35m) for the dual loop sites was retained, while the need to collect speed bin data as a matter of course was dropped. Speed/gap data could be collected if desirable (e.g. for the Auckland ATMS motorway sites), as well as surveys in the peaks conducted at 1,3, or 5 minute frequencies. It was envisaged that Transit Head Office would separately arrange for the regular undertaking of (visual) validation surveys at the weigh-in-motion (WIM) sites

Weigh-in-motion

While it was hoped to follow the FHWA practice of undertaking short-term weight monitoring surveys, the lack of reliable, convenient and affordable portable weigh-in-motion equipment meant that for the foreseeable future, weight monitoring was envisaged to continue to be restricted to the usage of the few permanent continuous

WIM sites administered by Head Office. That being the case, it is recognised that there is a need for additional permanent WIM sites on the state highway network, although not necessarily as many as had been envisaged in the past. Technological developments are ever continuing though, such that the cost and accuracy of permanent WIM sites is improving, with potential application in flexible chipseal pavements although their use only in stronger asphaltic pavements with smooth approaches is strongly preferred.

Database The data from the various surveys (visual, loop, classifier, dual loop) is to be provided in standard formats for inputting into the Transit Traffic Monitoring System database about to be commissioned. This is considered an integral key component of the traffic monitoring strategy that will resolve a number of processing, analysing and reporting difficulties that have persisted over the years. Information will also be exported to the RAMM database(s) in a systematic and reliable manner. A procedure is expected to be developed in RAMM to then estimate the AADT and vehicle compositions etc for the RAMM links that do not coincide with the precise traffic survey location.

In the case of continuous sites from which the seasonal factors will be applied, to associated short-term count sites, a necessary requirement of the system currently is for the daily flows to be estimated where they are missing. One presumes that the estimated ADT's will be based on nearby flows (in time and space) and on historical site specific or grouped data such as is presented in this guide and the appendices of the associated research project.

3.5.2 Suggested monitoring programmes for local roads

Quality Objectives

Based on the Transit NZ approach, and as a result of providing advice to some Councils, the following suggestions are provided for revising traffic monitoring programmes:

It is strongly recommended that quality targets and objectives are established and defined, such that the programme could be seen by an auditor or reviewer to have been developed in a prudent manner.

Targets to be stated ought to include the level of precision required for each type of survey and the overall level of precision for the traffic growth (or VKT) in a district.

It is an anomaly that many Councils presently count their sites on arterial roads more frequently than sites on roads lower in the hierarchy although in many instances the traffic variation on arterial roads is likely to be less than on other roads. It is considered that it is better to monitor more arterial sites less frequently rather than fewer arterial sites more frequently. The inference here, is that spatial variation is normally greater than temporal variation.

Policy statements and targets

It is strongly recommended further to the above, that policy statements and targets are specified in a similar manner to those adopted by Transit NZ. For example,

"all sites with flow > 7000 vpd to be loops (or equivalent)".

"all sites to be counted directionally with 15 minute frequency".

Subdividing the network For predominantly rural areas, it is suggested that the approach adopted by Transit NZ could be followed but adopting a longer programme timeframe (e.g. 3 years). Each road/traffic link would then be monitored at least once during the programme cycle. Possibly however, unsealed roads could be treated separately on an "as and when required basis" as is commonly the practice now when a survey is undertaken in connection with seal extension, or changing the frequency of grading operations is being contemplated.

For predominantly urban areas, it might be appropriate to divide the area into topographical areas with a view to deriving the traffic growth for each sub-area.

Control sites

It is suggested that all control sites should be monitored on a continuous basis given that the marginal cost of monitoring continuously is more than outweighed by the reduction in analysis costs and in the improved quality. For urban sites, the reliability and capacity of modern traffic equipment is such that the data could be downloaded monthly (or sometimes every three months) with no need for permanent power or phone.

Type of control sites

All continuous sites should be permanent loop installations, preferably dual loop and possibly with axle sensors. Dual loops offer the advantage that for the small additional installation cost, vehicle length (and speed) information is obtainable (along with count backup if one loop fails). It is suggested that adding axle sensors could be considered where the pavement is reasonably robust and where providing permanent power to a cabinet is practical. Generally however, permanent axle classification is likely to be unnecessary. Note also that since the start of the new millennium, special loops and software that can detect axles have begun operating overseas.

For the larger cities operating with SCATS, it is recommended that SCATS detectors are *not* used for traffic monitoring purposes, but rather that special counting loops are installed (on the departure rather than the approach lanes) and connected with the controller. The SCATS system can then be used to obtain continuous counts in a cost efficient manner.

Location of control sites

The location of the (continuous) control sites can be determined in a number of ways. They can be located on strategic cordon or screenlines consistent with the topography and any operational transportation planning models. These might also coincide with historical control sites in order to provide some continuity with historical records. They also ought to be selected to represent the different road types/traffic volumes in each area.

Number of Control sites

The number of control sites will be influenced by the above and vice-versa. Although theoretically it would be possible to shift equipment between control sites, this is considered to be impractical.

It is suggested that around between 2-5% of the survey sites be continuously monitored so as to provide the seasonal factors to adjust the short-term counts at the nearby sites. Some sites could possibly be shared with adjoining Councils, and with the approval of Transit NZ use could be made of some of the state highway continuous sites.

Short-term sites

It is expected that the number of sites will normally be derived by the available budget, which will not only relate to the regular monitoring programme but also include allowance for special or *ad-hoc* surveys.

Given that the overall number of sites that can be surveyed in the programme cycle is approximately known, best practice would typically be to locate them in accordance with the usual key objective of determining the total VKT in an area. This method is outlined in the NAASRA publication "Guide to Traffic Counting" and outlined in the 1990 ARRB conference paper by Silvester and Wanty entitled " New Zealand national traffic data collection system". This was also the same approach used in the sampling procedure for the National Traffic Database.

Sampling strategy

It involves determining the VKT for each of say 5 or 6 different traffic volume strata (easily achievable using RAMM, although reliant on the AADT estimates being unbiased), and allocating the total number of survey sites proportional to the VKT in each stratum. Alternatively, the road hierarchy could be used instead, given that this is a surrogate for traffic volume.

It is strongly recommended that this "sample" approach or the Transit NZ alternative of monitoring all traffic links be adopted, replacing the historical wholly subjective and "reactive" approach to traffic monitoring.

Usual practice would then be to manually rather than randomly assign the actual site locations, taking into account any topographical, transport planning, or practical considerations such as clearances from driveways and intersections.

Type of short-term sites

It is strongly recommended that traditional axle pair counts be dispensed with and replaced with either loop or classifier(s) surveys. The costs of installing loops and associated loop detection equipment is competitive with using single tubes and their associated problems. There are also economies of scale in calling for tenders for the installation of a number of loop sites, rather than just one or two.

Furthermore, eliminating axle pair counts will eliminate the need to undertake visual surveys to convert the axle pairs into vehicle counts. It also simplifies the design and operation of a traffic database to store and process the traffic survey data.

Visual surveys
It is acknowledged that apart from Transit NZ and some councils who undertake regular turning volume counts at key intersections, the regular monitoring programme need not include visual surveys. The exception is of course, the short validation survey that each contractor should undertake to check that the equipment is counting correctly.

Additionally however, it is recommended that a one or two hour vehicle composition survey is scheduled at least once a year at each control site to ensure that it is counting correctly. This count should separate vehicles into different types, either in terms of the Project Evaluation Manual vehicle classes used in RAMM and/or the number of vehicles with different axles/commodity etc for use in determining ESA.

Intersection surveys
Currently, a few city councils undertake intersection turning counts on a regular programmed basis, mainly within the CBD and outskirts of the CBD. Some of these surveys count cyclists separately although the reported intersection counts may not include them.

It is acknowledged that the regular intersection counts could reasonably substitute the need to otherwise conduct mid-block traffic surveys within the CBD, in which case cyclists should not be included in the resulting AADT estimate for the intersection approaches.

Weight surveys
While the usual practice for large overseas roading authorities is to have a three tier traffic monitoring programme based on undertaking count, classification, and weight surveys, it is expected that the collection of weight data in order to derive ESAs will not be undertaken directly by Councils. Rather it is hoped that the NZ supplement to the Austroads Pavement Design Guide will be further enhanced as a result of current and pending research that will assist the practitioner to determine annual ESA through practical indirect means.

The current research is primarily reliant upon the undertaking of commodity surveys, while the proposed research will enable ESA to be derived for a number of different typical surveys, and have an expanded base for then deriving annual ESA from the short-term survey, as well as deriving typical ESA for different road types and related to traffic volume.

Contractural and other considerations
It is strongly recommended that each Council require that the ASCII formatted raw traffic survey data be stored in standard electronic formats, including those for visual surveys. The data should preferably be provided in 15 minute intervals, or at least 60 minute intervals, on a per lane or direction basis.

In the case of classifier surveys, it is suggested that surveys with more than say ½% – 1% of the total number of vehicles classified as "unknown" should be repeated. Quality checks for low flow sites using a single classifier should also be introduced, particularly to check for the common observance that a significant number of vehicles in the far lane might not be recorded.

Contractors ought to be required to submit their monitoring schedule on a regular basis so that councils can arrange for an independent audit, in which case the contract should specify the acceptable precision limits before a re-survey is specified at contractor's cost. It is suggested that there also needs to be clauses allowing for contract termination for continual poorly performing contractors.

It is also suggested that councils consider combining contracts with adjoining councils and jointly develop a traffic monitoring database. A three (or possibly five) year regular monitoring programme is considered sensible for most councils (some of the sites would be expected to be surveyed at least once every year), with allowance in the contract for a number of special counts to be undertaken as appropriate, for specific purposes.

3.6 Current council regular monitoring programmes

Questionnaire results

A one page questionnaire was posted in mid 2000 to each of the 73 city/district councils asking some simple questions on their current traffic monitoring programmes and how they calculate AADT and store the data. Responses were received from 66 councils or their consultants (90%), and are summarised in the table below.

Number of regular survey sites	Number of councils	Number of continuous sites method of calculating AADT	Number of councils
0	3	Continuous sites: 0	59
10-30	6	Continuous sites: 1-5	5
60-80	5	Continuous sites: > 10	2
100-140	7	Axle factors: not applied	32
140-190	9	Axle factors: applied	26
200-250	7	Axle factors: N/A	2
> 250	9	Axle factors: not stated	4
All roads	12	Week factors: not applied	38
Not specified	8	Week factors: local used	4
TOTAL	66	Week factors: national used	7
No response	7	Week factors: applied	12
		Week factors: not stated	5

Monitoring strategy

There were three small councils without a regular traffic counting programme at present, while at least twelve councils survey every road in their district over a 3 to 5 year cycle. Types of sites There were seven councils with at least one continuous or semi-continuous site although surprisingly, most indicated that they did not use this continuous data for providing the seasonal factors to adjust their short term sites.

Three councils used either SCATS loops only or classifiers only, while most used a combination of axle pair tube counts and classifiers — interestingly it appeared that many use the GK5000 in count mode only and did not utilise its ability to classify [FHWA classification scheme].

Calculating AADT About half the councils did not apply axle factors to adjust their axle pair tube counts, and over half did not apply seasonal factors to convert the weekly ADT to an annual AADT. This is considered an unacceptably high number of councils not using the standard procedure to calculate the AADT, and it is to be hoped that this updated and enhanced traffic count guide will provide the impetus for this situation to change.

Concluding remarks

It is also hoped that councils will review their present traffic monitoring programmes to ensure that they are getting a quality value for money service. In particular, it is intended that the use of axle pair counts be phased out, particularly on medium to high volume roads where their accuracy is questionable, and also where there is a significant proportion of vehicles with three or more axles.

3.7 Recommendation

It is strongly recommended that a methodical, quality based approach is undertaken by each road controlling authority in revising their traffic monitoring programme according to specific targets and objectives.

It is recommended that the derivation of VKT, being a primary output required by Transfund, is used as the primary basis for determining the number of monitoring sites on different types of road within each city/district or sub-area.

It is urged that axle pair tube counts be discontinued and replaced by more reliable and informative means of measurement such as loops (or equivalents) and classifiers. Furthermore, the installation of a limited number of continuous loop or dual loop sites is recommended, making the need to use nationally derived seasonal factors redundant. Where SCATS is available, more continuous sites could easily be provided by connecting specially installed traffic count loops on the departure lanes to the controllers. The use of SCATS detectors is otherwise not recommended.

It is suggested that councils consider combining contracts and pooling resources in order to capture economies of scale. A three year monitoring programme is suggested as appropriate for most councils. Quality control measures and associated clauses should be incorporated into traffic counting contracts, along with a requirement to provide council with the electronic raw data in suitable ASCII format for later inclusion into a traffic database.

References

NAASRA. “Guide to Traffic Counting.

Mara, M. K. Traffic Stream Data. *Transfund NZ Research report 96*

Silvester and Wanty, 1990.“ New Zealand national traffic data collection system” ARRB conference.

Transit NZ. *Traffic Stream Data.* Research project PR3-0025.

