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Rural Truck Speed Differentials
The 1986/87 National Study

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Abstract

This study aimed to examine the effect of the increase in the heavy vehicle speed limit from 80 to 90 km/h on 1 January 1987. Articulated vehicle mean free speeds were found to have increased in four States; car speeds remained stable. The speed differential between cars and articulated vehicles was reduced from 10 to 8 km/h.

Keywords

Road safety, trucks, articulated vehicles, speed, speed differential, crashes

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RURAL TRUCK SPEED DIFFERENTIALS

THE 1986-87 NATIONAL STUDY

BY

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ABSTRACT

This study and others have shown that trucks already exceed the legal speed limits. Truck drivers are travelling at speeds they consider safe in respect of their vehicle, the traffic volume, road environment and police activity.

The principal aim of this study was to examin the effect of the increase in the heavy vehicle speed limit on rural roads from 80 to 90 km/h on 1 January 1987 in every State except Queensland, and in the ACT. Mean free speds were used to gauge whether there had been any significant effect of the speed limit increase on driver behaviour and road safety.

The sampling methods used in this study are biased towards over sampling of trucks and elevating truck mean speeds. Scant attention has been given to sample design in most of the previous studies cited.

Articulated vehicle mean free speeds have increased in four States, as has the percentage travelling faster than 90 km/h. This included Queensland, the control State for the study. Car speeds remained stable during the study period.

There has been an increase in the number of platoons led by cars over the study period. There was a decline in the number of articulated-led platoons.

Speed differentials have been reduced from 10 km/h to 8 km/h for the articulated/car vehicle mixes. Thus a successful decrease in 'speed dispersion' has been accomplished.

Analysis of crashes in Victoria and Western Australia showed no significant changes which could be attributed to the change in heavy vehicle speed limit.

EXECUTIVE SUMMARY

A. This study and others have shown that trucks already exceed legal speed limits. Truck drivers are travelling at speeds they consider safe in respect of their vehicle, the traffic volume, road environment and police activity.

B. Articulated vehicle mean free speeds increased in four States, as did the percentage travelling faster than 90 km/h. There has been a reduction of 2 km/h in the speed differential between cars and articulated vehicles.

C. Car mean free speeds remained stable with some slight increases in Victoria and Western Australia.

D. The control State Queensland which did not increase its truck speed limit also experienced an increase in articulated vehicle mean free speeds.

E. The results obtained from an analysis of mean free speeds recorded on all-roads and two-lane roads are similar.

F. The number of car led platoons has increased by 63% across ALL speed categories between October 1986 and October 1987. This increase straddles the speed limit change in January 1987.

G. During the same period there was a 31% decrease in articulated led platoons across ALL speed categories.

H. It appears that trucks have been over sampled due to the elevated number of sampling sessions during the night time hours. This could also have biassed upwards the mean truck speeds reported in this study.

I. The results of the present study seem to be consistent with the trends in mean free speeds which have emerged from the South Australian time series. Mean free speeds of articulated vehicles have been steadily increasing since 1965 regardless of the legal speed limits.

J. There does not seem to have been any significant changes in truck related crashes in Victoria and Western Australia (the only States examined) concident with the change in heavy vehicle speed limits.

Acknowledgements

This project required information on many aspects of vehicle behaviour from all the States and Territories. The tireless cooperation and ready assistance provided by the officers from these authorities is gratefully acknowledged. A special round of thanks goes to the field teams in each of these authorities who sat, watched and recorded vehicle speeds.

The staff of the Federal Office of Road Safety were terrific in their enthusiasm and support on this year long project. The principal project officer, the Director, Research and the Assistant Secretary, Road User Branch were always a willing foil for thrashing out problems as they arose.

A special thanks goes to our own staff involved in the project. Sue Soames provided meticulous research assistance and her efforts and cheerful comradeship were always appreciated. Leonie Gibbons did a sterling job on the crash time series. Malcolm Mearns of Datacol was responsible for a most professional job of punching the speed data.

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ABBREVIATIONS and DEFINITIONS

ABS	Australian Bureau of Statistics.
Accident	Another term used in the literature for "Crashes". This study prefers the term crashes to accidents because it is more vehicular specific.
ACRUPTC	The Advisory Committee on Road User Performance and Traffic Codes.
ACT	Australian Capital Territory, the Australian Federal Capital Territory.
ADR	Australian Design Rule - standards for vehicle design.
Amphometer	A speed measurement device used in NSW. Two rubber tubes containing air are placed across the road. Vehicles crossing the tubes create a pneumatic pulse which is used to calculate the vehicle's speed.
ANOVA	The parametric statistical testing procedure called Analysis of Variance.
ARRB	Australian Road Research Board.
Artic	Articulated vehicle or Semi-trailered vehicle.
ATAC	Australian Transport Advisory Council.
Auto correlation	A correlation coefficient computed between pairs of observations with lag t terms. Thus the first order auto correlation coefficient is derived by correlating all data points with their following (t=1) term.
Automatic counter or classifier	A speed measurement device which can also classify vehicles into two different length categories or bins. The device consists of two rectangular wire loops fixed to or buried into the road surface connected to a data logger. The loops have an oscillating radio frequency signal feed to them by the data logger. A vehicle passing over the loops disturbs the static magnetic field set up by the loops and is thus counted and its speed measured.
Bias	The bias B of a point estimator t of the population parameter T is given by B = E(t) - T where E(t) is the expected value of t. t will be an unbiased estimator of T if E(t) = T.
Bus	A passenger omnibus.
Car towing	A Car towing a trailer, caravan or other vehicle.
Car	A passenger car or car derivative such as a Station wagon.

CB	Citizens band radio used extensively by truck drivers to communicate between trucks. A typical 5 watt CB has an operational range of 5 to 8 km.
Cusum	Cusum analysis is a plot of the cumulative sum of deviations of a time series from the mean (or arbitrary reference level 'k') level of the time series.
DOT	Federal department of Transport - now Transport and Communications.
Entity set	The name a database is given in the extended relational data model used by ZIM.
FORS	Federal Office of Road Safety, Commonwealth Department of Transport and Communications.
Free speeds	The speed of a vehicle in the traffic stream as measured by either a radar gun, amphometer or infra-red beam. A free speed is one where the vehicle is at least 4 seconds behind the preceding vehicle. This restriction eliminates vehicles which are platooned behind a lead vehicle and thus would have their speed restricted by the lead vehicle. Speeds are reported in kilometres per hour as integer values. See spot speeds.
HCV	Heavy commercial vehicles; referring to rigid trucks, articulated and buses generically.
Heavy vehicles	See HCV
Infra-red light beams	A speed measurement device used by Western Australia. It consists of two beams of invisible infra-red light placed across the road. A vehicle passing through the beams breaks the beams. The time difference between the breaks is used to calculate the vehicle's speed.
kph or km/h	a measure of velocity in kilometres per hour.
K-S	Kolmogorov-Smirnov one sample test of goodness of fit.
K-W	Kruskal-Wallis oneway ANOVA. K-W is the non parametric version of one way ANOVA.
Lvan	A light van i.e. Toyota Hiace.
Motorcycle	A motorised two wheeled vehicle which carries up to two people and sometimes includes a sidecar.
mph	a measure of velocity in miles per hour.
NAASRA	National Association of Australian State Road Authorities.
NMDS	National Mass Data System. A diverse collection of safety and traffic databases kept by FORS.
Normal & Gamma distributions	Statistical probability distributions which have known

	mathematical attributes which are useful in traffic research.
NRFII	National Road Freight Industry Inquiry.
NSW	New South Wales, the Australian State.
ORS	Office of Road Safety - former name of FORS.
Pcthv	Percentage of heavy vehicles. The percentage of the total traffic volume made up of heavy vehicles.
Platoon	A platoon of vehicles is a small queue of vehicles immediately following a lead vehicle which is acting as a block in the traffic stream. The definition of free speeds precludes measuring the speeds of platoon members because they are within 4 seconds of another vehicle.
Q flow weights	Weights for stage 2 (1st after) which are computed by dividing the total traffic flow rate (in vehicles per hour) for stage 2 by the corresponding flow rates at the same site in stage 1 (Before stage). Thus these weights take into account not only the total volume of traffic, but the length of the recording session which varied between study stages.
Q-flow rate	Flow rate of vehicles in a traffic stream expressed as vehicles per hour passing a survey site. Also referred to as flow rates.
QLD	Queensland, the Australian State.
Radar	Sometimes called a "Radar Speedgun"; a speed measurement device used extensively by Australian Police forces for speed enforcement. The speedgun directs a radar frequency beam toward a vehicle (oncoming or receding) and uses the doppler shift to calculate the vehicle's speed. There are a number of frequency bands used by these speedguns - X and K band. Many vehicle drivers have radar detectors mounted in their vehicles and can detect a radar beam some kilometre or more ahead. Slant radar which places a very narrow radar beam at an acute "slant" across the road reduces the utility of these radar detectors considerably.
Raw weights	Within each stage, the total traffic volume divided by the sample traffic volume.
ROSTA	Road Safety and Traffic Authority of Victoria. ROSTA was the predecessor of RTA.
RTA	Victorian Road Traffic Authority.
SA	South Australia, the Australian State.
SAA	Standards Association of Australia.
Sample traffic volume	Of the total traffic volume at a site only a certain fraction is sampled. These vehicles become the sample

traffic volume.

SAS — Statistical Analysis System. The other statistics package used for data analysis.

Space speeds — Speeds of vehicles observed on a long homogeneous stretch of road at one brief time. As an example, if the speeds of all vehicles contained on eight kilometres of the Hume Highway were measured during a brief snapshot, these speeds would be space speeds.

Speed window — The speed window is the degree of overlap between the minimum and maximum speeds for cars and articulated vehicles.

Speed dispersion — Originally, this term referred to the speed difference between trucks and cars. I prefer to rename this term "Speed Differential" so as not to confuse it with the statistical term "speed dispersion" referring to the variance of speed measurements.

Speed differential — The individual speed difference between serial sequential pairs of vehicles travelling in a single lane of traffic. For the purposes of this report, I have restricted the discussion of speed differentials to 2 lane roads (single carriageways) only.

Spot speeds — Speeds of vehicles measured at one location or spot over long periods, typically with a radar gun. All free speeds in this report are spot speeds.

SPSS — Statistical Package for the Social Sciences - the computer program used in the analysis of the data.

Study stage — Stage 1 - the before survey, October-December 1986. Stage 2 - the 1st after survey, March-April 1987. Stage 3 - the 2nd after survey in September-October 1987.

TA or TARU — Traffic Authority or Traffic Accident Research Unit of New South Wales.

TAS — Tasmania.

Total traffic volume — The total volume of traffic which passed a recording site in a specified stream direction.

Truck — A Rigid truck as distinct from an Articulated vehicle.

Un-weighted results — The statistical analysis has been performed on the raw data without any weighting applied.

VHSOSS — Victorian Heavy Speed and Operational Safety Study.

VIC — Victoria, the Australian State.

WA — Western Australia, the Australian State.

Weighted results — The statistical analysis has been carried out with weights applied to the data.

ZIM The database package used for the study.

I. INTRODUCTION

This study began at the June 1986 meeting of the Australian Transport Advisory Council (ATAC). At that meeting it was resolved to increase truck speed limits from 80 km/h to 90 km/h on 1 January 1987. This would occur in all States and Territories except for the Northern Territory (no speed limit), Queensland which already had a speed limit of 90 km/h and Western Australia which increased its limit from 90 to 100 km/h on the Eyre highway. The decision was an interim measure for a trial period to determine whether any negative road safety results would occur.

By September the Federal Office of Road Safety (FORS) 'Safety Aspects of Increased Truck Speed Limits' project had been started and the first surveys took place in October 1986. The contract for the collation and analysis of the speed survey data was put to tender in early December 1986 and the successful tender chosen and commissioned on 16 January 1987.

The principal aim of the project was to monitor the safety aspects of the increase in truck speed limits on rural roads from 80 km/h to 90 km/h which occurred on 1 January 1987. These aspects included truck speeds, platooning and crashes involving trucks.

The study had three survey periods: A 'before' survey in October-December 1986. a 'first after' legislative change survey in March-April 1987 and a final 'second after' followup in September-October 1987.

Depending on the outcome of the three stage study, a recommendation would go to ATAC to increase truck speeds further from 90 to 100 km/h in July 1988.

Each State would use its own existing field teams and survey sites with forms designed by FORS. FORS were to coordinate the data collection with each of the participating States and pass the data onto the consultant.

The States would also be asked to provide a dump of their crash statistics databases for all crashes involving trucks. This crash data would be used to assess any crash and fatality outcomes of the legislative change.

The consultant was required by the brief to present a seminar on the first study stage results. The seminar was presented at FORS Canberra on 5 March 1987. The final report was required by mid November for inclusion into the ATAC briefing in December 1987.

This report has become a sizable and significant document on the subject of truck free speeds. It has been designed to be a reference document which would allow future researchers to directly continue many of the threads left by such a large project.

The database from this project is in the custody of FORS as part of the National Mass Data System (NMDS) and full documentation for its use is included in this report.

II. REVIEW OF THE LITERATURE

"Truck and bus speed limits on rural roads". Loong, Budd & Quayle (June 1985) for FORS (Working Document WD83) has certainly shaped the current study. This particular paper is based on a number of previous works. These were:

* the 1978 Victorian Heavy Speed and Operational Safety Study (VHSOSS).
* the 1984 National Road Freight Industry Inquiry (NRFII).
* the Introduction of Australian Design Rules (i.e. ADR's) 35 and 38.
* the 1983 Rural Speed Survey conducted for the Advisory Committee on Road User Performance and Traffic Codes (ACRUPTC).

In this paper, Loong et al. discussed truck and speed limit compliance:

1. Loong et al. noted. based on the 1983 free speed survey, that the speed limit compliance was very low for trucks and buses on all types of rural roads throughout Australia.

2. Taking all types of roads together the 85th percentile for truck and bus speeds varied from 86 km/h to 99 km/h. Only two out of the 15 sets of results showed figures below the 90 km/h speed limit at the time.

3. Speed limits appear to have little effect on the operating speeds of trucks and buses on rural roads.

In relation to crash rates, the conclusions drawn from the National Road Freight Industry Inquiry (NFRII) based on the 1981 Fatal Accident File available from FORS suggested the following:

1. There are considerably higher fatal crash rates for trucks in rural areas.

2. That articulated trucks have far higher crash rates than rigid trucks. These crash rates are lower than those for cars and station wagons.

3. In multi-vehicle crashes involving a truck, ten per cent of those killed were the occupants of the trucks and 90 per cent were the occupants of other vehicles.

4. Lastly, for all crashes, the crash rate for articulated trucks is a little under half of that for cars and station wagons. Undoubtedly higher speed will increase crash severity but work done by the Traffic Accident Research Unit of New South Wales (TARU) indicates that there may be a threshold speed level beyond which survivability is not affected.

The work of Solomon (1964) and the ROSTA (1978) study indicates that on primary rural roads crash occurrence potential can be reduced if truck and car speeds are brought closer together.

This leads to the concept of speed dispersion, which I have termed speed differential. The FORS submission to the National Road Freight Inquiry (NRFII) recommended the abolition of differential speed limits and the implementation of 100 km/h speed limits for trucks.

The major conclusion which the Loong et al. study came to was that taking all the factors into consideration.

> "It is concluded that differential speed limits for trucks and buses operating on rural roads should be eliminated. On the basis of observed speeds and industry opinion a speed limit of 100 km/h for trucks and buses on rural roads is indicated."

Some of the factors which Loong et al. considered in relationship to speed differentials were:

1. Reducing speed differentials to minimise overtaking.
2. The possibility of crash occurrence.
3. Crash severity.
4. Speed limit compliance and enforcement.
5. The braking standard for truck and trailer as compared to the new ADRs.
6. Industry opinion.
7. The road environment.
8. Cost benefit evaluation.

One point that they did note was that:

> "It appears that the benefits of an overall reduction of speed dispersion may be offset by the disbenefits caused by these additional overtaking manoeuvres." [1]

Thus the thrust of the Loong et al. study is that reducing speed differentials will increase rural road safety in relationship to trucks.

The paper entitled "Heavy Vehicle Speed Limits" (1985) by the Federal Office of Road Safety concerns the case for removing speed limit differentials.

On page 26, Appendix 3 of this paper the authors compare and contrast the 1978 Callaghan study of free speeds and the 1983 survey of free speeds. Both studies were coordinated by FORS on behalf of ATAC.

The first point made about mean speeds and speed dispersions is that the 1978 study (Callaghan, 1978) indicated that the difference in statewide mean speeds of cars and trucks was between 11.6 and 19.5 km/h. By contrast this differential had reduced to between 9 and 18 km/h in the 1983 study. The authors put this down to generally higher truck speeds in 1983.

A point that needs to be made here is that the definition of the speed differential as "speed dispersion" is the difference between the mean speeds of cars and trucks in contrast to the concept that I will be using in this paper. Speed differentials are the individual speed differences between serial sequential pairs of vehicles.

The other important point that is made here is the question of compliance. As Callaghan pointed out in 1978, over 50 per cent of the heavy vehicles exceeded 80 km/h and almost 50 per cent of cars exceeded 100 km/h (the

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[1] Refers to the NFRII recommendation that only trucks conforming to the new braking ADRs be allowed to travel at faster speeds.

speed limits at the time). By contrast, in 1983 there is an indication of a higher degree of compliance by car drivers with more than 40 per cent of cars exceeding the speed limit (divided highways in NSW & QLD) . There was a reasonable level of compliance to truck speed limits in Queensland with only 20 per cent exceeding 90 km/h on undivided highways and 37 per cent on divided highways. For other States however the proportion of trucks exceeding 80 km/h ranged from 53 to 85 per cent.

Thus the conclusion that the authors came to is that speed limits do not influence free speed significantly, particularly speed limits which are regarded as unreasonable by the truck operators themselves. To quote:

> "The 1983 speed survey clearly indicates that truck drivers by their massive non-compliance regard 80 km/h to be an unreasonably low limit. If the truck speed limit was increased to the general speed limit, which is in excess of 95 km/h, and this was accompanied by a public information campaign about speed dispersion there is good reason to expect that the new limit would be much better complied with, that the high limit would be more effectively enforced and that very high truck speeds would be reduced and that overall speed dispersion would be reduced as well."

A problem with both the Callaghan paper of 1978 and also this review paper from FORS is that no sample sizes are quoted.[2]

The conclusions of this paper (Callaghan, 1978) were that there was a relative lack of compliance with speed limits in most States. Drivers select the speeds they consider most appropriate to the prevailing conditions. Also the free speed distributions for cars and their drivers

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[2] For the Callaghan study (1978), appendix B1 on page 30 in New South Wales 16 sites were observed and the sample sizes range from as small as about 51 through to a maximum of 496. It appears that the sample sizes were about 3,500 to 4,000 vehicles per State. The states sampled were NSW, VIC, QLD and SA.

In the Loong & Budd study and also the HCV surveys in 1983 (ROSTA, 1983) there is no indication in either paper of the sizes of the vehicle samples taken. There is an indication in the Loong & Budd paper about the number of sites surveyed - that is to be found in Appendix A page 12. This lack of published sample sizes I consider to be a serious problem. The comparability of the studies is a function of the sample sizes.

In this respect the only study with which I can very carefully compare the present study is the 1978 Callaghan study which quotes sample sizes. These sample sizes were:

New South Wales	5,516
Victoria	unknown
Queensland	9,086
South Australia	6,884
Western Australia	2,000
A.C.T.	1,104

The grand total is approximately 29,590 vehicles. So the Callaghan study of 1978 is quite definitely comparable to the present study (see table 1.1). In fact the collection forms and procedures seem to have set the ground rules for all subsequent surveys.

have higher standard deviations than those for HCVs. Callaghan noted that the free speed distributions tended to be normal.

Callaghan findings included:

1. that 50 per cent of heavy commercial vehicles exceed the 80 km/h speed limit and almost 50 per cent of cars exceed the 100 km/h limit in most States.

2. that the speed differentials between cars and their derivatives and heavy commercial vehicles is generally between 12 and 23 km/h. This is based on the subtraction of the free speed means.

The paper by J.E.Cowley titled "The 1979/80 ACRUPTC Survey of Vehicle Free Speeds in Capital Cities of Australia" published in September 1980 is another landmark study of HCV speeds.

This survey measured free speeds of cars and derivatives, trucks and other vehicles on a wide spectrum of urban roads in capital cities of the six States of Australia and the Australian Capital Territory. The survey was carried out between November 1979 and July 1980 and consisted of 145 sites covering a total sample of 4,268 vehicles.

The cities covered were Sydney, Melbourne, Brisbane, Adelaide, Perth and Hobart and the Australian Capital Territory. The guidelines for the survey called for free speeds to be measured on level straight roads (dry pavements) on weekdays between 0800 hrs and 1700 hrs during non-holiday periods.

A wide variety of road classes including freeways, arterial, non-arterial, divided and un-divided roads with a variety of posted speed limits were included in the sample.

One interesting conclusion that Cowley reached regarding the use of averages weighted by vehicle sample sizes as a method of reporting results was:

> "It is unlikely that simple and weighted averages would differ markedly for cars because the sample sizes are large and generally consistent".[3]

One of the main conclusions Cowley reached, highlighted in Table 4 (Cowley, 1980) was that the 85th percentile speeds range from 67 to 74 km/h and that 55 per cent of cars in Australian capital cities exceeded the posted urban speed limits. Also the speed means ranged from 60 to 80 km/h and the 85th percentile ranged from 70 to 90 km/h depending on the particular road type. The proportion of vehicles exceeding the speed limit ranged from 30 to 40 per cent for freeways and speed zoned arterials and up to 55 to 65 per cent for roads operating under the 60 km/h general limit. Thus the speeds of cars in Australian capital cities were very high in comparison with existing speed limits.

Moving on to trucks Cowley noted that 37 per cent of rigid trucks exceeded the speed limit. Truck speed compliance across Australia was more consistent than for cars.

Once more the conclusion he reached was that the free speed of rigid

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[3] Thus like Callaghan in 1978, Cowley reported unweighted simple averages.

trucks in Australian cities;

> "tend to be high in comparison with the posted speed limits on arterial and non-arterial roads subject to general 60 km/h speed limits".

The free speed characteristics of rigid and articulated trucks was similar and ranged within plus or minus 5 km/h depending on the State. Apparently Thompson (1978) noted the same feature.

As far as speed differentials are concerned, Cowley noted in Table 4 that rigid trucks were in general somewhere between 0 and 15 km/h slower than cars.

J.E.Cowley was responsible for another paper titled "A Review of Rural Speed Limits in Australia" published in January 1980.

Cowley's major conclusion (1980,68) was that there appears to be no meaningful relationship between the free speed parameters and the speed limit values. If anything the correlations are negative. He also recommended that the absolute speed limits for Australia should be somewhere in the vicinity of 100 to 110 km/h and that there appears to be no clear advantage for either level for daytime operation.

As for speed differential limits for the four vehicle classes, heavy trucks, omnibuses, vehicles towing and motorcycles with passengers, he recommends a 90 km/h limit for the first three i.e. heavy trucks, omnibuses and vehicles towing, and no differential limit for motorcycles with passengers. The 90 km/h differential limit is conditional upon the 110 km/h speed limit for general traffic being implemented. He also concludes that there is substantial evidence supporting the differential 90 km/h limit for heavy vehicles even when there is 100 to 110 km/h general speed limit in place.

The main thrust of Cowley's report was to examine past and present rural speed limit provisions in relationship to the different speed limits enforced on Australian rural roads and to relate this to the findings from local and overseas studies of the safety benefits of rural speed limits.

Cowley raises the question of the comparison between crashes and casualty rates and speed limits. This harks back to the Solomon study (1964) which showed that as speed limits rose then the fatality rates rose dramatically as well. The problem that Cowley highlights is that it is very difficult to do these comparisons because of the different reporting criteria used especially with casualty information. Thus the only practical method is to compare fatality rates.

Cowley also notes that there is very little support for differential speed limits for night time driving. Cowley suggests that one of the main objectives of speed limits is to reduce the variance of speeds within the traffic stream. This has the effect of primary safety as the risk of crash involvement increases as speeds above the mean traffic speed increase. A secondary safety effect is that severity of crashes increases steadily with speed, as shown by Solomon in 1964.

In conflict with the above objectives is that by reducing traffic speeds an increase in journey time, trip cost and energy consumption is produced. More importantly, compliance with the speed limits drops as motorists tend to go faster than the speed limit.

Gavin Maisey's paper "The Effect of Increasing the Speed Limit and

Associated Penalties for Heavy Vehicles on the Eyre Highway" (Maisey, 1983) has substantially influenced the present study. It has also provided valuable longitudinal data for calibrating this present study.

Maisey's study is one of the best studies of trucks in the literature to date. It consisted of a 24 hour unobtrusive observation of traffic speeds on the Eyre Highway, recorded over three survey periods. The first period was nine months prior to a change in the legislation and then six months and eight months after the change.

The legislative change increased the speed limit for heavy vehicles travelling along the Eyre Highway in Western Australia from 80 km/h to 90 km/h on 1 February 1983.

The major finding of this study was that the proportion of heavy vehicles exceeding 90 km/h decreased from 80 per cent in the before study to 73 per cent in the first after dropping to the final 67 per cent in the second after study. Also the percentage of articulated vehicles travelling faster than 110 km/h fell from 21 per cent to 7 per cent and then returned to 13 per cent (see plot 5.2).

An interesting point made by Maisey is that the free speeds of cars should be used as a control to calibrate the changes in truck speeds. Thus the open speed limit of 110 km/h for cars and motorcycles remain unchanged across the study period. Maisey observed very little change in the car speeds between the before and the two after periods.
An important definition which Maisey adopted was that semi-trailers (articulated vehicles) were used as an indicator of heavy vehicle speeds in general. Very few rigid trucks were observed in his Study.

Maisey maintains that there were no long term trends, either increasing or decreasing, leading up to the change in legislation which would have affected the results.

The unobtrusive method that Maisey used to measure free speeds consisted of infra-red light beams with the detectors some 3 to 4 metres from the road and field officers some 100m from the road.
Maisey maintained that monitoring of CB communications suggested that very few drivers at all were aware that the speed surveys were being conducted. Maisey cites a paper by Johnston & Fraser, 1983, which found that visible digital detectors did not influence driver speed behaviour.

The results of the Maisey study were:

1. The proportion of vehicles exceeding 90 km/h decreased following the change in legislation. This decrease went from 80 per cent of vehicles travelling faster than 90 km/h to 73 per cent on the first after to 67 per cent on the second after.

2. The mean speeds fell approximately 2 km/h and 4 km/h from 100 km/h recorded in the before study.

3. The reduction in high speeds of the semi-trailers in the first after period was statistically significant (using the log odds ratio test) but the change in the second period was not significant.

4. Day/night effects: Maisey found that the speeds of semi-trailers were much higher at night than during the day-time. Most of the decrease in semi-trailer speeds in the two after periods was observed

during the night-time hours. In the before period, 39 per cent of semi-trailers at night were observed at speeds exceeding 110 km/h and this dropped to 11 per cent and 14 per cent respectively in two after studies. He found that this reduction in high night-time speeds of semi-trailers exceeding 110 km/h in the first after period was statistically significant when compared with cars and motorcycles.

5. Vehicle direction effects: Maisey found that the westward bound semi-trailers recorded speeds consistently higher than most eastward bound. The 85th percentile speed for the before study for westward bound semi-trailers was 120 km/h and 106 km/h for eastward bound vehicles.

Most of the reduction in semi-trailer speeds in the after studies was in the westward direction.

Maisey concluded that there was no substantial increase in the number of semi-trailers or other motor vehicles involved in reported crashes in 1983 compared with previous years. Thus, there did not seem to be any negative safety aspects to the speed limit increase, and he concluded that:

"the current speed limit for heavy vehicles on the Eyre Highway remain at 90 km/h provided that the increase penalties remain for the violations of the limit."

III. Methodology

The study's methodology was a "before and after" design with matching on study sites. The legislative change occurred on 1 January 1987 and the three surveys were designed to straddle the legislative change.

The legislation increased the speed limit for all HCV from 80 km/h to 90 km/h on rural roads. This occurred in each of the seven States in the study (see Table 3.1) with the exception of QLD and WA. QLD had no speed limit change and the speed limit remained at 90 km/h for the duration of the study. Thus QLD acted as a control for all other States. WA's speed limit rose from 90 km/h to 100 km/h only on the Eyre highway from 1 January 1987 for articulated vehicles only.

The before study occurred during October-December, 1986. Tables A1 - A3 (Appendix A) describe the sites in detail.

The first after survey occurred in March-April 1987 (see Tables A4 - A6, App. A) and the second after survey took place in September-October 1987 (see Tables A7 - A9, App. A), a year after the first survey.

The same study sites were used in each of the three surveys.

The measurement instruments used to record vehicle free speeds include radar speedguns (all States except NSW & WA), amphometers (NSW) and infra-red light beams (WA). The question of recording bias induced by the use of these instruments is discussed in Appendix I.

Site selection was determined in consultation with each State. Only rural roads were selected and as all States had existing speed monitoring sites on these roads, a selection of these was used in the study. The sites chosen were straight level stretches of rural main roads or freeways.

III.1. Data Collection procedures

The data collection was carried out by each State's existing field teams using a form devised by FORS (see Appendix D). This form was a copy of the NSW form.

The data collected was of two types. Firstly, a header sheet was completed for each recording session and described the site, its location, time and date of the session, site characteristics (road type, surface etc) and weather conditions. A separate tally sheet was kept for each session and tallied the total number of vehicles passing that site by vehicle type.

The second set of data collected consisted of the free speeds for a sample of the total traffic volume. Thus the vehicle type, its free speed, the time of recording, direction of travel and platoon length behind it, if any, were recorded for each vehicle sampled.

Survey sessions consisted of a minimum of 4 hours in duration at times selected by the States. A rigorous time sampling strategy was not used to address the issue of time of recording bias. FORS had specified the three time periods (6am - 6pm, 6pm - 12pm, 12am - 6am) and the days Saturday, Tuesday and one other day.[4]

Traffic streams were generally sampled in one direction only. Appendix C outlines some of the problems encountered with sample direction.

The methodological issue of inter-experimenter variability could not be addressed by the study design. The authors were able to attend a limited number of field team recording sessions in NSW and the ACT. These suggested that more work needs to be done to reduce the recording noise entering the data at this stage. Overall, the field teams were experienced teams used by each State on a regular basis.

The total traffic volumes were collected to allow post sample weighting to adjust for flow rate differences between the three phases of the study. Section III.3. addresses this issue.

There is debate over the question of conspicuity of speed measurement and its consequent effect on driver behaviour. There are two related issues in this debate: one is the effect of the speed measurement device on driver behaviour and the other is the presence of the field team, its conspicuity and the effect on driver behaviour.

Victorian officials went to some lengths to demonstrate the experimenter bias induced due to the presence of field teams by the roadside. However, it would seem that any vehicle parked on the roadside may affect driver behaviour. The effects were equivocal.

Gavin Maisey's team in WA were situated 100m from the roadside and were considered invisible to the drivers. CB evidence reinforces this belief.

The issue of bias induced by the presence or absence of radar is discussed in detail in Appendix I. The evidence suggests that the use of a speed recording device which is also a police speed detection device does significantly .ffect driver behaviour.

A related issue is whether automatic counter data is a valid and reliable method for collection of free speed data. Appendix I examines this issue and finds these devices wanting.

III.1.a.1. Site descriptions - site characteristics

The site description documentation is contained in Tables A1 through A9 in Appendix A.

Tables A1. A4 and A7 contain the temporal attributes of the sites that were used to record free speeds for each study stage.

Part of the reason for including these Tables is to illustrate the variety from State to State of times in which the free speeds were recorded. Probably the most consistent set was in Western Australia where all the sites were under 24 hour surveillance.

[4] This lack of rigour became apparent when the sample fractions by State and vehicle type are examined (table 1.1). If the sampling regime was at all systematic then the sample fractions by vehicle type should be equal.

Tables A2, A5, A8 contain information describing the road characteristics of each site. Tables A3, A6, A9 contain more details concerning the environmental aspects of each site.

III.1.a.2. Site descriptions - Traffic volumes

Tables B1 through B3 (Appendix B) contain a complete list of the total traffic volumes observed at all the study sites broken down by vehicle type for each of the stages. Thus looking at Table B1 for the first location (site 1001, New South Wales site number 1) we see that the speed recordings were carried out on 21.10.1986. The recording session started at 0200 hours and was completed at 0600 hours.

During that period of time the total volume of traffic that passed that recording site was 130 vehicles as indicated by the far right hand column. Those 130 vehicles were broken down into (reading from left to right) 81 cars, 36 articulated vehicles, 9 rigid trucks, 3 buses, no cars towing, 1 motorcycle and no light vans.

Tables B4 through B6 contain a complete list of the sample traffic volumes observed at all the study sites broken down by vehicle type and stage of the study. Thus comparing location No. 1001 once more with the its sample volumes (Table B4) we see that from the total traffic volume of 130 vehicles which passed this site between 0200 and 0600 on the 25.10.1986, 81 were sampled.

Of those 81 vehicles sampled there were (Table B4): 42 cars, 23 articulated, 7 trucks, 1 bus, 2 cars towing, no motorcycles and 6 light vans.

Interestingly enough this particular site illustrates some of the anomalies that were discovered in the site data from a number of the States. For instance, the total traffic volume reported no cars towing (Table B1) yet two vehicles were sampled (Table B4). Similarly, the total traffic volume for light vans was none, yet there were 6 light vans sampled.[5] The quality of the total traffic volume information reported on the header sheets is questionable. This is an unfortunate consequence of the lack of tight and consistent survey control.

III.1.b. Sampling method

Table 3.1 summarises the sampling frame for this study. The sampling methodology consisted of a mixture of systematic sampling and 24 hour surveillance of the traffic streams. Western Australia and Tasmania carried out the 24 hour surveillance due to low traffic volumes.

The sampling was to have occurred at three levels - date of each study stage, sites selected and traffic flow sampling by time of day and week.

1. The date of each study stage was dictated by the political agenda. The before stage (October 1986) was followed one year latter by Stage 3 (October 1987). The first after study (stage 2)

[5] The Tally sheets included with the header sheets were checked carefully against the totals reported on the Header sheet. The Sample volumes reported on the Header sheet were ignored and replaced by the number of records found from the free speed sheets.

occurred in March/May 1987, four (4) months after the legislative change on January 1, 1987.

2. Site selection was dictated by the States' existing traffic surveys. They selected from their site suites a group of rural sites with potentially high volumes of trucks.

3. Within a site, systematic sampling was anticipated, usually every fifteen minutes, with five minute recording blocks. The site sampling was far from ideal.

<u>From the statistical standpoint the sampling methodology for this study was not rigorous and is probably biased towards over sampling of trucks.</u> The sampling methods outlined in the study brief could not be enforced by FORS.

Referring to Table 3.1 which outlines the total number of vehicles surveyed by State, study stage and vehicle type a number of pertinent points emerge.

1. The sample volumes were 27,199 in the before survey dropping to 24,451 in the first after survey and rising back to 25,853 in the second after survey. These numbers constitute the number of vehicle free speeds which were measured by the respective field staffs in all the States combined.

2. The total traffic volumes which passed the field staffs while they were sampling, thus forming the universe of vehicles which could be sampled was 58,081 in the before survey, 53,332 in the first after and 52,986 in the second after survey. Thus the sample fractions were quite healthy, ranging from 46 per cent in the before survey to 45 per cent in the first after through to 48 per cent in the second after survey.

3. The consistency of the sampling fractions across the study stages in aggregate is reassuring.

It should be noted that each State used its own field staff and its own established sampling procedures to measure all of these free speeds, quite independent of each other and FORS. If anything the consistency which has emerged is a reflection of the well established field work and field procedures which the States have been using for a number of years to measure free speeds. Thus FORS was quite fortunate in being able to tap into this well established system.

4. For articulated vehicles the sampling fraction fluctuated from 80 per cent down to 73 per cent and then up to 79 per cent across the three study stages - a range of 7 per cent. Rigid trucks fluctuated from 81 per cent through to 72 per cent then back to 72 per cent - a range of 9 per cent. Cars fluctuated from 37 per cent to 39 per cent to 42 per cent across the three stages - a range of 5 per cent.

5. HCV have been over sampled compared to cars. The sampling instructions emphasised articulated vehicles. Given that over sampling did occur then a process of post sample weighting was called for (see section III.3.). Sections IV.2.e and IV.2.f. examine some of the possible causes of this sample bias.

6. The 100 per cent sampling fractions for WA and Tasmania are a reflection of the small traffic volumes in those States. No explanation

for the variation in the sampling fractions for the other States is available. New South Wales, Victoria and Queensland for the first after and the second after surveys had approximately the same total traffic volumes but their sampling fractions were radically different (Table 3.1).

Point five above leads to the question of how were the individual vehicle types sampled compared to each of the other States. Table 3.2 lists the sampling percentages of each vehicle type within each State for each Study Stage.

Western Australia and Tasmania were the only two States which implemented 24 hour surveillance and thus removed any sampling effects due to Time of Day. Articulated vehicles consistently accounted for 20% of the vehicles sampled in WA for each of the study stages. The percentage of articulated vehicles ranged from a low of 4% in the ACT to a high of 45% in VIC.
The percentage of cars fluctuated across States from 30% in VIC to 79% in TAS.

This examination of the sampling percentages by vehicle type strongly suggests that either the actual distributions of vehicle types in the States are radically different or that the samples in each State are biased towards different vehicle types. None of the State distributions resemble the overall Australian distribution of "Registered motor vehicles" published by the ABS (see Table 3.2). But the proportions of vehicle types on register are not the same as the proportions of vehicles likely to be observed on the road.

The observed bias in vehicle distributions then leads to an examination of the Time of Day effects. In an ideal study, each State would have used 24 hour surveillance (thus controlling time of day as a sample factor) and all sampled on the same days (thus controlling for day of week and time of year). In practice the States sampled in blocks of four hours spread unevenly across the day all on different days spread over a month.

Examining Time of Day alone, Table 3.3 and plot 3.1 illustrate the number of active sample sessions aggregated across all States and all sampling days for each of the study stages.[6]

There seems to have been a heavy emphasis on sampling between 1700 hrs and 2200 hrs. The number of sampling sessions varies widely over the 24 hour period. In an ideal study, this frequency distribution would be close to a straight horizontal line.

If a particular vehicle type, such as a truck was more likely to be on the road at a particular time of day (such as between 1700 and 2200 hrs), then that vehicle type would have been over sampled as a function of the number of active sampling sessions. The distribution of plot 3.1 is quite similiar to the sampling distribution of articulated vehicles in plot 4.18.

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[6] A three dimensional plot of the sampling session frequencies was drawn for each State. Thus the X axis contained the Time of Day of the sampling session, the Y axis the date on which the sample took place and the Z axis was the number of sessions.

Thus plot 1.0 is a side on view of the Z and X axis with the Y axis collapsed.

Conclusions

a. The total sampling fractions for each stage as noted in Table 3.1 were consistently above 45 per cent of the total observed traffic streams in each study stage.

b. The sample traffic volumes were equal to the larger studies done elsewhere in Australia - Cowley 1980 and Callaghan 1978.

c. The sampling fractions for articulated vehicles for each stage were consistently greater than 73 per cent.

d. The sampling fractions for cars for each stage were consistently greater than 40 per cent.

e. The survey design is such that statistically we cannot say with any confidence that the sample is representative of the Australian vehicle population. Clearly, trucks have been over sampled, but to what extent is unknown. The effects of time of day and the number of active sampling sessions have contributed substantially to this bias.

III.1.c. Speed recording methods

The following section outlines the methods that each State used to record free speeds. Some States did not provide this detailed information.

A. Western Australia

Measuring device:

Two infra-red light beams were used to detect vehicle speeds, they were linked to a Digitector speed recording instrument.

Two devices with infra-red light beams 25 metres apart were set back three to four metres from the roadway. These two infra-red light beams were linked to the digitector with 100 metres of cable so that the observers were well obscured by surrounding vegetation.

Visibility of surveys:

The visibility of the field team was further minimised by situating the observers and vehicles well back off the roadway.

Monitoring of CB radios indicated that vehicles using the road were not aware of the speed recording operation. Two police officers were used to complete the surveys and unmarked police vehicles were used for transport to and from the survey sites.

Site selection:

The sites selected were flat straight open road, 110 km/h maximum speed limit with surrounding vegetation and not in close proximity to urban centres. The road type was two-lane undivided highway.

B. New South Wales.

Measuring Device:

An amphometer which consisted of two air tubes connected to KR11 transducer counting unit. The spacing between the tubes was 15 metres. Some sites used different equipment with tube spacings of 5 metres. Two people were used to record information: One recorded the speeds and the other counted the volumes. The type of vehicle used to transport the field officers was a Falcon wagon and was a hire car with Queensland plates.

Visibility of the surveys:

The field team parked well back from the road so that it was not readily obvious what the car was doing. CB radio was used to monitor whether the car was inconspicuous or not and there seemed to be no problems with conspicuity.

Site selection:

As specified by FORS letter 19.9.86 but with consideration given to the practical problems of travel to and from the locations.

Straight level sections and the ability to get the field team vehicle off the road was one of the major criteria.