Traffic Design Group 2001. Upgrade and enhancement of traffic count guide. *Transfund New Zealand Research report 202.*

Wanty D, Mara K. *Traffic Count Accuracy and Monitoring Programmes.* IPENZ 1994 conference, vol. 2, pp 90-95

Appendix A:
Week Factors for Each Traffic Pattern Control Group

Reproduced from the Transfund NZ research project 202 ,
Upgrade and enhancment of Traffic Count Guide

Factors exclude the Easter holiday period
(defined as the Thursday before Good Friday to Easter Tuesday)

Year	Week 2 begins (the Monday after the first Sunday)
1998	Monday 5 January
1999	Monday 4 January
2000	Monday 3 January
2001	Monday 8 January
2002	Monday 7 January
2003	Monday 6 January
2004	Monday 5 January
2005	Monday 3 January
2006	Monday 2 January
2007	Monday 8 January
2008	Monday 7 January
2009	Monday 5 January
2010	Monday 4 January

Appendix A1:
Group Average Week Factors

Group beg Mon. Week	1a1 *urb art Auck*	1a2 *urb art non Ak*	1b1 *urb art Auck*	1b2 *urb art non Ak*	2 *urb cbd Auck*	3 *urb ind'l Auck*	5 *rur urb fringe*	6a *rur strat a*	6b *rur strat b*	7a *rur rec summer*	7b *rur rec winter*
2	1.343	1.172	1.236	1.073	1.282	1.682	0.886	0.833	0.851	0.510	0.696
3	1.127	1.056	1.074	1.032	1.118	1.155	0.924	0.910	0.947	0.628	0.838
4	1.043	0.997	1.007	0.987	1.023	1.015	0.906	0.889	0.946	0.713	0.804
5	1.043	1.006	1.019	0.973	1.063	1.034	0.945	0.961	0.981	0.847	0.970
6	1.047	0.977	1.033	0.993	1.054	1.158	0.881	0.915	0.925	0.852	0.840
7	0.979	0.961	0.989	0.969	1.008	1.066	0.971	0.944	0.977	0.830	1.008
8	0.970	0.958	0.974	0.956	0.984	1.081	0.991	0.948	0.949	0.834	0.980
9	0.986	0.974	0.978	0.960	0.970	1.271	0.982	0.957	0.988	0.891	1.004
10	0.975	0.963	0.976	0.980	0.995	1.028	0.985	0.984	0.989	0.973	1.009
11	0.978	0.981	0.989	0.986	1.050	1.000	1.021	0.973	1.007	0.988	0.994
12	0.971	0.968	0.990	0.958	1.026	1.019	0.985	0.982	0.988	1.020	1.041
13	0.992	0.985	0.987	0.974	1.051	1.021	1.048	1.022	1.053	1.054	1.145
14	0.980	0.999	0.975	0.977	0.974	0.912	1.084	1.044	1.074	1.176	1.205
15	1.084	1.009	1.053	0.985	0.950	1.187	0.923	0.985	0.891	0.861	0.915
16	1.041	0.982	1.033	0.979	0.988	1.066	0.954	0.958	0.900	0.872	0.880
17	0.982	0.984	0.996	0.973	0.969	1.054	1.027	0.998	0.996	1.047	1.018
18	1.001	0.994	1.013	0.985	0.976	1.041	1.096	1.062	1.075	1.198	1.237
19	1.027	0.999	1.023	0.996	1.020	1.119	1.078	1.077	1.079	1.285	1.262
20	1.023	1.002	1.020	1.009	1.076	1.093	1.122	1.098	1.101	1.317	1.273
21	0.994	0.991	1.011	1.011	1.090	1.037	1.099	1.107	1.121	1.342	1.305
22	1.036	1.012	1.027	1.016	1.131	1.069	1.107	1.092	1.083	1.325	1.215
23	1.053	1.012	1.051	1.049	1.097	1.016	1.048	1.089	1.044	1.159	1.095
24	1.074	1.030	1.071	1.045	1.141	1.113	1.089	1.138	1.087	1.274	1.184
25	1.030	1.017	1.034	1.037	1.044	0.993	1.109	1.152	1.126	1.393	1.282
26	1.037	1.013	1.009	1.033	1.053	0.978	1.107	1.137	1.106	1.348	1.261
27	1.082	1.019	1.042	1.045	1.063	1.080	1.039	1.107	1.035	1.182	1.087
28	1.093	1.010	1.050	1.044	1.057	1.035	0.988	1.061	0.965	1.091	0.964
29	1.053	1.005	1.034	1.042	1.040	1.037	1.063	1.121	1.063	1.320	1.131
30	1.037	1.009	1.030	1.062	0.983	1.037	1.149	1.167	1.162	1.455	1.312
31	1.021	1.010	1.022	1.055	1.071	1.061	1.128	1.163	1.163	1.429	1.247
32	1.019	1.004	1.017	1.031	1.058	1.063	1.110	1.135	1.135	1.433	1.148
33	1.006	1.007	1.011	1.031	1.109	1.071	1.121	1.136	1.135	1.408	1.167
34	1.023	1.006	1.024	1.023	1.093	1.065	1.116	1.140	1.130	1.404	1.128
35	1.019	1.002	1.024	1.022	1.089	1.057	1.096	1.149	1.095	1.326	1.130
36	1.005	0.990	1.027	1.013	1.072	1.026	1.061	1.104	1.070	1.307	1.092
37	1.017	0.999	1.025	1.019	1.198	1.103	1.076	1.108	1.095	1.317	1.108
38	1.019	1.000	1.021	1.013	1.168	1.103	1.056	1.095	1.062	1.208	1.090
39	1.035	0.990	1.020	1.009	1.063	1.023	0.984	1.024	0.956	1.008	0.960
40	1.033	0.985	1.021	0.998	1.074	1.004	0.933	0.981	0.918	0.924	0.886
41	1.008	1.002	1.001	1.009	1.078	1.028	1.023	1.043	1.022	1.099	1.023
42	0.985	0.996	0.987	0.989	1.073	1.040	1.051	1.065	1.085	1.241	1.172
43	1.019	0.998	1.025	0.979	1.059	1.077	0.955	0.966	0.949	0.954	0.949
44	1.067	1.039	1.063	0.998	1.118	1.131	0.963	1.008	0.967	0.946	0.990
45	1.006	0.964	1.009	0.968	1.041	1.075	1.053	1.024	1.069	1.125	1.168
46	0.992	0.966	0.972	0.978	1.030	1.049	0.983	0.993	0.997	0.899	1.052
47	0.985	0.961	0.955	0.959	1.041	1.031	0.969	0.975	1.011	1.034	1.042
48	0.988	0.951	0.986	0.934	1.041	1.004	0.981	0.969	0.995	1.049	1.012
49	0.985	0.937	0.960	0.930	0.988	1.032	0.970	0.987	1.001	1.065	1.078
50	0.997	0.921	0.957	0.907	0.994	1.016	0.954	0.956	0.987	1.069	1.079
51	1.008	0.920	0.951	0.909	0.980	1.027	0.951	0.950	0.982	0.997	1.045
52	1.137	1.021	1.025	0.944	1.051	1.065	0.809	0.851	0.790	0.681	0.733

Appendix A2:
Group Standard. Deviation Week Factors

Group	1a1	1a2	1b1	1b2	2	3	5	6a	6b	7a	7b
	urb art Auck	*urb art non Ak*	*urb art Auck*	*urb art non Ak*	*urb CBD*	*urb ind'l*	*rur urb fr.*	*rur strat*	*rur strat*	*r rec sum*	*r rec win*
Week											
2	0.285	0.106	0.148	0.098	0.158	0.058	0.122	0.133	0.095	0.084	0.105
3	0.160	0.055	0.080	0.065	0.072	0.027	0.066	0.093	0.096	0.127	0.095
4	0.099	0.041	0.053	0.038	0.056	0.053	0.059	0.145	0.104	0.179	0.137
5	0.086	0.034	0.059	0.040	0.050	0.038	0.055	0.040	0.069	0.113	0.098
6	0.081	0.015	0.052	0.060	0.083	0.115	0.090	0.066	0.079	0.128	0.157
7	0.047	0.008	0.061	0.061	0.053	0.103	0.020	0.074	0.043	0.067	0.087
8	0.045	0.035	0.045	0.044	0.071	0.135	0.068	0.056	0.039	0.050	0.066
9	0.054	0.005	0.047	0.034	0.085	0.450	0.017	0.069	0.034	0.058	0.101
10	0.030	0.021	0.051	0.038	0.067	0.040	0.071	0.048	0.035	0.068	0.080
11	0.034	0.006	0.042	0.040	0.058	0.049	0.026	0.099	0.029	0.085	0.191
12	0.065	0.012	0.058	0.039	0.062	0.023	0.037	0.055	0.040	0.090	0.085
13	0.052	0.022	0.047	0.020	0.043	0.053	0.032	0.045	0.056	0.078	0.071
14	0.023	0.016	0.038	0.028	0.048	0.002	0.028	0.038	0.044	0.012	0.098
15	0.157	0.005	0.136	0.019	0.127	0.115	0.036	0.101	0.037	0.060	0.054
16	0.108	0.021	0.077	0.017	0.148	0.070	0.063	0.061	0.045	0.085	0.083
17	0.045	0.012	0.060	0.024	0.150	0.053	0.085	0.063	0.093	0.169	0.144
18	0.058	0.021	0.056	0.014	0.162	0.037	0.038	0.052	0.044	0.081	0.096
19	0.120	0.009	0.099	0.022	0.155	0.034	0.042	0.071	0.045	0.065	0.114
20	0.087	0.027	0.081	0.029	0.052	0.062	0.039	0.076	0.053	0.058	0.091
21	0.049	0.022	0.057	0.023	0.056	0.034	0.045	0.087	0.057	0.028	0.096
22	0.094	0.020	0.079	0.024	0.104	0.035	0.064	0.114	0.081	0.212	0.212
23	0.056	0.029	0.054	0.039	0.047	0.071	0.033	0.082	0.040	0.053	0.078
24	0.079	0.012	0.071	0.031	0.056	0.154	0.073	0.097	0.104	0.200	0.190
25	0.064	0.028	0.060	0.040	0.049	0.121	0.081	0.110	0.089	0.054	0.163
26	0.066	0.048	0.051	0.031	0.051	0.161	0.055	0.119	0.073	0.070	0.150
27	0.117	0.011	0.065	0.039	0.055	0.060	0.060	0.095	0.080	0.106	0.149
28	0.127	0.020	0.062	0.039	0.048	0.028	0.032	0.079	0.060	0.047	0.255
29	0.094	0.021	0.086	0.035	0.071	0.040	0.072	0.127	0.110	0.229	0.175
30	0.072	0.033	0.073	0.077	0.080	0.009	0.061	0.097	0.056	0.106	0.115
31	0.070	0.021	0.066	0.064	0.085	0.019	0.038	0.118	0.068	0.166	0.163
32	0.061	0.020	0.062	0.034	0.067	0.050	0.040	0.093	0.056	0.083	0.154
33	0.036	0.019	0.046	0.029	0.080	0.043	0.042	0.097	0.045	0.063	0.142
34	0.060	0.020	0.059	0.027	0.027	0.033	0.045	0.097	0.054	0.055	0.142
35	0.070	0.036	0.071	0.035	0.043	0.056	0.045	0.131	0.053	0.054	0.184
36	0.050	0.008	0.061	0.023	0.052	0.019	0.050	0.086	0.044	0.051	0.156
37	0.060	0.015	0.063	0.042	0.091	0.130	0.033	0.073	0.044	0.080	0.138
38	0.060	0.023	0.061	0.031	0.092	0.100	0.038	0.060	0.062	0.059	0.137
39	0.101	0.020	0.056	0.027	0.044	0.022	0.061	0.061	0.075	0.072	0.158
40	0.127	0.006	0.071	0.025	0.061	0.044	0.028	0.040	0.029	0.031	0.092
41	0.051	0.008	0.053	0.025	0.066	0.028	0.069	0.083	0.086	0.203	0.162
42	0.043	0.016	0.050	0.019	0.078	0.097	0.037	0.050	0.046	0.063	0.086
43	0.064	0.023	0.057	0.023	0.050	0.111	0.021	0.076	0.035	0.089	0.103
44	0.110	0.026	0.096	0.031	0.071	0.047	0.023	0.051	0.050	0.046	0.188
45	0.086	0.013	0.075	0.038	0.054	0.095	0.048	0.044	0.053	0.042	0.111
46	0.064	0.016	0.057	0.040	0.064	0.072	0.031	0.061	0.062	0.035	0.106
47	0.103	0.012	0.043	0.038	0.085	0.096	0.033	0.056	0.094	0.033	0.049
48	0.111	0.012	0.066	0.027	0.090	0.096	0.036	0.045	0.035	0.064	0.079
49	0.107	0.008	0.056	0.024	0.064	0.093	0.025	0.068	0.027	0.050	0.077
50	0.127	0.008	0.070	0.024	0.068	0.082	0.023	0.036	0.033	0.051	0.064
51	0.135	0.013	0.070	0.027	0.063	0.108	0.024	0.043	0.041	0.059	0.061
52	0.236	0.091	0.064	0.070	0.062	0.057	0.053	0.062	0.063	0.071	0.108

Appendix B:
Heavy Vehicles Week Factors for Each Traffic Pattern Control Group

Reproduced from the Transfund NZ research project 202 ,
Upgrade and enhancement of Traffic Count Guide

Factors exclude the Easter holiday period
(defined as the Thursday before Good Friday to Easter Tuesday)

Year	Week 2 begins (the Monday after the first Sunday)
1998	Monday 5 January
1999	Monday 4 January
2000	Monday 3 January
2001	Monday 8 January
2002	Monday 7 January
2003	Monday 6 January
2004	Monday 5 January
2005	Monday 3 January
2006	Monday 2 January
2007	Monday 8 January
2008	Monday 7 January
2009	Monday 5 January
2010	Monday 4 January

Appendix B1:
Group Average HV Week Factors

Week	1a *urb art*	1b *urb art*	5 *rur urb fr.*	6a *rur strat*	6b *rur strat*	7a *r rec sum*	7b *r rec win*
2	1.174	1.081	1.115	1.042	1.021	0.828	0.982
3	0.981	0.986	0.954	0.931	0.977	0.776	0.899
4	0.963	0.965	0.957	0.911	1.000	0.803	0.943
5	0.998	0.984	0.965	0.948	0.941	0.870	0.944
6	0.969	0.966	0.959	0.940	0.947	0.895	0.963
7	0.918	0.899	0.933	0.889	0.893	0.830	0.980
8	0.930	0.898	0.967	0.918	0.899	0.847	1.003
9	0.923	0.908	0.937	0.920	0.923	0.865	1.038
10	0.938	0.918	0.930	0.908	0.912	0.901	1.010
11	0.949	0.958	0.965	0.950	0.941	0.923	1.067
12	0.913	0.917	0.922	0.913	0.909	0.949	1.019
13	0.936	0.910	0.948	0.934	0.932	0.972	1.085
14	0.981	0.959	0.972	0.998	0.967	0.996	1.066
15	1.008	0.949	0.930	0.988	0.847	0.842	0.945
16	0.978	0.966	1.071	0.955	0.921	0.914	0.956
17	0.946	0.940	1.045	0.975	0.945	0.976	1.024
18	0.955	0.974	1.022	1.031	0.979	1.022	1.157
19	0.970	0.989	1.030	1.057	1.009	1.072	1.139
20	0.978	1.019	1.052	1.087	1.017	1.088	1.182
21	0.955	1.003	1.022	1.065	1.035	1.069	1.142
22	1.001	1.028	1.050	1.073	1.032	1.126	1.152
23	1.043	1.102	1.120	1.137	1.096	1.167	1.101
24	1.035	1.121	1.146	1.161	1.151	1.261	1.199
25	1.012	1.089	1.092	1.138	1.153	1.233	1.187
26	1.003	1.052	1.062	1.168	1.165	1.161	1.181
27	1.041	1.167	1.086	1.210	1.169	1.211	1.170
28	1.082	1.150	1.097	1.243	1.169	1.241	1.111
29	1.050	1.152	1.132	1.237	1.183	1.210	1.170
30	1.048	1.139	1.180	1.243	1.202	1.288	1.137
31	1.004	1.105	1.123	1.166	1.205	1.233	1.154
32	1.022	1.062	1.086	1.138	1.149	1.185	1.083
33	1.028	1.061	1.101	1.130	1.145	1.173	1.069
34	1.024	1.058	1.105	1.142	1.138	1.206	1.028
35	1.005	1.048	1.078	1.159	1.131	1.172	1.080
36	0.989	1.027	1.056	1.049	1.076	1.136	1.078
37	0.990	1.007	1.042	1.038	1.078	1.148	1.062
38	1.011	1.034	1.040	1.057	1.038	1.120	1.055
39	0.968	1.028	0.988	1.006	1.009	1.053	0.975
40	0.912	0.991	0.958	0.995	0.967	1.047	0.957
41	1.024	0.994	0.964	0.989	0.989	1.026	0.978
42	0.980	0.981	0.953	0.970	0.984	1.031	0.991
43	0.954	0.970	0.914	0.955	0.943	0.956	0.948
44	1.078	1.066	1.004	1.027	0.994	1.036	1.036
45	0.939	0.977	0.960	0.952	0.936	0.976	0.982
46	0.942	0.976	0.912	0.913	0.933	0.927	0.928
47	0.934	0.941	0.923	0.879	0.947	0.942	0.914
48	1.001	0.937	0.896	0.886	0.944	0.924	0.933
49	1.004	0.919	0.862	0.915	0.909	0.911	0.947
50	1.009	0.904	0.845	0.873	0.883	0.882	0.864
51	1.009	0.897	0.830	0.880	0.857	0.849	0.845
52	1.423	1.130	0.956	1.054	0.975	0.805	0.961

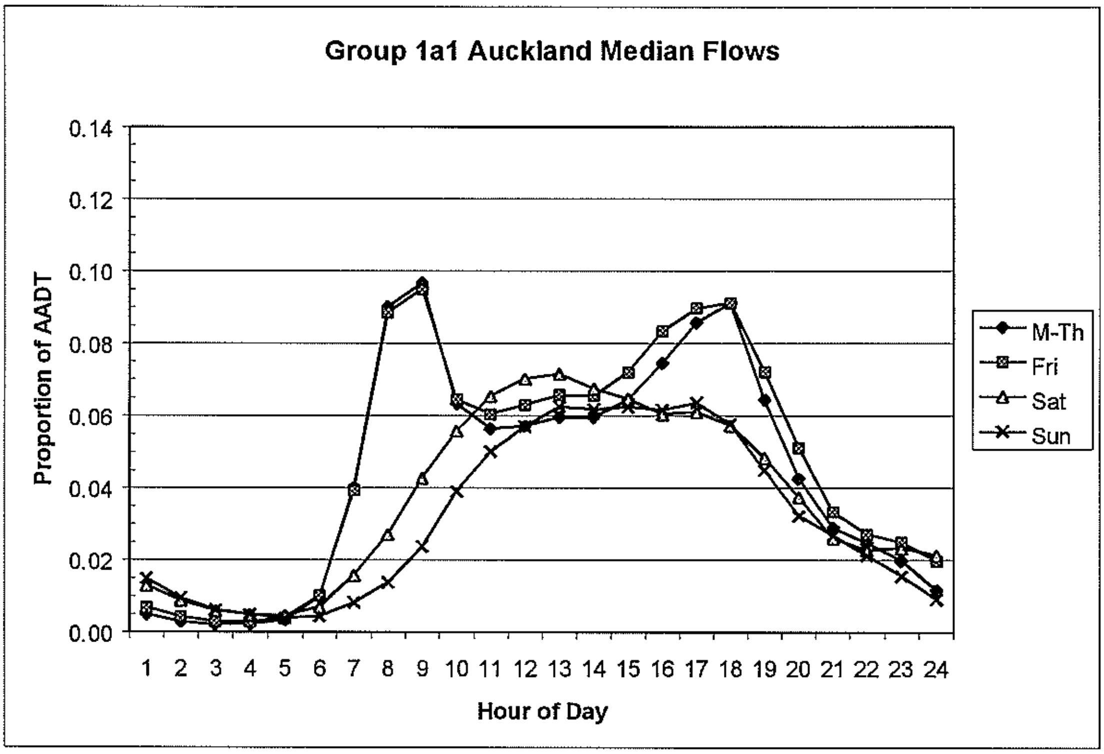
Appendix B2:
Group Standard Deviation HV Week Factors

	1a	1b	5	6a	6b	7a	7b
	urb art	*urb art*	*rur urb fr.*	*rur strat*	*rur strat*	*r rec sum*	*r rec win*
Week							
2	0.111	0.152	0.159	0.195	0.167	0.280	0.268
3	0.075	0.195	0.066	0.117	0.291	0.180	0.143
4	0.055	0.185	0.074	0.129	0.309	0.119	0.205
5	0.063	0.174	0.051	0.090	0.091	0.046	0.126
6	0.051	0.108	0.098	0.095	0.079	0.042	0.263
7	0.050	0.088	0.059	0.074	0.080	0.044	0.216
8	0.058	0.076	0.184	0.064	0.068	0.052	0.212
9	0.035	0.079	0.051	0.076	0.063	0.055	0.290
10	0.038	0.073	0.057	0.073	0.051	0.055	0.233
11	0.055	0.087	0.033	0.095	0.070	0.036	0.372
12	0.033	0.062	0.049	0.089	0.067	0.031	0.301
13	0.041	0.048	0.059	0.088	0.058	0.053	0.320
14	0.069	0.065	0.067	0.132	0.088	0.041	0.240
15	0.088	0.116	0.053	0.271	0.061	0.045	0.295
16	0.089	0.056	0.288	0.043	0.080	0.024	0.134
17	0.061	0.082	0.225	0.115	0.076	0.072	0.186
18	0.027	0.054	0.076	0.126	0.069	0.024	0.321
19	0.062	0.076	0.066	0.116	0.078	0.045	0.330
20	0.038	0.154	0.080	0.133	0.077	0.058	0.317
21	0.046	0.096	0.064	0.174	0.093	0.049	0.284
22	0.039	0.077	0.063	0.202	0.084	0.136	0.224
23	0.071	0.105	0.076	0.213	0.093	0.139	0.146
24	0.055	0.181	0.093	0.217	0.098	0.103	0.219
25	0.049	0.199	0.084	0.240	0.098	0.128	0.183
26	0.062	0.177	0.049	0.092	0.144	0.045	0.200
27	0.069	0.390	0.068	0.139	0.170	0.081	0.193
28	0.079	0.304	0.059	0.157	0.147	0.111	0.270
29	0.052	0.275	0.056	0.121	0.142	0.069	0.206
30	0.075	0.261	0.108	0.142	0.136	0.189	0.183
31	0.042	0.194	0.064	0.196	0.169	0.137	0.260
32	0.065	0.162	0.054	0.142	0.127	0.075	0.170
33	0.051	0.110	0.063	0.146	0.123	0.096	0.225
34	0.059	0.082	0.055	0.147	0.095	0.071	0.200
35	0.039	0.067	0.067	0.146	0.119	0.051	0.105
36	0.036	0.060	0.076	0.120	0.083	0.040	0.140
37	0.030	0.090	0.024	0.073	0.125	0.047	0.155
38	0.040	0.088	0.056	0.061	0.121	0.062	0.142
39	0.060	0.107	0.068	0.101	0.050	0.043	0.126
40	0.099	0.111	0.052	0.086	0.056	0.073	0.146
41	0.060	0.078	0.058	0.073	0.082	0.043	0.167
42	0.047	0.068	0.075	0.095	0.067	0.032	0.160
43	0.048	0.083	0.046	0.103	0.084	0.032	0.191
44	0.082	0.124	0.045	0.093	0.092	0.053	0.276
45	0.076	0.093	0.067	0.067	0.081	0.057	0.127
46	0.077	0.103	0.048	0.078	0.105	0.068	0.106
47	0.115	0.083	0.081	0.108	0.153	0.054	0.110
48	0.175	0.093	0.051	0.063	0.146	0.064	0.079
49	0.252	0.084	0.058	0.076	0.118	0.054	0.099
50	0.320	0.099	0.059	0.071	0.126	0.035	0.080
51	0.287	0.083	0.062	0.082	0.077	0.025	0.072
52	0.612	0.222	0.118	0.135	0.135	0.105	0.186

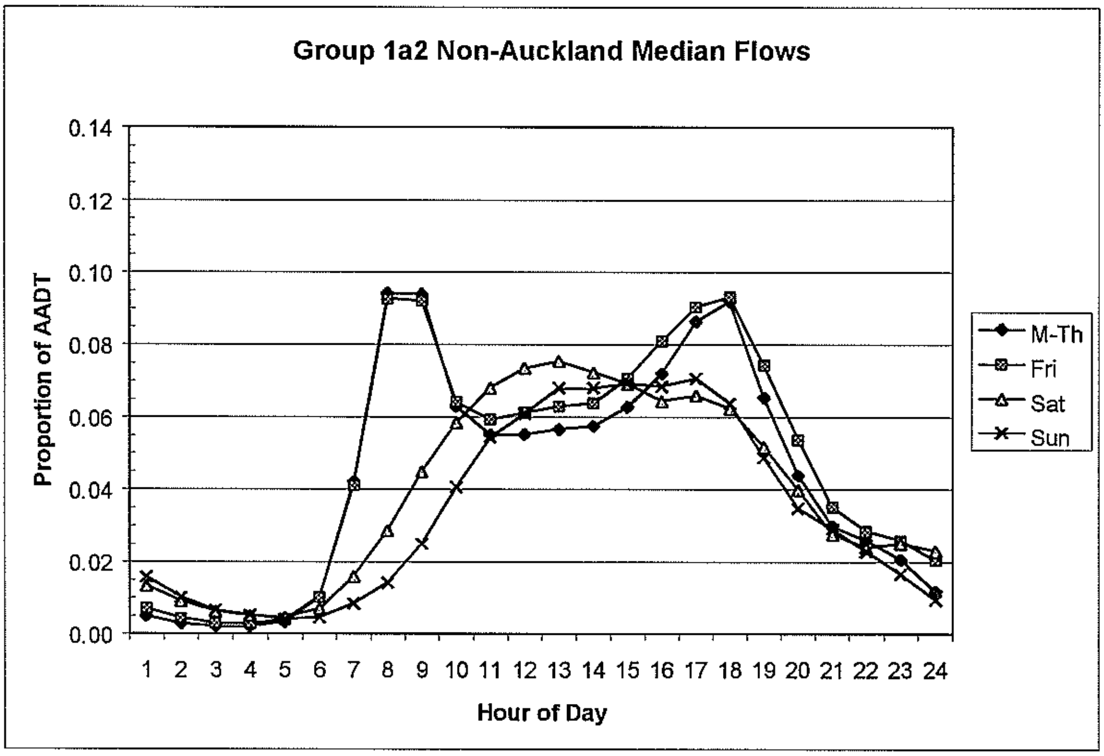
Appendix C:
Median Daily Profiles for Each Traffic Pattern Control Group

Reproduced from the Transfund NZ research project 202,
Upgrade and enhancement of Traffic Count Guide

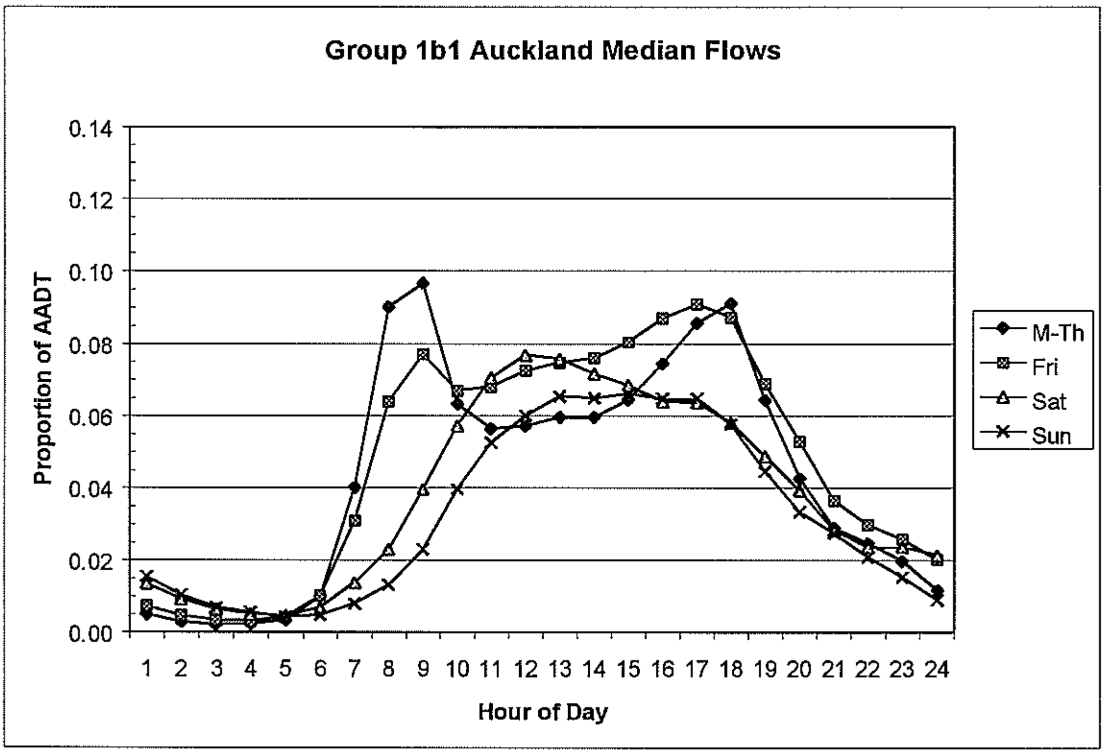
Group	Direction	Daily Profiles
1a1	2-way total	M-Th; Fri; Sat; Sun
1a2	2-way total	M-Th; Fri; Sat; Sun
1b1	2-way total	M-Th; Fri; Sat; Sun
1b2	2-way total	M-Th; Fri; Sat; Sun
2	2-way total	M-Th; Fri; Sat; Sun
3	2-way total	M-Th; Fri; Sat; Sun
5	2-way total	M-Th; Fri; Sat; Sun
6a	2-way total	M-Th; Fri; Sat; Sun
6b	2-way total	M-Th; Fri; Sat; Sun
7a	2-way total	M-Th; Fri; Sat; Sun
7b	2-way total	M-Th; Fri; Sat; Sun