C. Australian Capital Territory

Speed Measuring Device:

A radar speed gun with the brand name "Speedgun" manufactured by CMI Incorporated USA.

Number of Persons Involved:

Two people were involved in each survey period: one person for traffic unit classification, one person to record the speed measurements.

Visibility of surveys:

The type of vehicle used to undertake the survey was a Commonwealth registered Ford station wagon with a flashing light attached on its roof (which was turned off). The vehicle had a CB radio transceiver which enabled field staff to monitor truck drivers' conversations. No attempts were made to camouflage the vehicle.

Site Selection:

The sites were selected to meet the specifications supplied where possible. Two sites were selected after discussion with FORS. Majura Road (a two-lane undivided road) and the Barton Highway (four-lane divided road) were chosen.

D. Victoria.

Speed Measurement Device:

A radar gun through the back window of the vehicle. Vehicle speeds were measured from a distance of about 500 metres with speeds not being recorded any closer than 200 metres. They used the K-Band radar which is not the radar used for enforcement in Victoria.

Visibility of surveys:

The type of vehicle used to undertake the survey was a non-standard car (not an official car) e.g. Mitsubishi Colt or a Toyota Corona. The vehicles were parked in the same direction as the traffic flow with the bonnet up and if it was not raining, a spare tyre or director's chair obscuring the back number plate.

The vehicle was to be parked as far off the road as possible. CB radios were used to monitor truck drivers' comments but the staff were instructed not to make transmissions. CB radio transmissions indicted that drivers were aware of the survey vehicle.

Site Selection:
Nine rural sites were selected; either four-lane divided freeways or four-lane divided highways and two-lane highways. Other than that there are no other details on site selection.

III.2. Database manipulation procedures

Appendix E, Tables E.1 and E.2 contains the schematics of the database structures used to manipulate the header sheets in relation to the free speed data for all stages of the truck speed study.

The database model used to manipulate the truck speed data was the extended relational model, sometimes called the entity relational model, which is used by the database package ZIM.

Each stage of the study had three databases (entity sets). Using Stage One as an example, the first entity set is part 1 of the header sheet information called TRK1A. This database contains all the site descriptions - road type, road name etc..

The second part of the header sheet is contained in the entity set called TRK1B which contains all the total traffic volumes for all the corresponding sites in the database TRK1A. This database also contains all the computed means, all the computed traffic flows and all the computed sample volumes.

The main free speed entity set is called BFSP and contains the information coded for every vehicle sampled. This includes location, the date, the time the vehicle was recorded, its free speed, the vehicle type, the direction it was travelling in and also what sort of platooning occurred behind it.

A link function LINK1B and LINK1A were used to join the entity sets TRK1B to BFSP and TRK1A to BFSP. See Tables E.1 and E.2 for details.

The stages which were required to verify and link this set of three databases together for each of the stages are outlined in the schematic Table E.2 in Appendix E.

The first phase entailed matching all the header sheets for both stages to make sure that the data punched was correct. It also required a 100% verification of the header sheets themselves to double check all the directional information on the total and sample volumes. Also all the start and finish times as well as the dates and location numbers had to be checked. It was surprising how many mismatches occurred between TRK1A and TRK1B. The relationship used to link the two parts of the header sheets were match 1 which were based on the location, the date, the starting time and the finishing time.

The second phase concerned the computation of the first weight, i.e. the weight based on the sample volume divided by the total volume by vehicle, by site. This entailed a link - LINK1B - between TRK1B and the free speed data BFSP. LINK1B was linked on location start date and the time of the free speed. A special linking case had to be used for Western Australia because of the 24 hour recording. The relational link used was WA1.

Phase three created the matched Q-flow weights based on a linkage of BFSP and AFSP1 via the relationship QLINK12.

Finally, phase four output the linked header sheet information via LINK1A and the special case WA1A to BFSP and output all the variable required for the statistical analysis to an ascii file ready for input to SPSS.

The relational richness and speed of ZIM made this complex database task a lot less painful than using other database software such as SIR, ORACLE or dBASE III.

III.3 Weighting Functions

The original specification for the truck speed study included the collection of total traffic volumes passing the survey site during the sample period. The rationale for collecting the total traffic volumes at each stage was that the subsequent stages of the study could be weighted up by the total traffic volume observed during the before stage, i.e. Stage 1. Thus if during Stage 2 the total traffic volumes observed were half that of Stage 1 due to seasonal influences, time of the year or whatever, then by applying a weight the observed sample volumes could be adjusted accordingly.

Appendix C contains a detailed account of the weighting procedures examined. The nett result of this examination was that ALL results reported in this report are UN-WEIGHTED.

Table 3.1 Total number of Vehicle Free Speeds surveyed
by State, Study stage and Vehicle type

BEFORE survey, October 1986

SAMPLE SIZES

STATE	# of sites	Cars	Cars towing	Motor cycles	Buses	Light vans	Rigid Trucks	Artic trucks	TOTAL sample	Total volume	Sample fraction
NSW	12	2859	97	53	80	393	288	1063	4833	10950	44.1%
VIC	9	1954	115	13	190	92	776	2595	5735	23003	24.9%
QLD	10	4847	162	66	95	276	571	533	6550	12826	51.1%
WA	7	1888	264	22	55	73	147	614	3063	3063	100.0%
SA	9	2835			61		227	681	3804	5263	72.3%
TAS	2				8		179	142	329	329	100.0%
ACT	2	2266	68	27	34	133	243	114	2885	3240	89.0%
Total sample	51	16649	706	181	523	967	2431	5742	27199	58081	46.8%
Total volume		44423	343	482	664	2032	2996	7141	58081		
Sampling fraction		37.5%		37.6%	78.8%	47.6%	81.1%	80.4%	46.8%		

FIRST AFTER survey, April 1987

SAMPLE SIZES

STATE	# of sites	Cars	Cars towing	Motor cycles	Buses	Light vans	Rigid Trucks	Artic trucks	TOTAL sample	Total volume	Sample fraction
NSW	12	2416	66	40	67	347	255	1023	4214	12754	33.0%
VIC	9	951	88	15	140	80	391	1445	3110	13800	22.5%
QLD	10	4602	153	56	89	240	502	424	6066	12658	47.9%
WA	7	2020	235	42	35	56	158	647	3193	3193	100.0%
SA	9	2788	248	27	58	18	244	670	4053	5685	71.3%
TAS	2	964	32	4	14	34	99	80	1227	1227	100.0%
ACT	2	2046	49	39	25	141	176	112	2588	4187	61.8%
Total sample	51	15787	871	223	428	916	1825	4401	24451	53332	45.8%
Total volume		39946	1588	505	537	2276	2517	5963	53332		
Sampling fraction		39.5%	54.8%	44.2%	79.7%	40.2%	72.5%	73.8%	45.8%		

SECOND AFTER survey, October 1987

SAMPLE SIZES

STATE	# of sites	Cars	Cars towing	Motor cycles	Buses	Light vans	Rigid Trucks	Artic trucks	TOTAL sample	Total volume	Sample fraction
NSW	12	2353	67	30	61	290	264	1141	4206	12749	33.0%
VIC	9	910	133	15	96	124	319	1287	2884	12005	24.0%
QLD	9	4884	153	57	127	226	446	482	6375	12957	49.2%
WA	6	2122	325	41	58	75	193	784	3598	3598	100.0%
SA	9	2616	294	31	62	75	240	661	3979	5730	69.4%
TAS	2	1625	44	4	21	63	111	127	1995	1995	100.0%
ACT	2	2369	47	29	24	118	117	112	2816	4019	70.1%
Total sample	49	16879	1063	207	449	971	1690	4594	25853	52986	48.8%
Total volume		39950	1768	444	520	2191	2342	5771	52986		
Sampling fraction		42.3%	60.1%	46.6%	86.3%	44.3%	72.2%	79.6%	48.8%		

Notes:

1) Many sites had more than one recording session. The total number of recordings were:

Stage	number
1	94
2	72
3	70

2) *There are 6 missing cases in Stage 3.*

(3) Free speeds - a vehicle to vehicle gap of at least 4 secs

(4) Results reported above are un weighted.

(5) Stage 1, cartow total traffic volume is incorrect as supplied. No explaination available.

(6) Stages 1,2 & 3, total volumes for WA and TAS are presumed to equal sample volume.

Table 3.2.: Percentage of Vehicle Free Speeds surveyed by State, Study stage and Vehicle type

BEFORE survey, October 1986

% of Row TOTAL sample

STATE	Cars	Cars towing	Motor cycles	Buses	Light vans	Rigid Trucks	Artic trucks	TOTAL sample
NSW	59.2%	2.0%	1.1%	1.7%	8.1%	6.0%	22.0%	4833
VIC	34.1%	2.0%	.2%	3.3%	1.6%	13.5%	45.2%	5735
QLD	74.0%	2.5%	1.0%	1.5%	4.2%	8.7%	8.1%	6550
WA	61.6%	8.6%	.7%	1.8%	2.4%	4.8%	20.0%	3063
SA	74.5%	.0%	.0%	1.6%	.0%	6.0%	17.9%	3804
TAS	.0%	.0%	.0%	2.4%	.0%	54.4%	43.2%	329
ACT	78.5%	2.4%	.9%	1.2%	4.6%	8.4%	4.0%	2885
Total sample	61.2%	2.6%	.7%	1.9%	3.6%	8.9%	21.1%	27199
Total volume	76.5%	.6%	.8%	1.1%	3.5%	5.2%	12.3%	58081

FIRST AFTER survey, April 1987

% of Row TOTAL sample

STATE	Cars	Cars towing	Motor cycles	Buses	Light vans	Rigid Trucks	Artic trucks	TOTAL sample
NSW	57.3%	1.6%	.9%	1.6%	8.2%	6.1%	24.3%	4214
VIC	30.6%	2.8%	.5%	4.5%	2.6%	12.6%	46.5%	3110
QLD	75.9%	2.5%	.9%	1.5%	4.0%	8.3%	7.0%	6066
WA	63.3%	7.4%	1.3%	1.1%	1.8%	4.9%	20.3%	3193
SA	68.8%	6.1%	.7%	1.4%	.4%	6.0%	16.5%	4053
TAS	78.6%	2.6%	.3%	1.1%	2.8%	8.1%	6.5%	1227
ACT	79.1%	1.9%	1.5%	1.0%	5.4%	6.8%	4.3%	2588
Total sample	64.6%	3.6%	.9%	1.8%	3.7%	7.5%	18.0%	24451
Total volume	74.9%	3.0%	.9%	1.0%	4.3%	4.7%	11.2%	53332

SECOND AFTER survey, October 1987

% of Row TOTAL sample

STATE	Cars	Cars towing	Motor cycles	Buses	Light vans	Rigid Trucks	Artic trucks	TOTAL sample
NSW	55.9%	1.6%	.7%	1.5%	6.9%	6.3%	27.1%	4206
VIC	31.6%	4.6%	.5%	3.3%	4.3%	11.1%	44.6%	2884
QLD	76.6%	2.4%	.9%	2.0%	3.5%	7.0%	7.5%	6375
WA	59.0%	9.0%	1.1%	1.6%	2.1%	5.4%	21.2%	3598
SA	65.7%	7.4%	.8%	1.6%	1.9%	6.0%	16.6%	3979
TAS	81.5%	2.2%	.2%	1.1%	3.2%	5.6%	6.4%	1995
ACT	84.1%	1.7%	1.0%	.9%	4.2%	4.2%	4.0%	2816
Total sample	65.3%	4.1%	.8%	1.7%	3.8%	6.5%	17.9%	25853
Total volume	75.4%	3.3%	.8%	1.0%	4.1%	4.4%	10.4%	52996

Notes:

(1) % or Row totals displayed above have been computed using the Total sample (Row total) as the denominator.
Example. Cars, NSW, Stage 1: 59.2% = 100 * 2859/4833.

(2) 'Motor Vehicle registrations in Australia', ABS publication # 9304.0. For Westren Australia, the number of registrations are listed below.

	N	% of total
Cars	746000	86.1%
Motor cyc	36200	4.2%
Buses	6000	.7%
Rigid trucks	65900	7.6%
Artic trucks	4700	.5%
Other trucks	7600	.9%

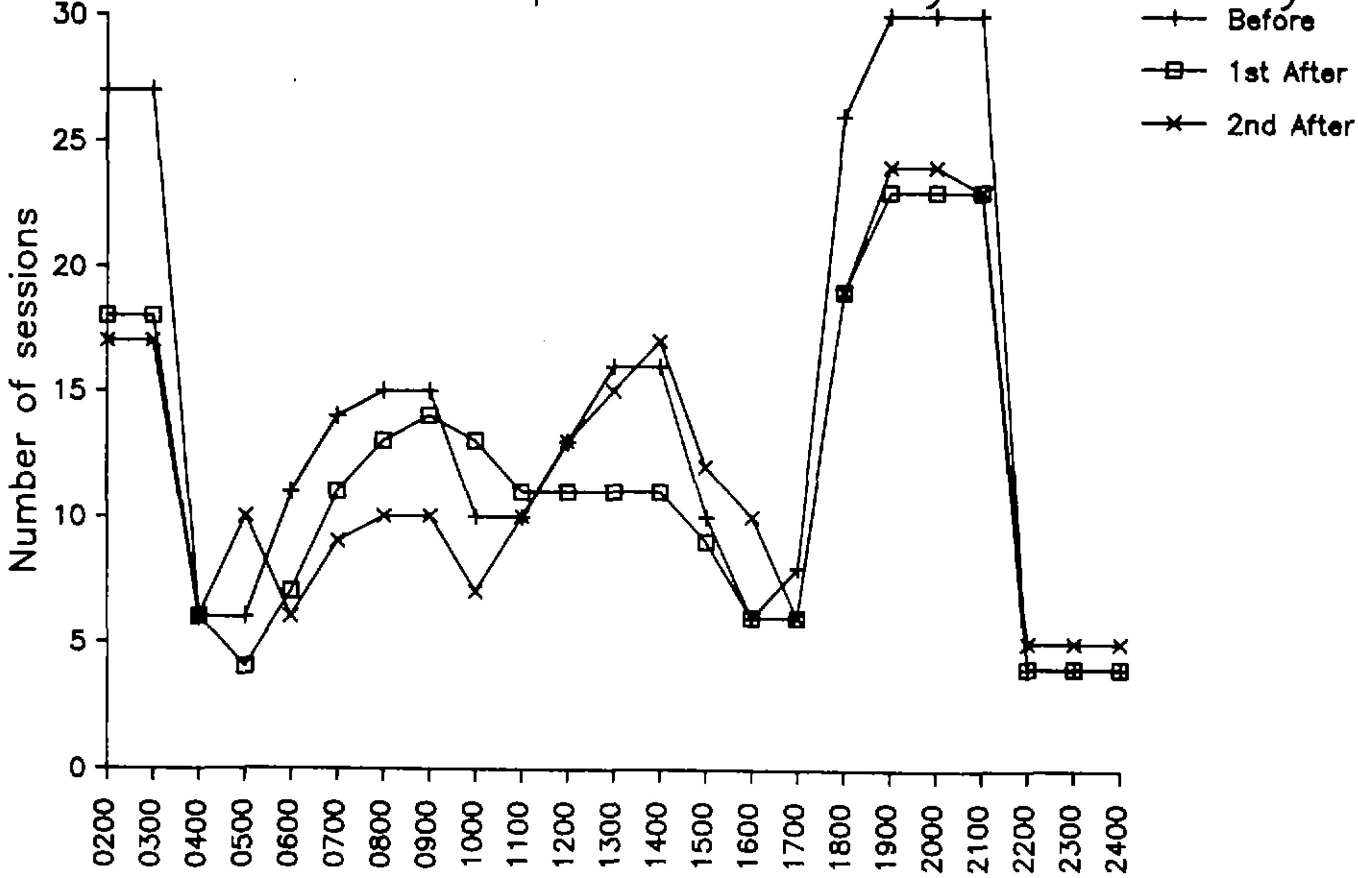
	866400	

Table 3.3: Number of active sample sessions by time of day

Time of day	Before	1st After	2nd After
0000	21	12	11
0100	23	15	13
0200	27	18	17
0300	27	18	17
0400	6	6	6
0500	6	4	10
0600	11	7	6
0700	14	11	9
0800	15	13	10
0900	15	14	10
1000	10	13	7
1100	10	11	10
1200	13	11	13
1300	16	11	15
1400	16	11	17
1500	10	9	12
1600	6	6	10
1700	8	6	6
1800	26	19	19
1900	30	23	24
2000	30	23	24
2100	30	23	23
2200	4	4	5
2300	4	4	5
2400	4	4	5

Note:
(1) Sessions are not contiguous on any one day. They are spread over a time period of upto 1.5 months during each study stage.

Plot 3.1 Active Sample Sessions by Time of Day



IV. ANALYSIS and RESULTS

IV.1. Issues examined

There are eight major groups of questions which can be examined in relation to aggregated mean free speeds and speed differentials[7]. These are:

a. Any effects of legislation. **

What effect, if any, has the legislative change had upon free speeds of trucks? Legislative change can be generalised to include changes in speed limits and police enforcement practices.

b. Speed differential. **

Its effects on platooning, queue lengths, vehicle mixes and traffic volumes. Are there any trends before and after, specifically with Western Australia.

c. Speed vs Traffic Volumes. **

Examine speed vs traffic densities in terms of Q-flow rates. This then leads into weighting and whether weighting should be by total volumes or Q-flow based weights. Are there more appropriate weighting systems that should be used?

d. Speed measurement effects. **

Are there any effects on free speeds by using radar vs amphometers and infra-red light beams such as those used in Western Australia. This can also lead to an examination of the automatic classifier argument from Victoria.

e. Sampling Effects.

The effects of the sampling methods used on the free speeds. Look within States by location by sampling methods and examine the sorts of variability exposed. Are trucks under-represented in the sample vs ABS registered vehicles data ?.

f. Road Environment.

The overall effects of any of the road environment factors such as speed limits, visibility, weather, road type etc. which have been included on all the header sheets.

g. Speed vs Other Studies. **

Speed vs other time series collected by other observers. The South & Western Australian time series and the two previous

[7] Those marked with a '**' have been examined in this report.

studies by Loong et al. and Maisey.

h. Day of the Week.

The day of the week, time of the day and date effects. How have the mean free speed distributions been affected by the sample design. This also leads into weights.

i. Overtaking rates. **

Examine and if possible extend the work done on overtaking rates from the speed differential data available in the data.

IV.1.a. Statistical assumptions

Early on in the analysis of the free speed data it became apparent that there were problems with the aptness of the analysis of variance model for the free speed data. Various symptoms emerged from this early exploratory analysis.

a. Simple ANOVA (analysis of variance) assumes a balanced design i.e. the cell sizes are all equal. Tables 4.1 through 4.7 show that the cell sizes for comparisons between means are never equal. Thus the analysis of variance design which should be used in this instance is an unbalanced design.

   The ANOVA statistical procedures available in most statistical packages such as SPSS assume balanced designs. Few statistical packages have ANOVA procedures for handling unbalanced design. One such is the SAS GLM function.

b. In carrying out our initial ANOVA tests we noted continually that the test for the homogeneity of the variance i.e. the constancy of the error variance across factor levels (using the Bartlett test), failed. Thus the error variance was found to be non homogeneous.

c. When carrying out two-way ANOVA of free speed by State and stage, quite often there would be significant interaction effects without significant main effects.

d. A visual inspection of the shapes of the error distributions often indicated that the distributions were non normal. Subsequent testing using the K-S test confirmed these observations.

e. The independence of the observations and error terms was called into question because the free speeds are recorded serially. Tests for the presence of serial or auto correlation confirmed that the free speeds were auto correlated because the speed of the following vehicle was related to that of the lead vehicle. This was despite the definition of a 'Free speed' which called for at least a 4 second gap between vehicles.

   Tables 4.8 and 4.9 show the extent of this auto correlation in the free speed data. The auto correlations coefficients were 0.15 and higher and statistically significant.

   The conclusion drawn from this assumptions analysis was that the error terms were not independent. As a demonstration of this see plot C2 in Appendix C which contains the auto correlation coefficients for articulated vehicles in New South Wales. This is fairly typical of correlation plots obtained.

Summary:

1. The vast bulk of the free speed distributions were found to be non-normal. Thus the error distributions were found to be non-normal.

2. All the speed distributions were found to contain significant levels of auto correlation. Thus the error terms were not independent.

3. In the bulk of cases the error variance across factor levels was found to be non homogeneous.

Thus we concluded that the ANOVA model was not appropriate for testing the free speed data. We relied instead on nonparametric procedures[8] for testing the hypotheses on free speed.

IV.1.b. Assumptions matrix

Tables 4.8 and 4.9 contain the complete summary of all the testing which was done on the free speed data for both all-roads and two-lane to verify the aptness of the application of normal distribution based parametric statistic. There are two columns in Table 4.8 and 4.9. The first column corresponds to the significance tests for the K-S test of the normality and the second column is the significance tests for the presence of auto correlation in the data.

The rows of the Table 4.8 and 4.9 correspond to the results matrix Table 4.10, in that they contain the sub-groups which were tested. i.e. vehicle type by State etc.

[8] One consequence of this casualty of the switch to non parametric procedures was the 85th percentile. It is not a statistically appropriate measure to use because it assumes normal distributions.

An illustration of this is quite simple: If the mean remains constant, say from stage 1 to stage 2, but the variance decreases, the 85th percentile speeds should also decrease and travel towards the mean. Equally if the variance increases then the 85th percentile should move away from the mean.

The mean for cars in Stage 1 was 100 kph. standard deviation was 12.9; in Stage 2 the mean was 101 kph and the standard deviation was 13.4. Thus the variance had increased, the mean had only shifted by 1 kph. So you would expect the 85th percentile to increase as well. But the 85th percentile remained constant at 114 kph. In Stage 3 the mean dropped by 2 kph to 99 kph, the variance remained the same as stage 2 but the 85th percentile only dropped by 1 kph.

The 85th percentile measure is therefore not an appropriate measure of change in speeds where the underlying distributions are not normal.

Table 4.8 demonstrates that the bulk of the groups tested had distributions which were non normal and there were significant levels of auto correlation present. The exceptions were articulated vehicles in the States of Queensland, Tasmania and the ACT.

IV.2. Results: Aggregated free speeds

The analysis of the free speeds results will be broken into two sections; ALL roads and 2 lane only roads. The All roads analysis will cover all the survey sites in the study while the 2 lane analysis will only consider those which were 2 lane divided or undivided roads. Table 4.4 outlines the site numbers of the survey sites in all three study stages included in this definition.

IV.2.a. Aggregated Mean Free Speed Results - All roads

In all the previous studies reviewed in the literature the principal emphasis of the investigation has been to discern differences between the mean free speeds of vehicles across time and to use this as a means of assessing the change in vehicular free speeds.

The principal emphasis of this study is to examine the effect if any of the legislative increase in the truck speed limit on rural roads from 80 km/h to 90 km/h on January 1, 1987 in every State except Queensland. The study aims to use the changes in mean free speeds to gauge whether there has been any significant effect of this legislative change upon driver behaviour and road safety.

The imputation of a cause or link between legislative change and any change in vehicular speeds needs very careful statistical scrutiny. The use of a control State such as Queensland and also the use of cars as a control group as proposed by Maisey (Maisey 1983) are two experimental design features which are built into this study.

There are however, a large number of confounding factors beyond the control of this study which have not been investigated. A further complication is that a number of States have changed their speed limits. Victoria for instance, changed its rural freeway speed limit from 100 to 110 km/h in June 1987, mid-way through the study. Western Australia which already had a 90 km/h speed limit on the Eyre highway for trucks at the beginning of the study changed that speed limit to 100 km/h on 1 January 1987. The control State Queensland had a 90 km/h speed limit for articulated vehicles during the entire study.

Other confounding factors included the various policing activities of the States police forces (blitzes etc.) which may have occurred at various times on various roads during the period of the study.

IV.2.a.1 Conclusions - ALL roads

Tables 4.1 through 4.3 summarise the mean free speed results by vehicle type, study stage and State for ALL roads surveyed.

a. Over all study stages there has been an increase in mean free speeds of all vehicles. The means change from 96 to 97 to 97 km/h in stages 1, 2 and 3 (Table 4.1, 4.2, 4.3). This increase in mean free speeds[9] is statistically significant (see Table 4.10, section 1.2 [10]).

b. The mean free speed for all articulated vehicles increased across the three study stages from 90 to 92 to 94 km/h. This increase in mean free speeds is statistically significant (Table 4.10, section 2.2).

c. The mean free speeds for articulated vehicles increased in the States of New South Wales, Victoria, Queensland and South Australia as outlined in plot 4.1. These increases were statistically significant (Table 4.10, section 2.31, 2.32, 2.33 and 2.35).

d. The change in the mean free speeds for articulated vehicles in the ACT and also in Western Australia was statistically significant (Table 4.10, section 2.37 and 2.34). Western Australia experienced a net increase and the ACT experienced a net decrease. The apparent decrease in the mean free speeds in Tasmania for articulated vehicles (see plot 4.1) was not statistically significant (Table 4.10, section 2.36). Thus the results for Western Australia and ACT were equivocal.

e. The mean free speeds for cars over all study stages remained stable. This is illustrated in plot 4.2. There were no statistically significant effects of stage for cars as outlined in Table 4.10, section 3.2.

f. The only States which had statistically significant changes in mean free speeds for cars were South Australia, Tasmania and ACT (Table 4.10, sections 3.35, 3.36, 3.37). Plot 4.2 shows that South Australia experienced an increase and Tasmania and ACT experienced decreases in mean free speeds.

g. Mean free speeds of cars for all other States remained stable across the study stages. There was no statistically significant change in the mean free speeds across the stages for these States (see Table 4.10, sections 3.31 through to 3.34).

h. The percentage of all vehicles travelling faster than 90 km/h increased from 66 per cent through to 69 per cent to 68 per cent. Similarly, the percentage of vehicles travelling faster than 100 km/h for all vehicles increased from 37 per cent through to 40 per cent through 39 per cent (Tables 4.1-4.3).

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[9] Mean free speeds are reported to rounded integers in kilometres per hour because the data reported to FORS from the field was to that accuracy. Thus the error bars should be plus or minus 0.5 kph.

[10] Table 3.4 contains a matrix of statistical test results. The section numbers refer to the decimal numbers beside the main effect variables. Thus section 1.2 refers to the overall effects section 1, main effect of study stage (1.2).

i. The percentage of articulated vehicles travelling faster than 100 km/h increased in New South Wales, Victoria, Queensland and South Australia. Plot 4.3 illustrates this.

j. The percentage of articulated vehicles travelling faster than 100 km/h was equivocal in all other States. See plot 4.3. The percentage of cars travelling faster than 100 km/h increased marginally in New South Wales, Victoria, Queensland, Western Australia and South Australia. The increase was quite small as illustrated in plot 4.4.

An overall summary which springs from the analysis is as follows:

1. Articulated vehicle mean free speeds increased in four States as did the percentage travelling faster than 90 km/h.

2. Car mean free speeds remained stable with some slight increases in VIC and WA.

3. The control State QLD which did not increase its truck speed limits also experienced an increase in articulated vehicle mean free speeds.

4. The control State Queensland reflected the long term creep in heavy vehicle speeds.

IV.2.b. Aggregated speeds for two-lane roads only.

In the previous result section we examined the aggregated speeds for all-roads. It became apparent that it was very important to create a separate differentiated category of two-lane divided or undivided roads and analyze separately from all roads. The rationale for doing this was as follows:

a. The all-roads analysis contains a mixture of speed limits despite the reporting of a single speed limit in Table 4.1 through to 4.3. A case in point is New South Wales and Victoria where the freeway speed limits are higher than those on two-lane roads. The speed limits on the two-lane roads are far more homogeneous and do reflect the speed limit reported in Table 4.5 through to 4.7. The net effect of this mixture of speed limits in the all-roads analysis was that the net speeds could be inflated by the presence of higher speed limit roads such as freeways. This homogeneity also extends to the Q-flow rates as illustrated in Tables B10-12 (Appendix B).

b. From the safety perspective the impact of any changes in driving behaviour, especially of articulated vehicles, would be far more pronounced on two-lane undivided and divided roads than on freeways. On freeways there are more opportunities for overtaking large vehicles than on two-lane undivided roads. Thus any adverse affects of the legislative change should be more pronounced.

c. In the next analysis section we look at the concept of speed differentials. These are only applicable in this study to two-lane roads. The rationale is that to compute speed differential requires a single queue of vehicles which for simplicity will only occur on a two-lane road. Thus for completeness the analysis of aggregated speeds on two-lane roads is included so that it can be compared with the analysis of speed differentials on the same roads.

Table 4.4 contains a list of the site numbers that constitute the survey sites which were defined as being two-lane for the purposes of this analysis. Tables A1, A4 and A7 show precisely which roads and their site characteristic have been included. The definition used was two-lane carriageway divided or undivided.

The two-lane roads contain approximately one third of the total sample of vehicle free speeds.

IV.2.b.1. Conclusions - 2 lane roads

Comparing Table 4.1 through to 4.3, that is the all-roads speed analysis with Table 4.5 through to 4.7 for the two-lane only speed analysis, a number of points emerge.

a. Over all study stages there has been a slight increase in mean free speeds of all vehicles. The means changed from 96 km/h to 97 km/h and then to 97 km/h in Stages 1, 2 and 3. This increase in mean free speeds is statistically significant. (See Table 4.10 result 1.2 for two-lane roads [11])

b. The mean free speeds for articulated vehicles over all study stages increased from 90 to 93 to 95 km/h. This increase is statistically significant. (See result 2.2 in Table 4.10)

c. Mean free speeds for articulated vehicles increased in all States except Tasmania and the ACT. Plot 4.5 depicts this result and these increases are statistically significant. (See result 2.31 through to 2.35 in Table 4.10)

d. Mean free speeds for cars over all study stages decreased from 102 to 100 to 99 km/h. This decrease was statistically significant. (See result 3.2 in Table 4.10)

e. Mean free speeds for cars increased in Western Australia. Plot 4.6 depicts this result and this increase is statistically significant. (See result 3.34 Table 4.10)

f. The mean free speed for cars decreased in Tasmania and ACT and this result was statistically significant. (See result 3.36 and 3.37)

g. The percentage of articulated vehicles travelling faster than 90 km/h increased in all States except Tasmania. (See plot 4.7)

h. The greatest increase in the percentage of articulated vehicles travelling faster than 90 km/h was experienced in South Australia where it rose from 23 per cent through to 31 per cent through to

[11] In table 3.4, the second column gives the statistical test result for 2 lane roads. Column 1 provides the corresponding results for all roads.

50 per cent by stage 3 (See plot 4.7). This increase was statistically significant.

i. The percentage of cars travelling greater than 90 km/h increased in the States of New South Wales. Victoria and Western Australia and decreased in all other States. (See plot 4.8)

j. The percentage of articulated vehicles travelling greater than 100 km/h increased in the States of New South Wales, Western Australia and South Australia (See plot 4.9). These increases were statistically significant. There were marginal increases in all other States except Tasmania which decreased.

k. There was no consistent change in the percentage of cars travelling greater than 100 km/h (See plot 4.10). Victoria increased its percentage in a single step and Queensland and South Australia and the ACT decreased in a single step.

An overall summary *which springs from* the analysis is as follows:

1. Articulated vehicle mean free speeds increased in all States except Tasmania as did the percentage travelling greater than 90 km/h and 100 km/h.

2. Car mean free speeds remained fairly stable across the three stages with a slight increase in Western Australia and slight decreases in Tasmania and ACT.

3. The control State Queensland, which did not increase its truck speed limit, experienced an increase in articulated vehicle mean free speeds as did other States.

IV.2.c. All roads vs 2 lane roads conclusions

Comparing the ALL roads analysis (IV.2.a.) with the two-lane roads analysis (IV.2.b.) we find:

A. that the mean free speeds results by vehicle type, State and stage are virtually identical.

B. the overall differences between the all-roads and the two-lanes in terms of the mean free speeds overall are not dramatic. As an indication the overall means for all-roads for stage 1, 2 and 3 were 96, 97 and 97 km/h which was identical to the overall means for the two-lane roads for each of the three stages.

The standard deviations for the all-roads tended to be slightly lower than the standard deviations for the two-lanes. This to be expected given the smaller sample sizes in the two-lane roads. However, the standard deviations did not vary markedly. They were generally only 1 km/h higher than the all roads. Please check Table 4.1 through to 4.3 and Table 4.5 through to 4.7 for comparisons.

C. Articulated vehicle mean free speeds are very close. For instance, for all-roads the means in stage 1, 2 and 3 were 90, 92 and 94 km/h, whereas for the two-lane roads articulated vehicles they were 92, 93 and 95 km/h. The standard deviations were virtually identical. Thus for articulated vehicles there were very small differences between the all-roads and the two-lane roads.

D. A further comparison for articulated vehicles between all-roads and two-lanes based on the percentage greater than 90 km/h and the percentage greater than 100 km/h is also warranted. Again looking at Table 4.1 through to 4.7 the percentages of vehicles greater than 90 km/h tends to be around about 3 per cent higher overall on the two-lane roads than it does on the all-roads and the percentage greater than 100 km/h tends to be about 2 per cent higher on the two-lanes than the all-roads for articulated vehicles. These differences are not statistically significant.

Thus in summary the comparison between the all-roads and the two-lanes at the gross mean and percentage levels are not starkly different.

IV.2.d. Platooning - 2 lane roads

A platoon is a queue of vehicles immediately following a lead vehicle which is acting as a block in the traffic stream. The definition of free speeds precludes measuring the speeds of platoon members because they are within 4 seconds of another vehicle. This analysis has been restricted to two lane roads only (see Table 4.4).

IV.2.d.1. Platoon length by Speed category of platoon leader

An analysis of platoon lengths by the speed category of the platoon leader produced the following results:

Articulated vehicles - October 1986 to October 1987.

a. for articulated vehicle lead platoons where the platoon length was one vehicle, platooning was reduced by 67% in the <= 80 km/h speed category and 42% for the 81-90 km/h speed category (plots 4.14, 4.16 and Table 4.12). This may be due to the reduced number of articulated vehicles travelling at this slow speed.

b. platooning in all other platoon lengths for articulated vehicle lead platoons halved for the <= 80 km/h and 81-90 km/h speed categories.

c. there was no substantial change platooning for any other speed category above 90 km/h.

Cars - October 1986 to October 1987.

d. for car lead platoons the platoon reductions experienced by articulated vehicle were dramatically reversed. Plots 4.13 and 4.15 along with Table 4.11 illustrate the size of this reversal.

e. for platoons of one vehicle, platooning increased by 333% for the <= 80 km/h speed category, 205% in the 81-90 km/h speed category and 77% in the 91-100 km/h category.

f. the picture of increases outlined above was reproduced for most of the other platoon lengths.

Summary:

* Platooning of car led platoons has increased by 63% across all speed categories between October 1986 and October 1987. This increase straddles the legislative change in January 1987.

* The constituents of these car led platoons are unknown. The long term safety consequences of this increase is unknown.

* During the same period there was a 31% decrease in articulated le d platoons across ALL speed categories.

IV.2.e. Mean free speeds and Sample sizes by Time of day

The sampling specifications put out by FORS at the beginning of the present study included references to time of day and day of week. However, from a statistical perspective the sample design was not rigorous and the sampling of time of day and day of week were left to the States.

Thus the results presented below may simply be sampling abberations.

Time of day:

a. the night time mean free speeds (2100-0500 hrs) (95 km/h) for articulated vehicles was 5 km/h higher than the daytime mean free speed (Table 4.14, plot 4.12). Maisey (Maisey 1983) also noted this effect.

b. the mean free speeds of articulated vehicles were greater in stage 3 than in all other stages over most time periods.

c. the night time mean free speeds (2100-0500 hrs) (105 km/h) for cars was 5 km/h higher than the daytime mean free speed (Table 4.13, plot 4.11).

d. there was very little change in mean free speeds for cars between the three study stages across the time periods. Thus cars acted as a credible control group.

e. The free speed window between cars and articulated vehicles has increased from 0 km/h in stage 1 to 14 km/h in stage 3.[12]

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[12] The speed window is the degree of overlap between the minimum and maximum speeds for cars and articulated vehicles. The following table illustrates this.

	Minimum, Maximum speeds (kph)	
Vehicle type	Stage 1	Stage 3
Cars	98 - 107	95 - 108
Artic	86 - 97	90 - 109
Window (kph)	0	14

Sample sizes:

f. the volume of articulated vehicles measured in this study peaks between 1800 and 2100 hrs. The lowest volumes are around 1000 hrs (plot 4.18).

g. the volume of cars peaks between 0800 and 1500 hrs. The lowest volumes are between 2200 and 0600 hrs (plot 4.17).

Summary:

* Articulated vehicles have the roads to themselves at night and this period also corresponds to the highest mean free speeds for articulated vehicles. Thus the low volume of traffic and possible reduced police enforcement levels at night may give rise to these elevated truck speeds.

* Prior to the legislative change the mean free speeds of articulated vehicles did not overlap the mean free speeds of cars. The speed window was 0 km/h. This speed window has now widened considerably to 14 km/h and may go part way in explaining why there has been such an increase in car led platooning.

IV.2.f. Sampling Bias

Sampling bias resulted from the less than rigorous sampling design of this study and the lack of control that FORS had over the State field teams.[13] The sources of bias were:

* seasonal effects
* economic activity and its demonstrated effects on road transport
* day and week of the year
* day of week effects in the replications of the three study stages
* time of day effects in the replications of the three study stages
* the interaction of time of day and day of week
* road environment factors i.e. road type and surface
* police activity
* environmental effects i.e. weather

The first step in any sample design exercise is to find any information which will assist in the design. The availability of population

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The window values = Max (artic) - Min (cars). If the value is negative, set to 0.

See table 3.53 & 3.54 for the maximum and minimum values.

[13] It should be noted that in all the previous studies of truck speeds cited in the literature review, scant attention is paid to sample design. It is important that any future studies address this critical issue in detail.

descriptions of vehicle types by traffic volume by road type would be an example of such information. This then could be used to decide on the sampling strategy and in estimating the sampling parameters.

Unfortunately, no such data was available at the time of writing this report. Thus we decided instead to document the character of the sampling which took place in this study.

To begin with, the sample distribution of vehicle types differed markedly between the States and from the overall expected distribution of registered vehicles (see Table 3.2). Section III.1.b. discussed this issue and pointed out that:

> "The survey design is such that statistically we cannot say with any confidence that the sample is representative of the Australian vehicle population. Clearly, trucks have been over sampled, but to what extent is unknown. The effects of time of day and the number of active sampling sessions have contributed substantially to this bias."

The sampling characteristics of Western Australia are of importance as it was one of the only States which had 24 hour sampling. The effects of time of day have been eliminated in the WA sampling. Plots 4.19 and 4.20 are the sample sizes by time of day for cars and articulated vehicles in WA.

One could assume that because WA used 24 hour sampling, then its sampling distribution should be "typical" of the population distributions for cars and articulated vehicles. However, the WA sampling distributions (plots 4.19 and 4.20) bear little resemblance to the over all sampling distributions as described by plots 4.17 and 4.18.

Thus it would appear that either the WA sampling distributions are not "typical" of the expected distribution of vehicle types by time of day or that time of day has seriously confounded the sampling used in this study. Further, as Maisey has noted, truck speeds tend to be higher during the night time than the daytime hours. Thus it appears that not only have trucks been over sampled due to the elevated number of sampling sessions during the night (plot 3.1), but that this could also have biased the mean truck speeds reported in this study upwards.

IV.2.g. Overtaking rates.

In the paper titled "Overtaking rates on low volume roads" by Troutbeck (Troutbeck 1981) a most interesting traffic model is developed. It can be used to estimate the number of overtakings by a vehicle of type A around vehicles of type B on low volume road.

Thus the expected overtaking rates of cars going past trucks or articulated vehicles can be calculated. The mathematical model developed is well documented by Troutbeck, is not complex and may be sufficient to gauge the likely interactions between vehicle types on two-lane roads.

It could be used to determine suitable routes for large volumes of articulated vehicles. Quoting from the abstract:

> "the model developed gives a simple method of estimating the rate with which faster vehicles catch up to slower vehicles. It relates catch-up rates and overtaking rates on a homogeneous road section with vehicles

travelling at constant speeds and with the uniform flows along with section traffic flows and speed parameters."

The caveat is that the model is only applicable to roads with low traffic volumes less than 150 vehicles per hour.

In this preliminary analysis the survey sites in Western Australia will be used as they all have traffic volumes of less than 150 vehicles per hour, are two-lane roads and have very good quality speed recordings using infra-red light beams.

One of the assumptions made by Troutbeck (from the abstract) is that

"the time the driver spends following other vehicles before overtaking is short in comparison with the journey time and that catch-up rates can be equated with overtaking rates. The model can be used as a tool for a selection of appropriate routes for road train operations and can be extended to the calculation of passenger car equivalents using the Walker method."

The beauty of this model is that it is based on well established probability distributions such as the cumulative probability distribution of the normal and gamma distributions. It dovetails beautifully with the work quoted above on speed differentials, i.e. vehicle duets and the mean speed differences between them. The work done on speed differentials above could, if extensively analyzed in relationship to overtaking rates, be used as an excellent calibration device for Troutbeck's work.