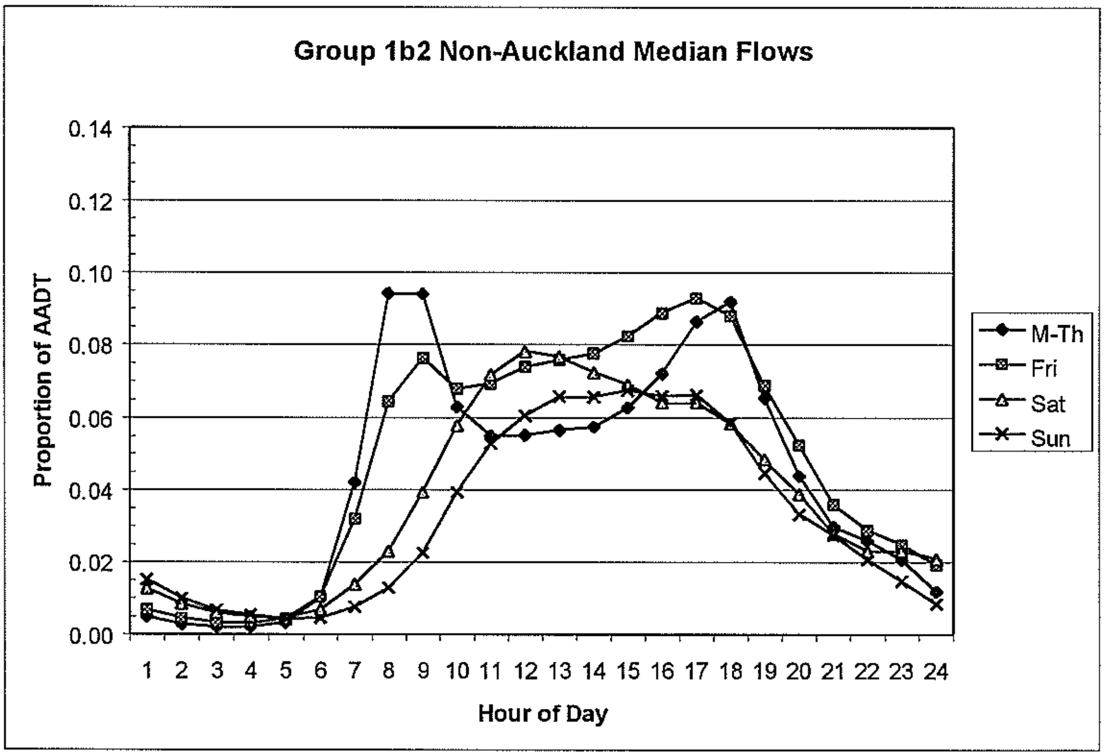


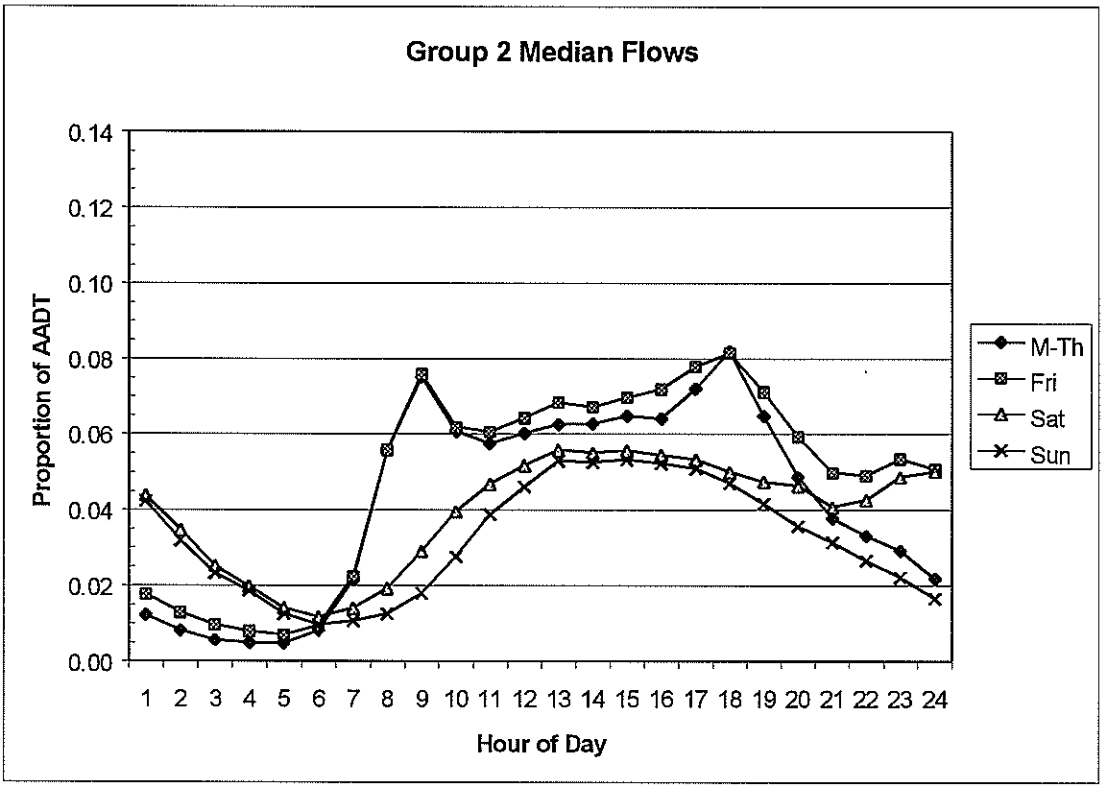
Group 1a1 Auckland Median Flows
Proportion of AADT
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Day
M-Th
Fri
Sat
Sun

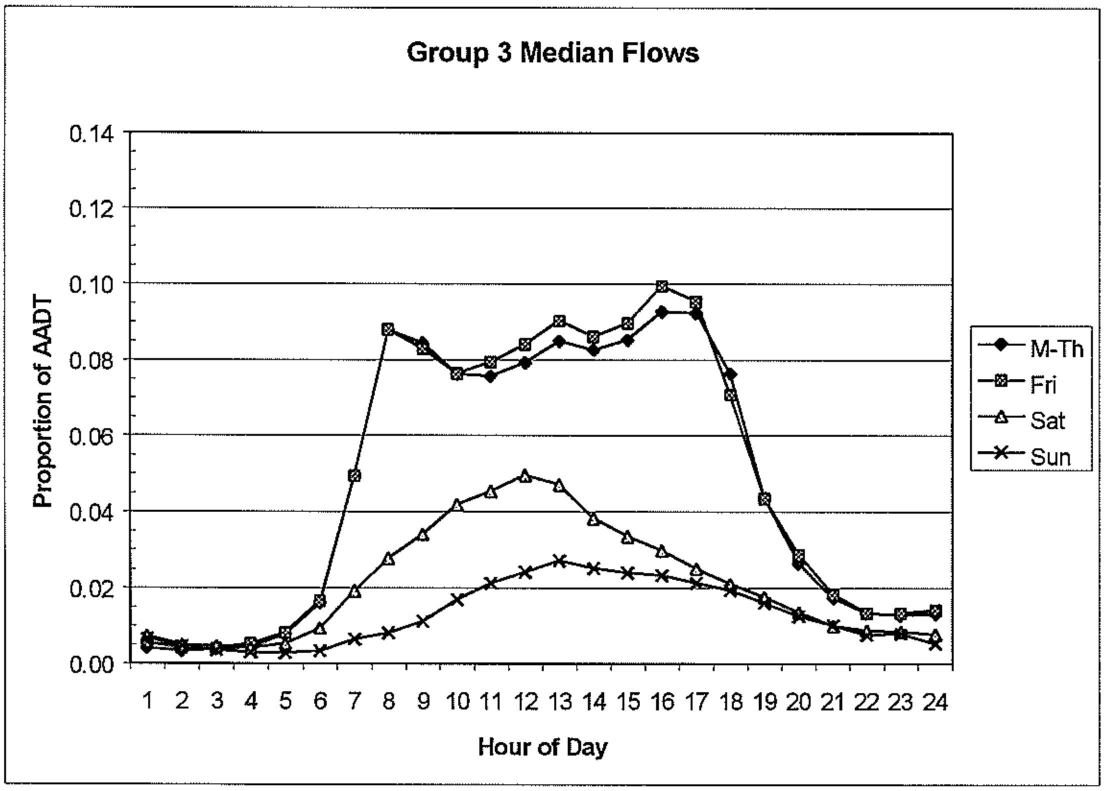


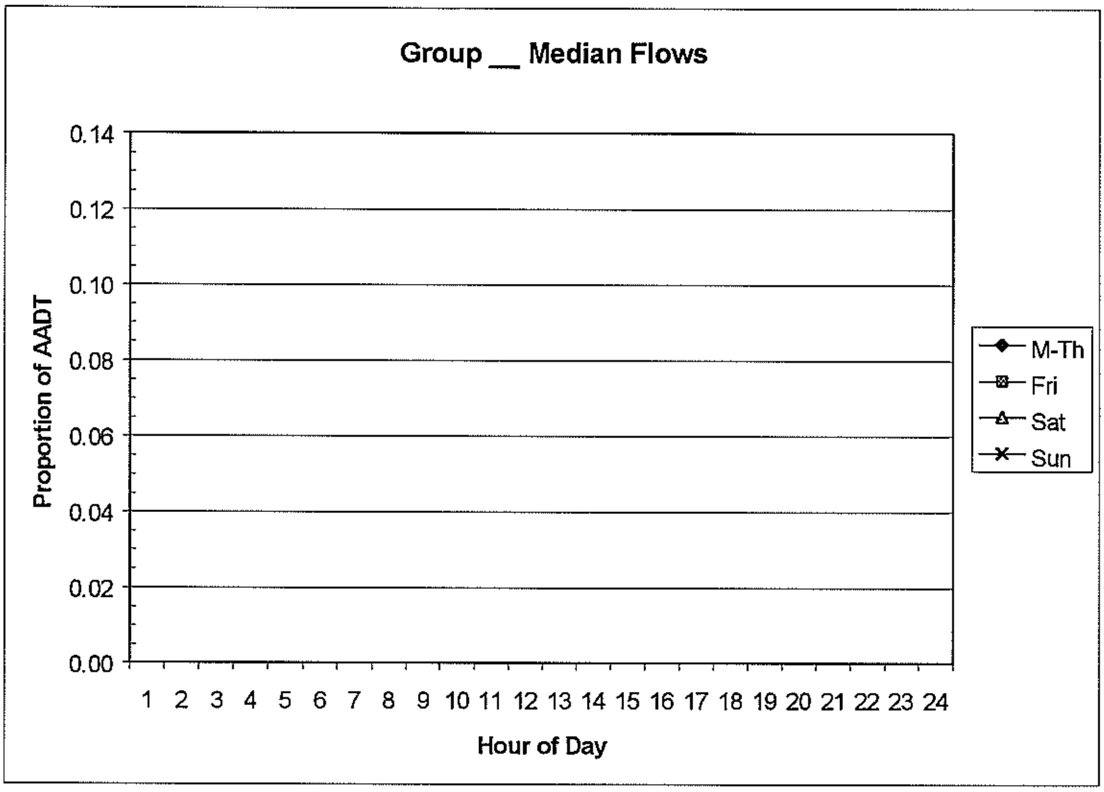
Group 1a2 Non-Auckland Median Flows
Proportion of AADT
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Day
M-Th
Fri
Sat
Sun


Group 1b1 Auckland Median Flows
Proportion of AADT
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Day
M-Th
Fri
Sat
Sun

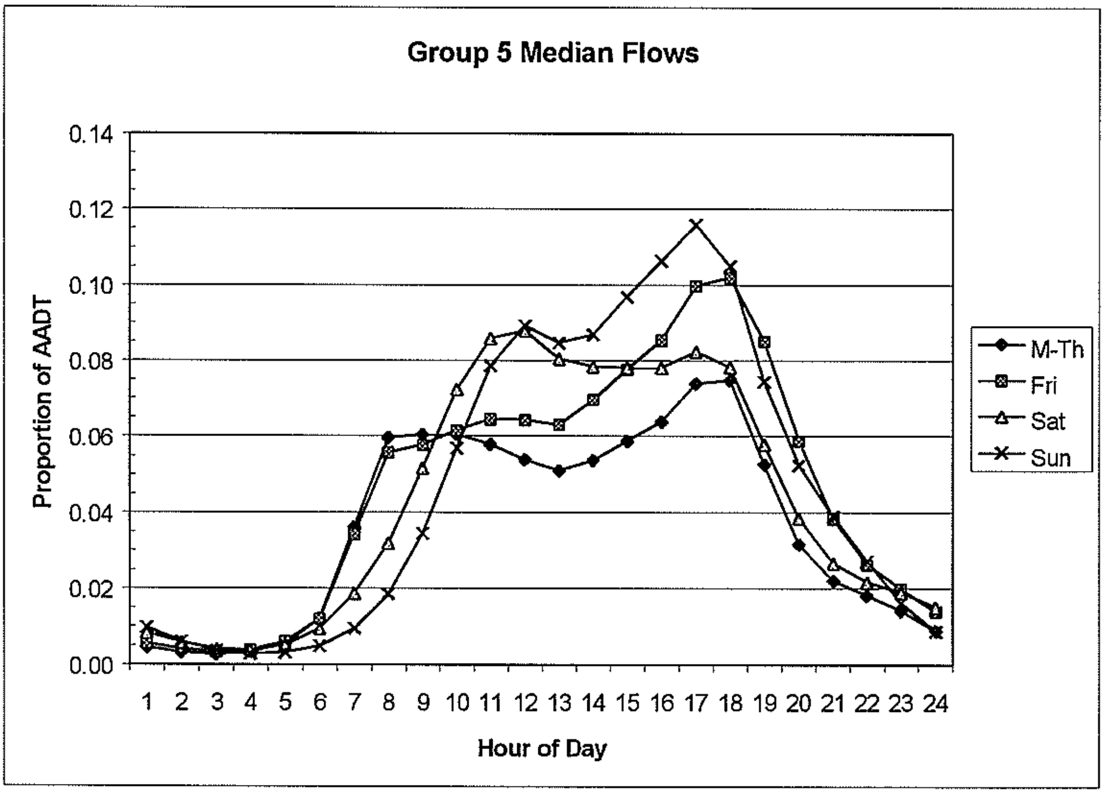

Group 1b2 Non-Auckland Median Flows
Proportion of AADT
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Day
M-Th
Fri
Sat
Sun

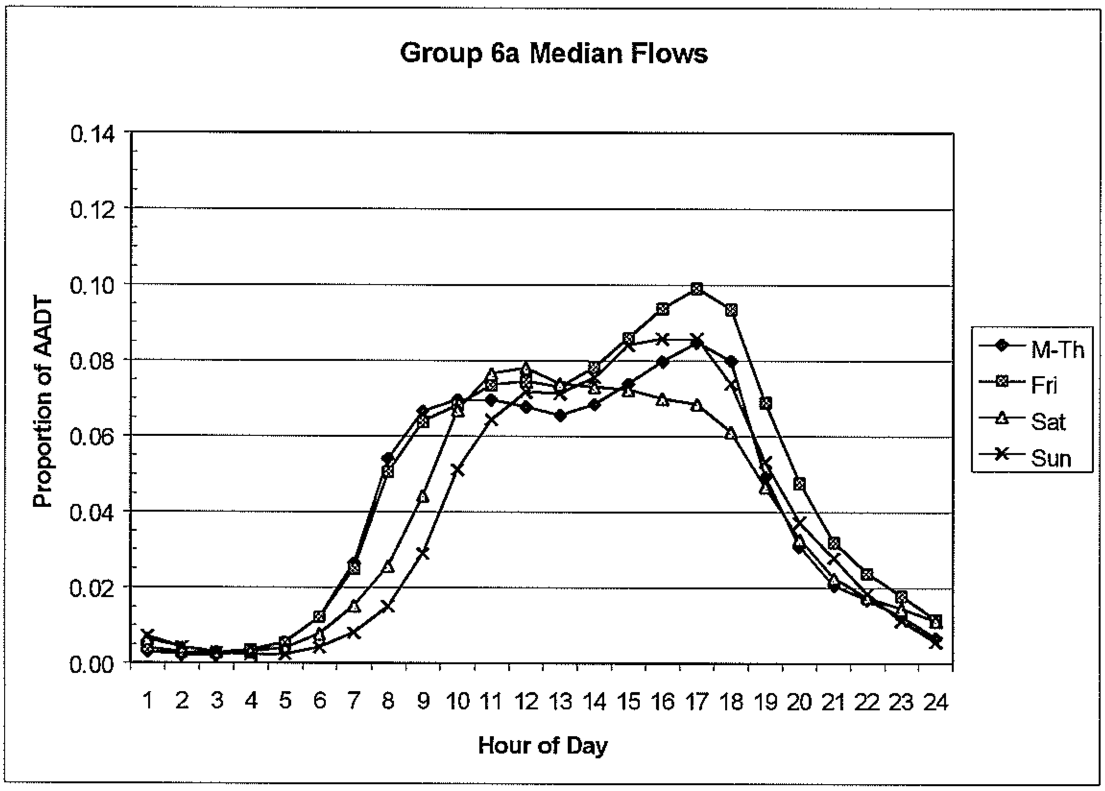

Group 2 Median Flows
Proportion of AADT
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Day
M-Th
Fri
Sat
Sun


Group 3 Median Flows
Proportion of AADT
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Day
M-Th
Fri
Sat
Sun

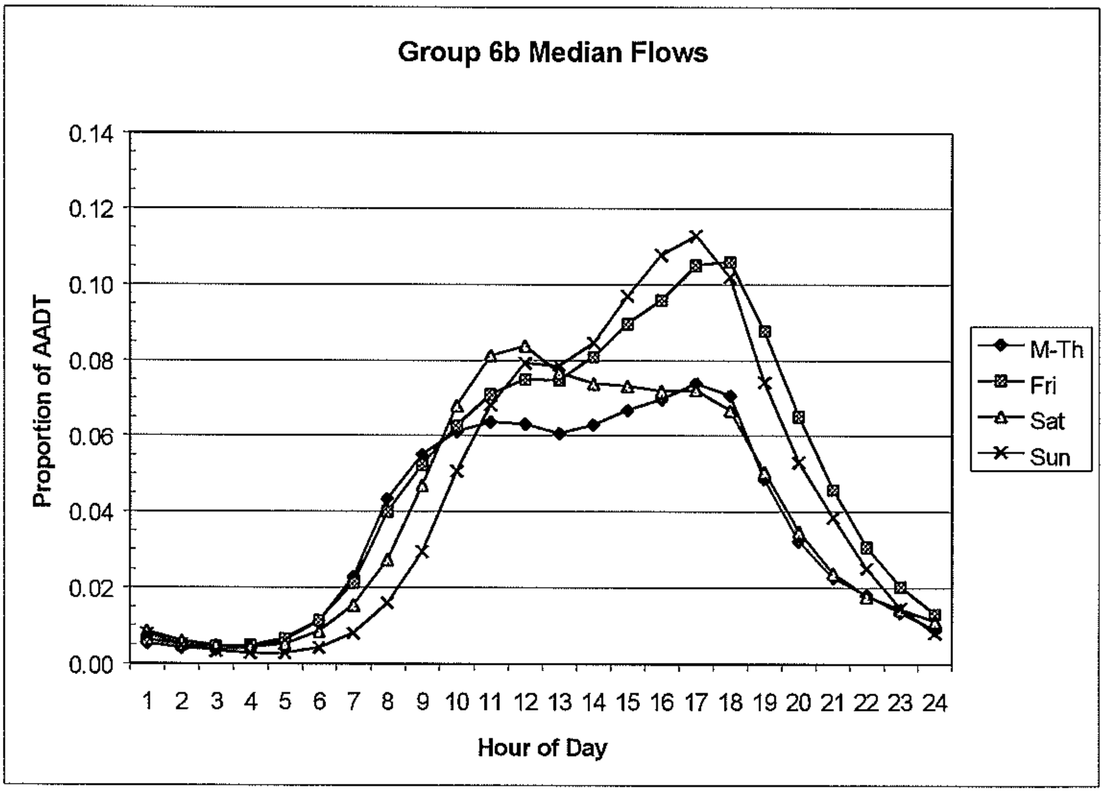


The above blank graph has been incorporated to allow you to graph & compare your own particular profile(s)

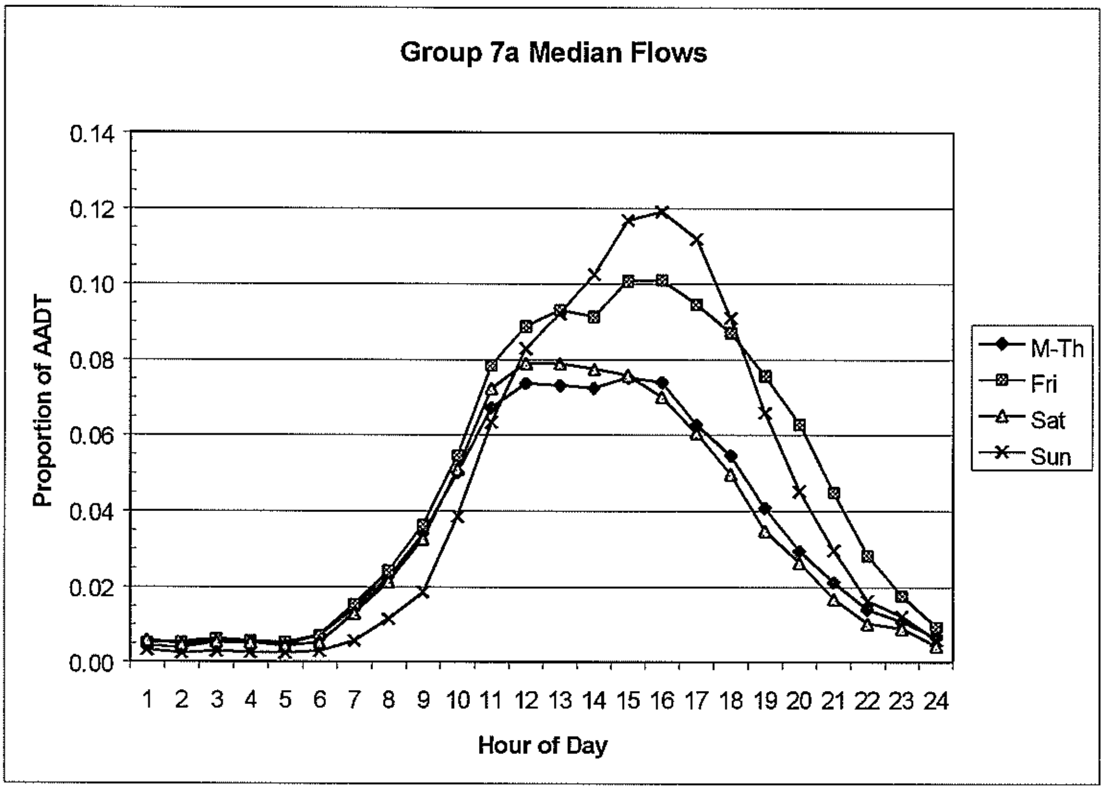


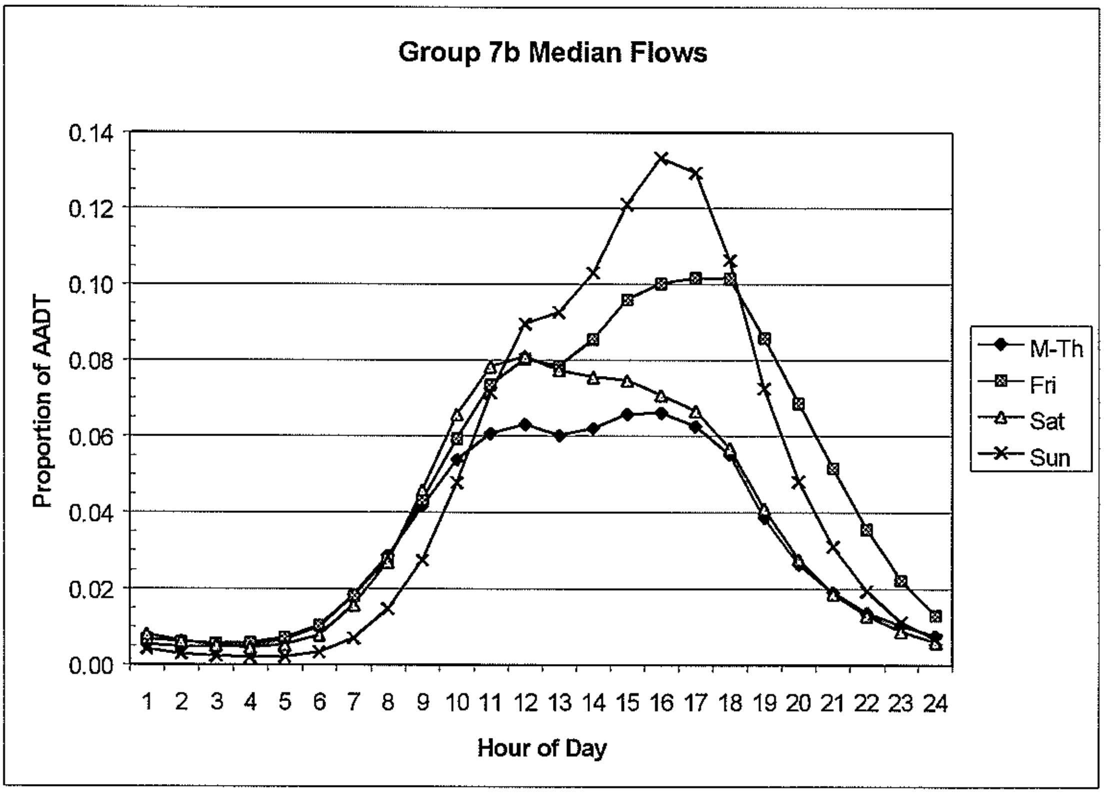


Group 6a Median Flows
Proportion of AADT
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Day
M-Th
Fri
Sat
Sun



Group 6b Median Flows
Proportion of AADT
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Day
M-Th
Fri
Sat
Sun