Some other assumptions that the model makes are:

* it is based on traffic travelling at uniform speeds
* constant flow rates
* long sections of a homogeneous road

Consequently the model may give unacceptable answers when applied to short sections of road which are different in character to adjacent sections. (Troutbeck 1981, 15)

The equations used to develop the overtaking rate displayed in Table 4.19 and also in plot 4.28 are drawn from Troutbeck's paper (1981) based on equation 11 (Troutbeck 1981, 7)

$$OR_{ab} = K_a . K_b . S_a . (\text{gamma})_{ab} \qquad (11)$$

This gives the overtaking rate (overtakings/hour/km of road) of vehicle type A overtaking vehicle type B as a function of the flow rates of vehicle types A and B (K_a, K_b), the standard deviation of vehicle type A (S_a) and a coefficient $(\text{gamma})_{ab}$.

The coefficient $(\text{gamma})_{ab}$ can be set equal to a fixed function F(z) (equation 14, (Troutbeck 1981, 8)) if all type B vehicles travel at the same speed U_b and thus the value of $(\text{gamma})_{ab}$ can be derived directly from Table I (Troutbeck 1981, 5). The value of z (equation 15, (Troutbeck 1981, 8)) is equal to

$$z = (U_b - V_a)/S_a \qquad (15)$$

were V_a is the space mean speed of vehicle type A.

A slightly more complex overtaking rate can be computed using equation 11 where the value of $(gamma)_{ab}$ is not set equal to F(z) because the assumption of the constancy of speed of vehicle type B is not made. Although preferable, this value has not been computed for this report.

Thus the overtaking rates displayed in Table 4.19 are those of cars overtaking articulated vehicles. It assumes that the articulated vehicles are all travelling at a uniform speed where the uniform speed has been set equal to the articulated vehicles mean free speed.

Table 4.19 contains the overtaking rate (overtakings/hour/km) for cars overtaking articulates and the site location number, the mean free speed, standard deviation, sample size and the flow rate (veh/hr) for each vehicle type.

Plot 4.28 shows that sites 300 and 303 have experienced substantial increases in the overtaking rates. At site 300 for instance, overtaking rates have doubled from 0.1 overtakings per hour to 0.2. Site 301, the Eyre Highway which has been looked at in more detail in previous sections, only experienced a very moderate increase in overtaking rates.

What significance does a change in the overtaking rates have in relation to the safety outcome of reducing road fatalities and increasing road safety?

The overall rationale for the speed limit change was to decrease the speed differentials between cars and articulates and thus reduce the perceived need by car drivers to overtake trucks.

A series of hypotheses emerge which could be tested:

1. the relationship between speed differentials and overtaking rates would possibly be a linear function with a positive slope. As speed differentials decrease so should overtaking rates.

2. the relationship between overtaking rates and the number of fatal crashes on a given road should be linear with a positive slope. As overtaking rates decrease so should the number of fatal crashes.

Referring to plot 4.28 and for site 301 (the Eyre Highway) and referring back to the Eyre Highway analysis (section IV.4) with reference to plot 4.30 the following points emerge:

1. that the parallel increases in both car and articulated vehicle speeds that were noted on the Eyre Highway are not linked with a dramatic rise in the overtaking rates (plot 4.28).

2. this parallelism between the increase in articulated vehicle speeds and car speeds for site 301 is reflected in the fact that the speed differential between the two vehicle types has remained. Overtaking rates for this site have remained fairly stable as a result.

3. site 300 has experienced a doubling in its overtaking rates. As Troutbeck himself says (Troutbeck 1981, 18)

> "The overtaking rates calculated using the model in this report indicates that the percentage of overtakings involving trucks increased rapidly as the percentage of trucks is increased."

4. Table 4.19 for site 300 shows that the speed differential between

cars and articulates has remained fairly constant at around about 9 km/h but that the flow rates for articulated vehicles have changed. They have gone from 6.7 veh/hr in stage 1 to 11.2 veh/hr in stage 3 which is nearly a 100 per cent increase. Cars by comparison have only risen by 2 veh/hr.

Thus it would seem that the doubling in the overtaking rates experienced at site 300 is a result of a doubling in the number of articulated vehicles on the road at site 300.

5. As a result of (4) above, a further relationship between overtaking rates and the percentage of heavy vehicles present on the roads can be entertained. It suggests that there will be a positive relationship between the percentage of heavy vehicles and the overtaking rates. Troutbeck plots just such a relationship (which is curvilinear) in figure 5 of his paper (Troutbeck 1981, 19).

What is now needed to further explore the utility of overtaking rates as a predictive indicator of the relative crash risk of a road is to relate the change in the overtaking rates for the period of the present study (October 1986 to October 1987) with site specific numbers of crashes or fatalities. This could be used to test Troutbeck's proposition in figure 5 of his paper.

If such a relationship could be shown then changes in overtaking rates may be a more refined indicator of overall road safety than the concept of speed dispersion.

Overtaking rates not only take into account speed differentials but also use the variance in vehicle speeds and most importantly the flow rates of the vehicle types on the roads. Thus more information is incorporated into the predictive index than just the difference between the mean speeds of two vehicles as is the case with speed dispersion.

Further work really needs to be done and overtaking rates promise to be a very promising indicator of general road safety.

IV.3. Speed differential results - 2 lane roads

Speed differentials are defined as the free speed difference between sequential pairs of vehicles which are within two minutes[14] of each other travelling along a single lane of carriageway. The first vehicle of a vehicle duet is called the lead vehicle and the next sequentially following vehicle is the following vehicle.

These sequential duets formed 'mixes' of vehicles. Thus a car leading followed immediately by another car is called a 'Car - Car' duet or vehicle mix. Table 4.15 contains the vehicle mix matrix used in this study. There are seven (7) vehicle types leading to forty nine (49)

[14] The vehicles included here are 'Free Speed' vehicles (greater than 4 second gap) and thus exclude platoons.

Also note that because the sampling design was less than perfect, there may be substantial bias in these results.

possible mixes of vehicle types. Each mix is assigned a mix code number from 1 to 49.

This data is restricted to two lane road sites. This was done to ensure that the sequential data was queued. Multi lane roads were excluded because queuing could not be ascertained from the data. Table 4.18 provides a list of the site numbers included under this definition.

A positive speed differential means that the lead vehicle is travelling faster than its following partner. A negative speed differential infers that the lead vehicle is travelling slower than its following partner. Thus, the following vehicle is catching up to the lead vehicle.

The concept of speed differentials was developed for this study because the authors were unhappy with using the concept of 'speed dispersion' which is so often cited in the literature for a number of reasons:

a. Statistically speaking, 'dispersion' refers to the variance of the free speeds. Thus ambiguity enters the discussion early.

b. Speed dispersions have been computed by subtracting the aggregated mean free speeds of the vehicles of interest. For instance (referring to Table 4.5) the speed dispersion of cars and articulated vehicles (all States combined) for the before analysis is 102 km/h - 90 km/h = 12 km/h.

Using Table 4.15 and looking at both Car - Artic and Artic - Car speed differentials, the differentials are 9.7 km/h and -10.4 km/h respectively for the same study stage across all States.

This comparison highlights two further points.

i. The aggregated speed dispersion figure of 12 km/h is larger in absolute terms than either of the speed differential mixes for the same vehicles.

ii. The speed differential presents two further pieces of information not available from 'speed dispersion'.

(1) The mix can be differentiated into the two logical mix types - cars followed by articulated vehicles and articulated vehicles followed by cars and

(2) the sign of the speed differential indicates whether the lead vehicle is pulling away from the following vehicle or not.

Speed differentials contain far more information about the individual dynamics of 'speed dispersion'.

IV.3.a. Descriptive analysis

Table 4.15 contains the mean speed differentials for the top twelve vehicle mixes sorted by frequency of occurrence for each of the study stages. The conclusions drawn are as follows:

a. the Car - Car mix dominates speed differentials across all stages.

b. the four most common mixes are:

i. Car - Car (mix 1)
ii. Artic - Artic (mix 28)
iii. Car - Artic (mix 34)
iv. Artic - Car (mix 7)

c. these four mixes reflect both the relative volumes of traffic surveyed and the comparative blocking strengths that cars and articulated vehicles have in a single lane of traffic. A car can be easier to overtake than an articulated vehicle (for the same vehicle speed) because the truck is a larger obstacle. A car however can vary its speed more than a truck and so combined with the road environment may form a difficult obstruction to overtake.

d. there was no statistically significant change in Car - Car mean speed differentials across the either study stages or States (Table 4.15, plot 4.21).[15].

e. there were statistically significant changes in both Artic - Car and Car - Artic mean speed differentials across both stage and speed differential State (Table 4.15, plot 4.21). There were no significant interaction terms.

Plot 4.22 and Table 4.16 contain the mean speed differentials for each State across the three study stages. There are no apparent changes within State across stage but this is due to the swamping of these results by the Car -Car vehicle mix. Thus at this aggregated level, not a lot of insight is available.

To remedy this situation, Table 4.17 presents a further breakdown of Table 4.16 by vehicle mix. It contains speed differentials broken down by State by Stage and vehicle mix. Plots 4.23 through 4.27 illustrate Table 4.17 for the States of NSW, VIC, QLD, WA and SA.

f. testing mixes 7 and 34 separately within each State, the only State which showed any statistically significant change across study stage was NSW with mix 7 (Artic - Car).

g. focusing in on the Eyre highway for mixes 7 and 34, a planned contrast with a oneway ANOVA showed that a statistically significant difference existed between the Eyre highway and every other WA site on mean speed differential (all stages combined).

<u>Summary:</u>

1. The four most frequent vehicle mixes are (in order) Car - Car, Artic-Artic, Car - Artic and Artic - Car.

2. There has been a significant decline in Car - Artic mean speed differentials over the study stages by 1.6 km/h from 9.7 to 8.1 km/h.

3. There has also been a significant decline in Artic - Car mean speed differentials by 1.6 km/h from -10.4 km/h to -8.9 km/h.

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[15] One and two way ANOVA was used in all testing of speed differentials because they were found to be normally distributed and well behaved, statistically.

4. Cars are still travelling faster than articulated vehicles but only by 8 km/h by stage 3 of the study. This value has dropped by 2 km/h since the before study in October 1986.

IV.3.b. Comparison to aggregated free speeds

As mentioned in section IV.2.e. on mean free speeds and time of day, the speed window between cars and articulated vehicles has widened from 0 km/h in October of 1986 to 14 km/h one year later.[16]

Absolute speed differentials (ignoring the minus sign) between cars and articulated vehicles have decreased from 10 km/h to 8 km/h over the same period. 'Speed dispersion' between cars and articulated vehicles have decreased from 12 km/h to 4 km/h over the same period (Table 4.18).[17]

By either measure of speed differential 'speed dispersion' has been reduced over the study period. The question still remains as to whether the legislative change had any bearing on this result.

To suggest that the legislative change had any effect on the observed driver behaviour via speed differentials presumes that ALL other known factors were held constant. They were not.

Then there are all the unknown factors (improved road conditions, fleet age weather, police activity etc.) which additively may have resulted in the effects observed.

All that can be safely said is that there are no obvious safety disbenefits from the legislative change. There are some practical benefits instead for the drivers. Before the legislative change their mean free speeds were 10 km/h over the legal speed limit. It is now only 5 km/h.

IV.4 The results of the present study vs previous studies.

This section compares some results of this study with those of other comparable studies done elsewhere in Australia.

IV.4.a. Other National Studies - the FORS paper.

Two previous national studies of heavy vehicle speed limits were done in 1978 and 1983 and are summarised in the paper "Heavy Vehicle Speed Limits" published by the Federal Office of Road Safety (FORS 1985).

The present FORS study which was conducted in 1986 and 1987 in three stages, is only the third national study of heavy vehicle speed limits

[16] These results are based on ALL roads, not just 2 lane roads. Thus the speed window value may be inflated.

[17] Both the 'speed dispersion' figures and absolute speed differentials are based on 2 lane roads only. Thus they are comparable.

documented in Australia. Of these three national studies, the present study seems to be the most extensive in that it includes all States and Territories of Australia except the Northern Territory, whereas the previous two studies only covered the five mainland States: New South Wales, Victoria, Queensland, Western Australia and South Australia.

In comparing the present study with these previous two semi-national studies it is important to introduce a few cautionary words.

We cannot guarantee complete consistency in the data collection methodologies across the three studies. If anything the data collection methodology of the present study is an evolution of the two previous national studies and is arguably better than them. Thus in the strict statistical sense we do not have a homogeneous data collection strategy. The comparisons of the three national studies contain random fluctuations and variability induced by the data collection methodologies employed.

Table 4.20 summarises the comparative data which is available from one of the major summary Tables listed on page 31 (FORS 1985, 31). To this original Table have been added three extra cells these being for each of the three stages of the present study.

The most important issue that emerges from the FORS paper and which was one of the driving forces behind the present study is to reduce speed dispersion (based on the difference between the mean speeds). This was to be achieved by increasing the speed limit for HCV.

Plot 4.29 summarises the apparent speed differences based on the aggregated means across these three national studies. The results look impressive. For instance, in New South Wales the difference of the speed means has reduced from 15 km/h to 5 km/h since 1978. Equally impressive is Queensland which has dropped from around about 12 km/h down to about 4 km/h. This drop coincided with a reduction in the HCV speed limit from 100 kph to 90kph in 1982. Every State has had a decrease in the speed differences since 1978.

As has been pointed out earlier (section IV.1, IV.3) the imputation of speed differences based on aggregated means has statistical drawbacks due to the non-normality of the speed distributions. Thus the means may not the appropriate measure of central tendency to be subtracted to form the speed difference between cars and trucks. Equally, the use of the 85th percentile may be misleading.

IV.4.b. The Eyre Highway comparisons.

The most consistently studied stretch of road for the purpose of any longitudinal study of truck speeds is the Eyre Highway in Western Australia, site Nos. 1301, 2301, 3301 in the present study.

Table 4.21 summarises the free speed comparisons for the Eyre Highway. The original study monitored an increase in truck speed limits from 80 to 90 km/h in May 1982 through to October 1983. The present FORS study monitored an increase in truck speeds from 90 to 100 km/h. The original study was done by Gavin Maisey of the Police Department of Western Australia in 1983 (Maisey 1983).

A number of points regarding Table 4.21 follow:

1. the Eyre Highway observations were based on 24 hour surveillance.
2. exactly the same procedures were carried out in the FORS study as in previous Western Australian studies.
3. Maisey maintained that cars and motorcycles together acted as a control group for articulated vehicles.

An inspection of plot 4.30 which plots the mean free speeds for the six sample points in Table 4.21 reveals the following:

1. Maisey noted in his study from May 1982 through October 1983 that the speeds of articulated vehicles dropped from around 100 km/h to 96 km/h.
2. by comparison, in the FORS surveys of October 1986 through October 1987 the mean free speeds of articulated vehicles rose from 103 km/h to 107 km/h. The decreasing trend observed in the Maisey study has been reversed in the FORS study.
3. the mean free speeds of cars and motor cycles which were supposed to be the control group in Maisey's study paralleled the movement in the mean free speeds of articulated vehicles.
4. in the FORS study the mean free speeds of cars again mirrored very closely the mean free speeds of articulated vehicles.

The FORS study is a complete reversal of the observations which Maisey made in 1983.

Are the observed changes in the mean free speeds statistically significant across the three stages for either cars or articulated vehicles?

An examination of the statistical distributions of car and articulated free speeds showed that the distributions were normal and there is a significant level of auto correlation for the articulated vehicles. Thus the use of inferential parametric statistics in this instance is justified.

To return to the previous question, none of the observed changes in mean free speeds for either cars or articulated vehicles in the present study are statistically significant.

Conclusions[18]

A. The mean free speeds for articulated vehicles decreased in study 1 from 100 to 98 to 96 km/h.

B. The mean free speeds for articulated vehicles increased in study 2 from 103 to 104 to 107 km/h.

C. The mean free speeds for cars mirrored articulated vehicles, more so in study 2 than in study 1.

D. The percentage of articulated vehicles travelling faster than 90 km/h decreased in study 1 and increased in study 2.

E. The 85th percentile for articulated vehicles decreased in study 1 and increased in study 2.

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[18] Study 1 refers to Maisey's 1983 study and study 2 refers to the present FORS study.

F. The observed increase in the mean free speeds for articulated and cars was not statistically significant in study 2.

Summary

The present study indicates a stasis in the speeds of cars and articulated vehicles which contrasts with the results obtained by Maisey where he found that the vehicular speeds decreased.

Plot 4.31 contains both the mean free speeds for articulated vehicles as well as the number of crashes reported in Western Australia over the same period of time. Visually there seems to be very little correlation between the number of crashes and the mean free speeds of articulated vehicles. If anything the number of crashes is slowly decreasing over a period of time and heading towards a static value of somewhere around about 50 crashes per year. By comparison the mean free speeds of articulated vehicles are climbing.

IV.4.c. The NAASRA studies in South Australia.

The South Australian free speed surveys implemented for NAASRA extend over an impressive time span from 1967 through 1985. The assistance of the South Australian officials in making the information available for comparison purposes is acknowledged.

Table 4.22 contains this time series along with the addition of the three extra points for the State of South Australia resulting from the present study.

Once more a cautionary word. Only a few of the sites used in this present study corresponded exactly with the sites used in the previous time series, 1967-1985. Interestingly enough the sample sizes look rather similar except in the case of the rigid trucks. Thus the results reported here are indicative and not perfectly consistent with the existing time series.

Plot 4.32 depicts this time series of mean free speeds. The time series for mean free speeds of cars is a steadily increasing trend and has risen from 90 km/h to about 105 km/h. Similarly the picture for articulated and rigid trucks is also an upward trend but with more perturbations en route.

Plot 4.32 could indicate improving road conditions and the characteristics of vehicles with their ability to travel faster. It would be illuminating to plot this time series up against the fatalities for the same period of time and examine the hypothesis of the link between speed and road fatalities.

The important point which emerges from plot 4.32 is that the results of the present study seem to be consistent with the apparent trends which have emerged from the South Australian time series.

Table 4.23 is a more specific Table which examines the NAASRA free speed survey of rural roads performed in 1985. The comparisons between the 1985 South Australian data and the three corresponding points for South Australia in the present study indicate a high degree of consistency in the results.

Table 4.1: Mean Free Speeds
by vehicle type, Study stage and State

BEFORE survey, October 1986

FREE SPEEDS: Mean free speeds by vehicle type by State

	Speed limit	Sample size	Mean (kph)	Sdev	15 th pctle	85 th pctle	% > 80 kph	% > 90 kph	% > 100 kph	% > 110 kph
CARS										
NSW	100	2859	104	12.2	92	117	97.3	88.0	61.5	28.6
VIC	100	1954	101	11.5	89	113	96.7	85.4	52.4	17.1
QLD	100	4847	96	11.7	84	108	90.7	68.5	35.6	9.7
WA	110	1888	107	13.4	93	121	96.8	89.5	70.9	36.2
SA	110	2835	102	13.3	89	116	95.0	83.0	57.2	23.4
TAS	110									
ACT	100	2266	96	12.0	83	108	89.9	66.3	31.6	9.9
Total		16649	100	12.9	87	114	93.8	78.3	49.1	19.2
Cars towing										
NSW	80	97	94	12.2	81	107	86.6	57.7	29.9	9.3
VIC	100	115	94	10.9	83	106	91.3	68.7	25.2	7.0
QLD	100	162	86	12.2	73	98	64.8	38.3	11.1	1.2
WA	100	264	89	13.0	76	103	75.8	45.5	18.2	6.4
SA	110									
TAS	80									
ACT	100	68	87	10.8	75	98	67.6	32.3	10.2	1.5
Total		706	90	12.6	77	103	76.5	48.0	18.5	5.2
Motor cycles										
NSW	100	53	109	12.9	95	122	98.1	96.2	73.6	45.3
VIC	100	13	109	19.2	89	129	100.0	92.3	61.5	30.8
QLD	100	66	97	16.0	80	113	83.3	65.1	39.3	18.2
WA	110	22	110	12.9	97	124	95.5	95.5	81.9	50.0
SA	110									
TAS	110									
ACT	100	27	105	16.2	88	121	92.6	77.8	63.0	29.6
Total		181	104	16.0	87	121	91.7	81.8	59.7	32.6
Buses										
NSW	90	80	100	10.3	90	111	95.0	85.0	51.2	10.0
VIC	80	190	87	9.0	78	97	77.9	32.6	7.9	.5
QLD	100	95	93	8.4	84	102	90.5	63.1	17.8	1.1
WA	80	55	102	12.3	90	115	96.4	87.3	54.6	23.6
SA	90	61	94	10.9	82	105	88.5	62.3	27.9	6.6
TAS	90	8	80	14.7	64	95	50.0	25.0	12.5	.0
ACT	100	34	83	12.0	71	96	55.9	26.5	8.9	.0
Total		523	92	11.7	80	104	84.1	54.8	23.6	5.2

	Speed limit	Sample size	Mean (kph)	Sdev	15 th pctle	85 th pctle	% > 80 kph	% > 90 kph	% > 100 kph	% > 110 kph
Light Vans										
NSW	100	393	95	12.0	83	108	89.3	65.1	32.8	11.5
VIC	100	92	96	10.2	86	107	92.4	77.2	34.8	4.3
QLD	100	276	91	10.3	81	102	84.4	55.8	17.0	4.0
WA	110	73	95	13.0	82	109	90.4	64.4	32.9	13.7
SA	110									
TAS	110									
ACT	100	133	89	12.2	76	102	78.2	46.6	17.3	1.5
Total		967	93	11.8	81	106	86.8	61.1	26.5	7.4
Rigid Trucks										
NSW	80	288	89	11.9	77	102	76.4	48.3	17.0	4.2
VIC	80	776	88	9.7	78	98	78.5	37.9	9.9	1.5
QLD	90	571	87	10.8	76	98	74.8	37.3	11.4	1.2
WA	90	147	94	11.6	82	106	88.4	68.7	24.5	8.8
SA	80	227	87	11.4	75	98	69.2	35.3	11.1	2.2
TAS	80	179	83	10.8	71	94	59.2	22.9	6.7	.0
ACT	80	243	84	10.3	73	95	67.5	27.2	2.9	.0
Total		2431	87	10.9	76	99	74.6	38.4	11.1	2.0
Articulated trucks										
NSW	80	1063	97	10.9	86	109	94.9	72.8	35.6	12.0
VIC	80	2595	86	9.0	77	96	72.1	28.6	7.2	1.0
QLD	90	533	89	9.5	80	99	84.4	45.0	12.0	1.5
WA	90	614	97	11.8	85	110	93.2	71.9	36.9	14.7
SA	80	681	87	11.1	75	98	70.2	30.6	13.1	3.5
TAS	80	142	87	10.6	76	98	70.4	38.0	9.8	2.1
ACT	80	114	85	10.2	74	96	69.3	26.3	6.1	.0
Total		5742	90	11.2	78	101	79.4	43.3	16.8	4.8
ALL vehicles										
NSW		4837	101	12.8	88	114	94.6	79.8	50.1	21.6
VIC		5735	92	12.3	79	105	82.3	51.1	24.0	6.8
QLD		6554	94	11.9	82	107	87.8	62.4	29.9	7.8
WA		3064	102	14.3	87	117	93.6	80.5	56.1	27.3
SA		3805	98	14.4	83	114	88.9	70.4	46.0	18.3
TAS		329	84	11.0	73	96	63.8	29.5	8.2	.9
ACT		2889	93	12.7	80	107	85.6	59.3	27.0	8.1
Total		27213	96	13.5	82	110	88.2	65.6	36.9	13.7

Notes:

(1) Free speeds - a vehicle to vehicle gap of at least 4 secs

(2) Results reported above are un weighted.

(3) Stage 3, there are two (2) vehicles included in the Grand N which are not in any of the vehicle code groups

(4) Speed limits on freeways for NSW & VIC are 110 kph

Table 4.2: Mean Free Speeds
by vehicle type, Study stage and State

1st After survey, April 1987

FREE SPEEDS: Mean free speeds by vehicle type by State

	Speed limit	Sample size	Mean (kph)	Sdev	15 th pctle	85 th pctle	%) 80 kph	%) 90 kph	%) 100 kph	%) 110 kph
CARS										
NSW	100	2416	106	13.0	92	119	97.3	88.9	65.5	33.9
VIC	100	951	102	11.0	90	113	97.9	87.1	54.5	18.3
QLD	100	4602	97	11.5	85	108	92.2	69.7	36.1	10.2
WA	110	2020	107	14.0	93	122	97.1	89.6	73.6	38.6
SA	110	2788	103	13.5	89	117	94.6	84.2	60.6	28.0
TAS	110	964	94	14.6	79	109	84.3	57.3	26.8	12.4
ACT	100	2046	96	11.5	84	108	91.8	69.1	31.3	8.6
Total		15787	101	13.4	87	114	93.8	77.9	49.6	21.0
Cars towing										
NSW	80	66	94	11.8	81	106	93.9	57.5	27.2	9.1
VIC	100	88	94	10.3	83	105	89.8	65.9	25.0	3.4
QLD	100	153	87	10.5	76	98	69.9	35.9	10.4	.7
WA	100	235	94	12.3	81	107	84.7	63.0	29.4	8.1
SA	110	248	91	12.8	77	104	80.6	50.0	22.2	4.8
TAS	90	32	81	12.4	68	94	53.1	12.5	3.1	3.1
ACT	100	49	89	8.9	79	98	89.8	40.8	8.1	.0
Total		871	91	12.2	78	104	81.3	51.3	21.2	4.8
Motor cycles										
NSW	100	40	108	14.7	93	123	97.5	90.0	67.5	45.0
VIC	100	15	106	8.5	97	115	100.0	93.3	86.6	26.7
QLD	100	56	101	15.8	85	118	96.4	78.5	48.1	14.3
WA	110	42	112	16.6	95	130	97.6	92.8	73.8	52.4
SA	110	27	110	18.2	92	129	92.6	92.6	77.8	48.1
TAS	110	4	108	10.8	97	119	100.0	100.0	100.0	25.0
ACT	100	39	103	15.9	86	119	94.9	77.0	46.2	28.2
Total		223	106	16.0	90	123	96.4	86.1	63.2	34.5
Buses										
NSW	100	67	101	10.3	90	112	95.5	86.5	59.6	10.4
VIC	90	140	91	7.4	83	98	91.4	52.1	8.5	.7
QLD	100	89	94	11.0	83	106	89.9	71.9	33.7	3.4
WA	80	35	102	14.2	87	117	94.3	88.6	62.9	25.7
SA	90	58	97	9.8	86	107	96.6	81.1	39.7	3.4
TAS	90	14	80	9.3	71	90	50.0	7.1	.0	.0
ACT	100	25	87	10.0	77	97	64.0	40.0	8.0	.0
Total		428	94	11.0	83	106	89.7	66.3	30.1	5.1

	Speed limit	Sample size	Mean (kph)	Sdev	15 th pctle	85 th pctle	% > 80 kph	% > 90 kph	% > 100 kph	% > 110 kph
Light Vans										
NSW	100	347	97	12.1	84	110	91.9	70.9	40.1	12.4
VIC	100	80	95	11.2	84	107	87.5	71.2	36.2	7.5
QLD	100	240	94	10.9	82	105	87.9	59.6	27.9	7.5
WA	110	56	96	9.7	86	106	96.4	64.3	37.5	10.7
SA	110	18	93	12.5	80	106	88.9	50.0	22.2	5.6
TAS	110	34	89	15.3	73	105	70.6	44.1	26.5	8.8
ACT	100	141	91	11.4	79	102	77.3	46.1	20.6	3.5
Total		916	95	11.9	82	107	87.7	62.4	32.6	9.0
Rigid Trucks										
NSW	90	255	90	11.2	78	102	80.4	43.5	16.0	4.3
VIC	90	391	88	9.8	78	99	81.3	41.9	9.7	1.3
QLD	90	502	87	9.9	77	97	74.3	35.9	9.4	1.0
WA	100	158	96	10.7	85	107	91.8	70.3	30.4	9.5
SA	90	244	86	10.5	75	97	72.5	36.0	6.9	.8
TAS	90	99	81	11.4	69	93	44.4	15.1	5.0	3.0
ACT	90	176	85	11.1	73	96	67.6	27.8	6.8	1.1
Total		1825	88	10.9	76	99	75.7	39.4	11.5	2.4
Articulated trucks										
NSW	90	1023	99	10.8	88	110	96.3	78.9	42.7	14.2
VIC	90	1445	88	7.9	80	97	87.0	36.6	7.7	.6
QLD	90	424	91	9.2	81	101	88.0	54.5	13.5	1.4
WA	100	647	95	15.4	79	111	93.0	67.3	33.1	13.0
SA	90	670	90	10.4	79	101	85.7	42.1	16.6	3.7
TAS	90	80	85	10.4	74	96	61.2	26.2	8.7	.0
ACT	90	112	85	11.7	73	97	68.7	27.6	5.3	2.7
Total		4401	92	11.5	80	104	89.0	53.1	21.4	6.2
ALL vehicles										
NSW		4214	102	13.1	88	116	95.5	81.7	54.2	24.9
VIC		3110	93	11.2	81	105	90.0	55.4	23.9	6.5
QLD		6066	95	11.7	83	107	89.7	64.7	31.4	8.4
WA		3193	103	15.1	87	119	95.1	81.8	59.3	29.3
SA		4053	99	14.3	84	114	90.9	72.1	47.4	20.6
TAS		1227	92	14.7	77	107	78.1	50.0	23.3	10.4
ACT		2588	94	12.1	82	107	88.1	62.6	27.5	7.6
Total		26451	97	13.6	83	112	90.9	68.9	39.8	15.8

Table 4.3: Mean Free Speeds
by vehicle type, Study stage and State

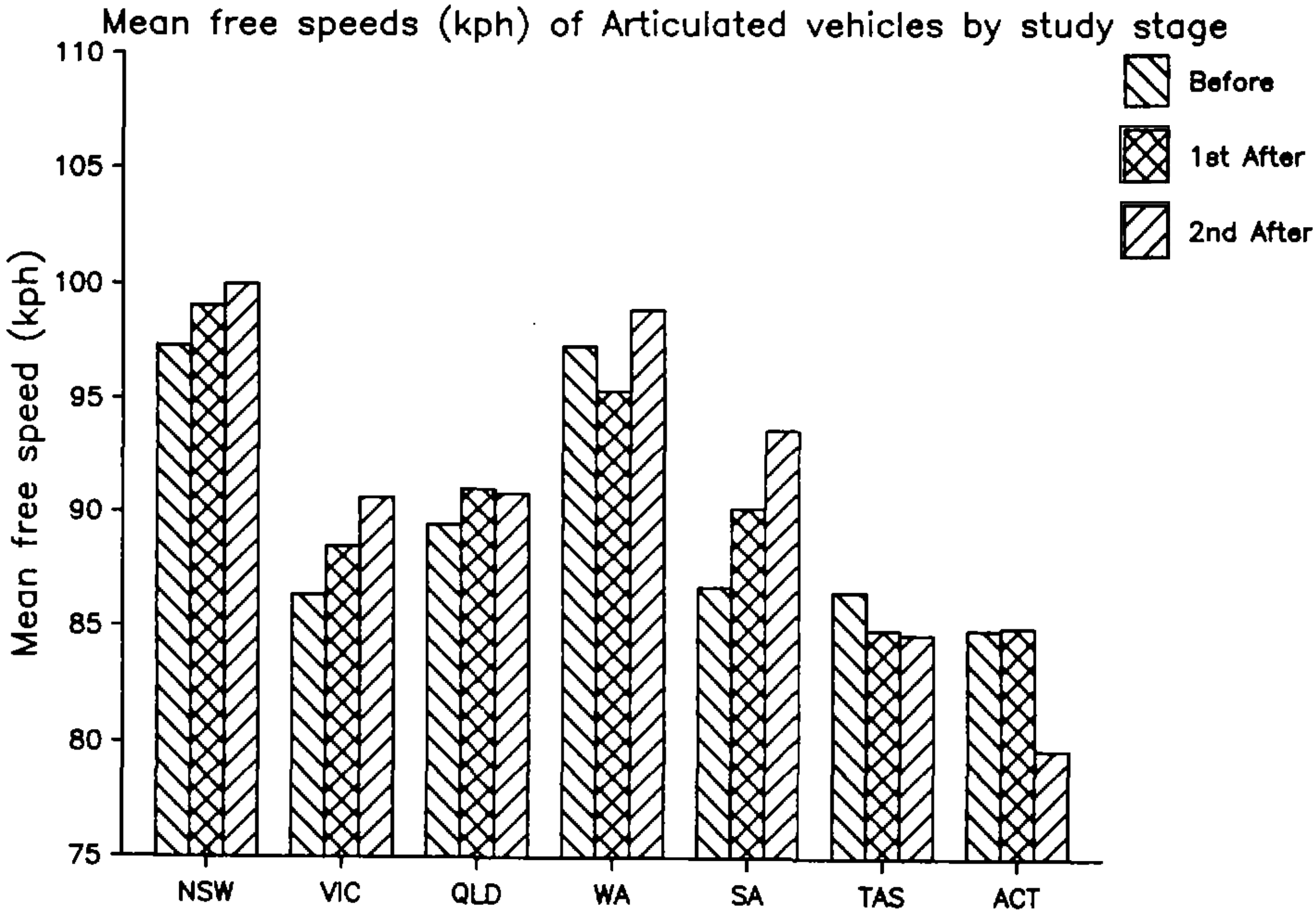
2nd After survey, October 1987

FREE SPEEDS: Mean free speeds by vehicle type by State

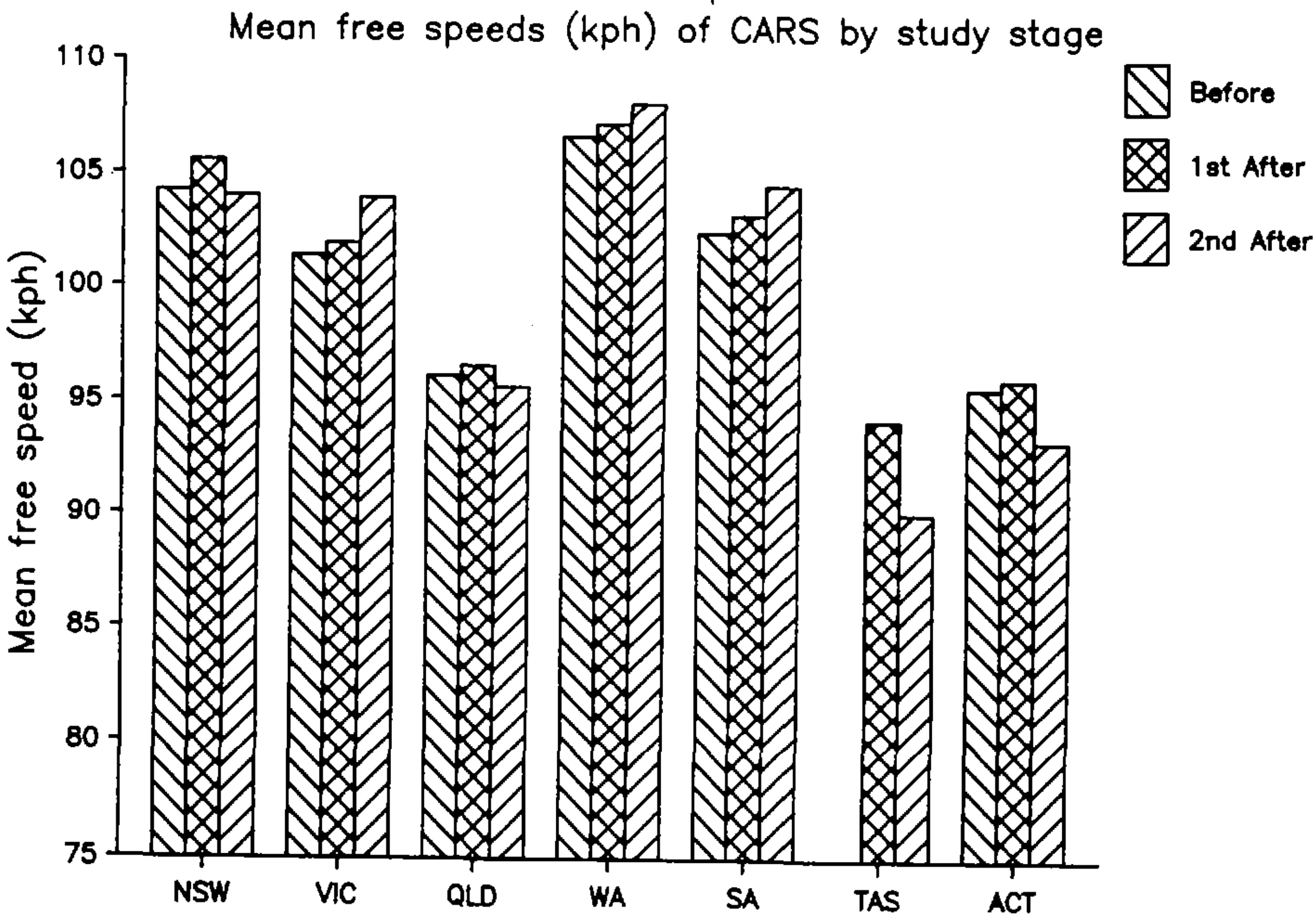
	Speed limit	Sample size	Mean (kph)	Sdev	15 th pctle	85 th pctle	% > 80 kph	% > 90 kph	% > 100 kph	% > 110 kph
CARS										
NSW	100	2353	104	12.1	91	117	97.6	88.7	61.4	27.2
VIC	100	910	104	11.4	92	116	98.7	90.8	62.1	22.6
QLD	100	4884	96	11.6	83	108	90.5	66.8	33.8	8.9
WA	110	2122	108	11.9	96	120	98.2	92.4	77.4	39.1
SA	110	2616	104	13.1	91	118	96.0	86.3	65.5	29.3
TAS	110	1625	90	12.3	77	103	79.3	44.0	18.2	5.3
ACT	100	2369	93	11.5	81	105	88.0	57.9	24.2	6.4
Total		16879	99	13.4	85	113	92.3	73.9	46.6	18.4
Cars towing										
NSW	80	67	96	13.3	82	110	86.6	61.2	41.8	13.4
VIC	100	133	96	11.5	84	108	88.7	68.4	41.3	7.5
QLD	100	153	85	11.7	72	97	60.8	28.1	8.5	.7
WA	100	325	94	12.0	82	107	88.0	60.3	32.9	8.3
SA	110	294	93	12.2	80	105	83.3	55.4	29.5	5.8
TAS	90	44	82	11.0	71	94	54.5	18.1	2.2	2.3
ACT	100	47	85	10.3	74	96	63.8	23.4	8.5	.0
Total		1063	92	12.7	79	105	80.3	52.0	27.7	6.1
Motor cycles										
NSW	100	30	112	14.7	97	127	100.0	96.7	76.7	50.0
VIC	100	15	103	10.4	93	114	93.3	93.3	66.6	26.7
QLD	100	57	102	15.8	86	119	96.5	80.7	45.6	19.3
WA	110	41	116	15.9	99	132	100.0	95.1	82.9	58.5
SA	110	31	110	12.1	97	122	100.0	93.5	77.4	45.2
TAS	110	4	91	12.4	78	103	75.0	50.0	25.0	.0
ACT	100	29	101	15.0	85	116	96.6	69.0	44.9	24.1
Total		207	107	15.7	91	123	97.6	86.5	63.3	36.2
Buses										
NSW	100	61	100	12.4	87	113	93.4	85.2	49.1	13.1
VIC	90	96	91	6.9	84	98	91.7	54.2	10.4	.0
QLD	100	127	94	9.9	84	105	92.9	63.8	27.6	5.5
WA	80	58	100	9.4	90	110	96.6	89.7	44.9	10.3
SA	90	62	96	8.6	87	105	98.4	72.0	30.6	6.5
TAS	90	21	78	9.7	68	88	38.1	9.5	.0	.0
ACT	100	24	82	9.8	71	92	45.8	16.6	8.3	.0
Total		449	94	11.0	83	105	88.9	65.1	27.2	5.6