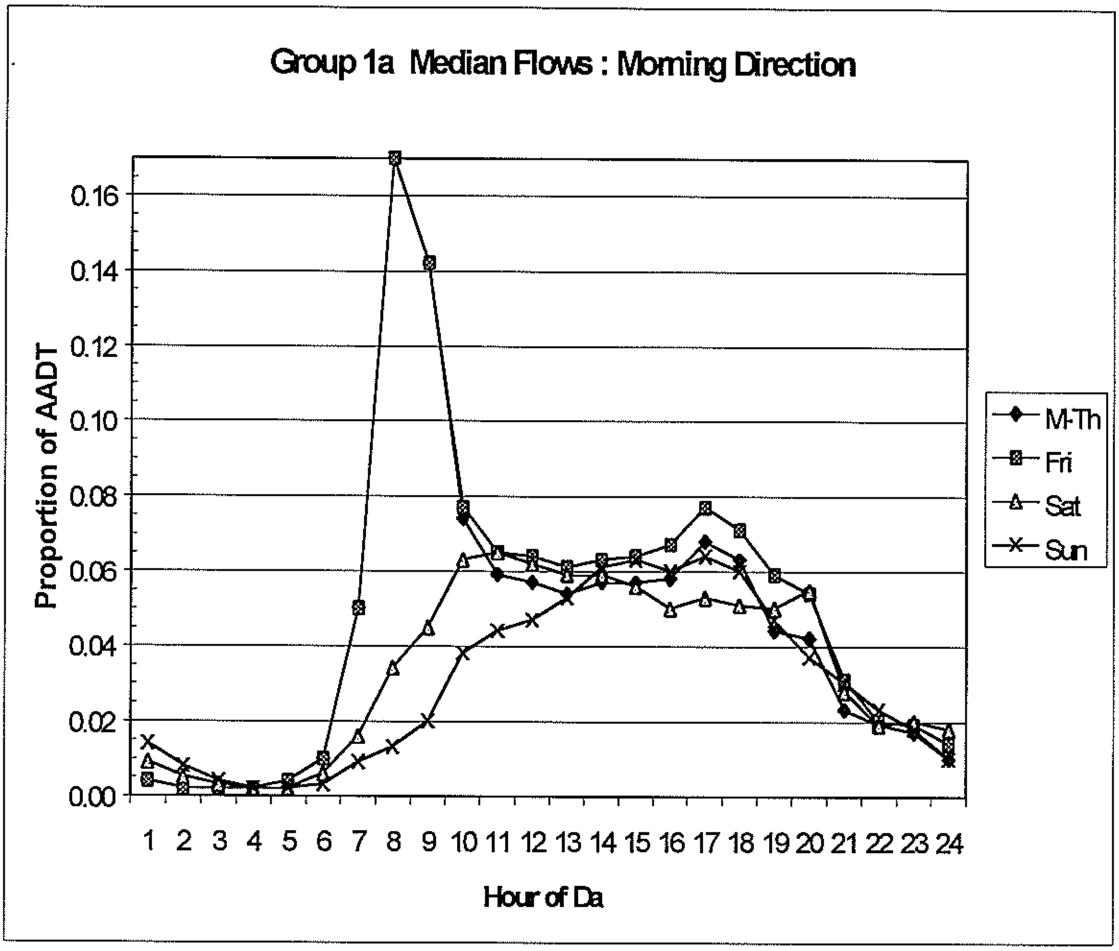

Group 7a Median Flows
Proportion of AADT
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Day
M-Th
Fri
Sat
Sun

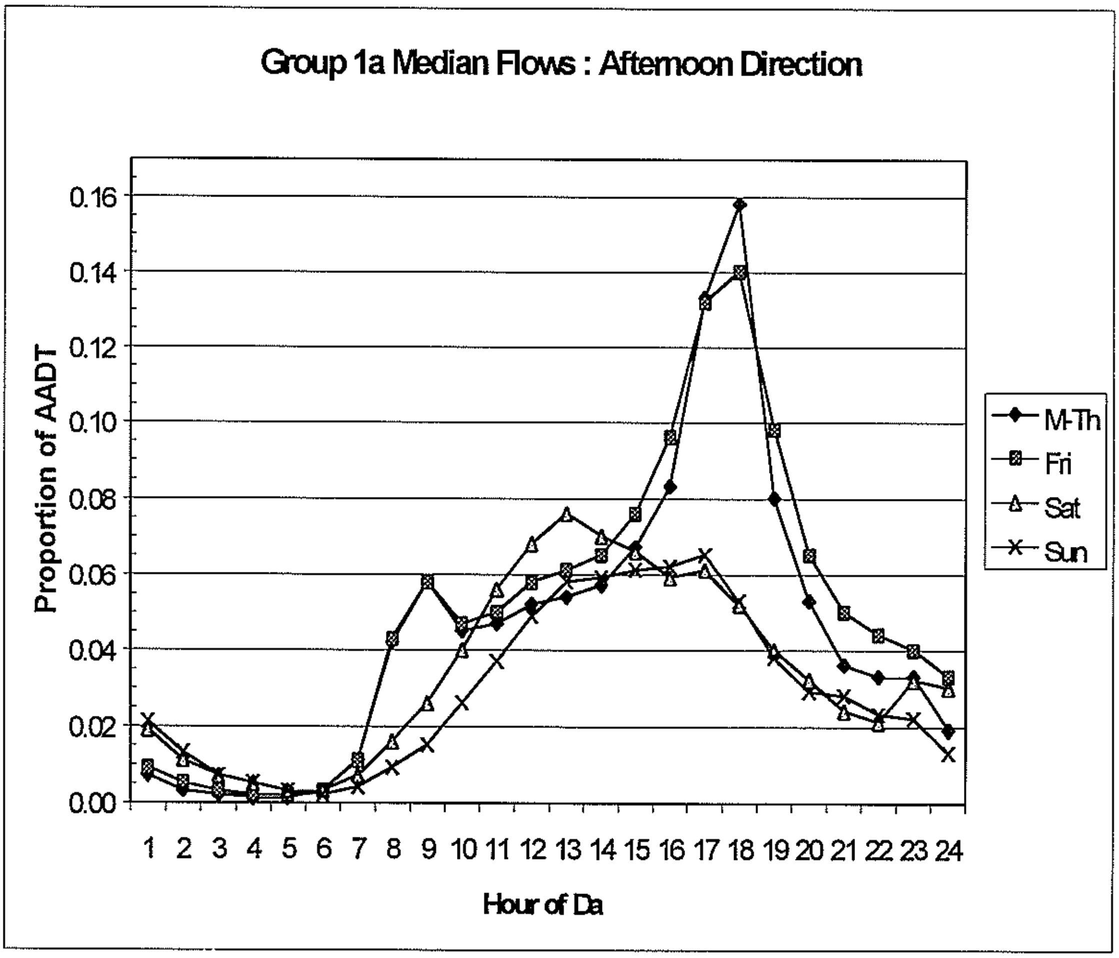

Group 7b Median Flows
Proportion of AADT
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Day
M-Th
Fri
Sat
Sun

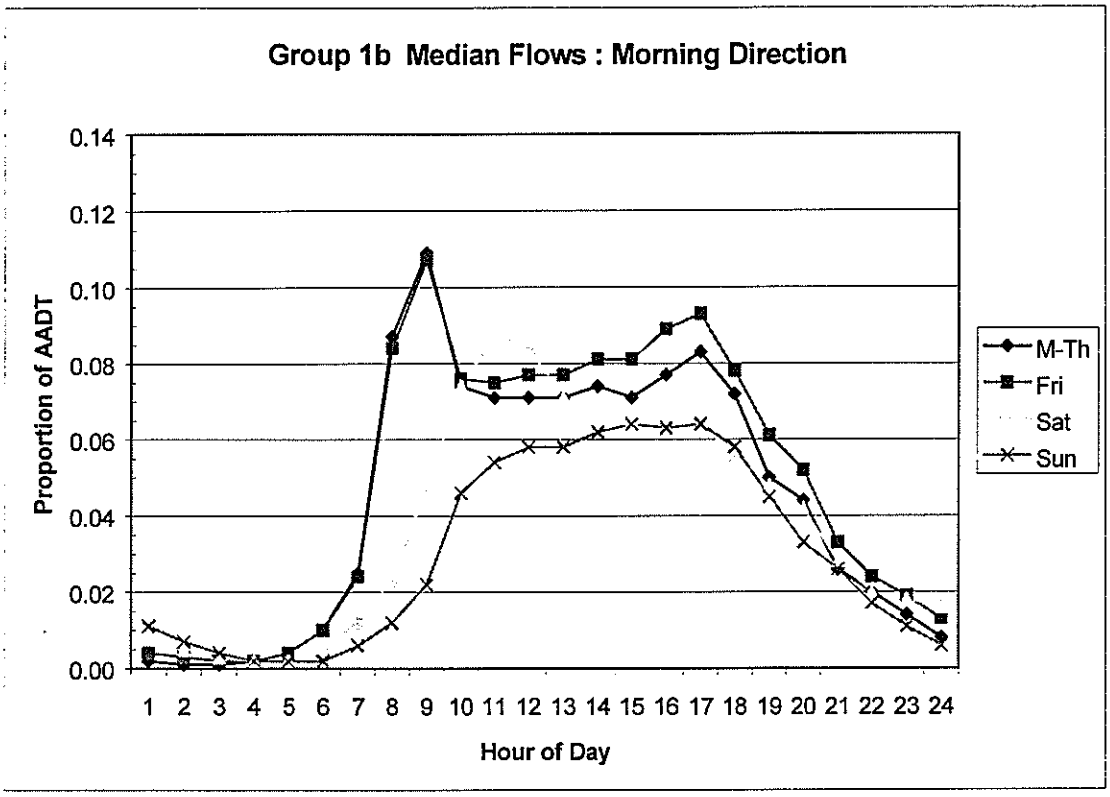
Appendix D:
Median Daily Profiles by Direction

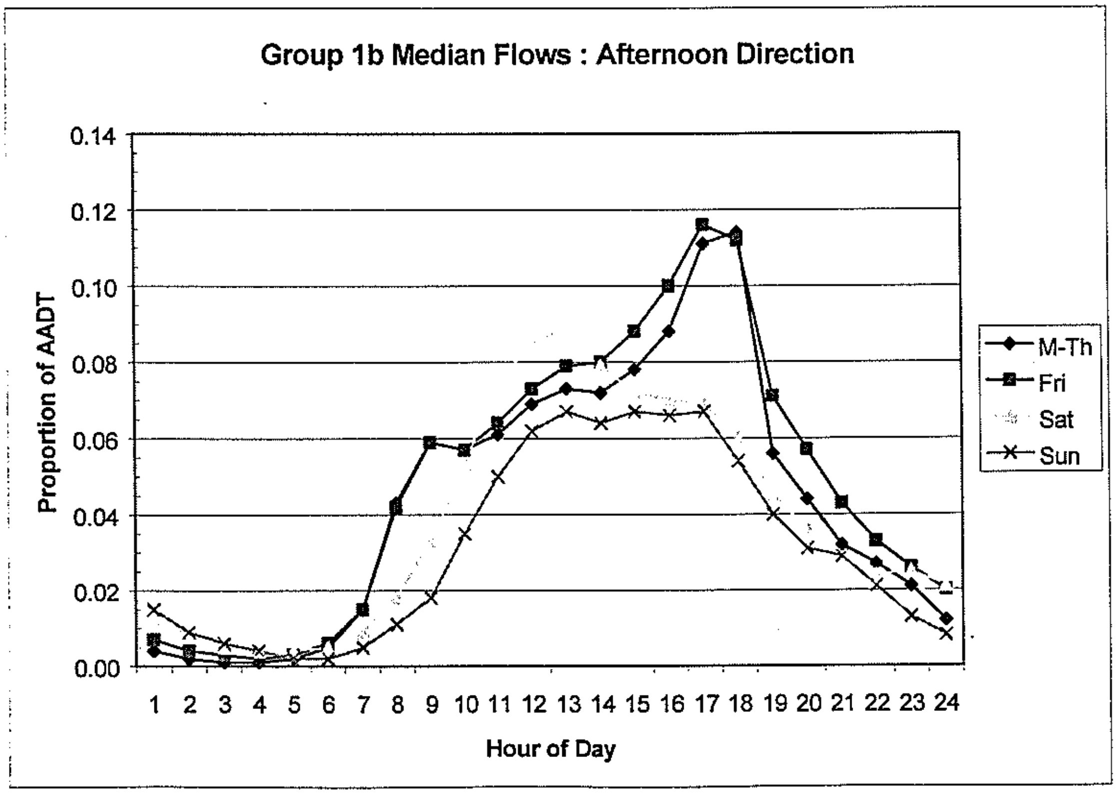
Reproduced from the Transit NZ research project PR3-0025, *Traffic Stream Data*, Appendix C1.

Group	Direction	Daily Profiles
1a	'morning'	M-Th; Fri; Sat; Sun
1a	'afternoon'	M-Th; Fri; Sat; Sun
1b	'morning'	M-Th; Fri; Sat; Sun
1b	'afternoon'	M-Th; Fri; Sat; Sun


Group 1a Median Flows : Morning Direction
Proportion of AADT
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Da
M-Th
Fri
Sat
Sun


Group 1a Median Flows : Afternoon Direction
Proportion of AADT
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Da
M-Th
Fri
Sat
Sun

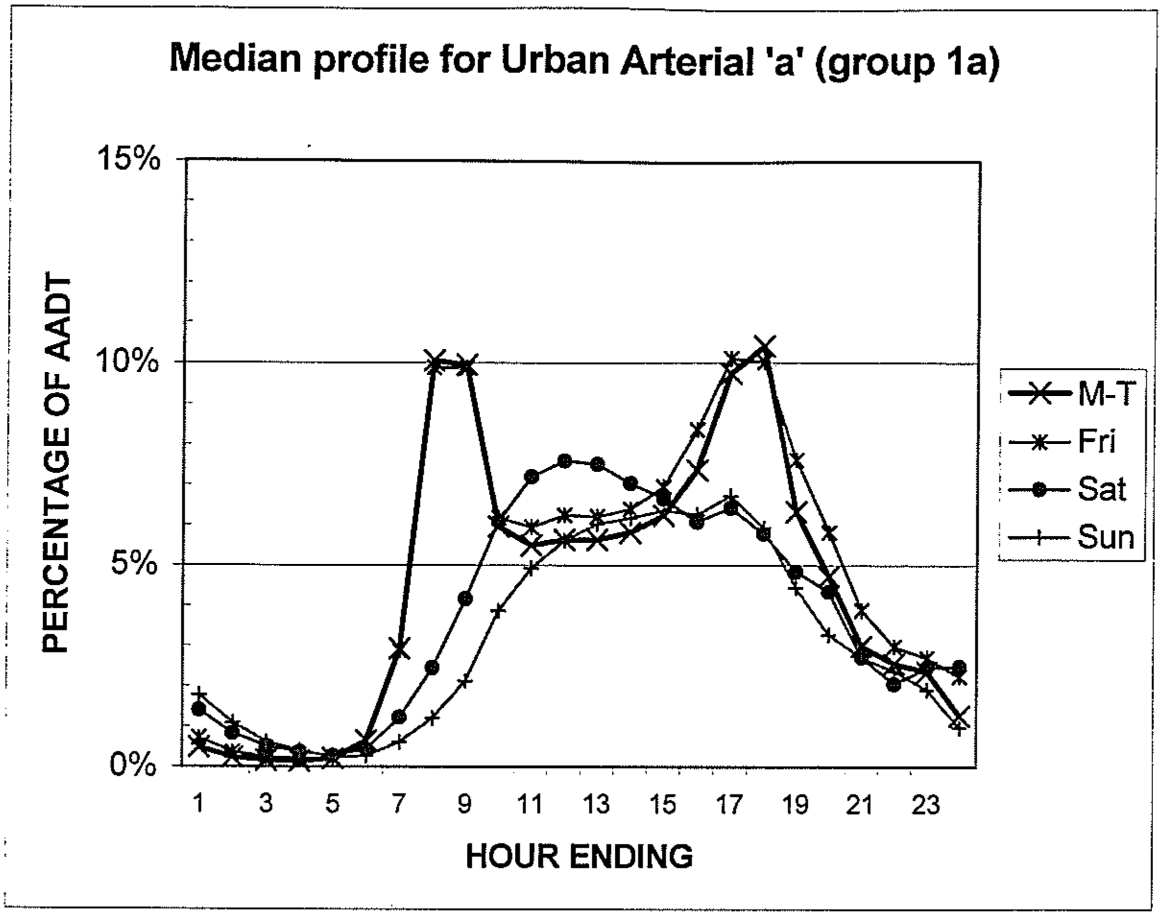

Group 1b Median Flows : Morning Direction
Proportion of AADT
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Day
M-Th
Fri
Sat
Sun

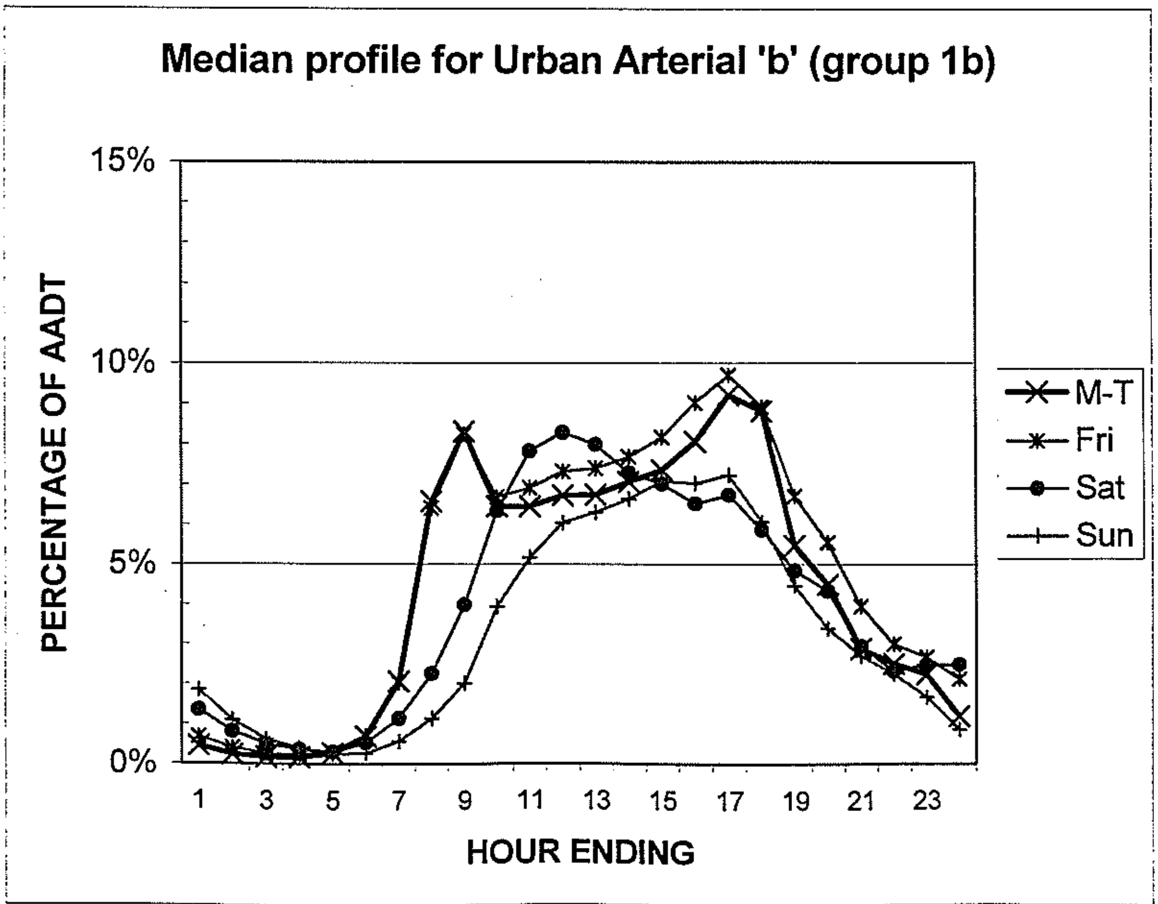

Group 1b Median Flows : Afternoon Direction
Proportion of AADT
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour of Day
M-Th
Fri
Sat
Sun

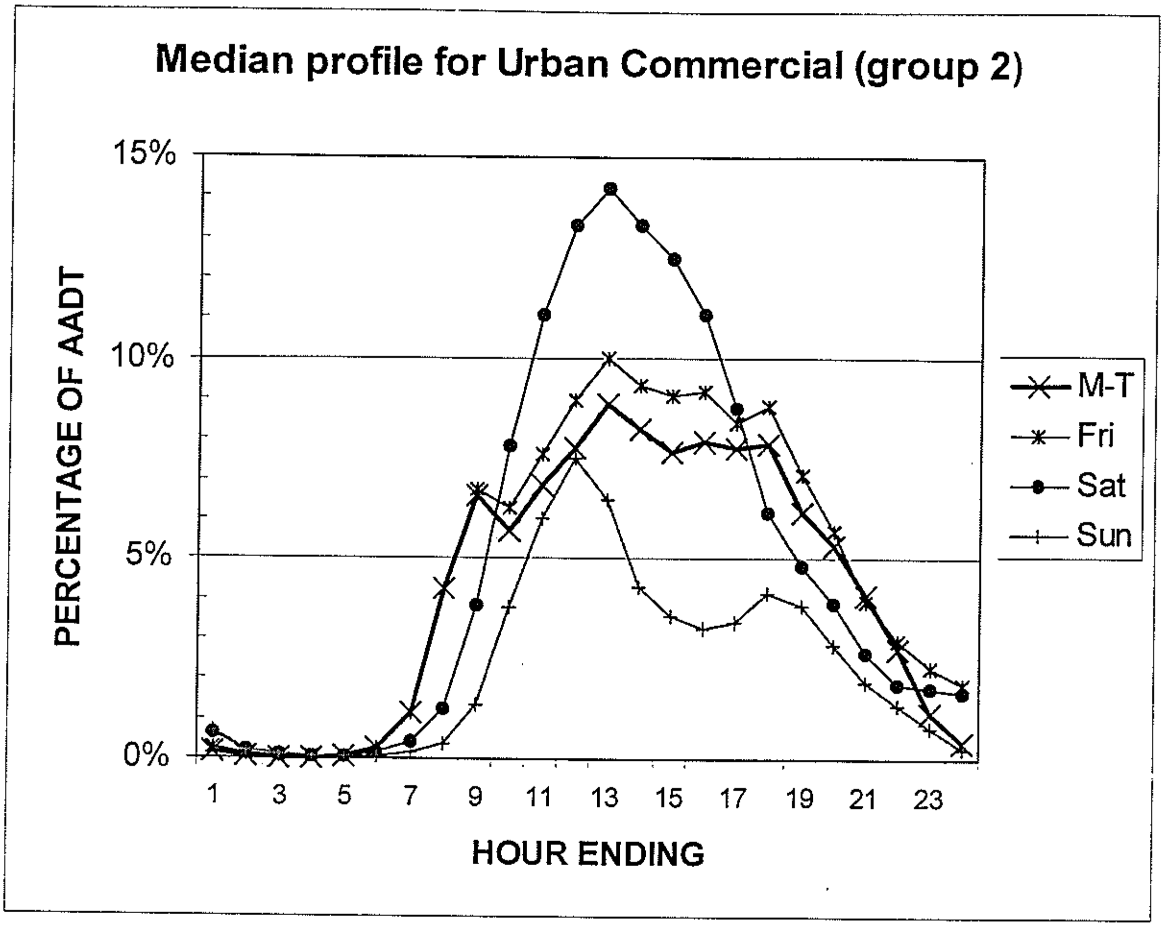
Appendix E:
Median Daily Profiles for Each Traffic Pattern Control Group

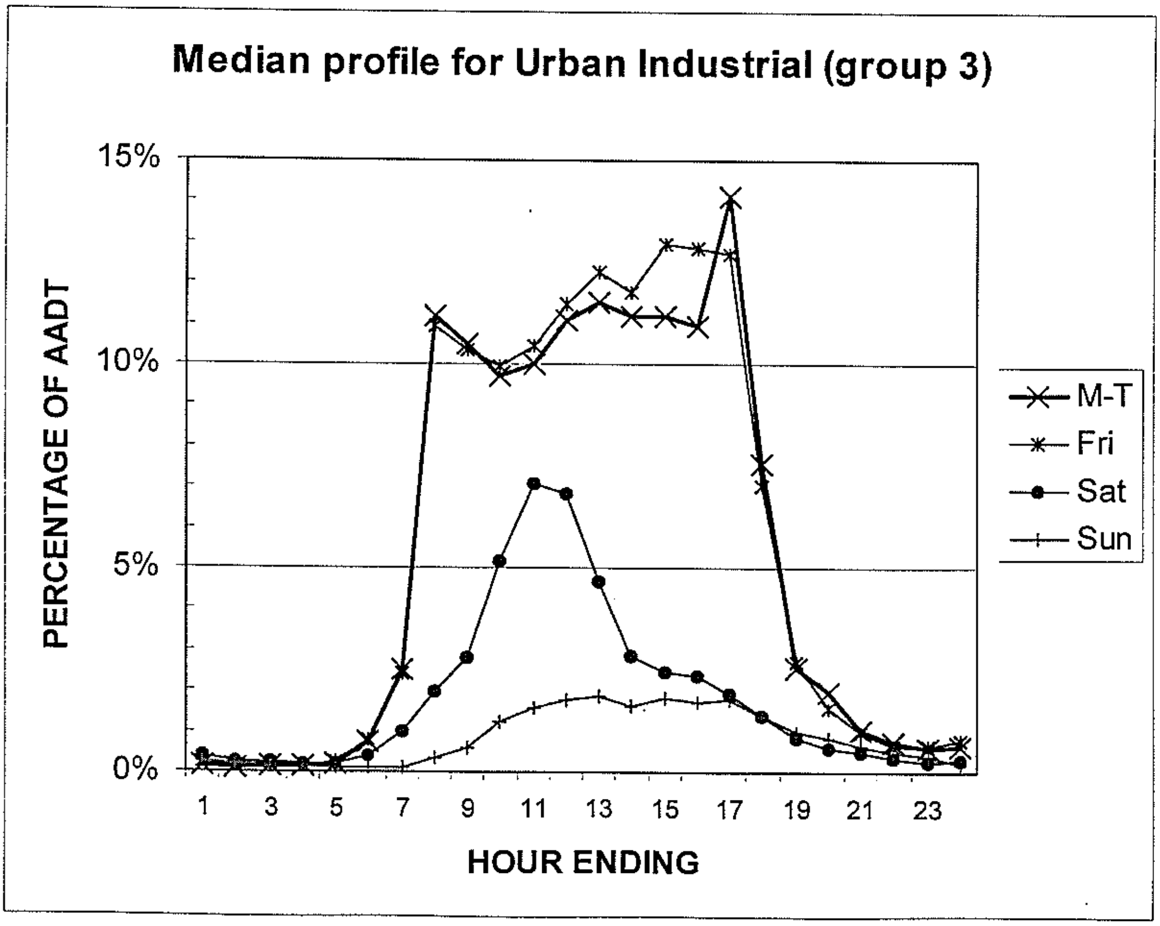
Reproduced from the Transit NZ research project PR3-0025, *Traffic Stream Data*, Appendix C1.

Group	Direction	Daily Profiles
1a	2-way total	M-Th; Fri; Sat; Sun
1b	2-way total	M-Th; Fri; Sat; Sun
2	2-way total	M-Th; Fri; Sat; Sun
3	2-way total	M-Th; Fri; Sat; Sun
4	2-way total	M-Th; Fri; Sat; Sun
5	2-way total	M-Th; Fri; Sat; Sun
6a	2-way total	M-Th; Fri; Sat; Sun
6b	2-way total	M-Th; Fri; Sat; Sun
7a	2-way total	M-Th; Fri; Sat; Sun
7b	2-way total	M-Th; Fri; Sat; Sun

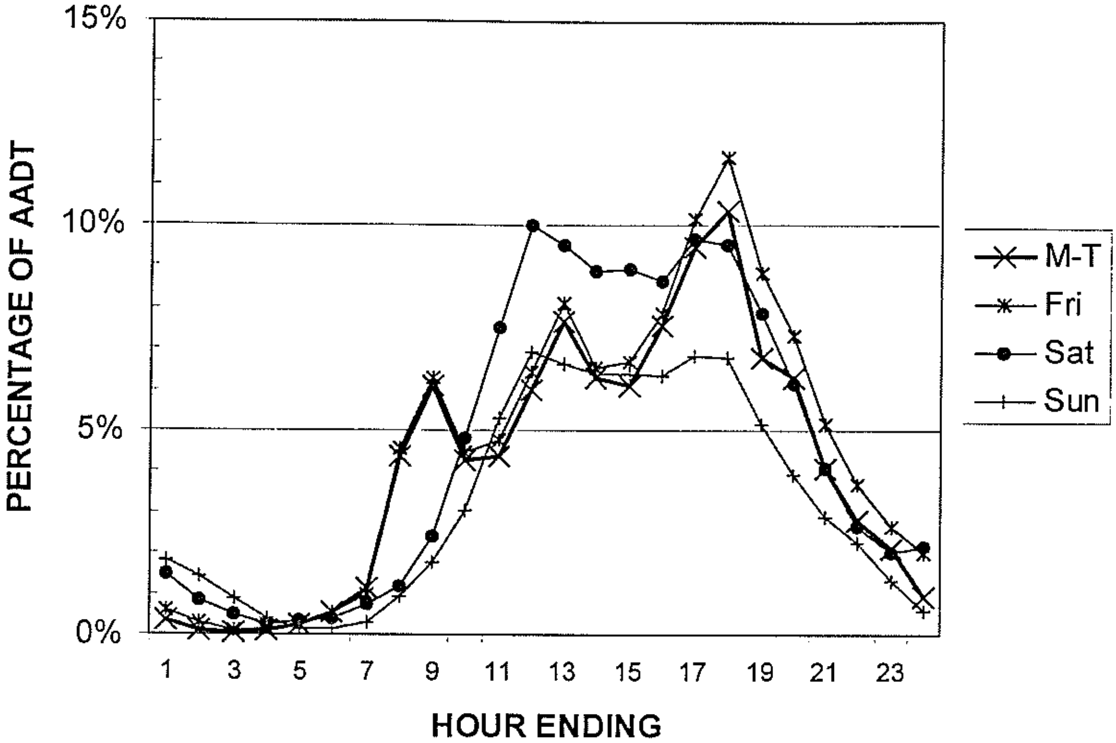

Median profile for Urban Arterial 'a' (group 1a)
15%
10%
5%
0%
PERCENTAGE OF AADT
1
3
5
7
9
11
13
15
17
19
21
23
HOUR ENDING
M-T
Fri
Sat
Sun