	Speed limit	Sample size	Mean (kph)	Sdev	15 th pctle	85 th pctle	% > 80 kph	% > 90 kph	% > 100 kph	% > 110 kph
Light Vans										
NSW	100	290	97	11.2	86	109	92.4	73.1	36.9	12.4
VIC	100	124	98	11.3	86	109	92.7	76.6	37.9	11.3
QLD	100	226	92	12.1	79	104	85.0	51.8	21.7	5.8
WA	110	75	93	12.1	81	106	86.7	60.0	25.3	5.3
SA	110	75	96	11.8	84	108	90.7	66.7	38.7	10.7
TAS	110	63	86	14.2	71	101	63.5	34.9	7.9	6.3
ACT	100	118	91	10.7	80	102	85.6	48.3	19.5	3.4
Total		971	94	12.1	81	107	87.4	61.6	28.7	8.5
Rigid Trucks										
NSW	90	264	90	11.8	78	102	81.8	47.0	17.5	2.7
VIC	90	319	90	9.8	79	100	81.5	46.4	14.7	.9
QLD	90	446	88	10.6	77	99	76.2	39.4	11.4	1.1
WA	100	193	96	12.1	84	109	91.7	67.3	34.1	13.0
SA	90	240	87	11.4	75	99	71.2	40.4	12.1	2.1
TAS	90	111	80	10.6	69	91	43.2	16.2	4.5	.0
ACT	90	117	83	10.9	72	94	56.4	24.8	8.6	.0
Total		1690	89	11.6	77	101	75.6	42.7	15.0	2.7
Articulated trucks										
NSW	90	1141	100	9.6	90	110	98.2	83.6	47.2	14.4
VIC	90	1287	91	7.7	83	99	92.5	48.5	10.7	.5
QLD	90	482	91	10.1	80	101	84.0	52.9	16.2	2.1
WA	100	784	99	11.2	87	110	97.1	77.3	39.9	14.2
SA	90	661	94	10.5	83	105	93.3	54.9	22.4	8.0
TAS	90	127	85	9.7	75	95	69.3	27.6	4.0	.0
ACT	90	112	80	13.3	66	94	51.8	22.3	5.3	.0
Total		4594	94	10.9	83	106	92.3	62.3	26.7	7.5
ALL vehicles										
NSW		4211	101	12.2	89	114	96.1	83.1	52.6	20.9
VIC		2884	95	11.4	83	107	93.0	64.1	30.2	8.5
QLD		6375	94	11.8	82	107	88.2	62.4	29.8	7.6
WA		3598	104	13.0	90	117	96.4	84.1	61.3	28.5
SA		3979	100	13.8	86	115	93.1	75.6	51.5	21.8
TAS		1995	89	12.4	76	102	75.1	40.2	15.6	4.6
ACT		2817	92	12.1	79	105	84.5	53.9	22.4	5.8
Total		25859	97	13.2	83	111	90.5	68.4	39.4	14.5

Plot 4.1: Articulated - Free speeds - all roads

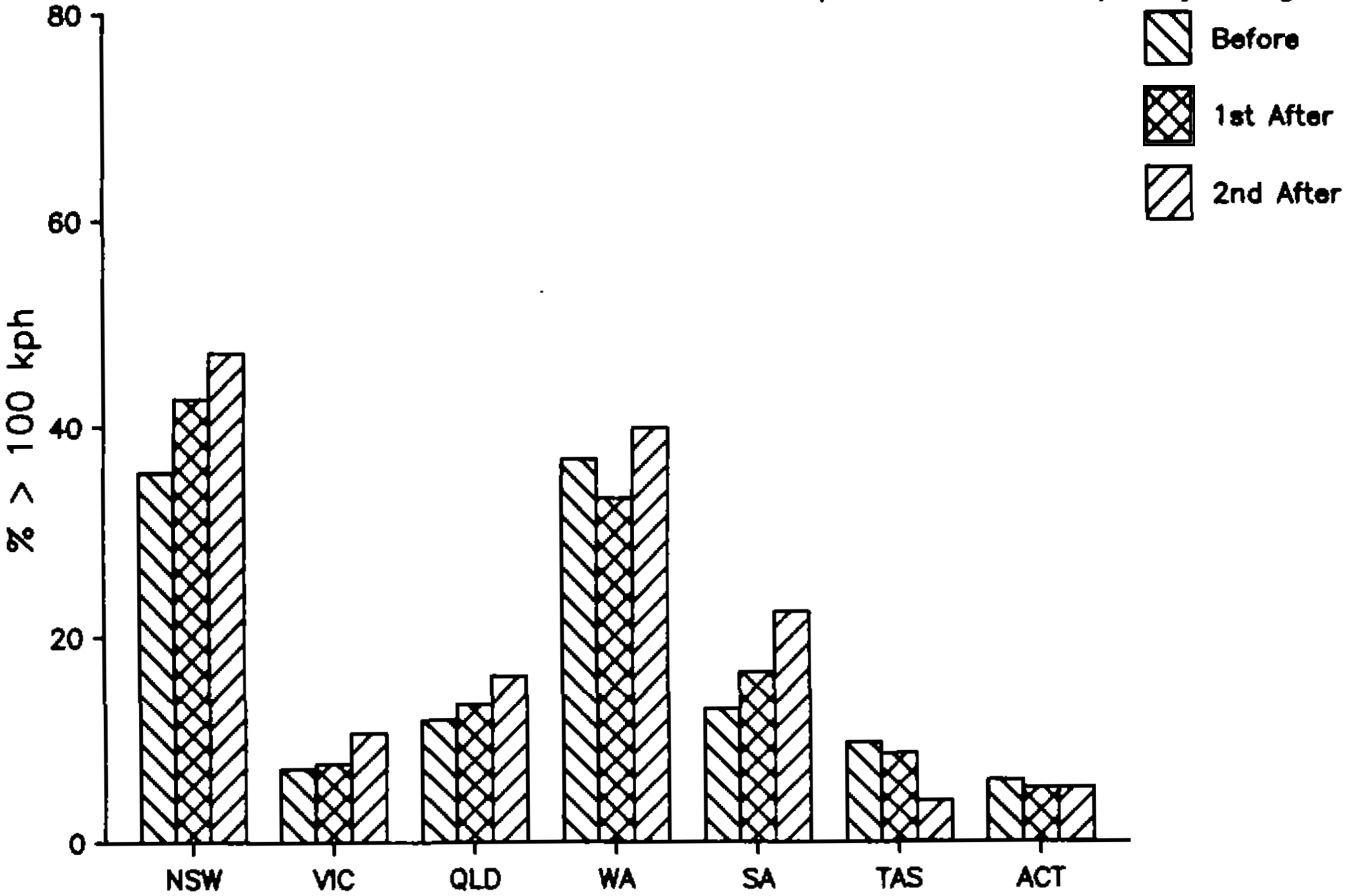


Plot 4.2: CARS - Free speeds - all roads



Plot 4.3: Articulated – % > 100 kph – all roads

% of articulated vehicles with mean free speeds > 100 kph by stage



Plot 4.4: Cars – % > 100 kph – all roads

% of cars with mean free speeds > 100 kph by stage

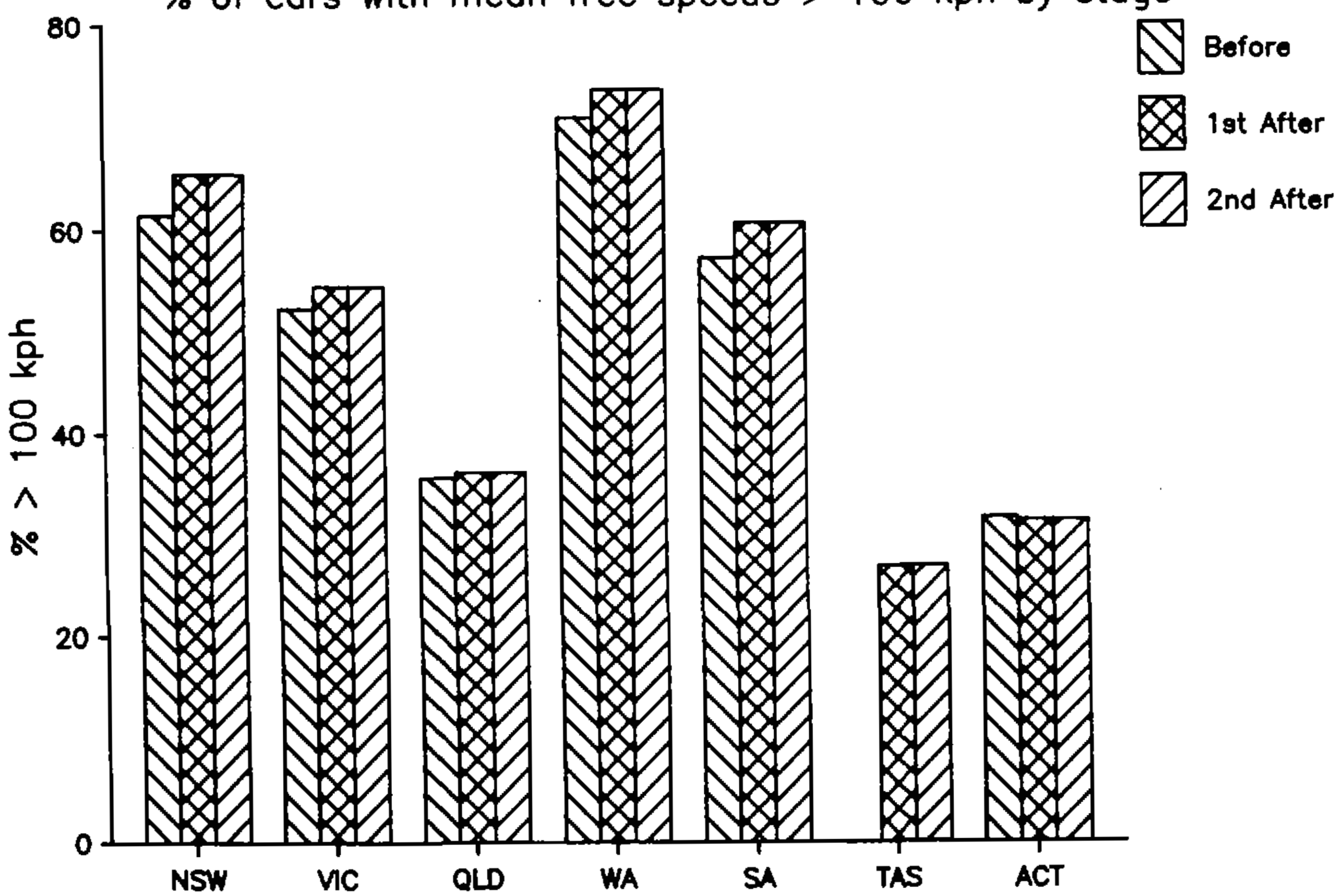


Table 4.4: 2 lane only road location site #'s

stg1	stg2	stg3
1001	2001	3001
1004	2004	3004
1005	2005	3005
1006	2006	3006
1007	2007	3007
1012	2012	3012
1150	2150	3150
1160	2160	3160
1170	2170	3170
1180	2180	3180
1220	2220	3220
1225	2225	3225
1245	2245	3245
1250	2250	3250
1300	2300	3300
1301	2301	3301
1302	2302	3302
1303	2303	3303
1304	2304	3304
1305	2305	3305
1306	2306	
1400	2400	3400
1405	2405	3405
1407	2407	3407
1501	2501	3501
1503	2503	3503
1601	2601	3601

Notes:
(1) Stg1 = Before, Stg2 = After 1, Stg3 = After 2
(2) These sites were chosen not only by being 2 lane roads only but because they were used in all three study stages (except site 306).
(3) Refer to Tables A1 through A9 for detailed site descriptions.

Table 4.5: Mean Free Speeds - 2 lane roads only
by vehicle type, Study stage and State

BEFORE survey, October 1986

FREE SPEEDS: Mean free speeds by vehicle type by State

	Speed limit	Sample size	Mean (kph)	Std dev	15 th pctle	85 th pctle	% > 80 kph	% > 90 kph	% > 100 kph	% > 110 kph
CARS										
NSW	100	975	102	12.5	89	114	95.5	82.5	50.5	22.6
VIC	100	553	101	12.8	88	114	94.2	83.0	52.8	19.5
QLD	100	581	92	13.1	79	106	82.1	53.0	24.6	7.7
WA	110	1888	107	13.4	93	121	96.8	89.5	70.9	36.2
SA	110	648	100	13.0	86	113	92.9	79.3	49.4	16.8
TAS	110									
ACT	100	392	99	12.9	86	113	92.9	77.3	47.5	16.3
Total		5037	102	13.8	88	116	93.7	80.9	55.0	24.4
Cars towing										
NSW	80	24	91	15.1	75	106	66.7	45.9	29.2	12.5
VIC	100	62	93	11.9	81	106	90.3	66.1	22.6	6.5
QLD	100	25	86	9.2	76	95	68.0	32.0	4.0	.0
WA	100	264	89	13.0	76	103	75.8	45.5	18.2	6.4
SA	110									
TAS	80									
ACT	100	11	88	10.5	77	99	72.7	45.4	9.0	.0
Total		386	90	12.7	77	103	76.9	47.9	18.4	6.2
Motor cycles										
NSW	100	16	104	12.3	91	117	93.7	93.7	68.7	31.3
VIC	100	2	104	31.8	70	137	100.0	50.0	50.0	50.0
QLD	100	11	96	21.9	73	119	81.8	54.5	27.2	18.2
WA	110	22	110	12.9	97	124	95.5	95.5	81.9	50.0
SA	110									
TAS	110									
ACT	100	2	113	14.1	98	128	100.0	100.0	100.0	50.0
Total		53	105	16.1	89	122	92.5	85.0	66.1	37.7
Buses										
NSW	90	37	99	11.6	87	111	91.9	78.4	54.1	13.5
VIC	80	47	87	10.7	76	98	78.7	27.6	10.6	2.1
QLD	100	15	86	8.5	77	95	66.7	33.4	.1	.0
WA	80	55	102	12.3	90	115	96.4	87.3	54.6	23.6
SA	90	18	95	9.9	85	106	94.4	66.6	33.3	5.6
TAS	90	8	80	14.7	64	95	50.0	25.0	12.5	.0
ACT	100	13	83	15.8	67	100	69.2	46.1	7.6	.0
Total		193	94	13.8	80	108	85.0	59.6	32.7	10.4

	Speed limit	Sample size	Mean (kph)	Std dev	15 th pctle	85 th pctle	% > 80 kph	% > 90 kph	% > 100 kph	% > 110 kph
Light Vans										
NSW	100	181	92	11.3	80	104	84.0	56.9	18.2	5.5
VIC	100	38	98	13.1	84	111	86.8	78.9	52.6	10.5
QLD	100	22	92	9.4	82	102	86.4	59.1	18.2	4.5
WA	110	73	95	13.0	82	109	90.4	64.4	32.9	13.7
SA	110									
TAS	110									
ACT	100	14	93	14.4	78	108	78.6	57.2	28.6	7.1
Total		328	93	12.1	81	106	85.7	61.3	25.9	7.9
Rigid Trucks										
NSW	80	128	86	12.0	74	99	68.0	41.4	10.1	2.3
VIC	80	189	87	10.2	77	98	74.6	39.2	8.0	1.6
QLD	90	134	83	11.9	71	96	63.4	24.6	5.9	1.5
WA	90	147	94	11.6	82	106	88.4	68.7	24.5	8.8
SA	80	37	88	11.9	76	101	73.0	40.6	13.6	2.7
TAS	80	179	83	10.8	71	94	59.2	22.9	6.7	.0
ACT	80	79	90	7.0	82	97	89.9	50.7	5.1	.0
Total		893	87	11.6	75	99	72.5	40.0	10.4	2.5
Articulated trucks										
NSW	80	478	96	10.2	86	107	95.8	72.4	29.5	8.6
VIC	80	1091	86	9.3	76	96	68.0	26.8	7.6	1.3
QLD	90	115	86	9.9	75	96	69.6	28.7	8.7	.9
WA	90	614	97	11.8	85	110	93.2	71.9	36.9	14.7
SA	80	134	85	10.2	74	95	63.4	23.1	8.2	2.2
TAS	80	142	87	10.6	76	98	70.4	38.0	9.8	2.1
ACT	80	77	87	8.1	79	96	79.2	35.0	6.4	.0
Total		2651	90	11.6	78	102	79.1	46.1	18.4	5.7
ALL vehicles										
NSW		1843	98	12.6	85	111	92.1	74.0	39.0	15.6
VIC		1982	91	12.6	78	104	77.3	45.9	21.6	6.8
QLD		903	90	13.0	76	103	77.2	45.0	18.8	5.6
WA		3064	102	14.3	87	117	,93.6	80.5	56.1	27.3
SA		838	97	13.8	82	111	87.4	68.3	40.9	13.6
TAS		329	84	11.0	73	96	63.8	29.5	8.2	.9
ACT		592	95	13.8	81	110	88.9	66.1	34.3	11.1
Total		9551	96	14.4	81	111	86.5	65.0	37.8	15.6

Notes:

(1) Free speeds - a vehicle to vehicle gap of at least 4 secs

(2) Results reported above are un weighted.

(3) Stage 3, there are two (2) vehicles included in the Grand N which are not in any of the vehicle code groups

(4) Speed limits on freeways for NSW & VIC are 110 kph

Table *4.6*: Mean Free Speeds - 2 lane roads only
by vehicle type, Study stage and State

1st After survey, April 1987

FREE SPEEDS: Mean free speeds by vehicle type by State

	Speed limit	Sample size	Mean (kph)	Std dev	15 th pctle	85 th pctle	% > 80 kph	% > 90 kph	% > 100 kph	% > 110 kph
CARS										
NSW	100	878	101	12.2	88	114	95.4	81.0	50.7	20.0
VIC	100	311	103	11.2	91	115	97.4	87.8	60.1	23.2
QLD	100	834	91	11.8	79	103	82.6	50.6	19.2	5.9
WA	110	2020	107	14.0	93	122	97.1	89.6	73.6	38.6
SA	110	645	99	13.7	85	113	90.5	75.3	46.6	19.2
TAS	110	964	94	14.6	79	109	84.3	57.3	26.8	12.4
ACT	100	327	99	13.5	85	114	93.3	79.2	42.2	15.6
Total		5979	100	14.6	85	116	91.9	75.5	49.8	22.9
Cars towing										
NSW	80	32	91	10.5	80	102	93.7	46.8	15.5	6.3
VIC	100	42	94	10.9	83	106	90.5	64.3	23.8	4.8
QLD	100	35	82	9.4	72	92	60.0	20.0	.0	.0
WA	100	235	94	12.3	81	107	84.7	63.0	29.4	8.1
SA	110	84	86	13.3	72	100	67.9	32.2	13.2	3.6
TAS	90	32	81	12.4	68	94	53.1	12.5	3.1	3.1
ACT	100	17	88	11.3	76	99	88.2	47.0	5.8	.0
Total		477	90	12.9	77	104	79.0	49.4	20.3	5.7
Motor cycles										
NSW	100	13	103	14.7	88	118	100.0	84.6	53.8	30.8
VIC	100	5	111	9.0	102	121	100.0	100.0	100.0	60.0
QLD	100	12	103	27.7	75	132	83.3	66.6	41.6	25.0
WA	110	42	112	16.6	95	130	97.6	92.8	73.8	52.4
SA	110	5	100	17.2	82	118	80.0	80.0	60.0	40.0
TAS	110	4	108	10.8	97	119	100.0	100.0	100.0	25.0
ACT	100	6	99	20.3	78	120	83.3	66.6	33.3	16.7
Total		87	108	18.2	89	127	94.3	86.3	65.6	41.4
Buses										
NSW	100	35	100	12.2	88	113	91.4	80.0	62.9	11.4
VIC	90	29	91	8.6	82	100	82.8	51.8	13.9	.0
QLD	100	8	87	9.1	77	96	87.5	25.0	12.5	.0
WA	80	35	102	14.2	87	117	94.3	88.6	62.9	25.7
SA	90	19	94	13.3	81	108	89.5	79.0	36.9	5.3
TAS	90	14	80	9.3	71	90	50.0	7.1	.0	.0
ACT	100	4	94	5.9	87	100	100.0	50.0	.0	.0
Total		144	95	13.4	81	109	86.1	65.3	38.9	9.7

	Speed limit	Sample size	Mean (kph)	Std dev	15 th pctle	85 th pctle	% > 80 kph	% > 90 kph	% > 100 kph	% > 110 kph
Light Vans										
NSW	100	153	93	11.0	82	105	87.6	58.8	26.8	4.6
VIC	100	28	94	11.7	82	106	82.1	71.4	35.7	3.6
QLD	100	14	90	12.6	77	103	78.6	50.0	14.3	7.1
WA	110	56	96	9.7	86	106	96.4	64.3	37.5	10.7
SA	110	8	91	12.1	79	104	75.0	50.0	12.5	.0
TAS	110	34	89	15.3	73	105	70.6	44.1	26.5	8.8
ACT	100	23	96	16.7	79	114	78.3	60.9	43.5	13.0
Total		316	93	12.0	81	106	85.4	58.8	29.7	6.6
Rigid Trucks										
NSW	90	111	87	9.4	77	97	75.7	32.5	9.1	.9
VIC	90	93	89	9.5	79	99	82.8	43.0	14.0	.0
QLD	90	126	86	8.6	77	95	74.6	32.5	3.1	.0
WA	100	158	96	10.7	85	107	91.8	70.3	30.4	9.5
SA	90	41	82	10.5	71	93	56.1	19.5	4.9	.0
TAS	90	99	81	11.6	69	93	44.4	15.1	5.0	3.0
ACT	90	52	91	9.6	81	101	90.4	50.0	15.4	1.9
Total		680	88	11.1	77	100	75.6	40.7	13.2	2.9
Articulated trucks										
NSW	90	502	98	9.3	88	108	96.6	79.5	40.3	9.8
VIC	90	644	89	8.1	80	97	88.2	38.5	8.5	.9
QLD	90	95	89	9.7	79	99	86.3	48.4	10.5	.0
WA	100	647	95	15.4	79	111	93.0	67.3	33.1	13.0
SA	90	158	87	10.5	76	98	75.3	31.6	12.6	3.2
TAS	90	80	85	10.4	74	96	61.2	26.2	8.7	.0
ACT	90	50	91	10.3	80	101	86.0	42.0	10.0	6.0
Total		2176	93	12.1	80	105	89.5	56.1	23.6	6.8
ALL vehicles										
NSW		1724	98	11.8	86	111	93.7	74.8	42.4	14.1
VIC		1152	93	11.2	81	105	90.1	54.5	24.6	7.3
QLD		1124	90	11.7	78	103	81.3	47.4	16.2	4.7
WA		3193	103	15.1	87	119	95.1	81.8	59.3	29.3
SA		960	95	14.3	80	110	84.4	61.9	36.0	14.1
TAS		1227	92	14.7	77	107	78.1	50.0	23.3	10.4
ACT		479	97	13.5	83	111	91.2	69.7	34.2	12.3
Total		9859	97	14.4	82	112	89.3	66.9	39.3	16.6

Table 4.7: Mean Free Speeds - 2 lane roads only
by vehicle type, Study stage and State

2nd After survey, October 1987

FREE SPEEDS: Mean free speeds by vehicle type by State

	Speed limit	Sample size	Mean (kph)	Std dev	15 th pctle	85 th pctle	% > 80 kph	% > 90 kph	% > 100 kph	% > 110 kph
CARS										
NSW	100	865	103	12.9	89	116	96.5	86.8	55.1	23.2
VIC	100	369	103	10.6	92	114	98.1	88.9	58.0	20.3
QLD	100	959	90	11.0	79	102	82.9	47.7	16.0	4.0
WA	110	2122	108	11.9	96	120	98.2	92.4	77.4	39.1
SA	110	628	100	13.9	85	114	90.6	74.4	52.1	20.2
TAS	110	1625	90	12.3	77	103	79.3	44.0	18.2	5.3
ACT	100	477	97	12.5	84	110	92.5	71.5	39.2	12.8
Total		7045	99	14.3	84	114	90.5	71.3	46.8	20.1
Cars towing										
NSW	80	20	99	12.1	87	112	95.0	75.0	55.0	10.0
VIC	100	41	97	12.0	84	109	92.7	68.3	41.5	12.2
QLD	100	44	79	11.4	67	91	38.6	11.3	6.8	.0
WA	100	325	94	12.0	82	107	88.0	60.3	32.9	8.3
SA	110	70	92	12.9	78	105	78.6	50.0	27.1	5.7
TAS	90	44	82	11.0	71	94	54.5	18.1	2.2	2.3
ACT	100	9	78	9.0	69	88	33.3	.0	.0	.0
Total		553	92	13.2	78	106	79.9	51.9	28.6	7.1
Motor cycles										
NSW	100	14	109	13.7	95	123	100.0	100.0	64.3	42.9
VIC	100	3	100	6.4	93	106	100.0	100.0	33.3	.0
QLD	100	8	96	7.3	88	103	100.0	75.0	25.0	.0
WA	110	41	116	15.9	99	132	100.0	95.1	82.9	58.5
SA	110	11	109	8.6	100	118	100.0	100.0	90.9	36.4
TAS	110	4	91	12.4	78	103	75.0	50.0	25.0	.0
ACT	100	3	104	11.0	93	115	100.0	100.0	66.7	33.3
Total		84	110	15.3	94	125	98.8	92.8	70.2	41.7
Buses										
NSW	100	25	102	16.0	86	119	88.0	84.0	64.0	16.0
VIC	90	16	92	6.8	85	99	93.7	49.9	18.6	.0
QLD	100	12	87	8.3	78	96	75.0	33.3	.0	.0
WA	80	58	100	9.4	90	110	96.6	89.7	44.9	10.3
SA	90	21	96	10.9	85	108	95.2	76.2	38.1	14.3
TAS	90	21	78	9.7	68	88	38.1	9.5	.0	.0
ACT	100	4	92	12.0	80	105	75.0	75.0	25.0	.0
Total		157	95	13.2	81	109	84.7	67.5	34.4	8.3

	Speed limit	Sample size	Mean (kph)	Std dev	15 th pctle	85 th pctle	% > 80 kph	% > 90 kph	% > 100 kph	% > 110 kph
Light Vans										
NSW	100	104	95	10.5	84	106	91.3	68.2	31.7	6.7
VIC	100	32	97	10.2	87	108	96.9	68.8	31.3	12.5
QLD	100	12	81	18.5	61	100	50.0	25.0	16.7	8.3
WA	110	75	93	12.1	81	106	86.7	60.0	25.3	5.3
SA	110	15	91	13.0	78	105	80.0	53.3	26.6	13.3
TAS	110	63	86	14.2	71	101	63.5	34.9	7.9	6.3
ACT	100	27	98	11.9	86	110	96.3	74.1	48.2	7.4
Total		328	93	12.9	79	106	83.8	58.2	26.2	7.3
Rigid Trucks										
NSW	90	112	90	12.7	77	103	82.1	47.3	16.9	4.5
VIC	90	78	90	9.5	80	100	87.2	46.2	12.9	1.3
QLD	90	120	86	10.1	76	97	68.3	35.8	5.0	.0
WA	100	193	96	12.1	84	109	91.7	67.3	34.1	13.0
SA	90	35	85	10.2	74	95	68.6	28.6	8.6	.0
TAS	90	111	80	10.6	69	91	43.2	16.2	4.5	.0
ACT	90	52	88	10.5	77	99	76.9	46.1	17.3	.0
Total		701	89	12.4	76	102	75.7	44.7	16.7	4.4
Articulated trucks										
NSW	90	559	99	8.9	90	109	98.6	82.9	45.3	12.0
VIC	90	531	89	7.5	82	97	90.4	43.1	8.3	.2
QLD	90	123	87	9.6	77	97	78.0	37.3	10.5	.0
WA	100	784	99	11.2	87	110	97.1	77.3	39.9	14.2
SA	90	112	92	9.4	82	102	89.3	50.0	16.1	4.5
TAS	90	127	85	9.7	75	95	69.3	27.6	4.0	.0
ACT	90	49	88	10.0	78	98	83.7	40.8	10.2	.0
Total		2285	95	10.9	83	106	92.6	63.6	28.4	8.1
ALL vehicles										
NSW		1701	100	12.1	88	113	95.8	81.6	48.0	17.2
VIC		1070	95	10.9	83	106	93.2	61.1	27.9	8.0
QLD		1278	89	11.1	78	101	79.3	44.2	14.1	3.1
WA		3598	104	13.0	90	117	96.4	84.1	61.3	28.5
SA		892	97	13.7	83	112	88.7	67.6	43.6	16.3
TAS		1995	89	12.4	76	102	75.1	40.2	15.6	4.6
ACT		622	95	13.1	82	109	89.5	66.0	34.8	10.3
Total		11156	97	13.9	83	111	89.2	66.7	39.5	15.6

Table 4.8: Statistical assumptions matrix for Free Speeds - ALL roads

Main effects	Normality	Auto correlation
1. <u>ALL vehicles</u>		
1.1 ALL vehicles	s	s
2. <u>ARTICULATED vehicles</u>		
<u>Within State</u>		
2.31 NSW	s	s
2.32 VIC	s	s
2.33 QLD	-	s
2.34 WA	s	s
2.35 SA	s	s
2.36 TAS	-	12-45
2.37 ACT	-	s
3. <u>CARS</u>		
<u>Within State</u>		
3.31 NSW	s	s
3.32 VIC	s	s
3.33 QLD	s	s
3.34 WA	s	1-345
3.35 SA	s	s
3.36 TAS	s	12-45
3.37 ACT	s	s

Notes:
(1) notation for significance levels: s = significant, reject null hypothesis. All 5 lags had significant coefficients. - = non significant, accept the null hypothesis. All 5 lags had non significant coefficients. Where some lags were non significant, this is denoted by the notation nn-nn i.e. 12-45 means that all lags except lag 3 were significant.
Alpha significance level adopted = 0.05.

Table 4.9: Statistical assumptions matrix for Free Speeds
2 lane roads only

Main effects	Normality	Auto correlation
1. ALL vehicles		
1.1 ALL vehicles	s	s
2. ARTICULATED vehicles		
Within State		
2.31 NSW	s	s
2.32 VIC	-	1-3--
2.33 QLD	s	1-34-
2.34 WA	s	1----
2.35 SA	s	-
2.36 TAS	s	12-45
2.37 ACT	-	--3--
3. CARS		
Within State		
3.31 NSW	-	s
3.32 VIC	s	s
3.33 QLD	-	-
3.34 WA	s	s
3.35 SA	s	s
3.36 TAS	-	12-45
3.37 ACT	-	-

Notes:
(1) notation for significance levels: s = significant, reject null hypothesis. All 5 lags had significant coefficients. - = non significant, accept the null hypothesis. All 5 lags had non significant coefficients. Where some lags were non significant, this is denoted by the notation nn-nn i.e. 12-45 means that all lags except lag 3 were significant.
Alpha significance level adopted = 0.05.

Table 4.10: Statistical tests matrix for Free Speeds

1. Overall effects

Main effects Variables	ALL roads	2 lane roads
1.1 State	s	s
1.2 Stage	s	s
1.3 Vehicle type	s	s
1.4 Speed meter	s	s

2. ARTICULATED vehicles

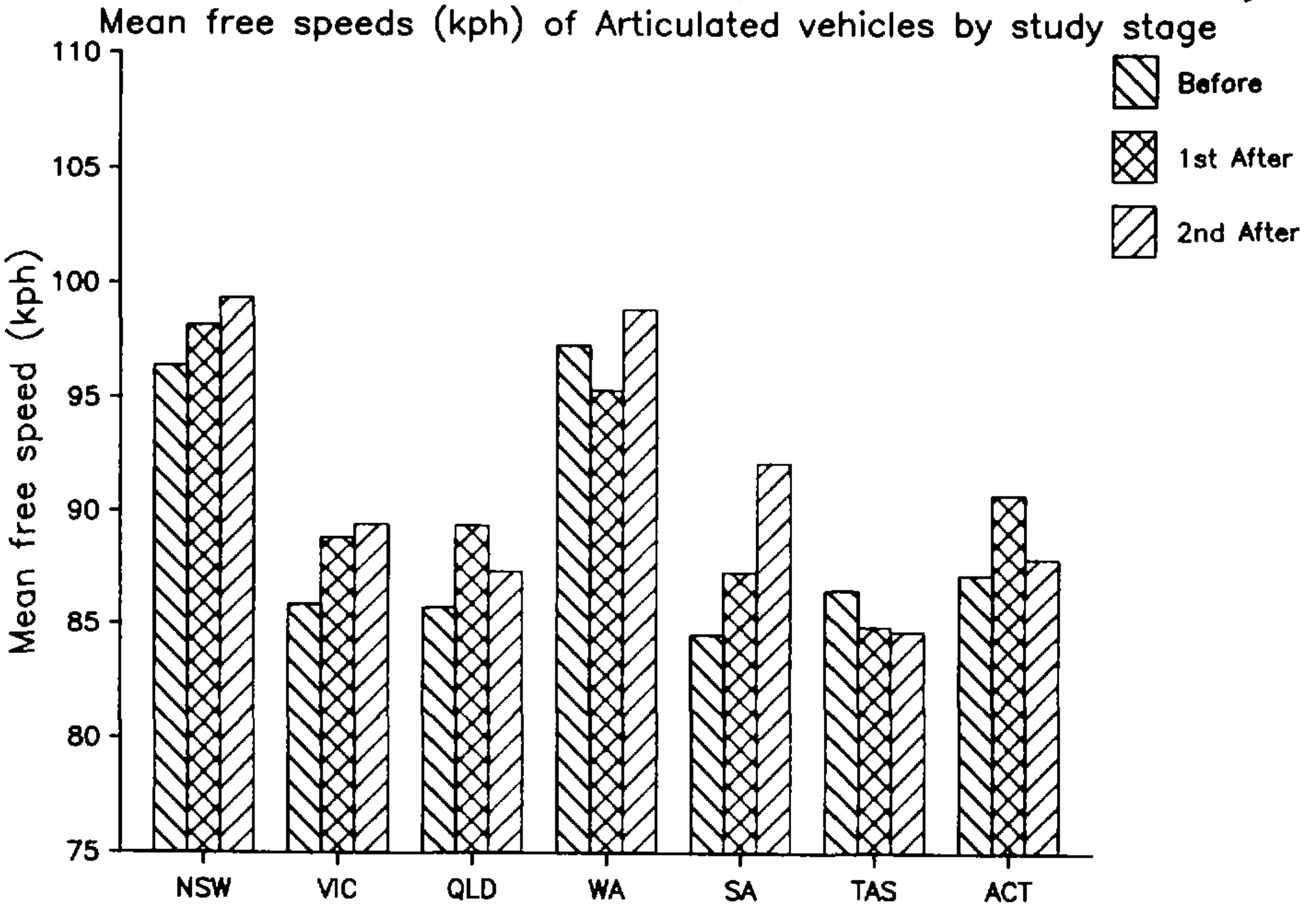
Main effects Variables		
2.1 State	s	s
2.2 Stage	s	s
Within State effects		
2.31 NSW	s	s
2.32 VIC	s	s
2.33 QLD	s	s
2.34 WA	s	s
2.35 SA	s	s
2.36 TAS	-	-
2.37 ACT	s	-

3. CARS

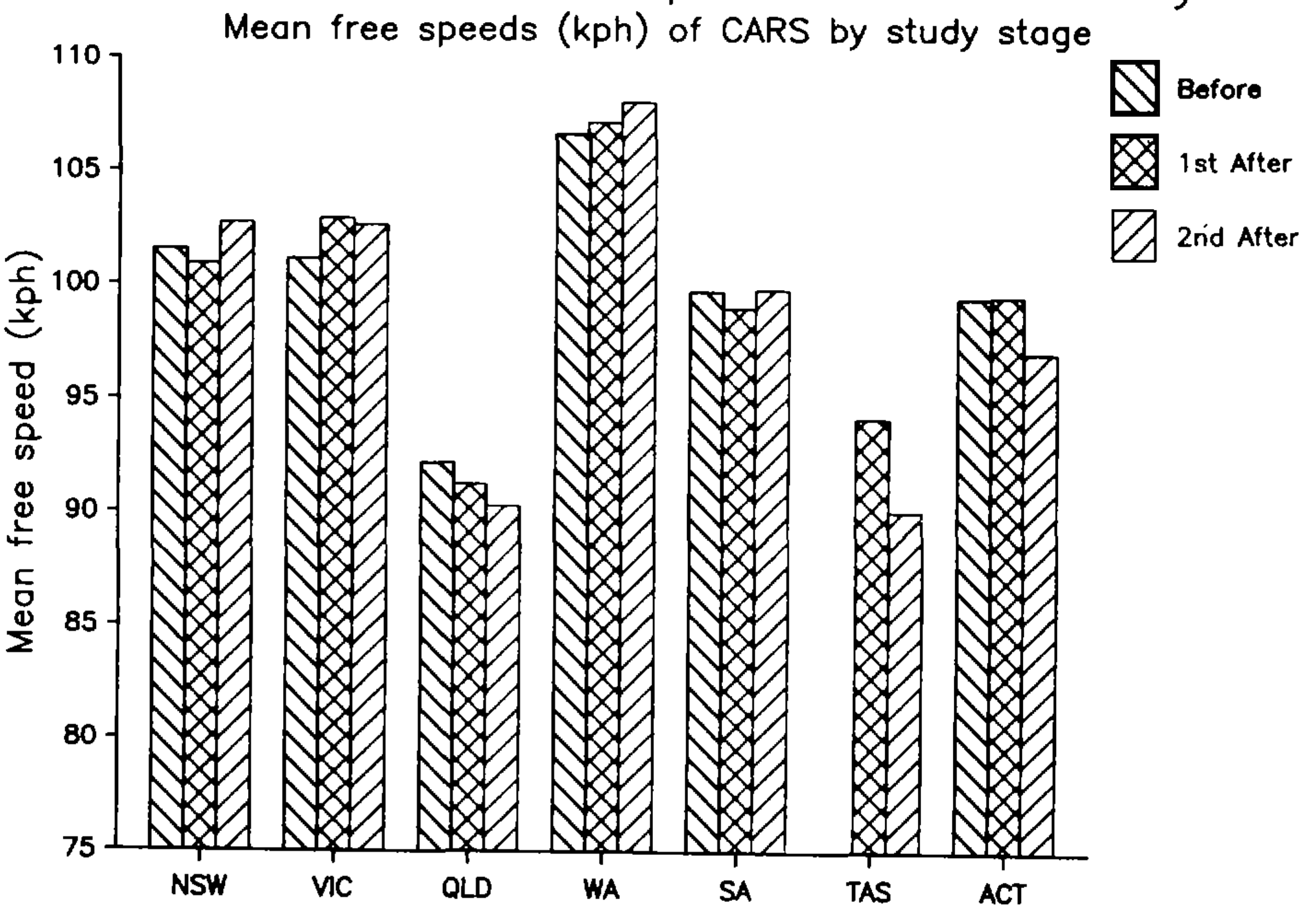
Main effects Variables		
3.1 State	s	s
3.2 Stage	-	s
Within State effects		
3.31 NSW	-	-
3.32 VIC	-	-
3.33 QLD	-	-
3.34 WA	-	s
3.35 SA	s	-
3.36 TAS	s	s
3.37 ACT	s	s

Notes:
(1) notation for significance levels: s = significant, reject null hypothesis, - = non significant, accept the null hypothesis.
Alpha significance level adopted = 0.05.
(2) Within State effects denotes a oneway anova (using the Kruskal-Wallis test) of Speed by Stage within the designated State.

Plot 4.5: Articulated - Free speeds - 2 lane only

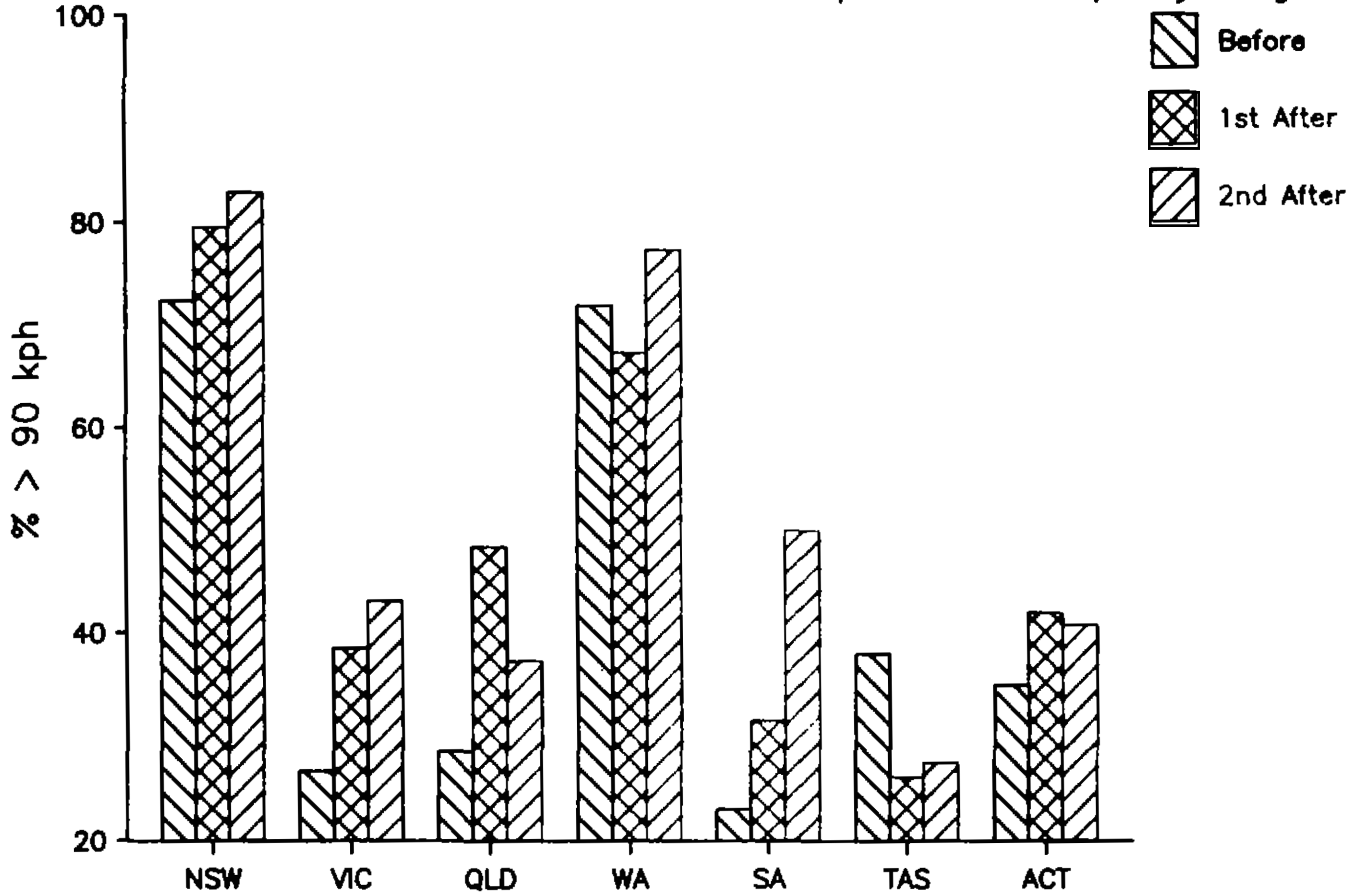


Plot 4.6: CARS - Free speeds - 2 lane only



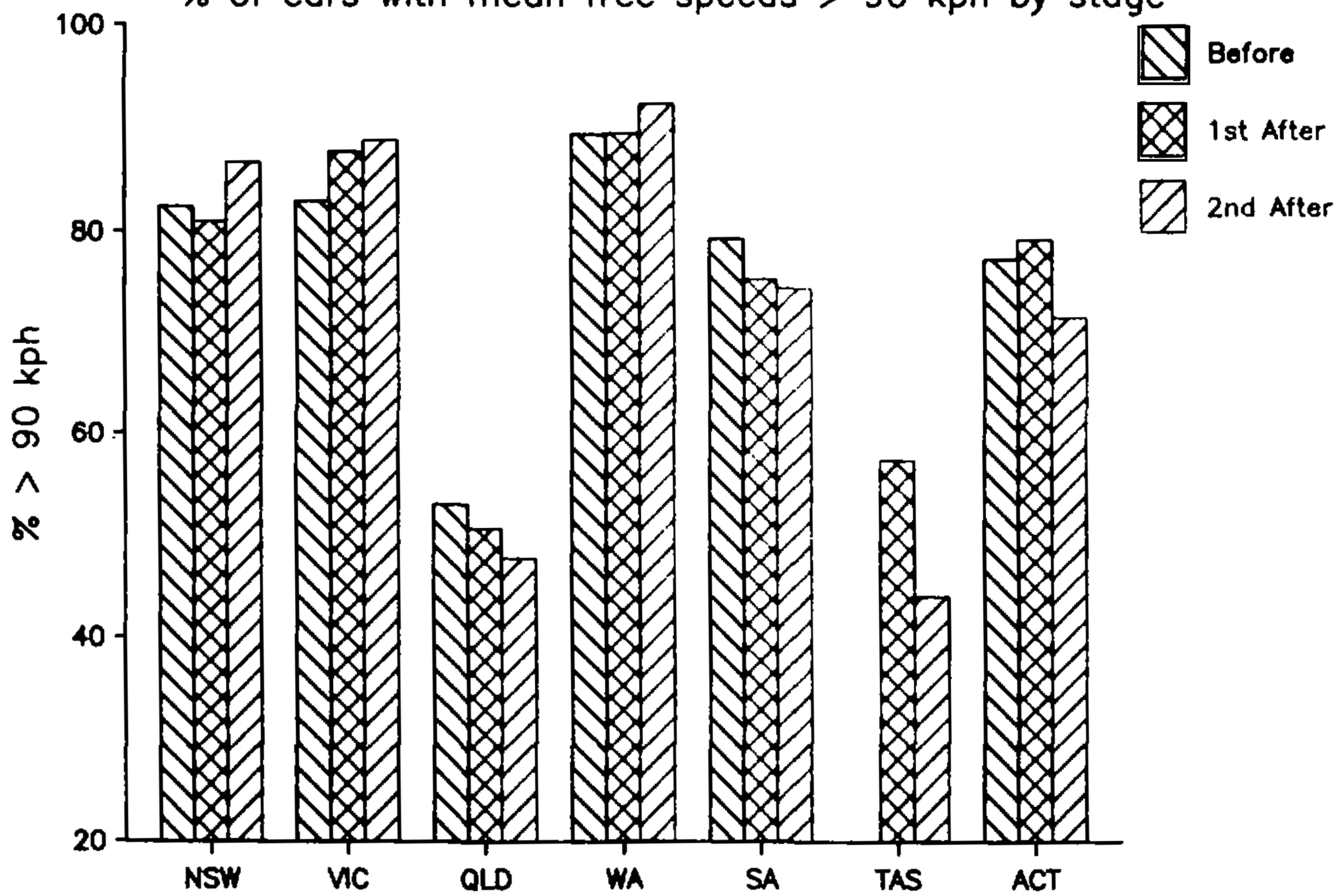
Plot 4.7: Articulated – % > 90 kph – 2 lane only

% of articulated vehicles with mean free speeds > 90 kph by stage



Plot 4.8: Cars – % > 90 kph – 2 lane only

% of cars with mean free speeds > 90 kph by stage



Plot4.9: Articulated - % > 100 kph - 2 lane only

% of articulated vehicles with mean free speeds > 100 kph by stage

Plot 4.10: Cars - % > 90 kph - 2 lane only

% of cars with mean free speeds > 100 kph by stage

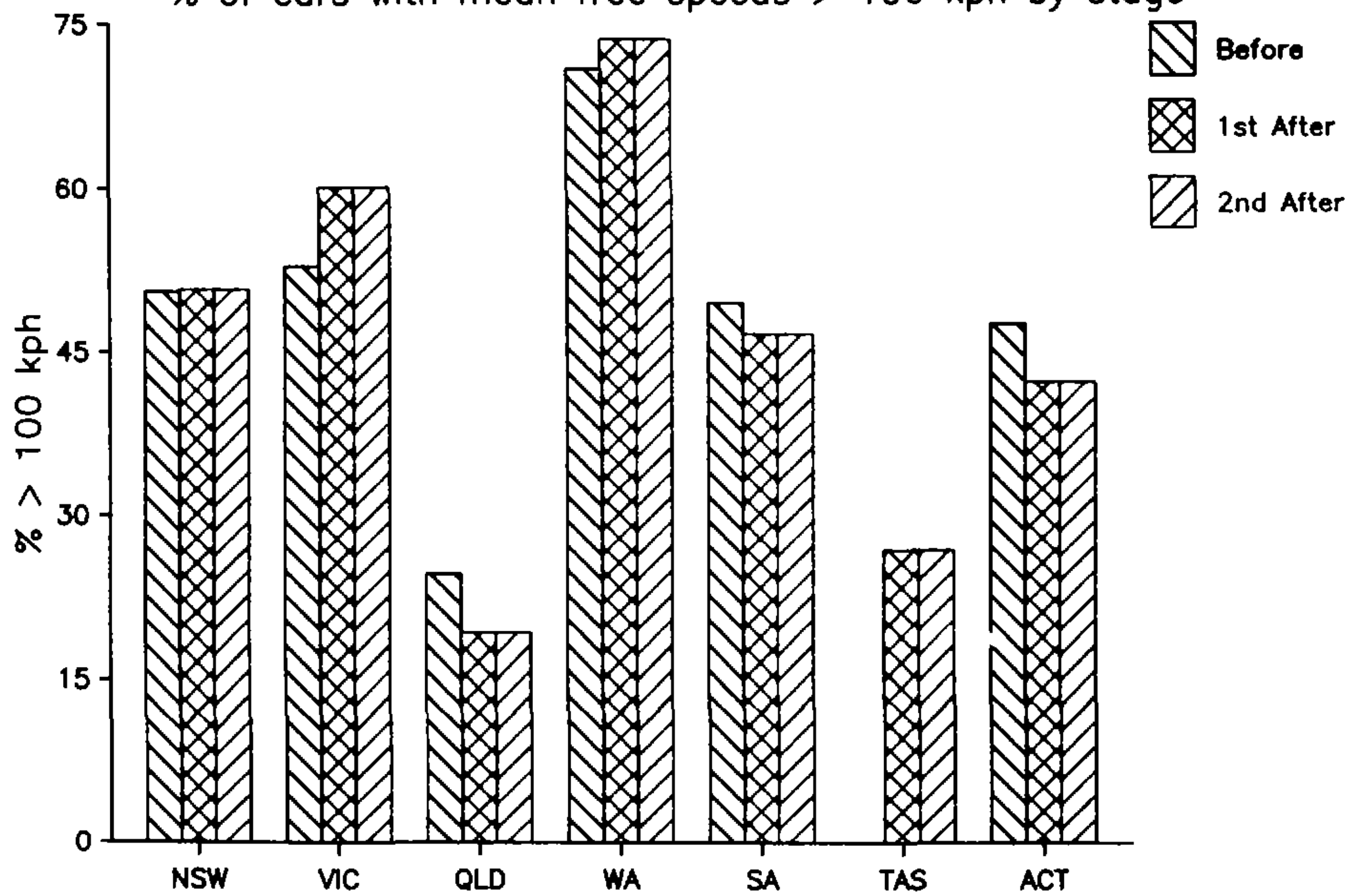


Table *4.11* CAR platoons by Speed category and platoon length - 2 lane roads

Speed category	Platoon length 0	1	2	3	4	>= 5	Total
Before survey - October 1986							
<= 80 kph	229	27	21	16	10	12	315
81-90 kph	489	69	29	22	16	19	644
91-100 kph	1102	113	49	22	11	9	1306
101-110 kph	1393	110	20	11	4	3	1541
>= 110 kph	1143	69	13	4	1	0	1230
Total	4356	388	132	75	42	43	5036
1st After survey - April 1987							
<= 80 kph	334	64	43	18	7	20	486
81-90 kph	708	140	66	33	18	14	979
91-100 kph	1251	195	55	24	3	9	1537
101-110 kph	1457	114	23	7	2	0	1603
>= 110 kph	1305	55	10	1	0	0	1371
Total	5055	568	197	83	30	43	5976
2nd After survey - October 1987							
<= 80 kph	441	117	48	17	20	29	672
81-90 kph	974	211	83	46	17	22	1353
91-100 kph	1428	200	53	25	5	8	1719
101-110 kph	1703	119	28	9	0	2	1861
>= 110 kph	1350	38	8	4	1	1	1402
Total	5896	685	220	101	43	62	7007

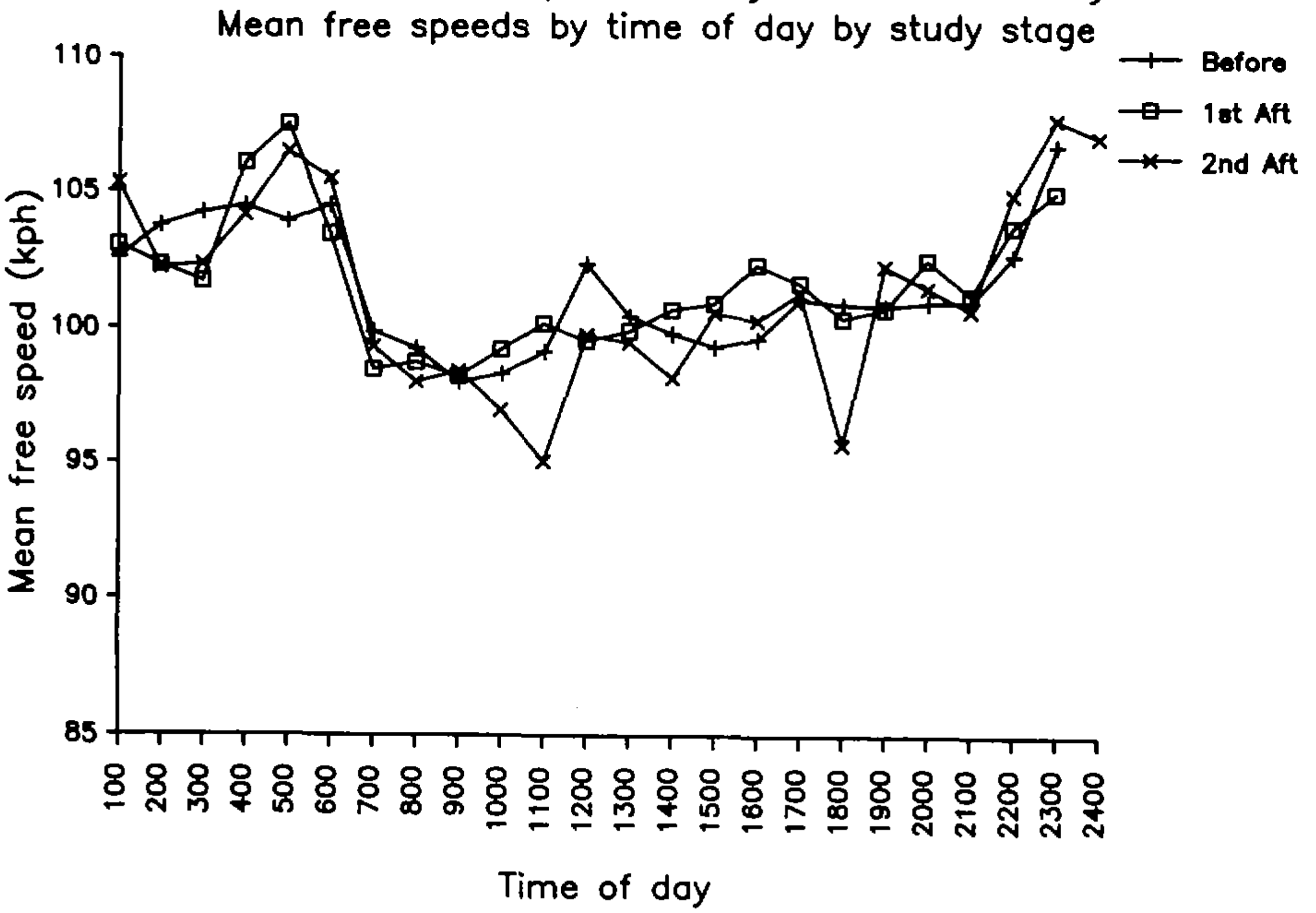
Note:
(1) Speed category refers to the speed (kph) of the platoon lead vehicle.

Table 4.12 ARTICULATED platoons by Speed category and platoon length - 2 lane roads

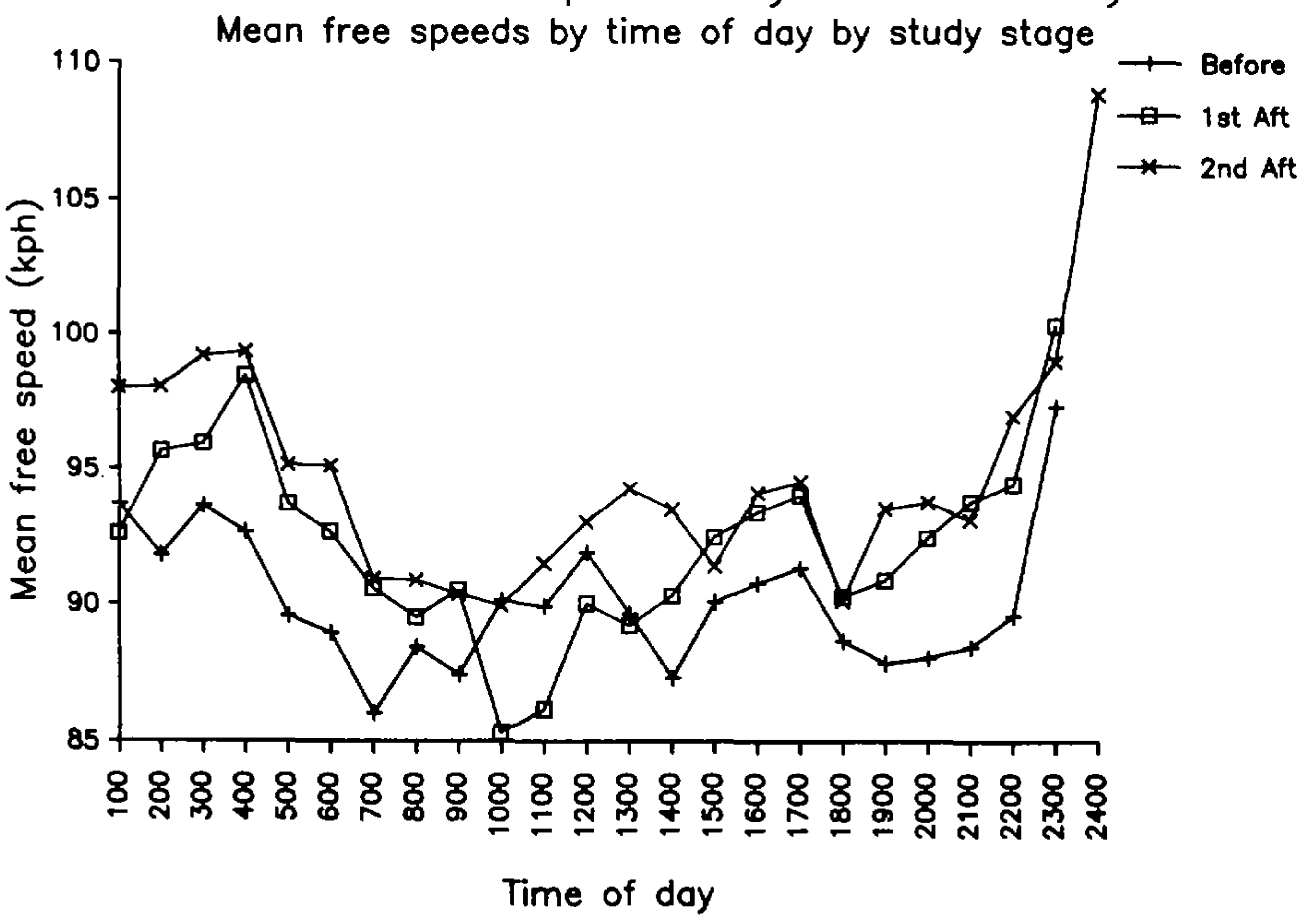
Speed category	Platoon length 0	1	2	3	4	>= 5	Total
Before survey - October 1986							
<= 80 kph	419	64	23	22	8	17	553
81-90 kph	689	106	39	18	7	15	874
91-100 kp	618	74	16	11	8	8	735
101-110 k	299	28	5	2	0	3	337
>= 110 kp	136	13	3	0	0	0	152
Total	2161	285	86	53	23	43	2651
1st After survey - April 1987							
<= 80 kph	163	28	14	7	6	10	228
81-90 kph	564	97	39	12	8	7	727
91-100 kp	585	80	27	9	3	3	707
101-110 k	311	45	7	2	2	0	367
>= 110 kp	130	13	3	0	1	0	147
Total	1753	263	90	30	20	20	2176
2nd After survey - October 1987							
<= 80 kph	115	21	16	4	3	9	168
81-90 kph	546	61	24	12	8	8	659
91-100 kp	692	73	28	7	2	0	802
101-110 k	420	28	10	4	1	0	463
>= 110 kp	167	14	3	0	0	0	184
Total	1940	197	81	27	14	17	2276

Note:
(1) Speed category refers to the speed (kph) of the platoon lead vehicle.

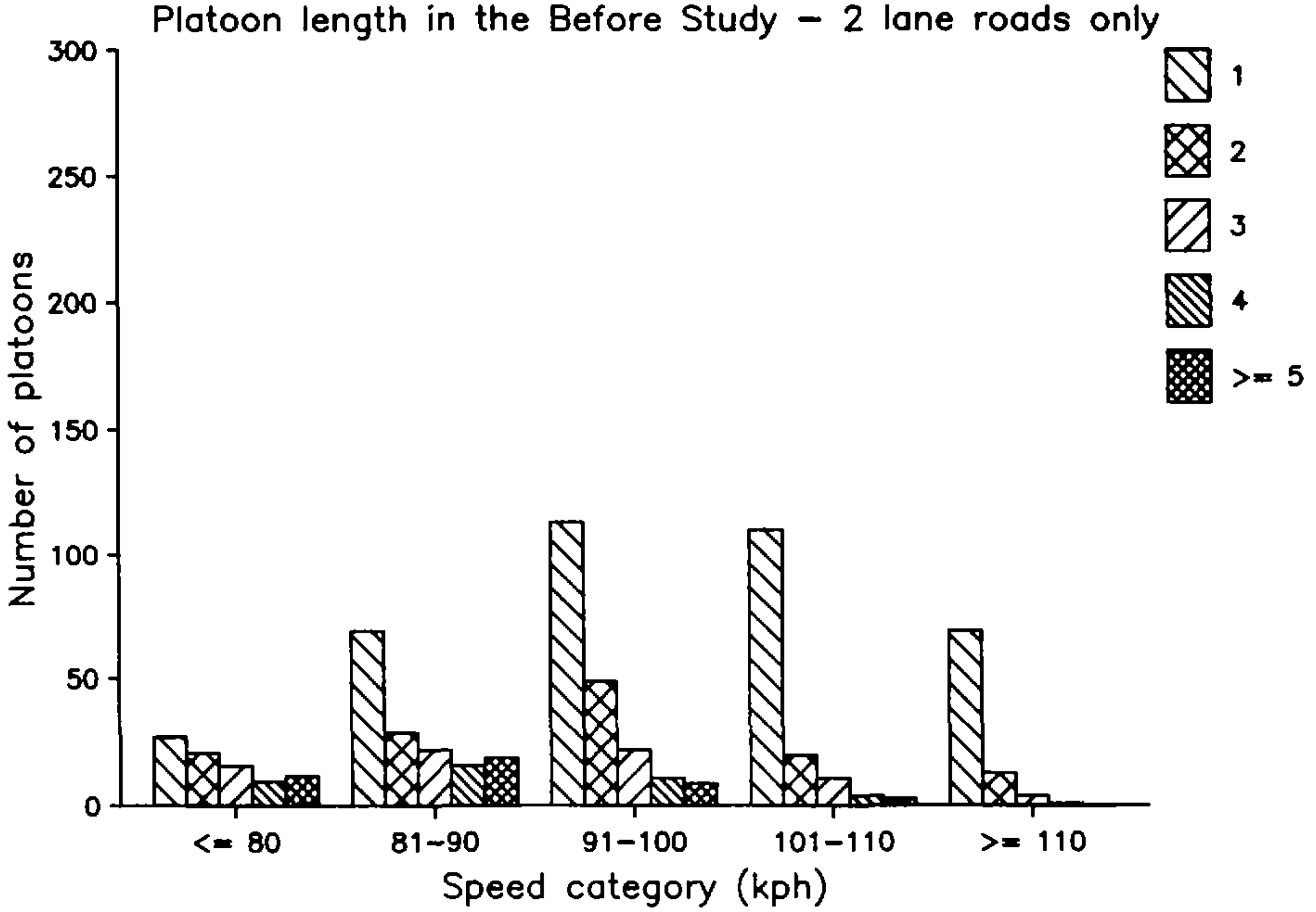
Plot 4.11: CAR speeds by Time of Day



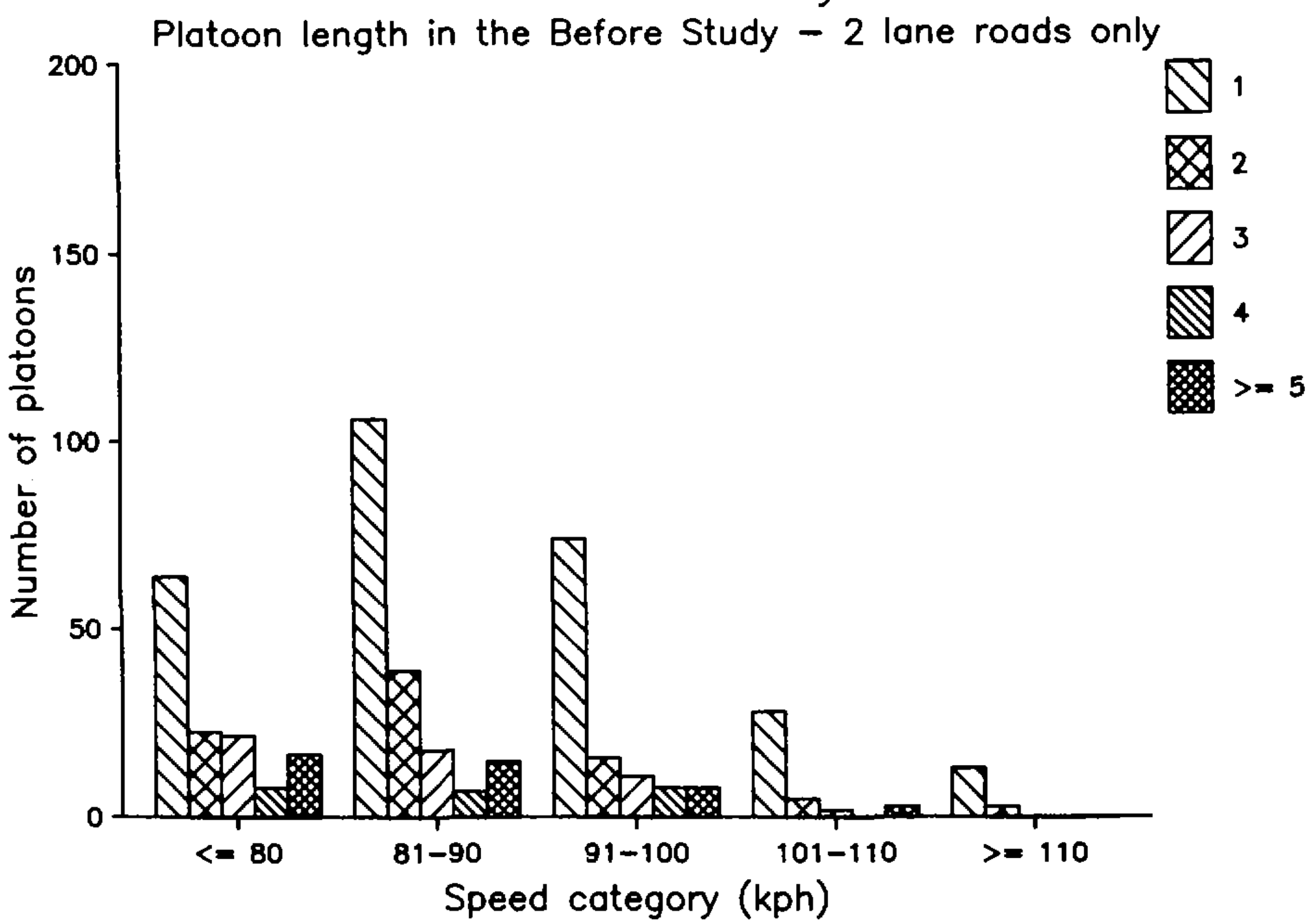
Plot 4.12: ARTIC speeds by Time of day



Plot 4.13: Platoons led by a CAR

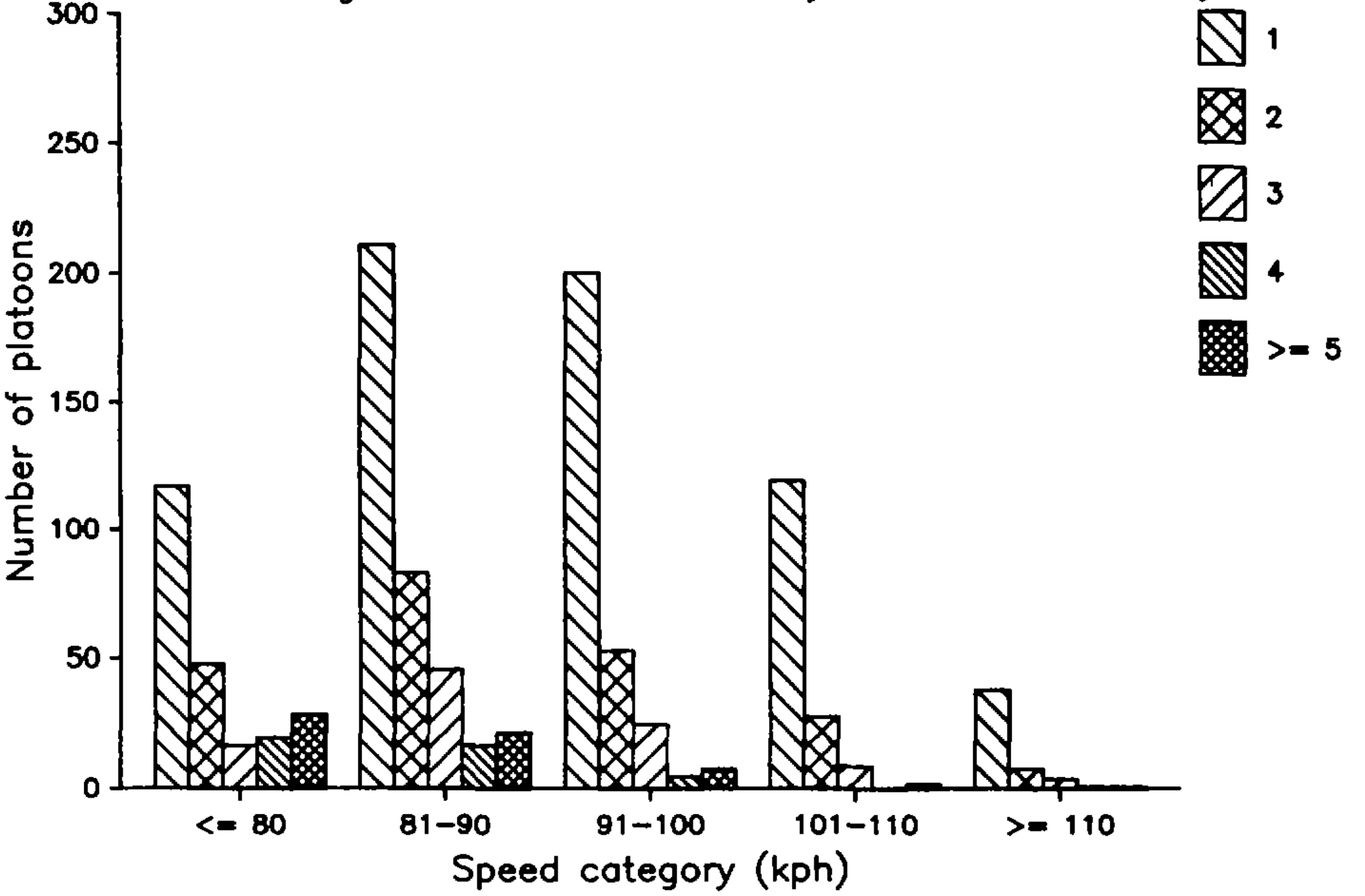


Plot 4.14: Platoons led by an ARTIC



Plot 4.15: Platoons led by a CAR

Platoon length in the 2nd After Study – 2 lane roads only



Plot 4.16: Platoons led by an ARTIC

Platoon length in the 2nd After Study – 2 lane roads only

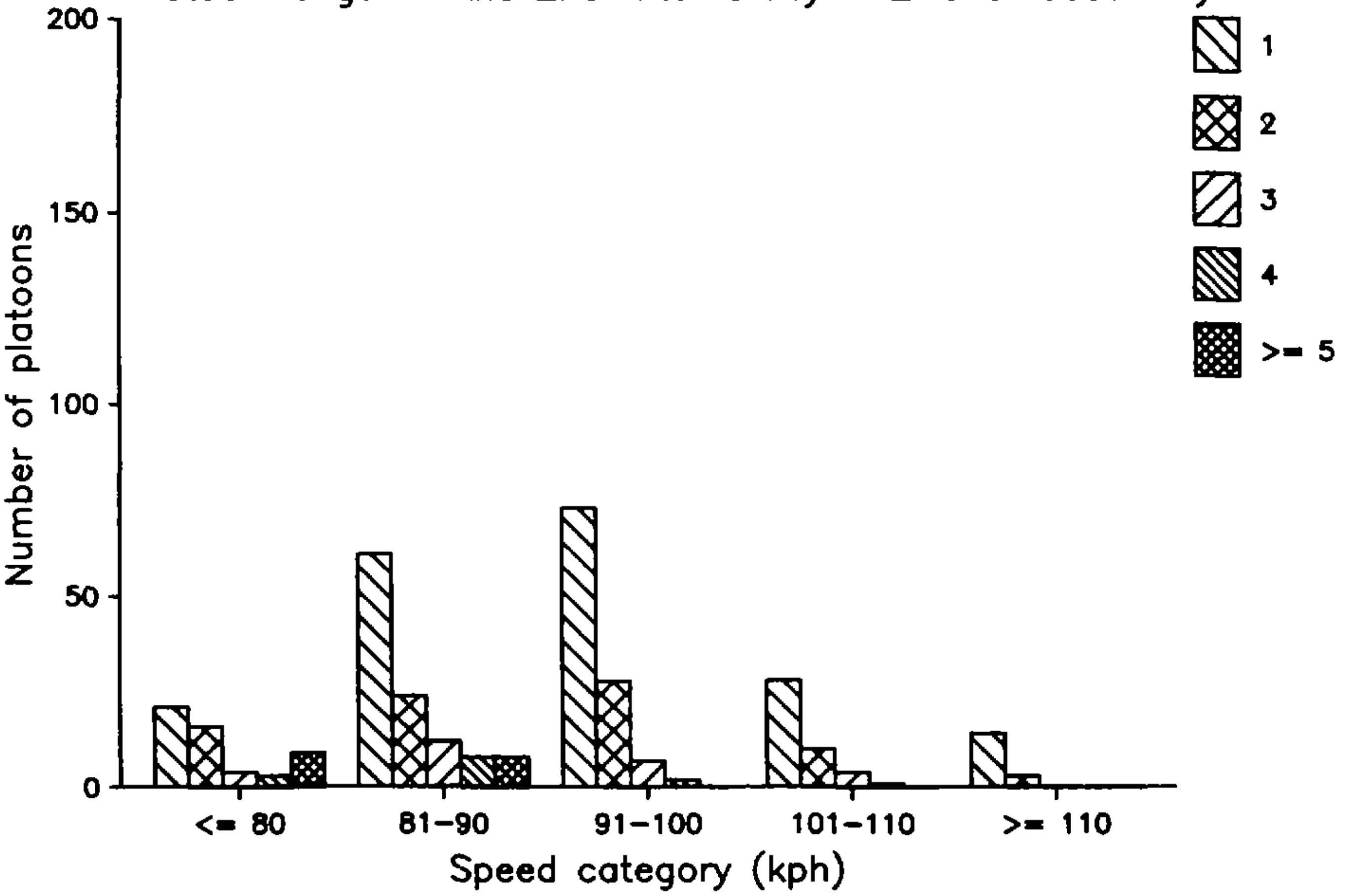


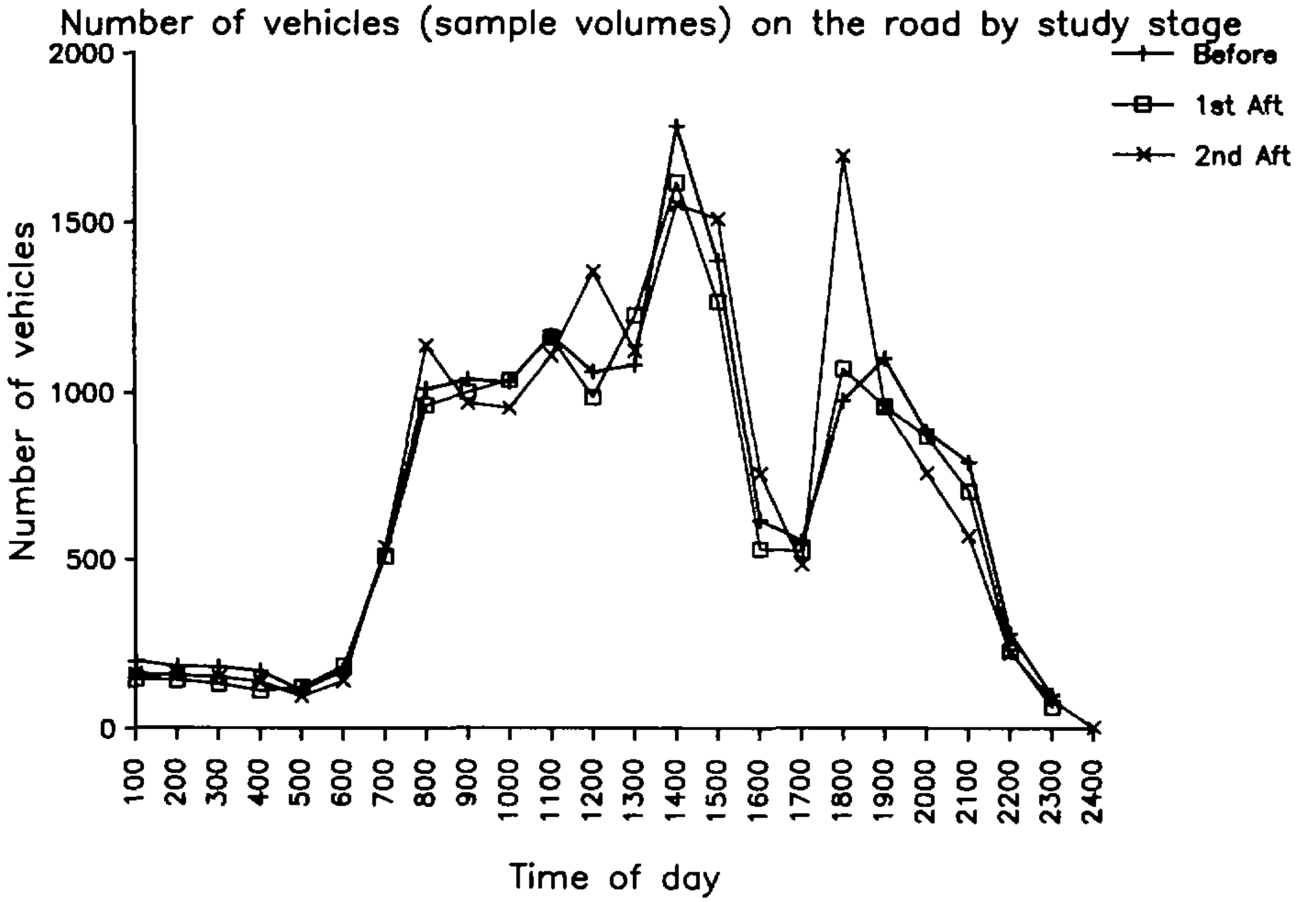
Table 4.13 CARs - Mean free speeds by time of day

	Before survey - October 1986			1st After survey - April 1987			2nd After survey - October 1987		
Time	Mean (kph)	Sdev	N	Mean (kph)	Mean Sdev	N	Mean (kph)	Sdev	N
100	103	15.1	280	103	15.9	149	105	14.8	164
200	104	14.3	183	102	15.0	146	102	14.3	160
300	104	14.1	182	102	14.8	135	102	15.5	155
400	104	15.7	170	106	14.5	115	104	13.5	141
500	104	14.2	114	107	16.1	125	106	13.6	98
600	104	14.2	172	103	12.9	187	105	13.9	144
700	100	11.8	528	99	11.6	511	99	12.4	539
800	99	11.9	1011	99	11.3	964	98	11.8	1140
900	98	12.1	1038	98	12.7	1002	98	12.2	970
1000	98	12.1	1030	99	13.7	1038	97	12.4	955
1100	99	13.1	1167	100	14.6	1163	95	13.6	1110
1200	102	12.6	1060	100	12.5	987	100	12.3	1357
1300	100	12.0	1080	100	13.3	1228	99	13.4	1124
1400	100	12.3	1783	101	13.2	1620	98	13.1	1556
1500	99	12.9	1388	101	12.1	1269	101	12.2	1512
1600	100	13.8	617	102	13.7	532	100	13.8	761
1700	101	13.7	554	102	13.1	526	101	13.9	485
1800	101	12.3	975	100	13.5	1072	96	14.1	1697
1900	101	12.4	1100	101	13.2	959	102	13.2	957
2000	101	12.5	884	102	14.2	872	101	13.8	762
2100	101	13.9	793	101	13.9	707	101	13.6	572
2200	103	15.0	280	104	15.0	231	105	13.7	225
2300	107	15.0	100	105	16.6	66	108	13.5	87
2400							107	15.4	4
Total	100	13	16409	101	13.4	15604	99	13.4	16675