Median profile for Urban Arterial 'b' (group 1b)
15%
10%
5%
0%
PERCENTAGE OF AADT
1
3
5
7
9
11
13
15
17
19
21
23
HOUR ENDING
M-T
Fri
Sat
Sun

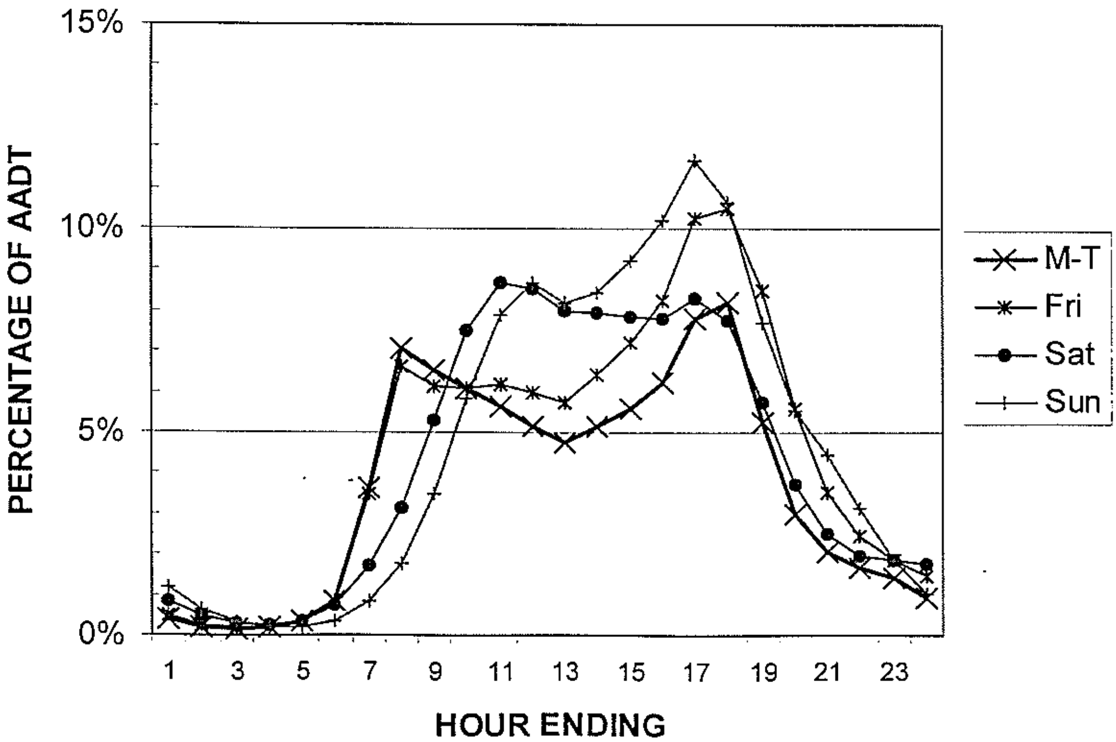

Median profile for Urban Commercial (group 2)
15%
10%
5%
0%
PERCENTAGE OF AADT
1 3 5 7 9 11 13 15 17 19 21 23
HOUR ENDING
M-T
Fri
Sat
Sun

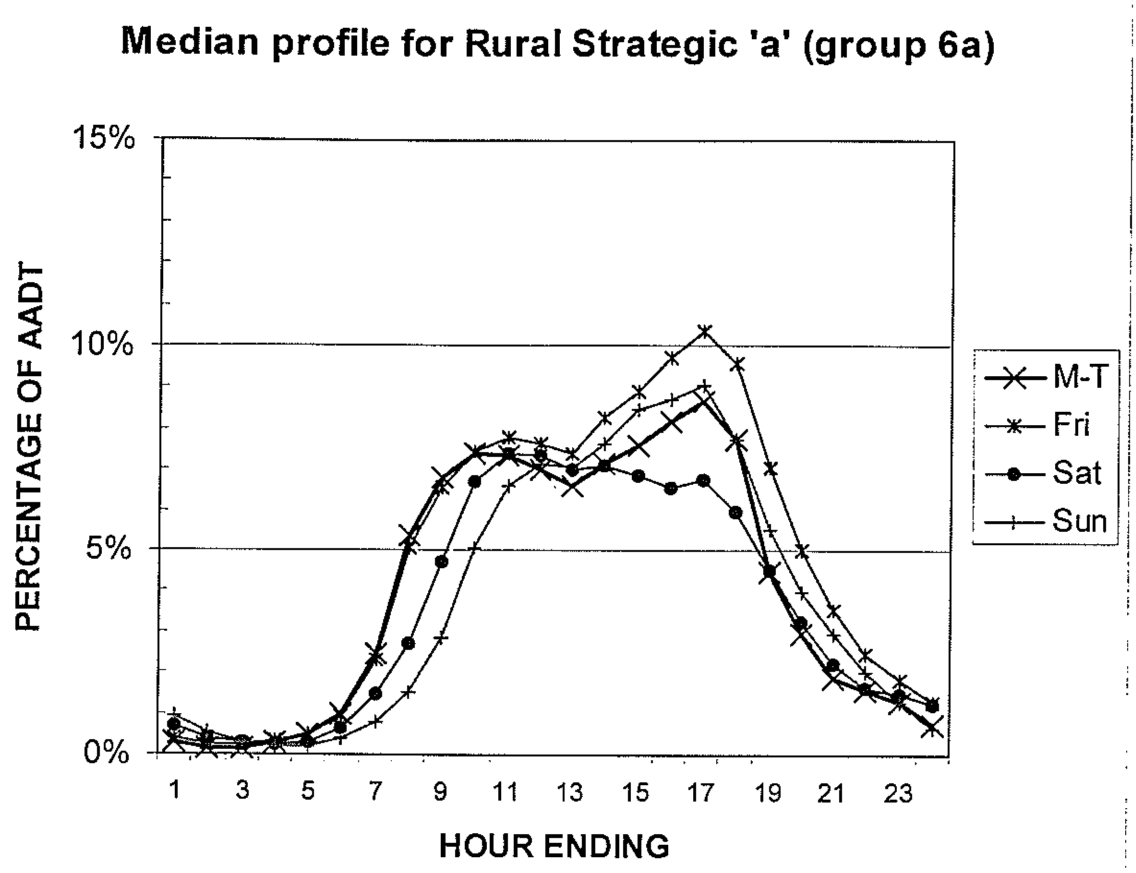

Median profile for Urban Industrial (group 3)
15%
10%
5%
0%
PERCENTAGE OF AADT
1 3 5 7 9 11 13 15 17 19 21 23
HOUR ENDING
M-T
Fri
Sat
Sun

Median profile for Urban Other (group 4)

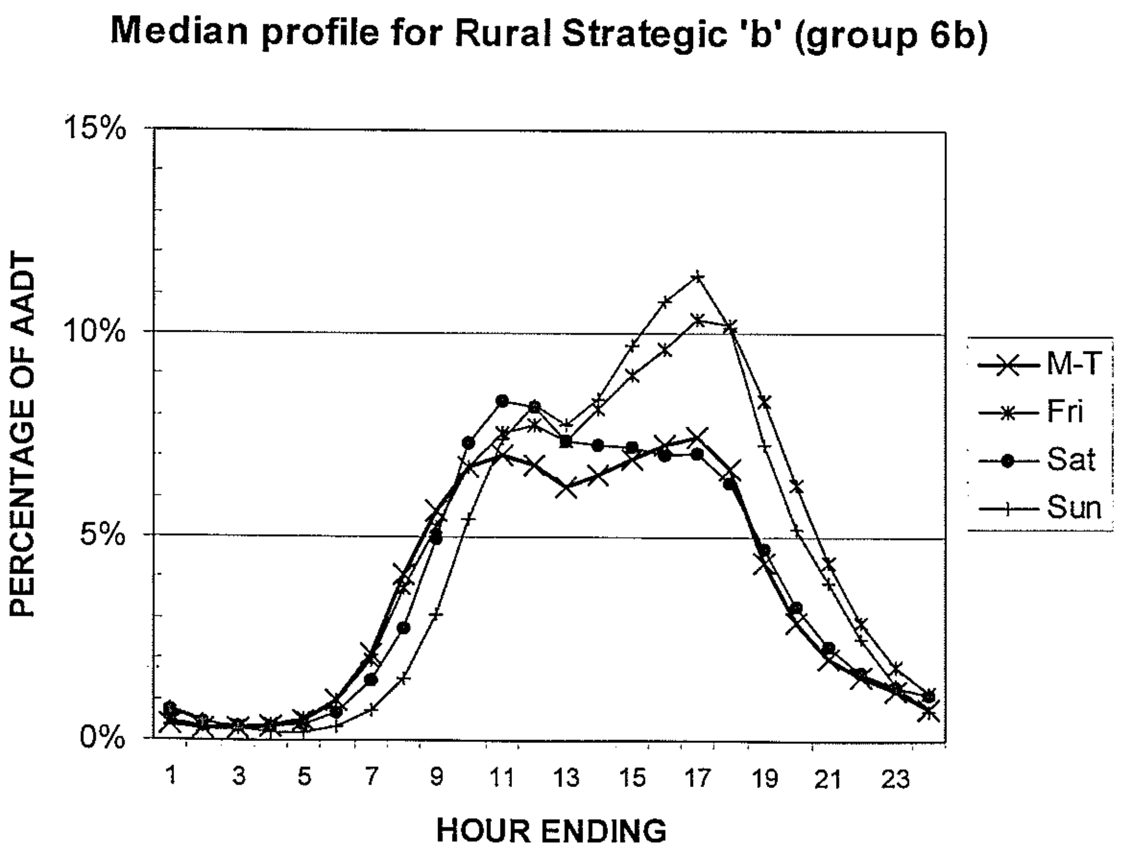


Median profile for Rural Urban Fringe (group 5)



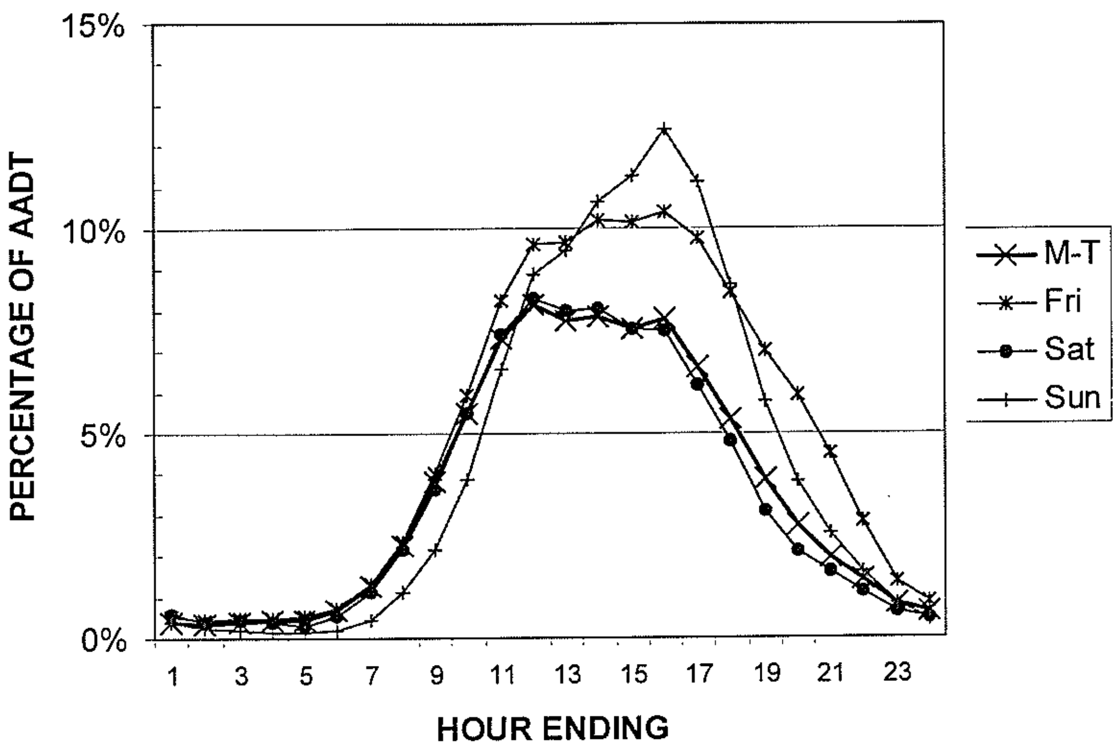


Median profile for Rural Strategic 'a' (group 6a)
15%
10%
5%
0%
PERCENTAGE OF AADT
1
3
5
7
9
11
13
15
17
19
21
23
HOUR ENDING
M-T
Fri
Sat
Sun



Median profile for Rural Strategic 'b' (group 6b)
15%
10%
5%
0%
PERCENTAGE OF AADT
1
3
5
7
9
11
13
15
17
19
21
23
HOUR ENDING
M-T
Fri
Sat
Sun

Median profile for Rural Rec. 'summer' (grp 7a)



Median profile for Rural Rec. 'winter' (grp 7b)