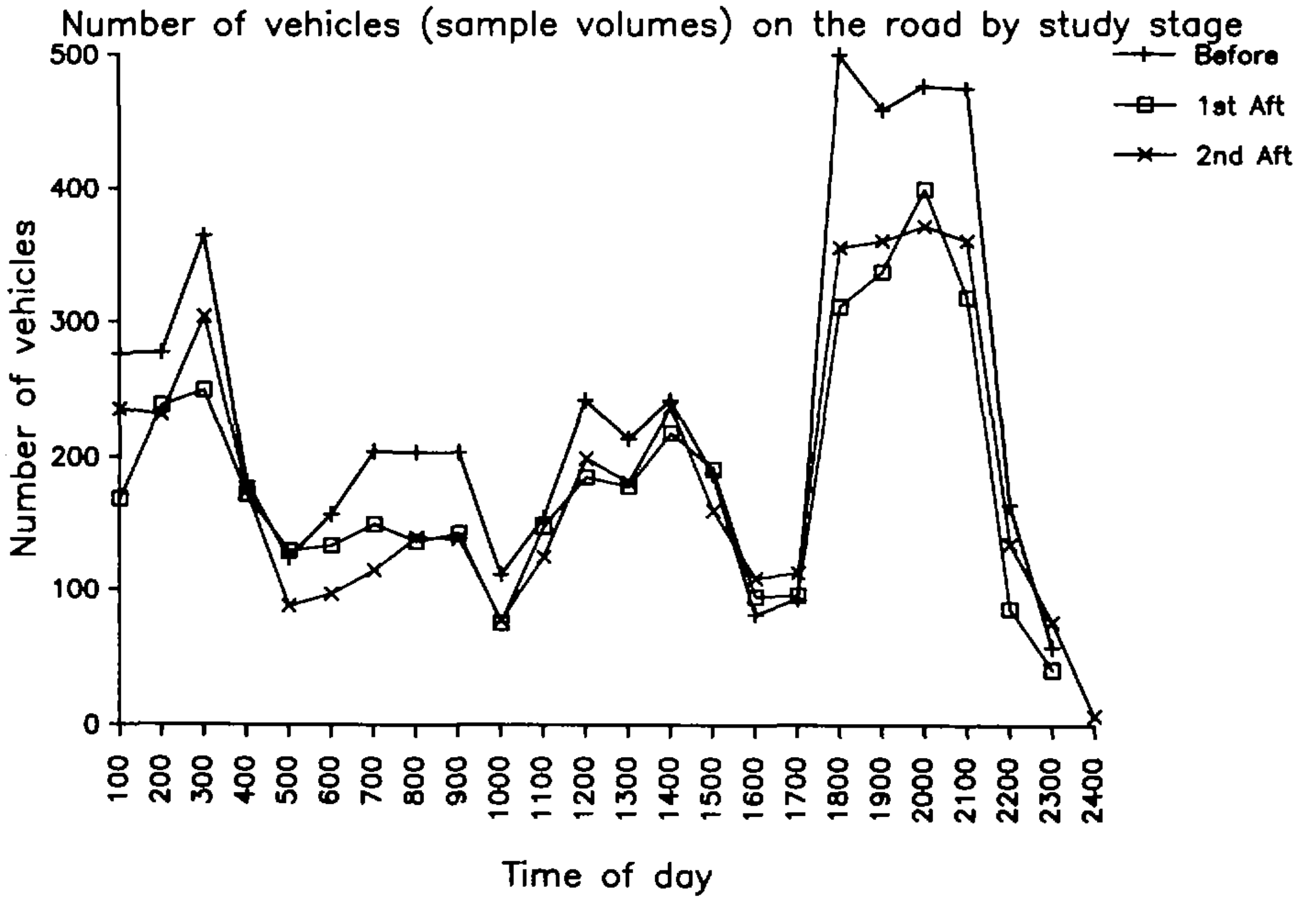
Table *4.14* ARTICULATED - Mean free speeds by time of day

	Before survey - October 1986			1st After survey - April 1987			2nd After survey - October 1987		
Time	Mean (kph)	Sdev	N	Mean (kph)	Sdev	N	Mean (kph)	Sdev	N
100	94	12.3	276	93	12.3	169	98	10.7	236
200	92	12.3	277	96	12.0	239	98	11.6	232
300	94	13.7	364	96	13.4	250	99	12.3	304
400	93	13.4	181	98	13.4	172	99	11.8	175
500	90	12.9	124	94	12.9	130	95	10.5	88
600	89	10.2	157	93	9.6	134	95	10.6	97
700	86	9.4	204	91	9.3	150	91	10.3	115
800	88	9.2	203	90	9.4	137	91	10.1	140
900	87	10.7	203	91	9.5	143	90	9.3	139
1000	90	11.4	111	85	17.2	75	90	12.5	77
1100	90	10.2	154	86	18.9	148	92	11.0	125
1200	92	10.7	242	90	9.1	185	93	11.1	199
1300	90	10.0	213	89	8.2	178	94	8.8	181
1400	87	10.6	242	90	10.9	218	93	9.8	237
1500	90	10.4	187	92	10.4	191	91	9.4	160
1600	91	10.2	81	93	9.6	95	94	9.7	109
1700	91	11.1	93	94	10.2	96	95	8.6	113
1800	89	9.4	499	90	10.3	311	90	9.9	355
1900	88	9.8	458	91	9.0	337	94	9.8	360
2000	88	10.2	476	92	10.2	399	94	11.3	371
2100	88	11.4	474	94	10.4	318	93	10.2	360
2200	90	10.2	164	94	11.2	86	97	9.5	135
2300	97	12.3	57	100	10.9	41	99	9.7	76
2400							109	8.9	7
Total	90	11.1	5440	92	11.5	4202	94	10.9	4391

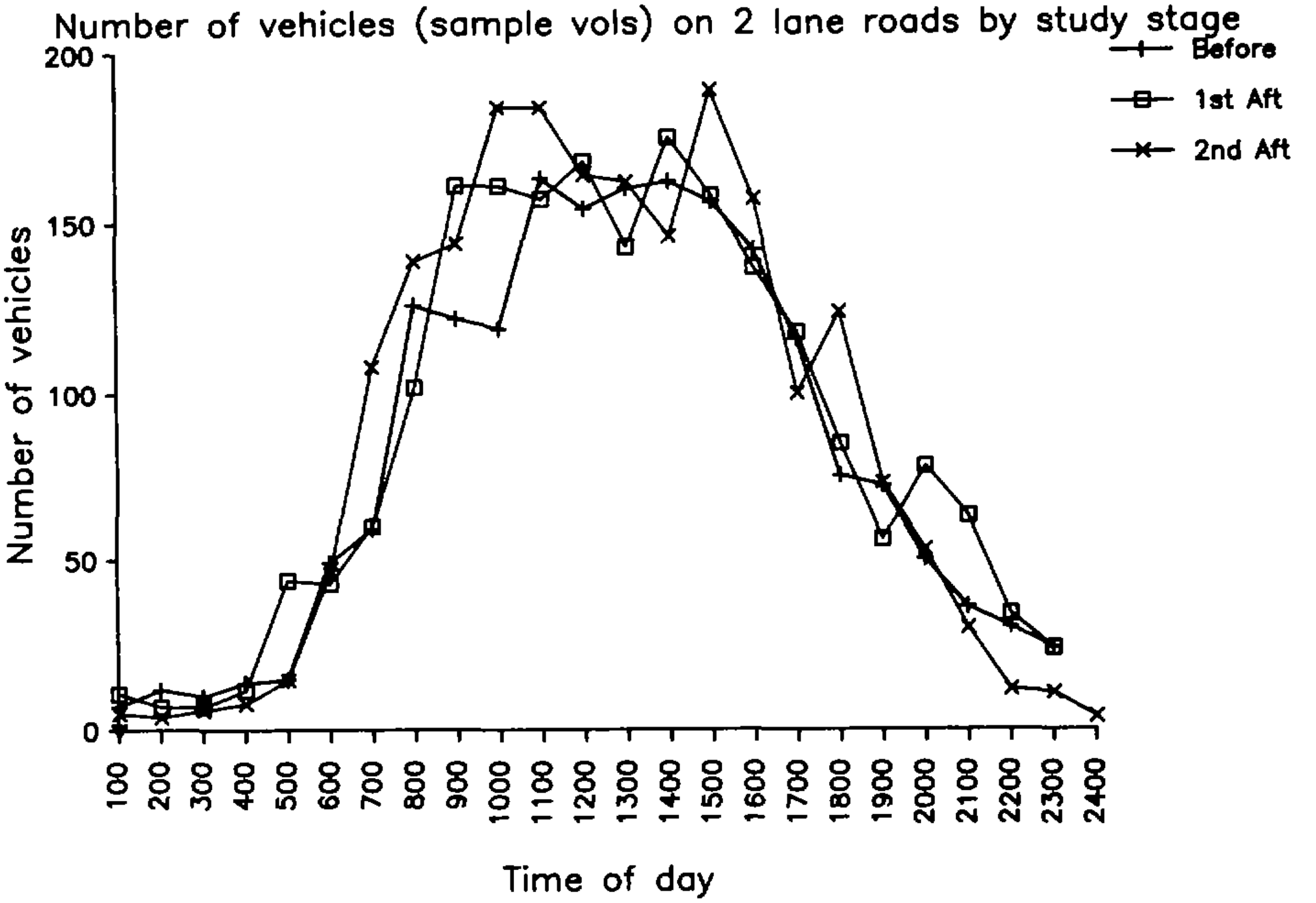
Plot 4.17: CAR sample volumes by Time of Day



Plot 4.18: ARTIC sample volumes by Time of day



Plot 4.19: CAR sample vol by Time of Day - WA



Plot 4.20: ARTIC sample vol by Time of day - WA

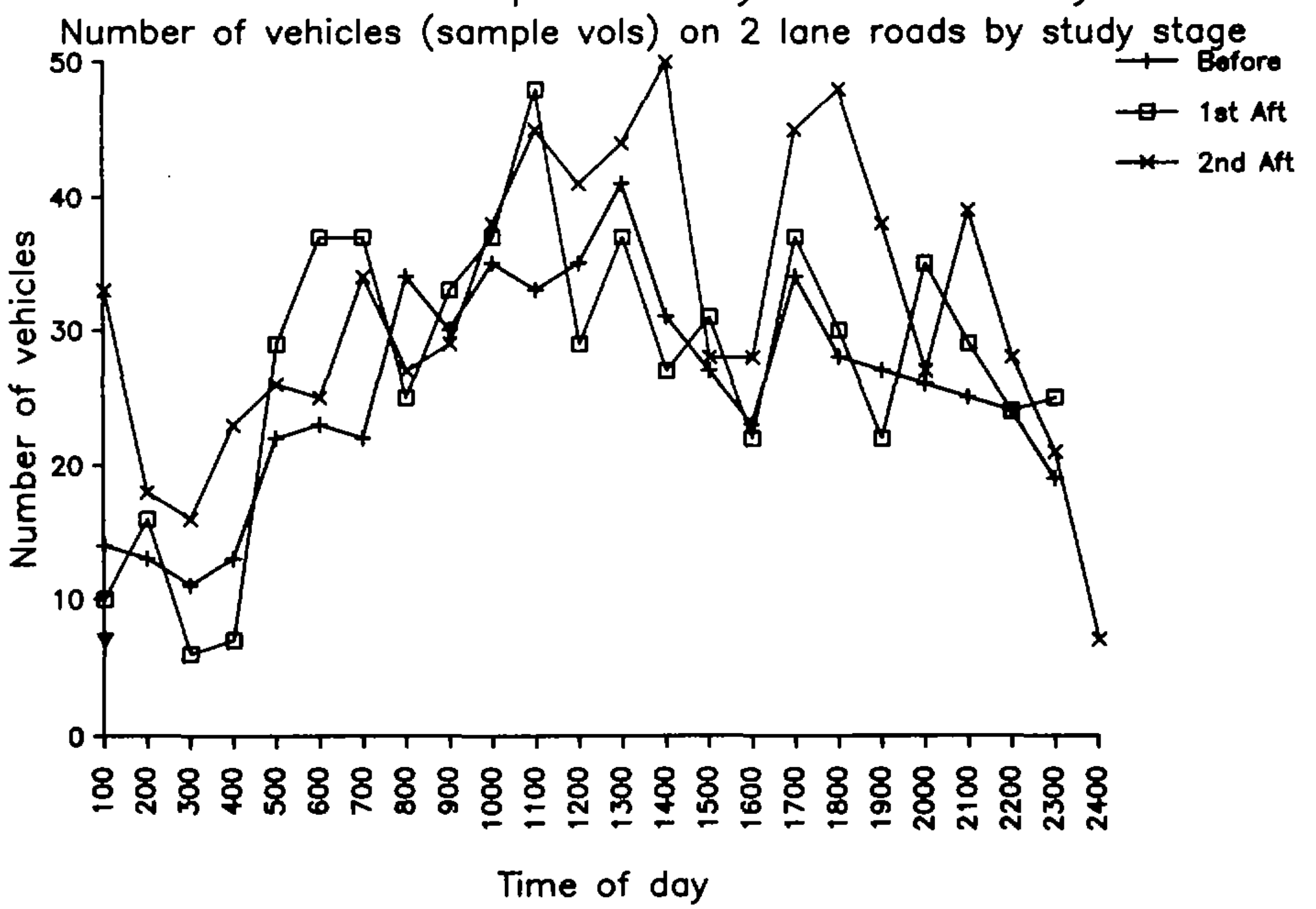


Table *4.15* Speed Differential (kph) by vehicle mix
by Stage - 2 lane roads

Mix Description	Stage 1 - Before Mix	Mean	Std	N	Stage 2 - 1st After Mix	Mean	Std	N	Stage 3 - 2nd after Mix	Mean	Std	N
Car - Car	1	.1	14.5	2136	1	.0	14.9	2908	1	.2	14.6	2850
Art - Art	28	.5	10.1	798	28	.0	10.4	659	28	-.7	10.0	692
Car - Art	34	9.7	13.1	624	34	7.6	13.8	556	34	8.1	13.1	649
Art - Car	7	-10.4	13.5	588	7	-6.8	13.8	529	7	-8.9	12.9	646
Car - Trk	33	9.4	12.9	253	33	9.2	13.0	303	6	-8.5	13.7	251
Trk - Car	6	-8.2	13.7	247	6	-8.2	12.6	285	33	8.6	13.7	266
Art - Trk	27	1.4	12.2	170	2	-7.9	14.7	191	2	-9.0	14.0	239
Trk - Art	49	-.7	12.3	165	29	9.4	14.1	182	29	9.4	14.0	224
Lvan - Car	5	-5.4	13.6	147	32	4.0	14.0	147	27	2.5	12.0	122
Car - Lvan	32	5.7	13.6	134	5	-5.2	15.1	143	32	7.1	14.4	118
Trk - Trk	26	.8	12.6	110	49	-1.5	12.5	95	5	-6.6	14.6	110
Ctow - Car	2	-9.8	13.2	109	27	3.5	11.8	94	49	-2.3	11.6	100

Notes:

(1) Legend to Vehicle Mix Matrix

2nd vehicle		Lead (1st) vehicle --> 30	31	32	33	34	35	36
Car	30	1	2	3	4	5	6	7
Car towing	31	29	8	9	10	11	12	13
Motor cyc	32	30	35	14	15	16	17	18
Bus	33	31	36	40	19	20	21	22
Light van	34	32	37	41	44	23	24	25
Rigid Truck	35	33	38	42	45	47	26	27
Articulated	36	34	39	43	46	48	49	28

(2) The vehicle mix codes link the vehicle codes, values 30 to 36.
Thus mix number 29 signifies vehicle codes 30 (Car) followed by vehicle code 31
a Car towing.
(3) Vehicle pairs were restricted to a maximum time gap between lead and following of 2 minutes.
(4) The vehicle mix order changes across the study stages.
The mix descriptions are for stage 1.

Table *4.16*: Speed Differential (kph) by State. and Stage - 2 lane roads

State	Mean	Std	N
Before			
NSW	.1	14.3	1551
VIC	.4	13.8	1201
QLD	-.1	14.0	789
WA	.1	15.5	1345
SA	.5	14.7	697
TAS	1.1	14.2	154
ACT	.1	14.0	420
Total	.2	14.5	6157
1st After stage			
NSW	.2	13.9	1450
VIC	.4	12.7	711
QLD	.3	13.5	995
WA	.1	15.3	1392
SA	.1	16.2	800
TAS	.3	15.5	1096
ACT	.3	15.6	321
Total	.2	14.7	6765
2nd After stage			
NSW	.1	13.6	1293
VIC	-.2	13.1	671
QLD	-.3	13.0	1159
WA	.3	15.6	2631
SA	-.1	16.0	735
TAS			
ACT	-.4	14.8	452
Total	.0	14.6	6941
Grand total	.1	14.6	19863

Notes:
(1) All vehicle mixes have been aggregated. Thus the Car - Car mix swamps the results.
(2) TAS was excluded as it failed to record satisfactory times for the free speed records.

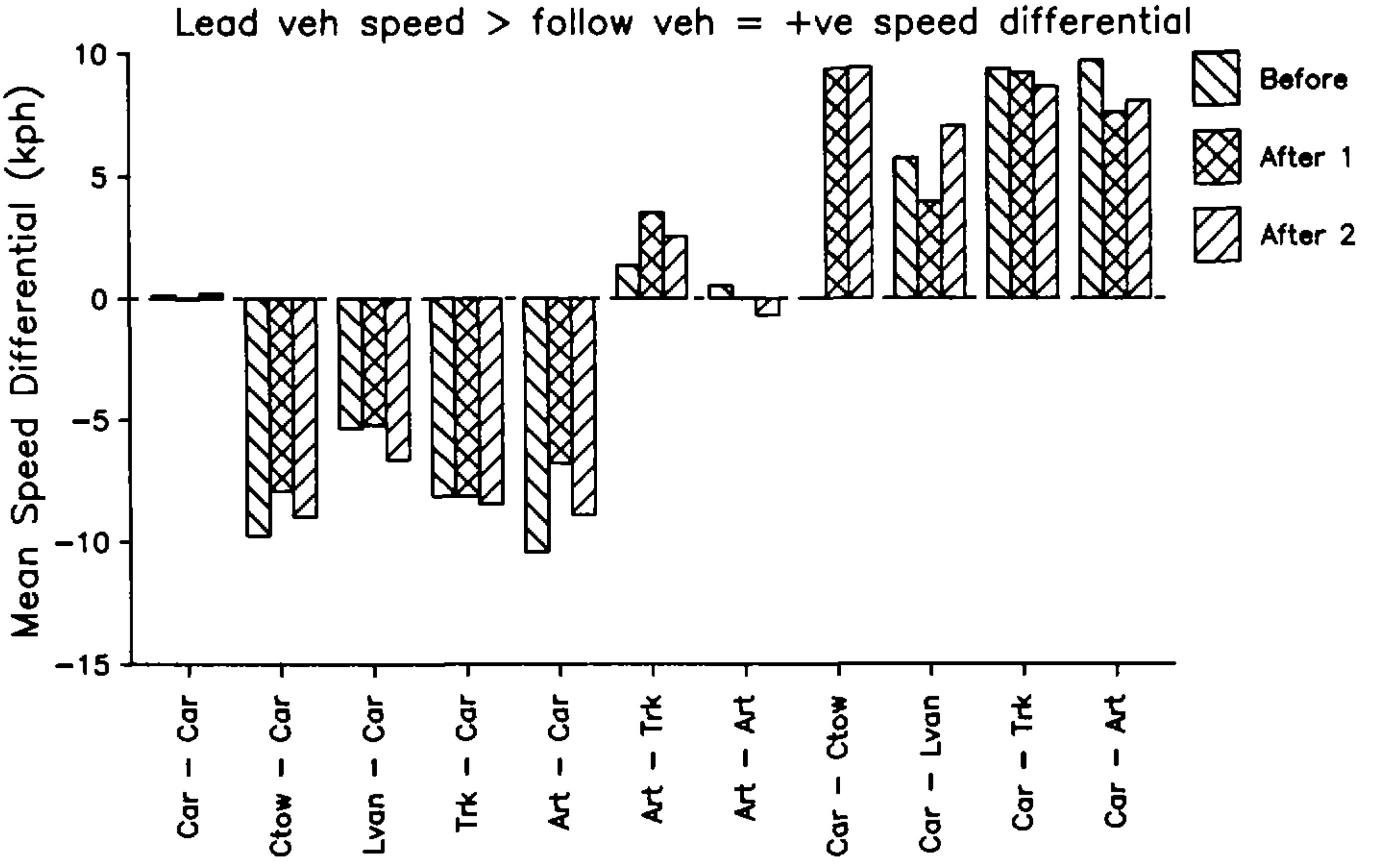
Table 4.17 Speed differential (kph) by vehicle mix
STATE by STAGE by mix - Most frequent mixes, 2 lane roads

Stage 1 - Before					Stage 2 - 1st After					Stage 3 - 2nd After				
Mix	Mean	Sdev	N	% of N	Mix	Mean	Sdev	N	% of N	Mix	Mean	Sdev	N	% of N
NSW														
Total	.0	14.3	1548			.2	13.9	1450			.1	13.6	1292	
1	.0	14.4	453	29%	1	.1	14.4	423	29%	1	.9	14.5	373	29%
34	6.9	12.2	188	12%	28	.7	11.5	188	13%	28	-.9	10.2	200	15%
7	-7.1	13.6	179	12%	34	4.3	13.4	165	11%	34	5.0	12.9	170	13%
28	-.7	10.7	157	10%	7	-3.3	13.6	160	11%	7	-6.1	12.3	168	13%
5	-6.5	13.4	100	6%	32	4.0	11.6	83	6%	32	4.6	11.9	53	4%
32	6.9	13.3	85	5%	5	-4.7	13.6	73	5%	5	-3.4	12.9	46	4%
33	10.1	12.6	65	4%	6	-11.5	11.0	47	3%	33	8.3	12.9	44	3%
6	-10.4	15.0	53	3%	33	9.1	13.6	42	3%	6	-9.0	13.3	43	3%
49	-3.5	9.8	30	2%	48	-2.5	10.0	28	2%	27	6.8	12.5	29	2%
25	2.8	13.2	28	2%	27	6.3	11.4	25	2%	49	-5.9	12.3	23	2%
VIC														
Total	.4	13.8	1201			.4	12.7	711			-.2	13.1	671	
28	.5	9.4	463	39%	28	-.2	9.7	301	42%	28	-.7	9.6	253	38%
34	13.0	11.8	158	13%	34	12.1	11.2	81	11%	7	-13.1	11.2	86	13%
7	-14.8	12.5	140	12%	7	-11.7	12.0	64	9%	34	12.4	11.0	77	11%
1	.4	14.3	79	7%	1	.4	15.0	57	8%	1	.1	13.4	67	10%
27	.1	11.5	61	5%	27	-.6	9.6	32	5%	27	.2	8.1	34	5%
49	.7	11.4	53	4%	49	.1	10.0	29	4%	49	-2.7	9.4	23	3%
33	10.3	13.4	33	3%	6	-10.4	11.8	19	3%	6	-10.8	13.1	18	3%
6	-9.6	14.9	31	3%	33	10.8	13.3	19	3%	29	13.0	11.6	13	2%
13	-5.6	16.4	19	2%	2	-6.9	11.2	11	2%	33	13.5	11.0	12	2%
29	10.6	11.5	17	1%	46	-.6	10.2	9	1%	26	-5.0	11.2	8	1%
QLD														
Total	-.1	14.0	789			.3	13.5	995			-.3	13.0	1159	
1	-.7	15.1	321	41%	1	.0	14.2	548	55%	1	-.3	13.4	662	57%
33	5.4	11.8	78	10%	33	6.3	11.7	87	9%	7	-3.3	13.1	84	7%
6	-5.6	13.5	73	9%	6	-2.5	12.6	77	8%	33	2.8	11.7	84	7%
34	3.0	12.4	68	9%	7	-1.3	12.1	60	6%	34	1.8	11.3	73	6%
7	-2.9	13.4	65	8%	34	.8	12.3	53	5%	6	-1.7	11.7	70	6%
26	1.1	11.3	21	3%	2	-5.3	13.6	23	2%	2	-7.3	13.6	33	3%
27	1.1	16.3	18	2%	26	-4.5	10.5	20	2%	29	5.7	14.6	26	2%
29	2.9	11.0	18	2%	29	6.1	9.6	20	2%	49	-1.6	9.4	17	1%
5	-.5	14.8	15	2%	28	-.4	9.6	15	2%	27	2.1	10.5	14	1%
28	4.1	14.6	15	2%	5	-4.1	12.4	13	1%	26	4.3	12.9	11	1%
WA														
Total	.1	15.5	1345			.1	15.3	1392			.3	15.6	2631	
1	.4	14.8	626	47%	1	-.3	14.7	646	46%	1	.3	14.8	1070	41%
34	12.4	12.9	120	9%	34	11.0	13.9	125	9%	34	10.9	13.0	268	10%
7	-13.3	13.1	118	9%	7	-11.3	13.6	113	8%	7	-11.1	12.7	241	9%
28	1.9	10.6	83	6%	28	.1	10.0	91	7%	28	-.9	10.2	193	7%
2	-11.4	13.3	68	5%	29	10.2	14.6	65	5%	2	-10.0	14.5	137	5%
29	10.3	13.3	59	4%	2	-9.8	13.7	61	4%	29	11.9	13.5	131	5%
6	-9.8	12.7	38	3%	33	10.8	11.5	44	3%	6	-13.3	12.9	82	3%
33	15.3	12.9	31	2%	6	-10.4	11.0	30	2%	33	12.6	14.6	63	2%
32	6.4	14.1	21	2%	39	2.1	16.9	19	1%	13	4.0	16.9	41	2%
5	-7.5	15.0	17	1%	27	3.7	13.2	18	1%	39	-.2	15.7	37	1%

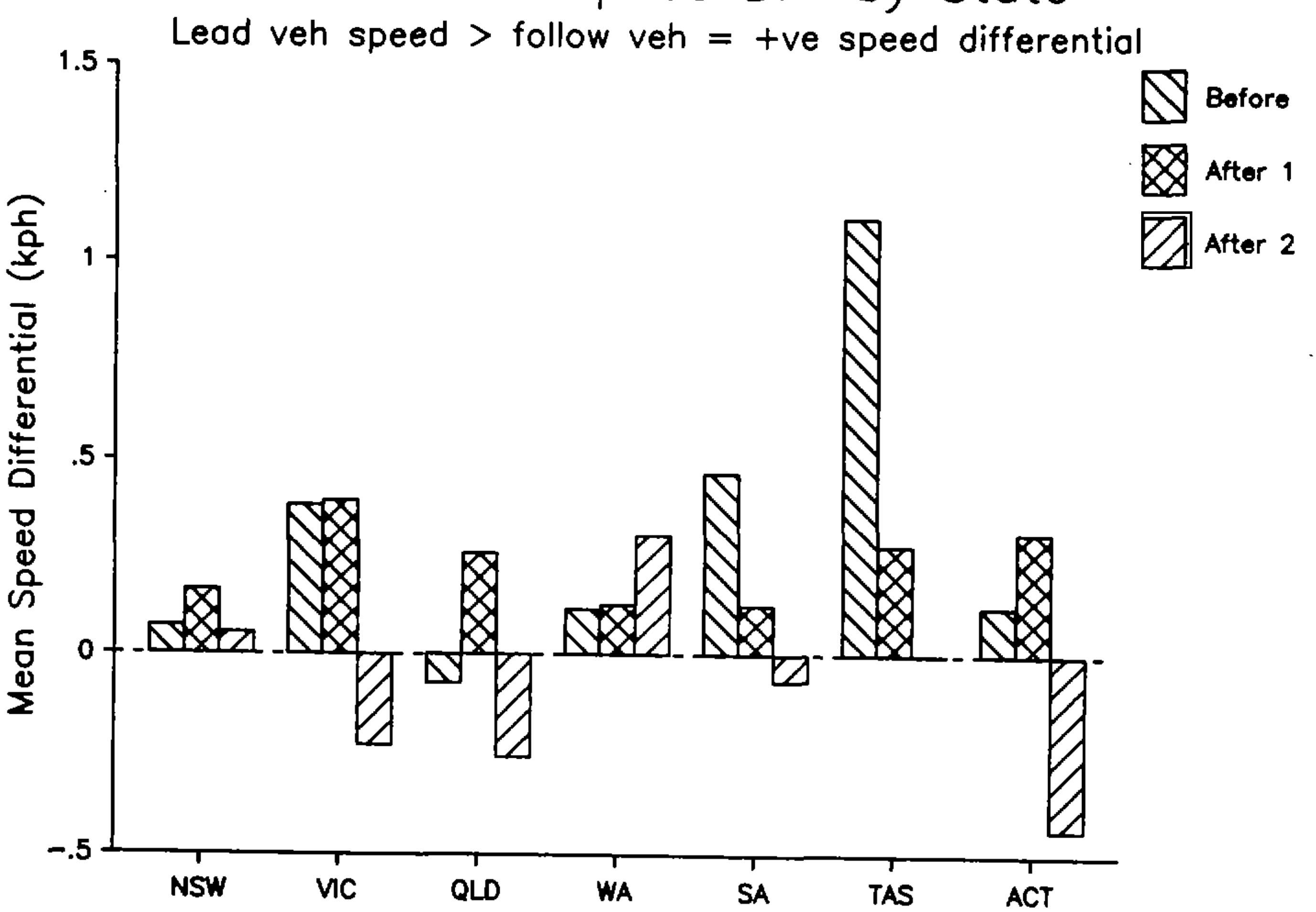
	Stage 1 - Before					Stage 2 - 1st After					Stage 3 - 2nd After			
Mix	Mean	Sdev	N	% of N	Mix	Mean	Sdev	N	% of N	Mix	Mean	Sdev	N	% of N
SA														
Total	.5	14.7	697			.1	16.2	800			-.1	16.0	735	
1	.6	14.2	458	66%	1	.4	15.9	391	49%	1	.6	16.1	395	54%
34	10.8	16.0	58	8%	34	9.0	15.4	63	8%	7	-8.8	13.7	48	7%
7	-12.9	11.0	54	8%	2	-7.0	17.9	55	7%	2	-6.3	14.3	47	6%
28	.8	9.1	42	6%	7	-8.4	15.2	53	7%	34	7.0	14.3	42	6%
6	-4.2	12.7	18	3%	28	-1.8	10.9	53	7%	29	2.8	14.8	41	6%
4	-5.2	12.9	17	2%	29	6.7	14.8	51	6%	28	2.1	11.8	29	4%
33	14.9	14.9	16	2%	6	-13.2	10.3	25	3%	4	1.7	13.1	15	2%
31	2.2	10.4	11	2%	33	13.1	14.6	20	3%	6	-11.1	12.8	14	2%
27	1.6	17.2	9	1%	4	-1.1	12.2	10	1%	31	6.1	15.8	14	2%
49	2.1	10.6	8	1%	8	-1.8	18.6	10	1%	33	20.4	12.1	14	2%
TAS														
Total	1.1	14.2	154			.3	15.5	1096		No time data recorded by TAS in stage 3				
26	-.1	13.9	49	32%	1	-.1	15.3	682	62%					
49	-.7	16.3	39	25%	6	-8.3	13.6	65	6%					
27	3.5	11.3	31	20%	33	9.4	14.4	65	6%					
28	2.1	13.8	27	18%	7	-6.5	14.2	59	5%					
45	4.0	24.4	4	3%	34	7.4	12.7	57	5%					
22	3.0	11.3	2	1%	5	-2.7	18.7	25	2%					
21	19.0	.0	1	1%	32	3.3	20.4	24	2%					
46	-5.0	.0	1	1%	2	-5.6	12.6	21	2%					
					29	10.2	16.0	21	2%					
					4	-9.9	14.5	10	1%					
ACT														
Total	.2	14.0	419			.3	15.6	321			-.4	14.8	452	
1	-.2	13.7	199	47%	1	-.7	15.9	161	50%	1	-.3	14.6	283	63%
6	-9.0	12.3	34	8%	33	11.8	12.4	26	8%	33	9.9	13.1	29	6%
7	-10.4	11.0	32	8%	6	-9.7	11.7	22	7%	6	-7.8	16.1	24	5%
34	11.9	12.7	32	8%	7	-6.4	9.9	20	6%	7	-12.4	13.6	19	4%
33	8.1	11.9	30	7%	34	10.8	16.8	12	4%	34	5.8	12.9	19	4%
26	2.8	6.4	13	3%	32	2.4	14.5	9	3%	5	.2	13.9	16	4%
27	-4.3	9.3	11	3%	5	-11.8	21.1	8	2%	32	.2	13.1	14	3%
28	-2.0	10.0	11	3%	49	11.4	10.0	7	2%	28	1.3	11.5	7	2%
32	4.9	15.2	7	2%	2	-15.5	9.8	6	2%	26	-5.7	10.6	6	1%
2	-7.0	11.7	6	1%	29	13.8	12.6	6	2%	2	-16.2	15.8	5	1%

Notes:
(1) Mixes vary in their sorted frequency order across stages within a state.

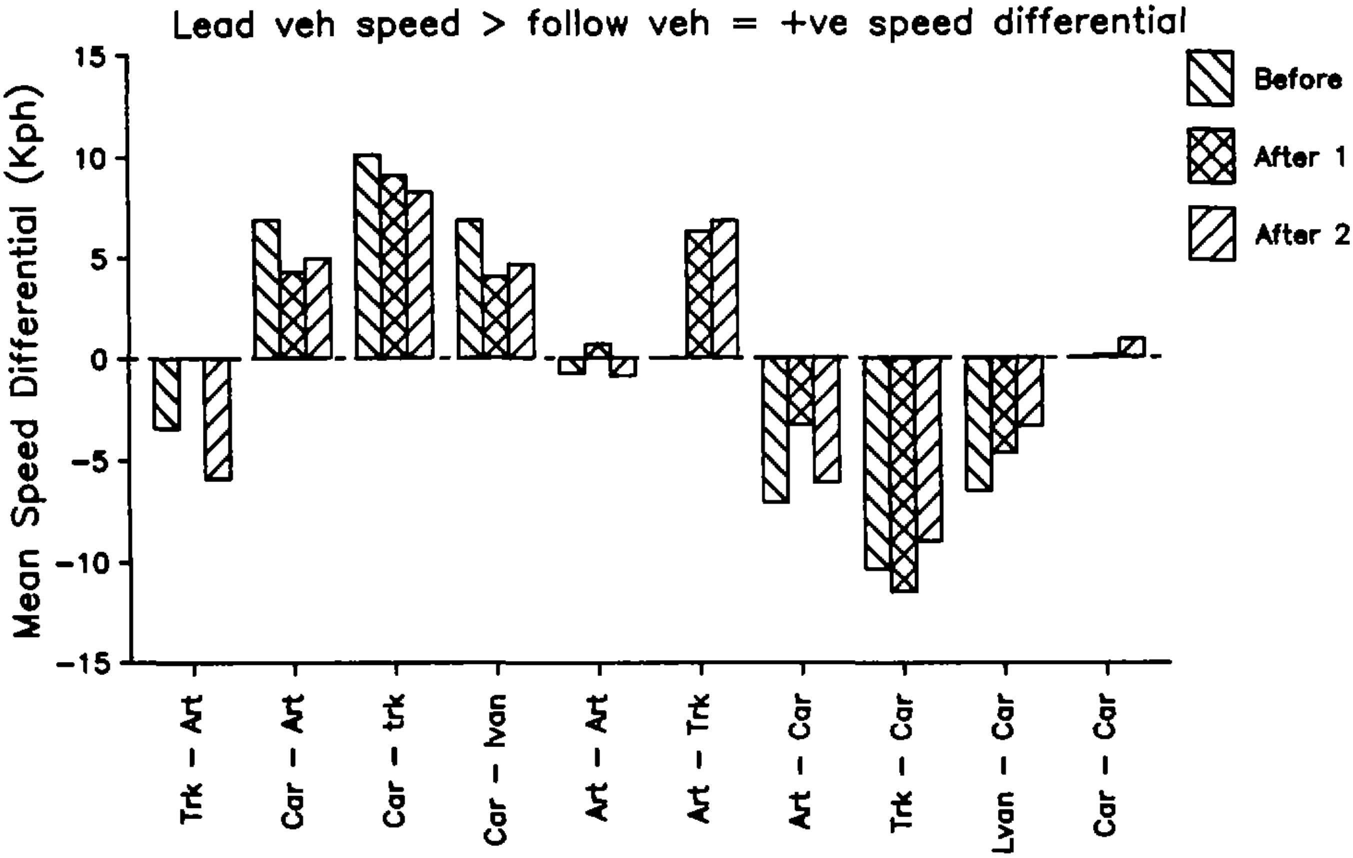
Plot 4.21: Mean Speed Diff by vehicle mix



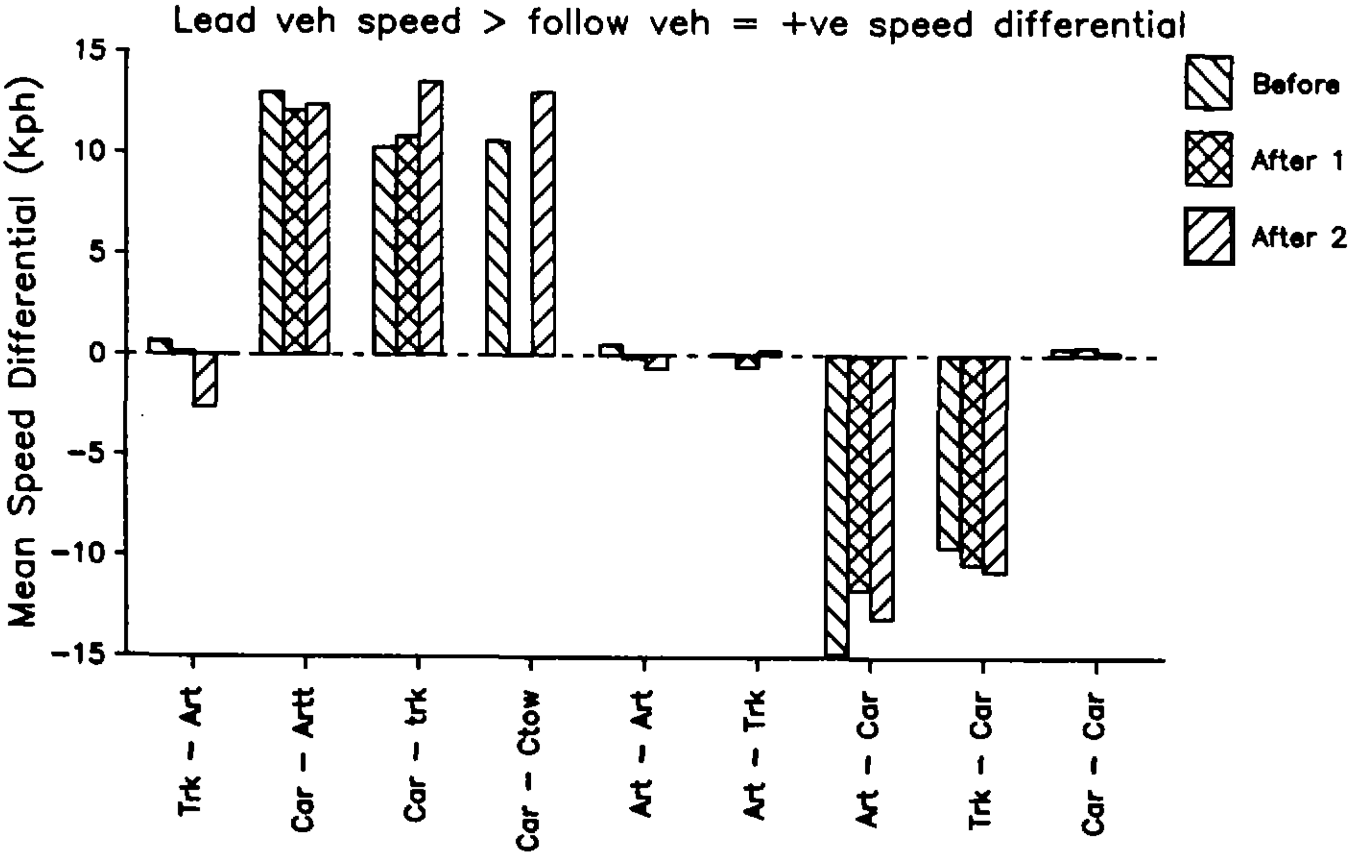
Plot 4.22: Mean Speed Diff by State



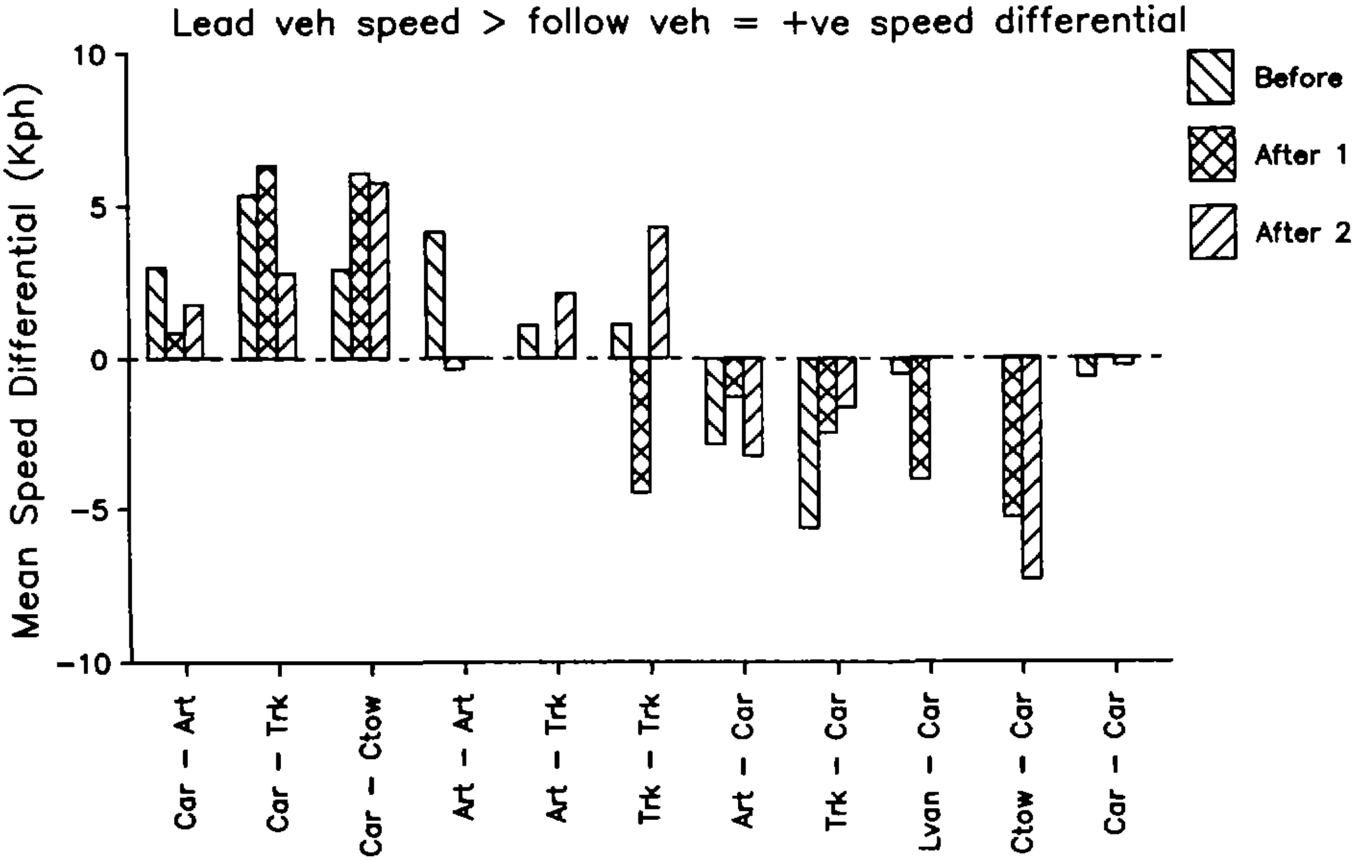
Plot 4.23: Speed differentials – NSW



Plot 4.24: Speed differentials – VIC



Plot 4.25: Speed differentials – QLD



Plot 4.26: Speed differentials – WA

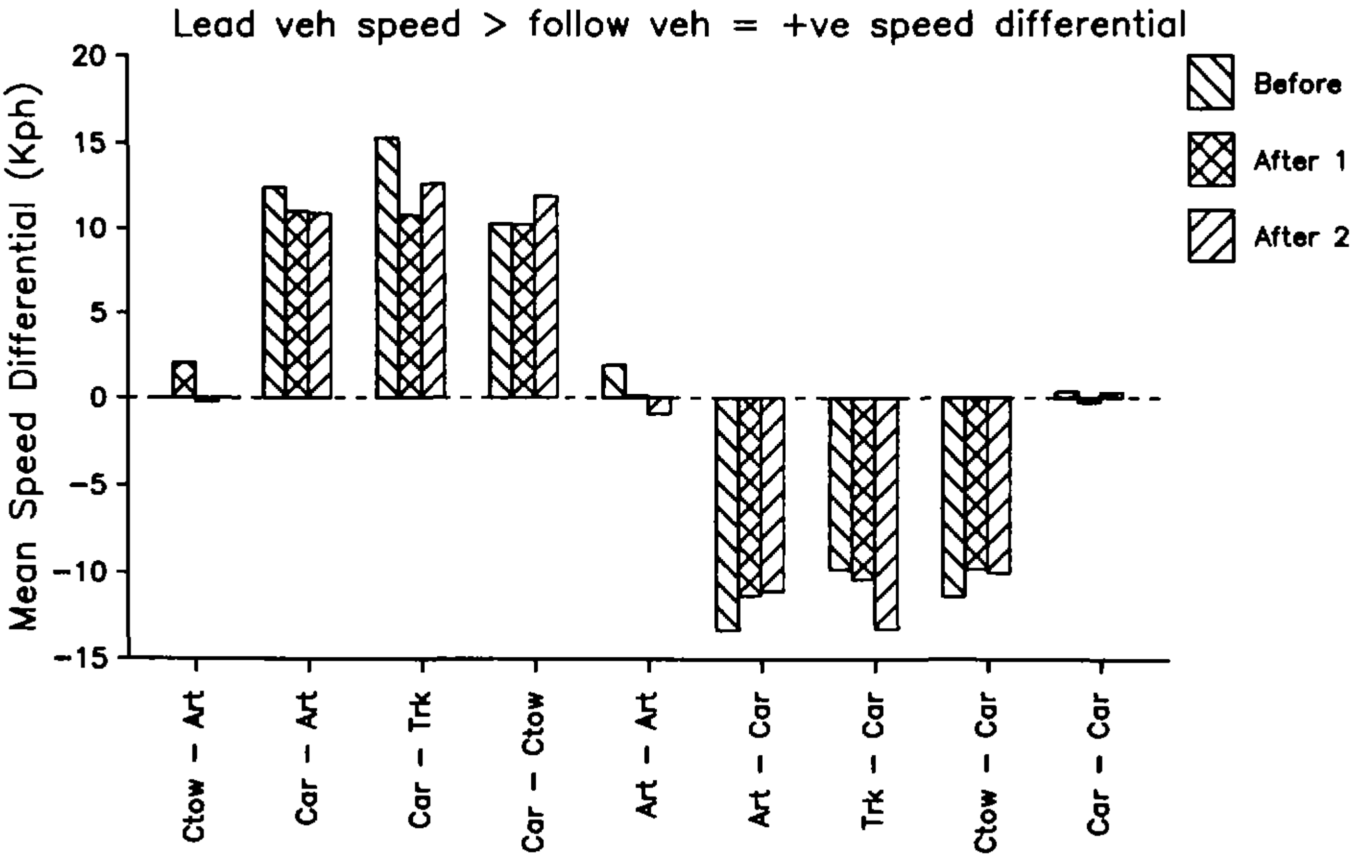
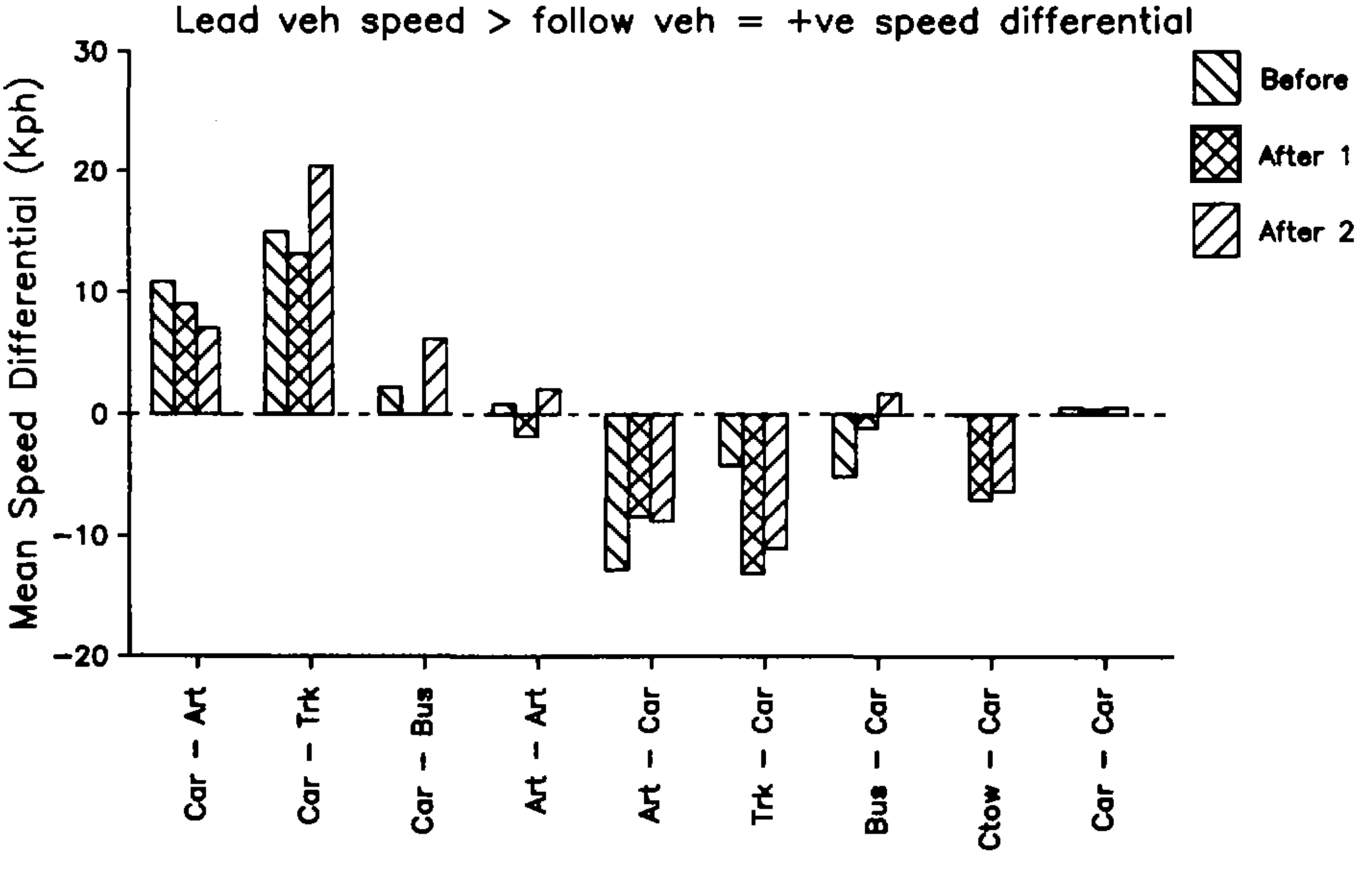


Table 4.18 Speed differentials vs 'Speed dispersion' by Stage
2 lane roads only.

Vehicle type	Mean Free speeds (km/h) Before	1st after	2nd after
Car	102	100	99
Articulated	90	93	95
Speed dispersion (km/h)	12	7	4
Mix	Speed differentials (km/h)		
Car - Artic	9.7	7.6	8.1
Artic - Car	-10.4	-6.8	-8.9

Notes:
(1) mean free speeds are taken from tables 3.21 - 3.23.
(2) speed differentials are taken from table 4.1.

Plot 4.27: Speed differentials - SA



Plot 4.28 Car -> Artic overtaking rates in WA

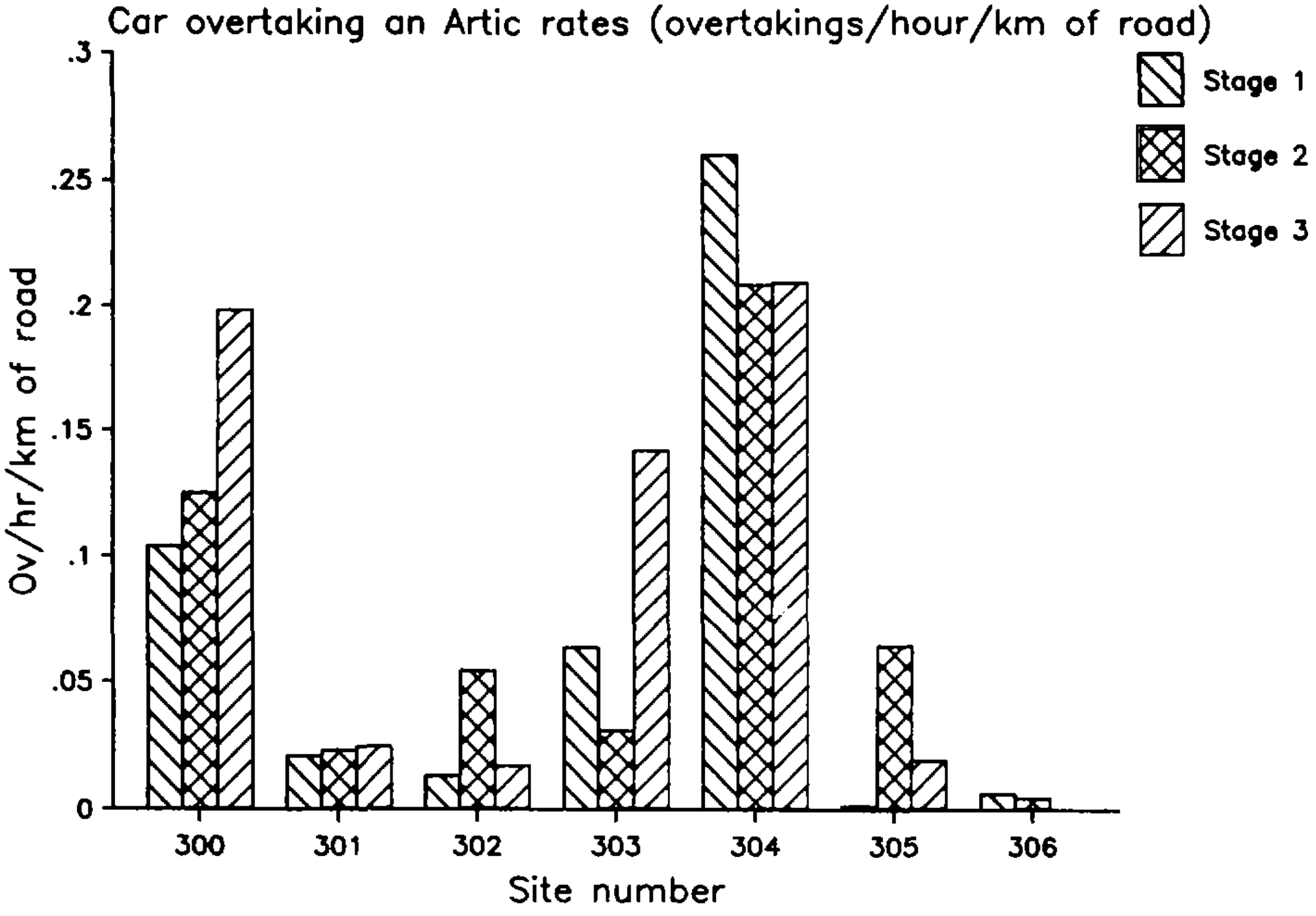


Table *4.19* Cars overtaking an Articulated
Overtaking rates (ov/hr/km), 2 lane roads in Western Australia

Overtake rate ov/hr/km	CARs loc	mean	sdev	n	Qflow	ARTICULATED loc	mean	sdev	n	Qflow
.10	1300	108	15.2	344	14.3	1300	99	14.6	161	6.7
.02	1301	106	16.4	134	5.6	1301	103	11.3	135	5.6
.01	1302	105	10.9	162	6.8	1302	92	12.7	34	1.4
.06	1303	106	11.3	500	20.9	1303	90	7.0	44	1.8
.26	1304	108	12.1	529	22.0	1304	95	7.7	205	8.6
.00	1305	103	17.1	178	1.7	1305	90	11.0	21	.6
.01	1306	107	14.8	41	7.4	1306	99	7.2	14	.9
.12	2300	110	13.6	334	14.0	2300	100	12.6	189	7.8
.02	2301	106	15.6	144	6.0	2301	104	10.6	128	5.3
.05	2302	108	13.6	176	7.3	2302	91	10.1	101	4.2
.03	2303	107	12.8	506	21.2	2303	95	9.9	26	1.1
.21	2304	107	12.3	596	24.8	2304	93	8.3	141	5.8
.06	2305	103	18.6	200	8.4	2305	71	32.8	43	1.8
.00	2306	109	15.9	64	2.6	2306	90	10.9	19	.8
.20	3300	109	12.3	416	16.9	3300	100	11.6	273	11.2
.02	3301	109	14.3	165	6.9	3301	107	11.3	153	6.3
.02	3302	108	11.8	173	7.1	3302	97	7.9	51	2.1
.14	3303	107	11.1	676	27.5	3303	95	8.4	97	4.0
.21	3304	108	11.8	508	20.8	3304	94	9.0	170	7.0
.02	3305	108	12.0	184	7.7	3305	94	8.3	40	1.7

Notes:
(1) - All articulated travelling at same mean speed
(2) Flow rates <= 150 veh/hr
(3) Based on a paper by R J Troutbeck, AIR 280-1 (ARRB), April 1981
(4) Qflow: Traffic flow rate in vehicles per hour
(5) Loc: site location number assigned by FORS

Table 4.20 Comparison of 1978 and 1983 Free Speed surveys, 2 lane roads only - FORS paper, Aug 1985

CARS 1978	Mean Speed	Sdev	85 th pctle	TRUCKS 1978	Mean Speed	Sdev	85 th pctle	Car - truck speed diff
NSW	98	14.2	112	NSW	83	9.7	92	15
VIC	98	12.0	109	VIC	78	9.5	88	20
QLD	94	11.4	105	QLD	83	9.8	93	12
WA	93	13.1	102	WA	0	.0	0	0
SA	96	12.3	108	SA	81	9.8	91	15

CARS 1983	Mean Speed	Sdev	85 th pctle	TRUCKS 1983	Mean Speed	Sdev	85 th pctle	Car - truck speed diff
NSW	96	12.4	108	NSW	84	9.9	94	12
VIC	96	10.0	106	VIC	87	8.5	96	9
QLD	91	10.4	101	QLD	82	8.8	92	9
WA	102	12.5	114	WA	84	12.0	96	18
SA	97	11.2	108	SA	81	10.3	90	16

CARS Oct 1986	Mean Speed	Sdev	85 th pctle	TRUCKS Oct 1986	Mean Speed	Sdev	85 th pctle	Car - truck speed diff
NSW	102	12.5	114	NSW	94	11.4	106	7
VIC	101	12.8	114	VIC	86	9.5	96	15
QLD	92	13.1	106	QLD	84	11.1	96	8
WA	107	13.4	121	WA	97	11.8	109	10
SA	100	13.0	113	SA	85	10.7	96	14

CARS Apr 1987	Mean Speed	Sdev	85 th pctle	TRUCKS Apr 1987	Mean Speed	Sdev	85 th pctle	Car - truck speed diff
NSW	101	12.2	114	NSW	96	10.2	107	5
VIC	103	11.2	115	VIC	89	8.3	97	14
QLD	91	11.8	103	QLD	88	9.2	97	4
WA	107	14.0	122	WA	95	14.6	111	12
SA	99	13.7	113	SA	86	10.7	97	13

CARS Oct 1987	Mean Speed	Sdev	85 th pctle	TRUCKS Oct 1987	Mean Speed	Sdev	85 th pctle	Car - truck speed diff
NSW	103	12.9	116	NSW	98	10.2	108	5
VIC	103	10.6	114	VIC	90	7.8	98	13
QLD	90	11.0	102	QLD	87	9.8	97	4
WA	108	11.9	120	WA	98	11.4	110	10
SA	100	13.9	114	SA	90	10.1	101	9

Notes:
(1) This table is based on the Federal Office of Road Safety's August 1985 paper title 'Heavy vehicle speed limits' page 31.
(2) Trucks are not defined in the paper and are assumed to be both rigid trucks and articulated vehicles.

Table *4.21* Eyre Highway Free Speed comparisons.
Western Australia, based on G Maisey, 1983 - sites 1301/2301/3301

ARTICULATED trucks - 24hr surveillance

Survey	Year	Month	Speed limit	Sample size	Mean (kph)	Sdev	85 % pctle.	% > 90 kph	% > 100 kph
Before	1982	May	80	81	100	15.4	116	80	44
After 1	1983	Aug	90	85	98	10.6	109	73	46
After 2	1983	Oct	90	92	96	14.4	111	67	28
Before	1986	Oct	90	135	103	11.3	115	88	66
After 1	1987	Apr	100	128	104	10.6	115	87	65
After 2	1987	Oct	100	152	107	11.4	119	91	75

CARS & MOTORCYCLES - 24hr surveillance **

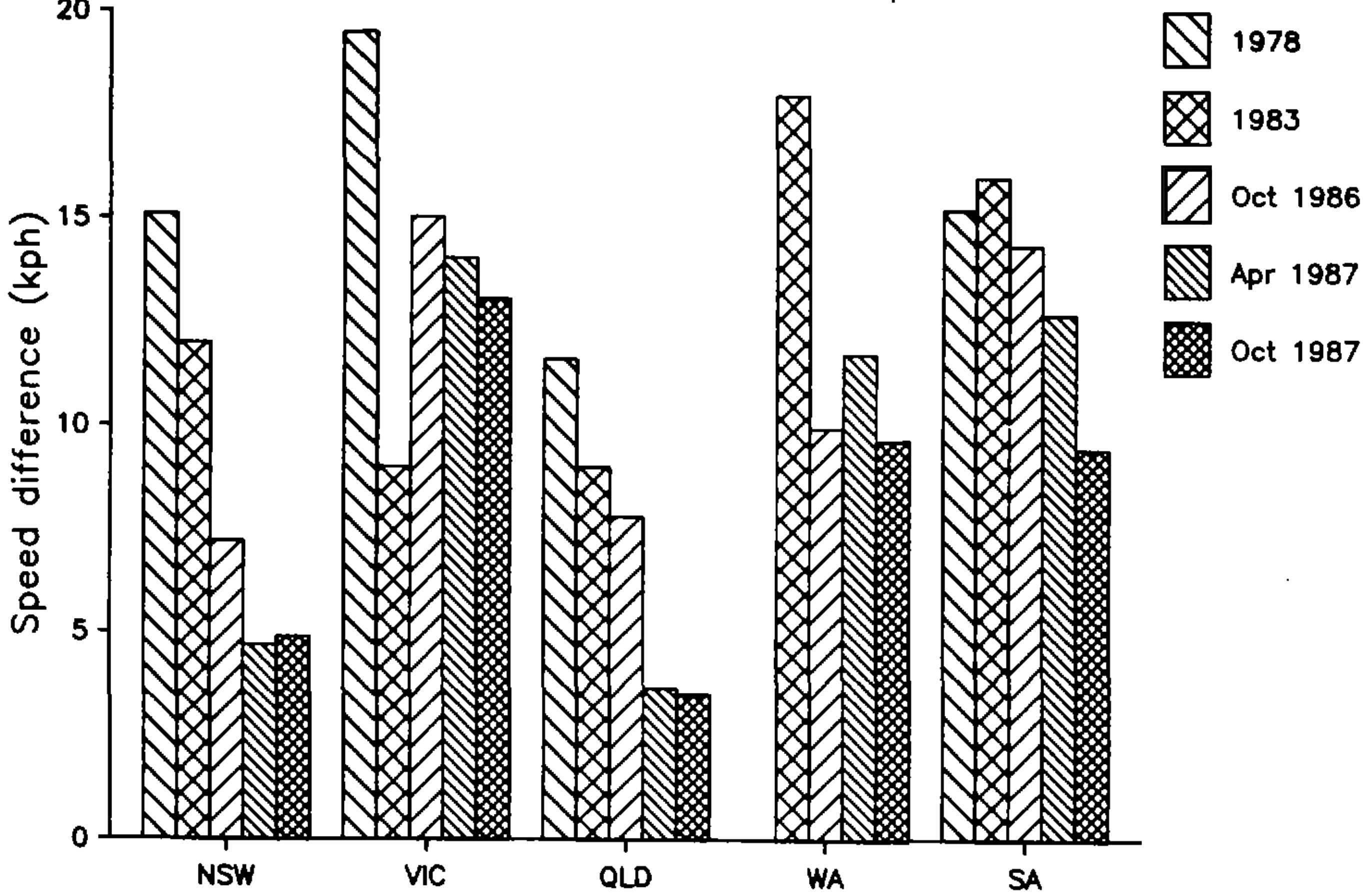
Survey	Year	Month	Speed limit	Sample size	Mean (kph)	Sdev	85 % pctle.	% > 90 kph	% > 100 kph
Before	1982	May	110	141	108	13.5	122	90	72
After 1	1983	Aug	110	71	109	12.5	122	92	77
After 2	1983	Oct	110	176	104	12.5	117	81	59
Before	1986	Oct	110	141	105	16.3	122	83	65
After 1	1987	Apr	110	150	106	15.6	122	85	64
After 2	1987	Oct	110	171	109	14.6	125	89	72

Notes:

**1) Table drawn from "Effect of increasing the Speed limit and associated penalties for Heavy vehicles on the Eyre Highway", Maisey, G E, Police Dept, Perth WA. Res Report 83/1

Plot 4.29: CAR & TRUCK speed differences

FORS national surveys, difference of mean speeds of cars & trucks



Plot 4.30: WA – Eyre Highway Free Speeds

Comparison based on G Maisey – Site No.1301,2301,3301

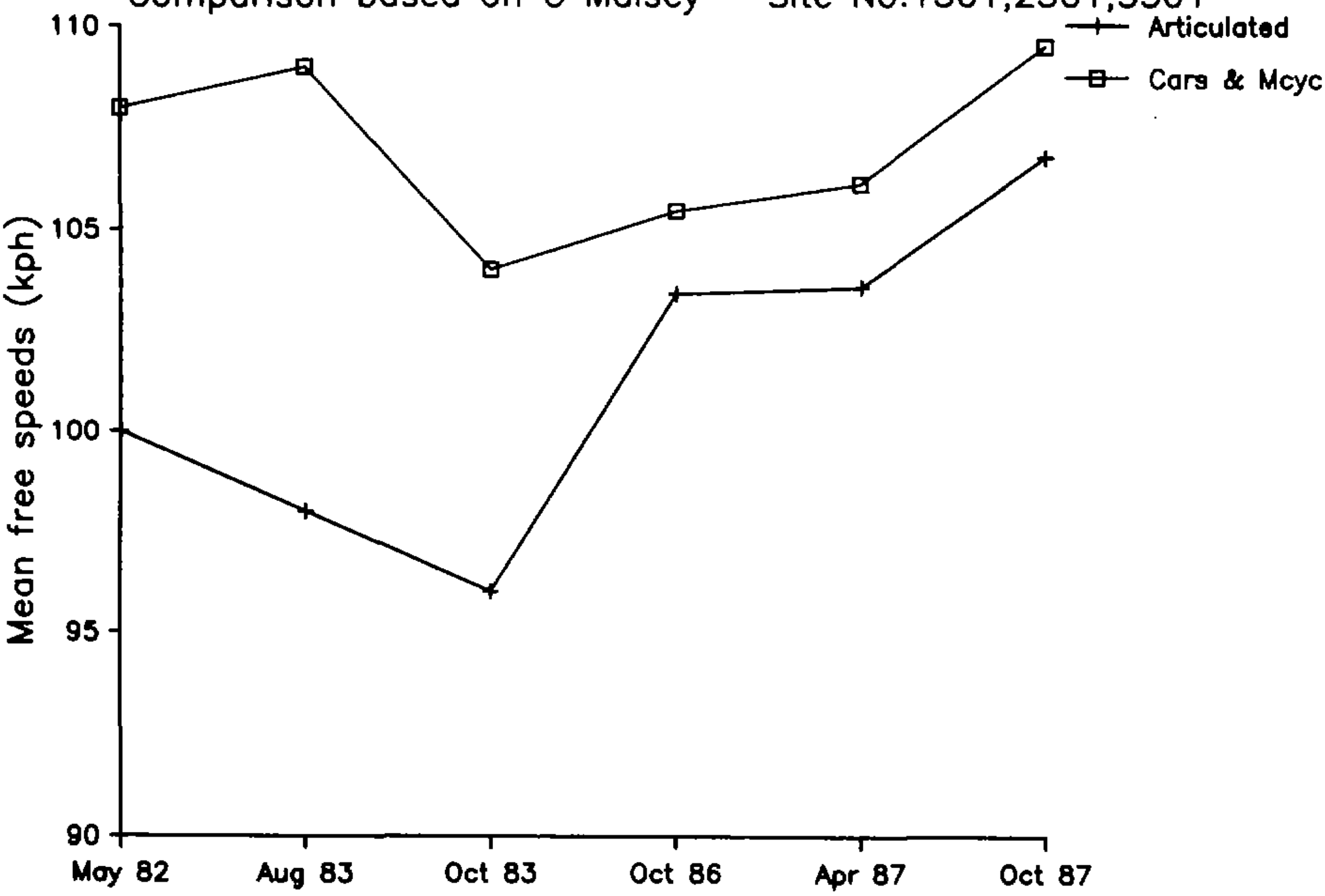


Table 4.22: South Australian Free Speed Survey Comparisons
NAASRA surveys, 1967-1985

Year	CARS Sample stations	CARS Mean (kph)	ARTICULTED trucks N	ARTICULTED trucks Mean (kph)	RIGID trucks N	RIGID trucks Mean (kph)
1967	64	91.0				
1968	66	91.4				
1969	66	91.7			490	70.7
1970	66	93.1			380	71.0
1971	64	95.5	273	72.0	335	72.6
1972	66	97.6	327	71.9	350	69.8
1973	66	98.0	303	73.2	426	75.1
1974	66	96.9	298	78.0	407	75.5
1975	66	97.1	362	79.7	385	75.7
1976	66	98.7	309	82.1	369	79.5
1977	66	99.1	320	83.7	337	80.3
1978	66	100.2	325	82.3	760	80.3
1979	66	98.9	421	80.6	749	78.7
1980	66	97.9	396	85.3	611	78.8
1981	66	100.4	379	85.1	641	84.0
1982	66	101.1	552	89.4	605	86.0
1983	66	100.2	534	89.4	740	85.7
1984	66	100.9	420	88.3	739	86.5
1985	66	102.2	539	89.4	778	85.6
**1986		102	681	87	227	87
**1987		103	670	90	244	86
**1987		104	661	94	240	87

Notes:
1) ** - FORS Truck speed study results for South Australia
   See tables 3.11 - 3.13
2) SA definition "others" interpreted as Rigid trucks
3) SA definition "Semis" interpreted as Articulated trucks

Table 4.23: South Australia: NAASRA Free speeds on Rural Roads, 1985

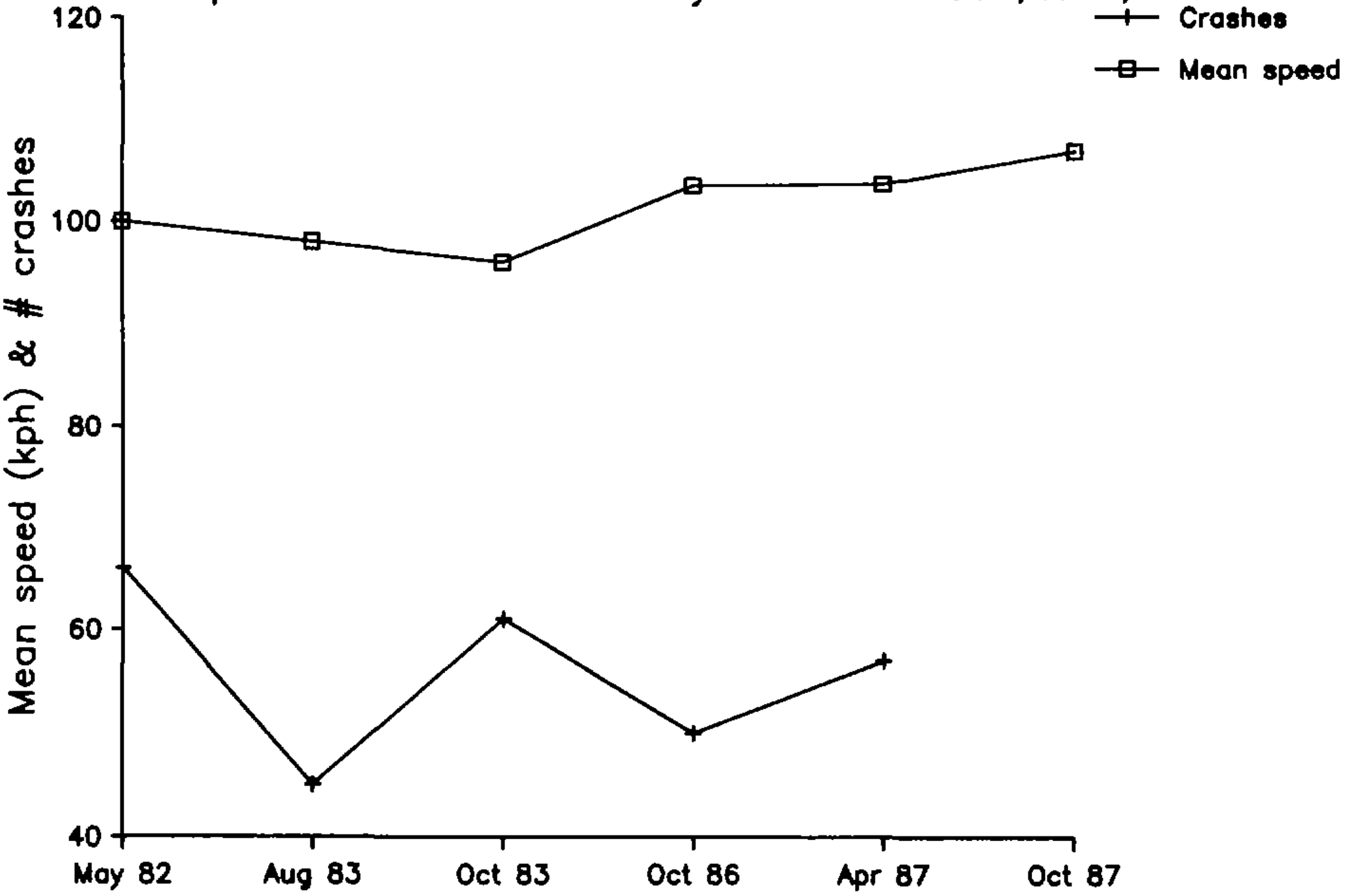
Mean Free speeds

1985	N	Mean (kph)	Sdev	85 th pctle
Cars	3518	102	12.5	115
Semis	539	89	10.3	99
Others	778	86	10.8	96
Oct 1986**				
Cars	2835	102	13.3	116
Semis	681	87	11.1	98
Others	227	87	11.4	98
April 1987**				
Cars	2788	103	13.5	117
Semis	670	90	10.4	101
Others	244	86	10.5	97
Oct 1987**				
Cars	2616	104	13.1	118
Semis	661	94	10.5	105
Others	240	87	11.4	99

Notes:
1) ** - FORS Truck speed study results for South Australia See tables 3.11 - 3.13
2) SA definition "others" interpreted as Rigid trucks
3) SA definition "Semis" interpreted as Articulated trucks

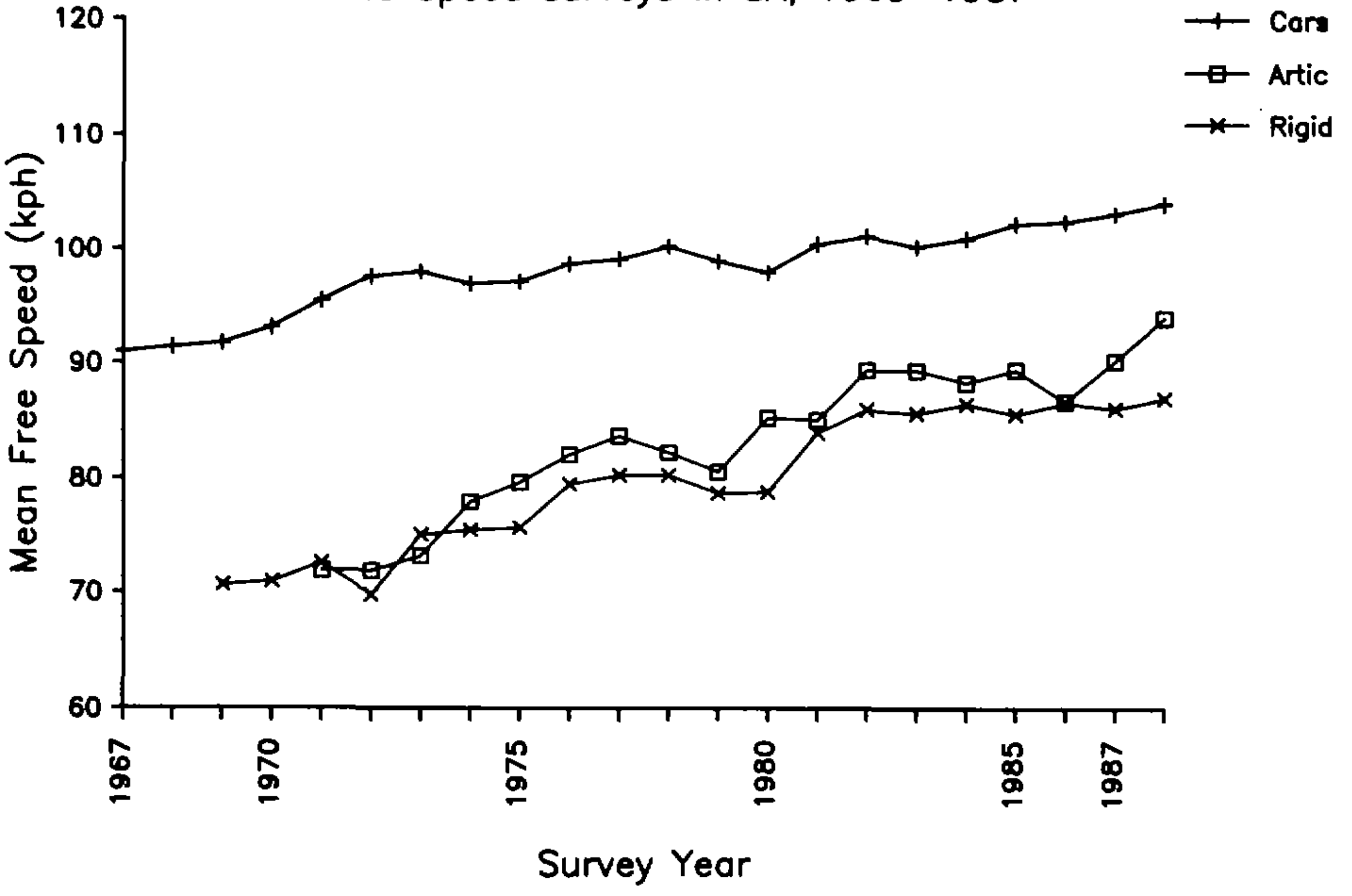
Plot 4.31 WA - Eyre hwy Free Speeds vs # Crashes

Comparison based on G Maisey - Site No.1301,2301,3301



Plot 4.32: SOUTH AUSTRALIA: Free speed surveys

Free Speed surveys in SA, 1969-1987



V.1. Crash statistics - Western Australia & Victoria.

The study by Solomon (Solomon 1964) was a landmark in research on the relationship between crashes and speed differential between cars and trucks especially on two lane roads. Solomon showed that as the speed differential increases, so the number of overtakings and with this the crash rates and severity climb.

The ROSTA study of HCV (ROSTA 1978) concluded that on primary rural roads crash occurrence potential could be reduced if truck and car speeds are brought together. Loong et al. support this argument (Loong et al. 1985, 6):

> " If truck speeds are increased to reduce speed differentials, the benefits derived from the reduction of crash occurrence rates would outweigh the disbenefits caused by increased severity".

Croft (Croft 1985) concludes that the literature points to an association between speed and speed differential and crash occurrence and severity.

The Eyre Highway study by Maisey examined the relationship between increasing the truck speed limit (thus reducing the car/ truck speed differential) and crashes. Maisey concluded (Maisey 1983, 7):

> "The limited data showed no substantial increase in the number of semi-trailers or other motor vehicles involved in reported accidents in the 1983 period compared with previous years."

Plot 4.31 contains an extension to Maisey's original results with the addition of the present study Eyre highway results. This plot provides six points in time for the free speed surveys along with the corresponding truck involved crash statistics.

The correspondence between the longitudinal speed data for the Eyre highway (plot 4.31) and the time series of crashes in rural Western Australia (plot 5.1 & 5.2) suggests the following:

1. There is no obvious or dramatic correlation between the Eyre highway data and either crashes or fatalities. This conclusion is based on a careful visual examination of plots 5.1 & 5.2.

2. Neither change in speed limits (Feb 83 or Jan 87) has induced any perceptible change in the crash or fatalities time series.

The work by Fieldwick on the relationship between rural speed limit and crash rates (Fieldwick 1981) indicated:

> "that the change in crash rate is an almost linear function of speed limit".[19]

He cites the results of many international studies where speed limits were

[19] Fieldwick 1981, pg 16.

reduced during the mid 1970's during the oil embargoes. His work raises the negative aspect of increasing truck speed limits.

Similarly, the paper by Frith & Derby (Frith & Derby 1986) which dealt with the deregulation of the freight industry[20] in New Zealand in 1983 suggested that:

> "on State highways truck fatal crashes have experienced an increase with respect to other fatal crashes since deregulation with a one year lag followed by a stabilization which has not occurred for all crashes."[21]

The literature suggests:

A. reducing speed differentials will reduce overtaking maneuvers and this would reduce the number of crashes

B. as truck speeds increase, so would the occurrence and severity of crashes increase for collisions involving trucks.

The results of the present study favour point (A) above. Certainly the Eyre highway evidence strongly suggests that the increased truck speed limits have had no perceptible deleterious effects on crashes or fatalities. However, the Eyre highway is not representative of rural highways in Australia.

V.1.a. Descriptive time series analysis

Each of the participating States in this study was asked to provide crash and fatality data. This data was to overlap with the free speed surveys to ascertain whether there was any adverse effect of increasing the truck speed limits.

Appendix F outlines the data requested from each of the States. The only States that could provide the information requested in time for inclusion in the report were WA and VIC. The data requested consisted of a dump of each States crash statistics database for all crashes since July 1981 for crashes which involved at least one truck. A minimum set of variables were requested and the format of the data transfer specified.

V.1.b. Western Australia

Plots 5.1 & 5.2 present the raw crash and fatality statistics for ALL crashes in Western Australia involving a truck (see Appendix F for definitions) aggregated by month for the time period July 1981 through June 1987. As such, the WA crash data overlapped two of the three free survey points in the present study. The crashes are split into Urban vs Rural.

[20] The deregulation affected the number of trucks, not the speed limits.

[21] Frith & Derby 1986, pg 114, para 29.

Rural crashes (plot 5.1) have remained stationary[22] hovering around a monthly mean of 50.5 crashes (Table 5.1). A Cusum analysis [23] (plot 5.5) indicates significant changes away from the mean during the periods:

Large increases
* March - May 1982
* Sept - Dec 1982
* July - August 1983
* Sept - Dec 1983
* Dec 1984
* March - June 1987

Large decreases
* Jan - Mar 1983
* Jan - Mar 1984
* Aug - Oct 1985
* Dec 1985 - Feb 1986
* Nov 1986 - Mar 1987

The legislative changes took place in February 1983 and January 1987. Both

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[22] The term 'Stationary' has a specific statistical meaning when used in time series analysis. A time series is said to be strictly stationary if:
* all the y_t have the same marginal distribution, this being normal.
* all the y_t have the same mean.
* constant variance
* covariance (y_t, y_{t+j}) = covariance (y_{t+i}, y_{t+j+i})

The term here is not being used in the strict statistical sense, only to indicate the constancy of the mean.

[23] Cusum analysis is a plot of the cumulative sum of deviations of a time series from the mean (or arbitrary reference level 'k') level of the time series. Frith & Derby (Frith & Derby 1986, 109, para 18,19) used this analysis in their paper on freight deregulation in New Zealand.

A Cusum is calculated as follows:

$S(x,n) = Sum_{1..n} (x_t - k)$

where:

S(x,n)	the cumulative sum of a time series 'x' (crashes) for terms t: 1, 2 ...n.
x_t	the time series values from t: 1,2...n .
n	the time series runs from t:1,2....N where n: 1 <= n <= N.
k	an arbitrary reference level which the time series moves about. If the mean is used, then the last Cusum value- S(x,N) will be zero by definition.

The values of S(x,n) are plotted on the Y axis and the values of n are plotted on the X axis.

The Cusum curve will be horizontal when the mean remains equal to k. It will slope up when the mean > k and down when the mean < k.

Approximate 95% significance levels can be applied to any change of S(x,n) of greater than 2 standard deviations.

months coincide with negative slopes in the Cusum which indicates that the monthly number of crashes was declining below the mean monthly level.

The picture for rural fatalities is similar to crashes. Rural fatalities are stationary about the mean level of 1.0 per month (Table 5.1). The Cusum analysis on rural fatalities (plot 5.6) indicates large and significant movements above this mean level in Sept - Dec 1983, Jan 1983 and July 1986. Downward movements were slower and spread out over six to twelve months.

In summary, for Western Australia:

1. Monthly crash and fatality numbers have remained stationary about the mean level over the entire time series.

2. There is no evidence to indicate (from the Cusum plots) any massive leaps in crash or fatality numbers as a result of legislative changes in either February 1983 or January 1987.

V.1.c. Victoria

Plots 5.3 & 5.4 present the crash and fatality trends for fatal crashes in Victoria involving a truck (see Appendix F for definitions) aggregated by month for the time period July 1981 through December 1986. The crashes are split into Urban vs Rural and overlap only one free speed survey point.

The trend series for rural crashes (plot 5.3) indicates that the number of crashes began to decline from June 1984. Prior to this the number of crashes was stationary about a mean level of 14 per month (Table 5.1). The picture for fatalities is similar (plot 5.4).

The Cusum analysis of rural fatal crashes (plot 5.7) indicates substantial movements above the mean level in the periods Aug - Dec 1981, Sept - Dec 1983 and March - Sept 1984. Downward movements below the mean were less dramatic.

Large and significant movements above the mean level of rural fatalities are indicated by plot 5.8 in Feb - Oct 1982, Mar - Oct 1984 and Feb - Sept 1985. Significant decreases occurred between Oct 1982 - March 1983 and Oct 1984 - Feb 1985. There seems to be a cyclic process present in the increases and decreases in rural fatalities.

In summary, for Victoria:

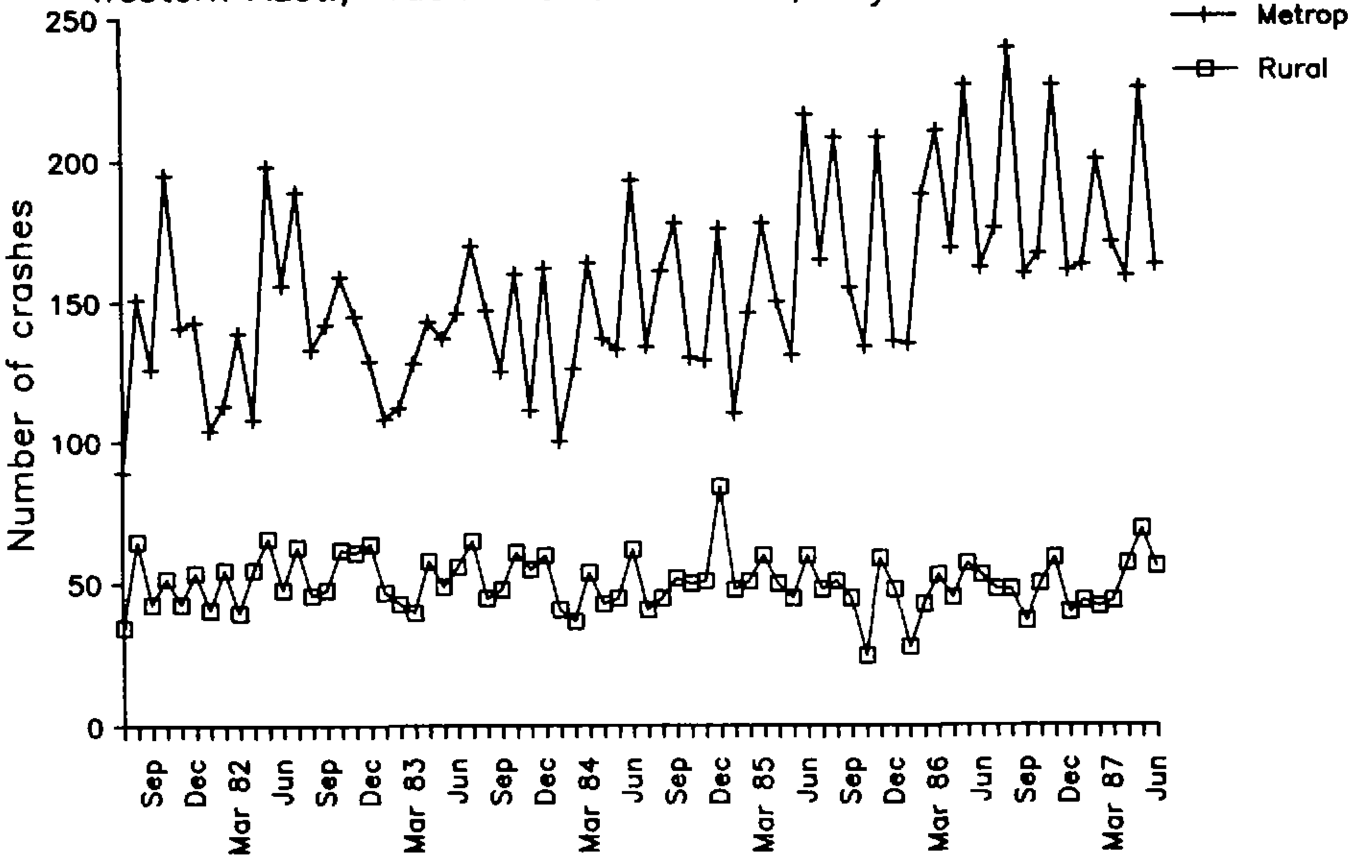
1. Monthly crash and fatality numbers have remained stationary about the mean level until June 1984 from whence they have declined.

2. Further time series analysis may reinforce the initial observation of a cyclic trend in rural fatalities.

In conclusion, there does not seem to be any significant change in truck related crashes or fatalities coincident with legislative changes to truck speed limits in Western Australia. For Victoria, the downward trend of crashes and fatalities is of interest.

Plot 5.1: Urban - Rural Crashes (raw)

Western Aust., Truck involved crashes, July 1981 - June 1987



Plot 5.2: Urban - Rural fatalities (raw)

Western Aust., Truck involved fatalities July 1981 - June 1987

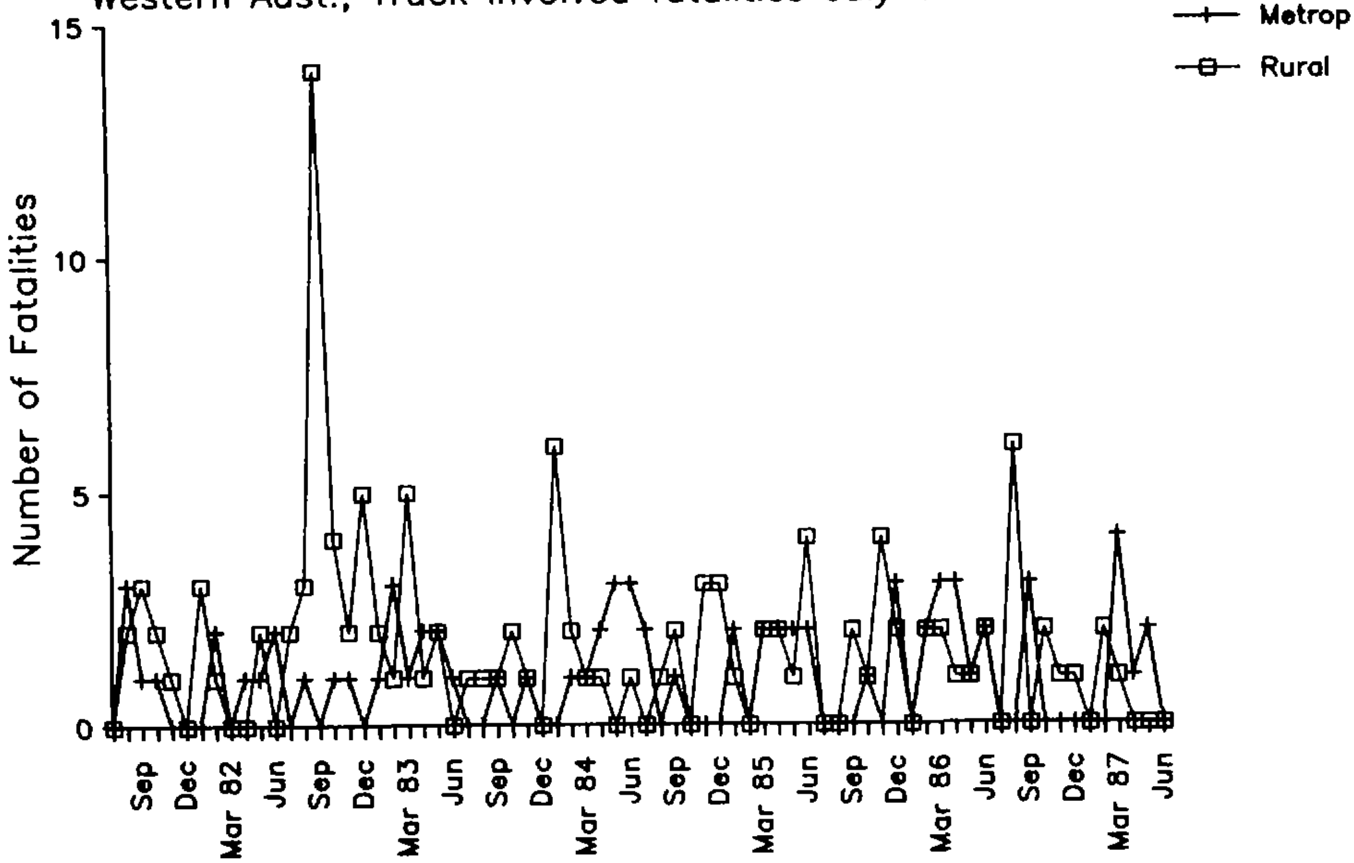


Table 5.1. Mean number of crashes and fatalities which involved trucks in the States of Western Australia and Victoria. July 1981 - June 1987.

Western Australia: July 1981 - June 1987

	Mean (per mth)	Sdev
Fatalities		
Rural	1.0	1.1
Urban	1.7	2.1
Crashes		
Rural	50.5	9.7
Urban	155.7	33.2

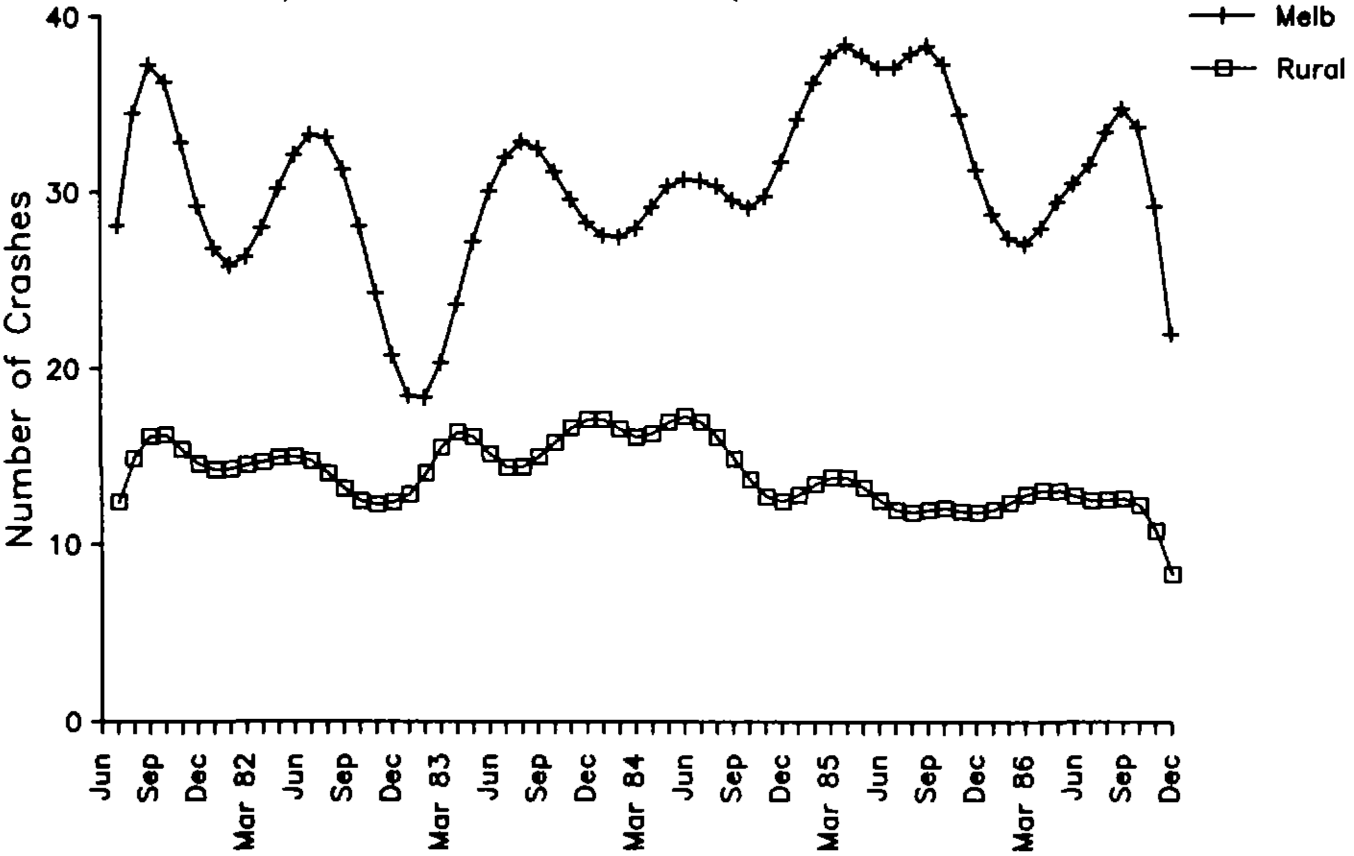
Victoria: July 1981 - Dec 1986

	Mean (per mth)	Sdev
Fatalities		
Rural	3.7	2.4
Urban	4.1	2.5
Crashes		
Rural	14.1	4.1
Urban	30.7	8.3

Notes:
(1) Crashes in Victoria are only fatal crashes which involved a truck. In Western Australia, all crashes are reported involving trucks.
(2) The means are based on monthly values.

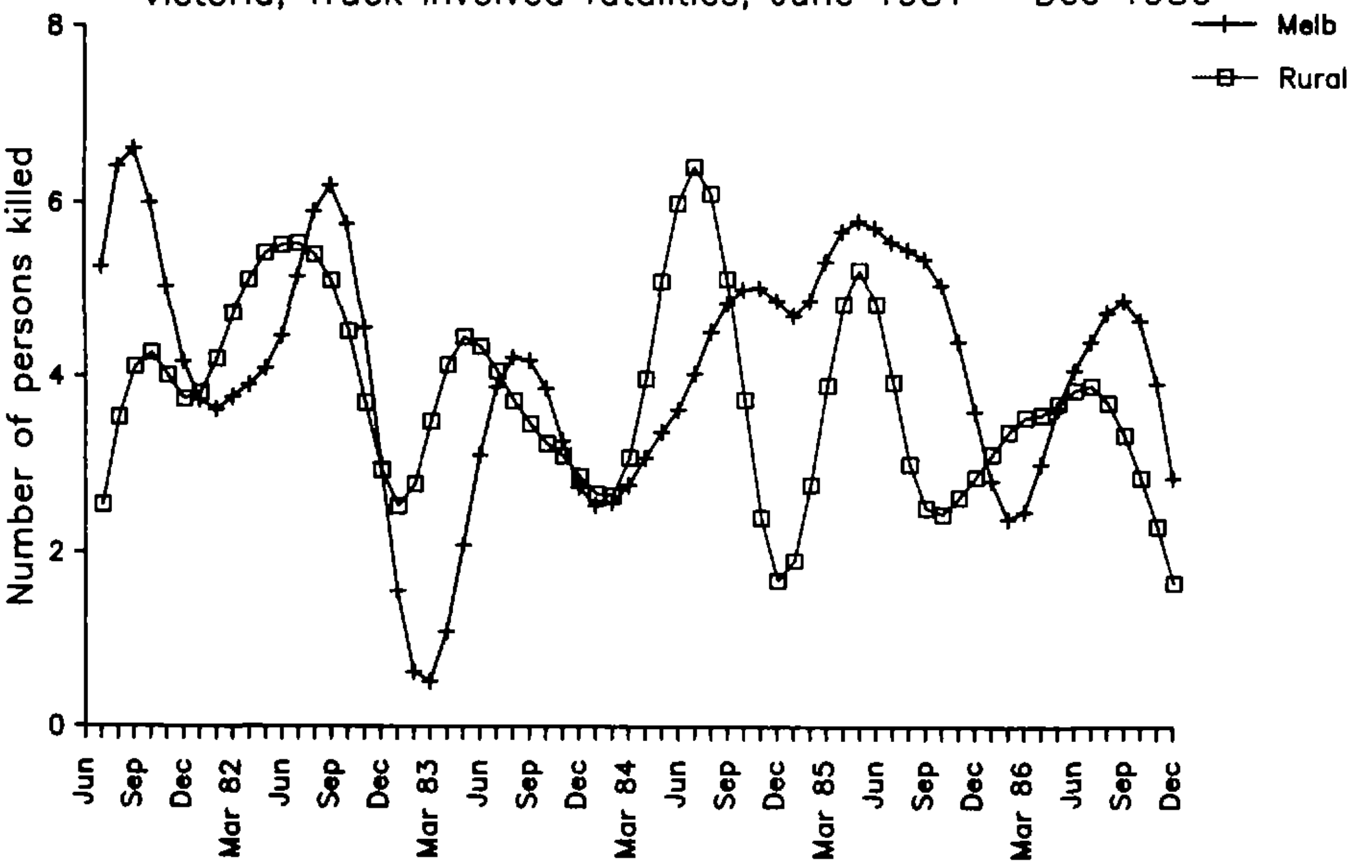
Plot 5.3: Urban - Rural Crashes (Trend)

Victoria, Truck involved crashes, June 1981 - Dec 1986



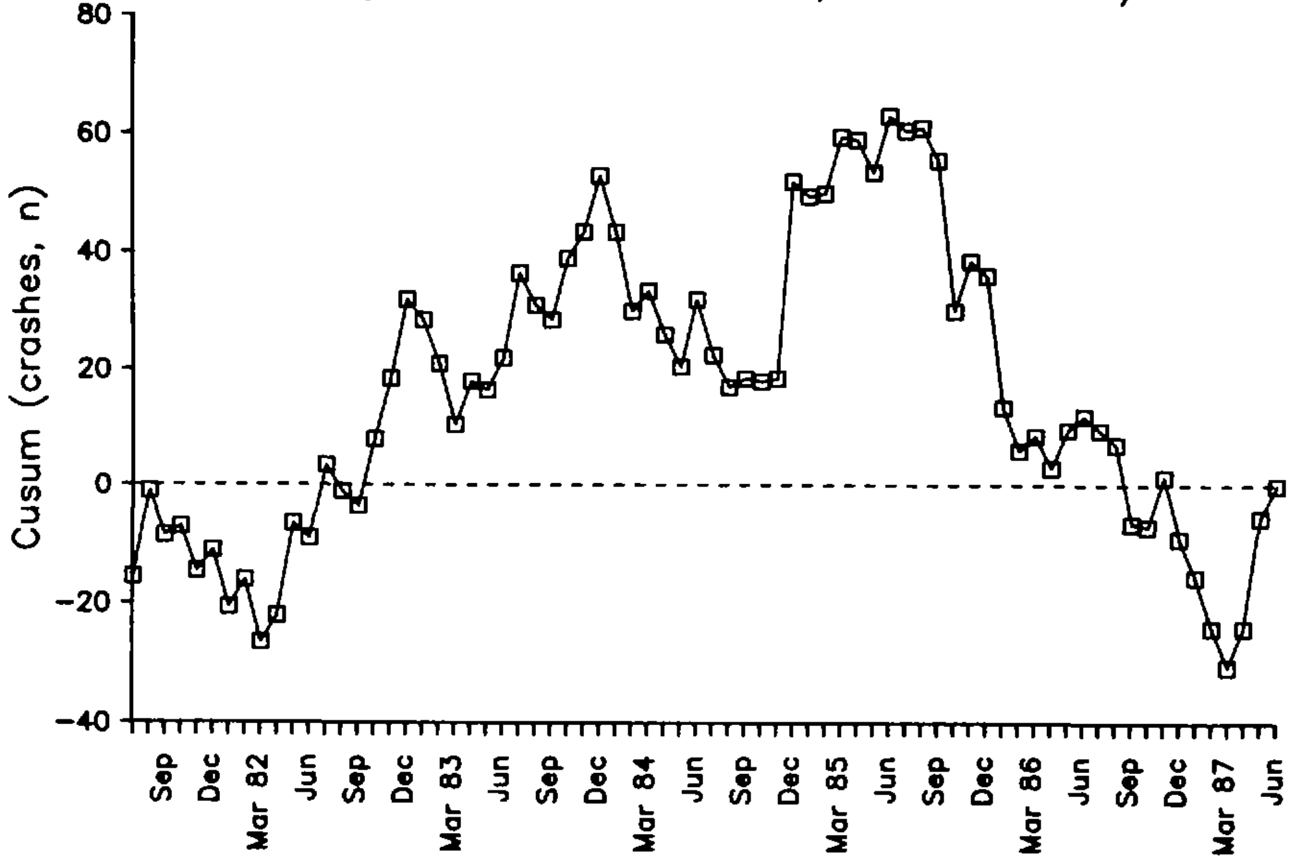
Plot 5.4: Urban - Rural Fatalities (Trend)

Victoria, Truck involved fatalities, June 1981 - Dec 1986



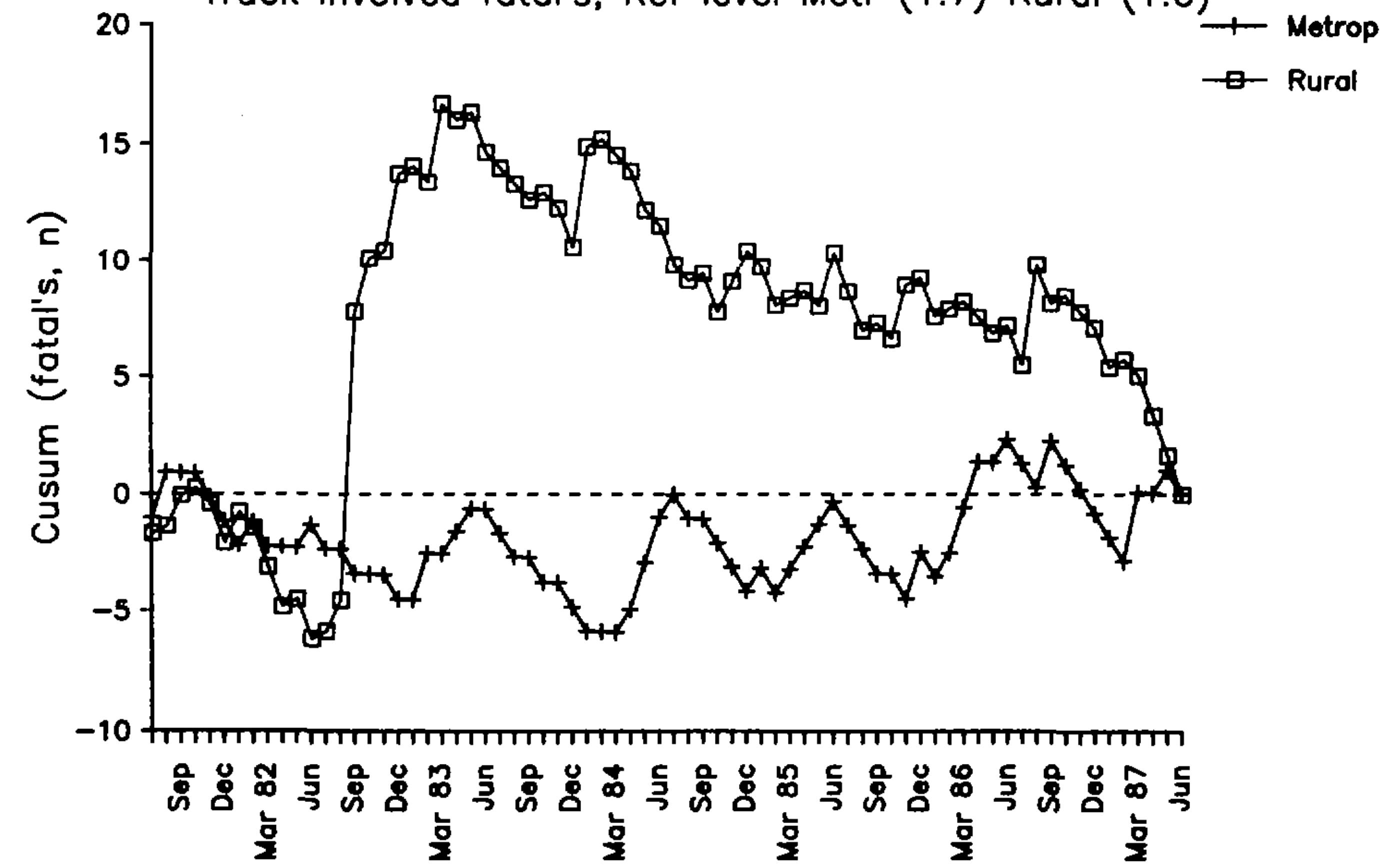
Plot 5.5: Cusum - Rural crashes

West. Aust., Truck involved crashes, Ref level = 51/mth

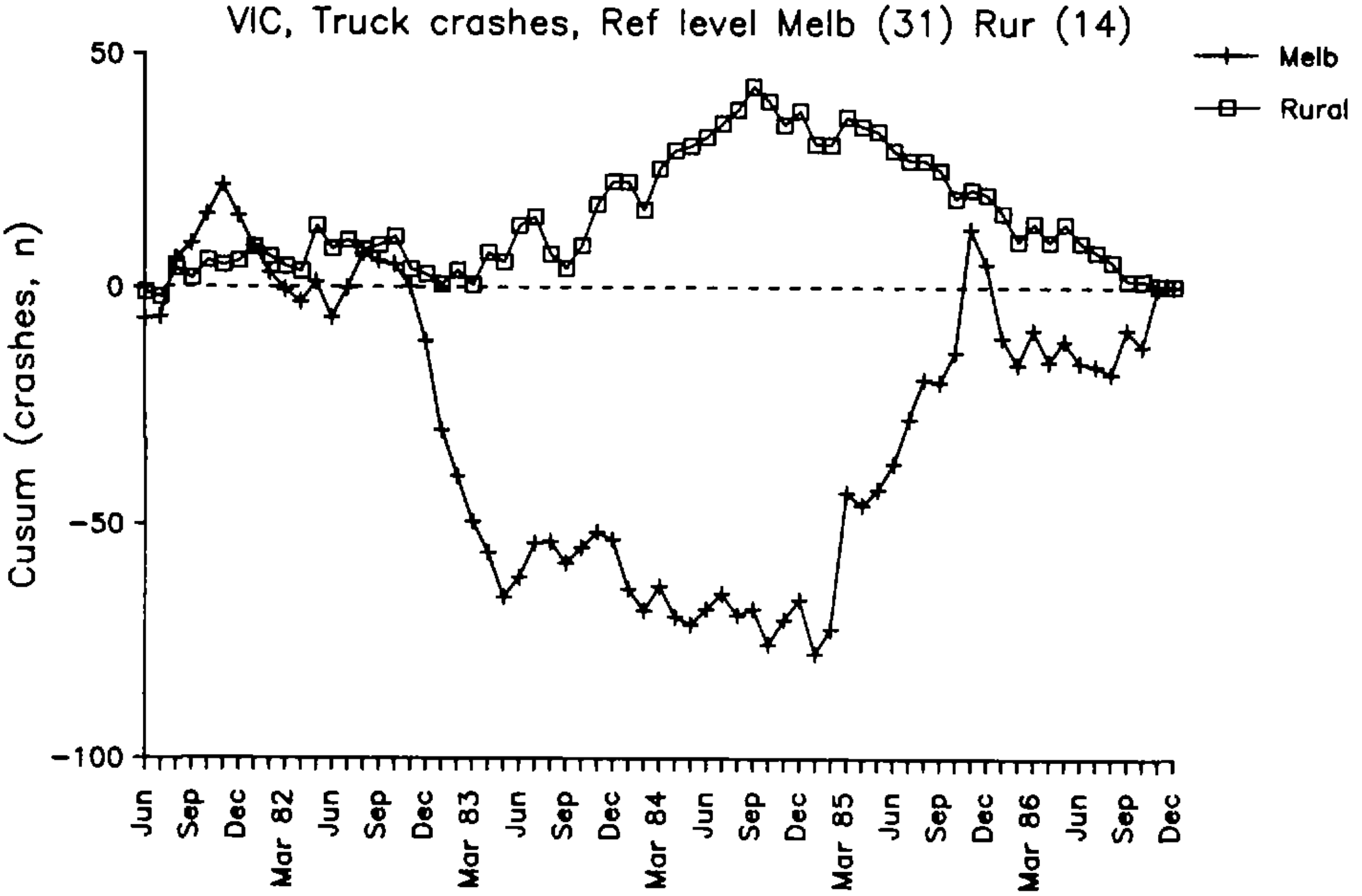


Plot 5.6: Cusum - Urb & Rural fatal's in WA

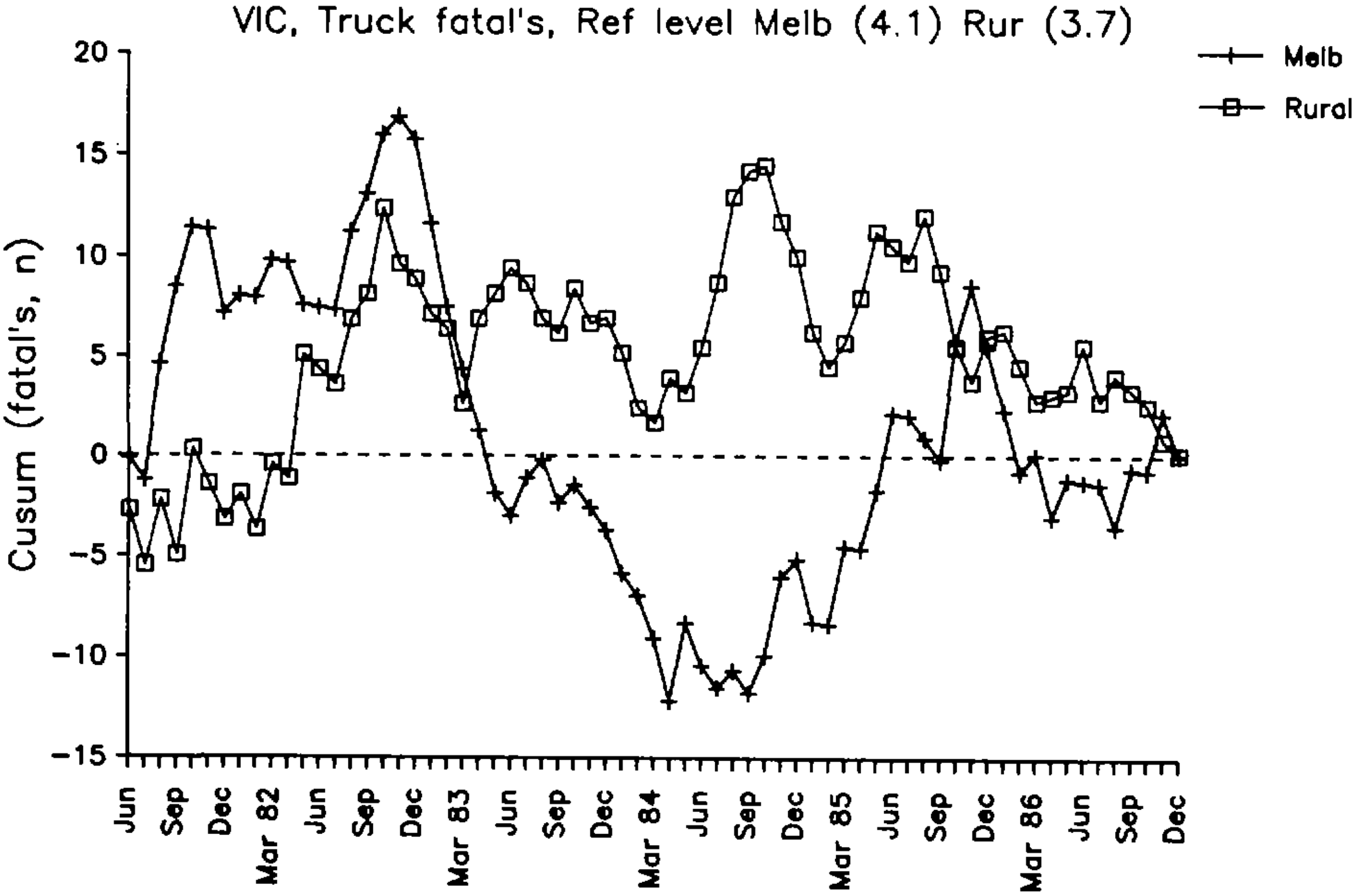
Truck involved fatal's, Ref level Metr (1.7) Rural (1.0)



Plot 5.7: Cusum - Melb & Rural crashes



Plot 5.8: Cusum - Melb & Rural fatalities



VI. SUMMARY of RESULTS and DISCUSSION

The major conclusions drawn from the analysis of the free speed data are collated below.

1. Statistical assumptions (IV.1.a.)[24]:

   1.1. The vast bulk of the free speed distributions were found to be non-normal. Thus the error distributions were found to be non-normal.

   1.2. All the speed distributions were found to contain significant levels of auto correlation. Thus the error terms were not independent.

   1.3. In the bulk of cases the error variance across factor levels was found to be non homogeneous.

   1.4. Thus we concluded that the ANOVA model was not appropriate for testing the free speed data. We relied instead on non parametric procedures for testing the hypotheses on free speed.

2. Aggregated free speeds - all roads (IV.2.a.):

   2.1. Articulated vehicle mean free speeds increased in four States as did the percentage travelling faster than 90 km/h.

   2.2. Car mean free speeds remained stable with some slight increases in VIC and WA.

   2.3. The control State QLD which did not increase its truck speed limits experienced the same increases in articulated vehicle mean free speeds as other States.

   2.4. The control State Queensland seems to be confounded. By contrast, the vehicle group 'cars' does appear to have acted as a control.

3. Aggregated speeds for two-lane roads (IV.2.b.):

   3.1. Articulated vehicle mean free speeds increased in all States except Tasmania as did the percentage travelling greater than 90 km/h and 100 km/h.

   3.2. Car mean free speeds remained fairly stable across the three stages with a slight increase in Western Australia and slight decreases in Tasmania and ACT.

   3.3. The control State Queensland, which did not increase its truck speed limits experienced the same increase in articulated vehicle mean free speeds as other States. Thus the control seems to be confounded by some other variable.

   3.4. Thus in summary the comparison between the all-roads and the two-lanes at the gross mean and percentage levels are not starkly

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[24] (III.1.a) refers to the section of the report from which this summary has been drawn.

different.

4. *Platooning on 2 lane roads (IV.2.c.):*

   4.1. *The number of car led platoons has increased by 63% across ALL speed categories between October of 1986 and October 1987. This increase straddles the legislative change in January 1987.*

   The constituents of these platoons are unknown.

   4.2. *During the same period there was a 31% decrease in articulated le d platoons across ALL speed categories.*

5. *Time of day (IV.2.e.):*

   5.1. *Articulated vehicles have the roads to themselves at night and this period also corresponds to the highest mean free speeds for articulated vehicles. Thus the low volume of traffic and possible reduced police enforcement levels at night may give rise to these elevated truck speeds.*

   5.2. *Prior to the legislative change the mean free speeds of articulated vehicles did not overlap the mean free speeds of cars. The speed window was 0 km/h.*

   This speed window has now widened considerably to 14 km/h and may go part way in explaining why there has been such an increase in car led platooning.

   5.3. *An examination of the sampling percentages by vehicle type strongly suggests that either the actual distributions of vehicle types in the States are radically different or that the samples in each State are biased towards different vehicle types. None of the State distributions resemble the all over Australian distribution of "Registered motor vehicles" published by the ABS (see Table 3.2). (Section III.1.b.)*

   5.4. *The survey design is such that statistically we cannot say with any confidence that the sample is representative of the Australian vehicle population. Clearly, trucks have been over sampled, but to what extent is unknown. The effects of time of day and the number of active sampling sessions have contributed substantially to this bias. (Section III.1.b.)*

   5.5. *It would appear that either the WA sampling distributions are not "typical" of the expected distribution of vehicle types by time of day or that time of day has seriously confounded the sampling used in this study. Further, as Maisey has noted, truck speeds tend to be higher during the night time than the daytime hours.*

   Thus it appears that not only have trucks been over sampled due to the elevated number of sampling sessions during the night (plot 3.1), but that this could also have biased the mean truck speeds reported in this study upwards. (Section IV.2.f.)

6. *Speed differentials (IV.3):*

   6.1. *By either measure of speed differential 'speed dispersion' has been reduced over the study period. The question still remains as* *to whether the legislative change had any bearing on this result.*

6.2. The four most frequent vehicle mixes are (in order) Car - Car, Artic - Artic, Car - Artic and Artic - Car.

6.3. Cars are still travelling faster than articulated vehicles but only by 8 km/h by stage 3 of the study. This value has dropped by 2 km/h since the before study in October 1986.

7. Comparison to previous studies (IV.4.):

7.1. The present study indicates a stasis in the speeds of cars and articulated vehicles at one location on the Eyre highway which contrasts with the results obtained by Maisey where he found that speeds decreased.

7.2. The most important issue that emerges from the FORS paper and which was one of the driving forces behind the present study is to reduce speed dispersion (based on the difference between the mean speeds). This was to be achieved by increasing the speed limit for HCV.

7.3. The important point which emerges from plot 4.32 is that the results of the present study seem to be consistent with the apparent trends which have emerged from the South Australian time series.

8. Crash statistics (V.1.):

8.1. In conclusion, there does not seem to be any significant change in truck related crashes or fatalities coincident with legislative changes to truck speed limits in Western Australia. For Victoria, the downward trend of crashes and fatalities bodes well for the legislative changes which lie beyond the VIC time series.

9. Overtaking Rates (IV.2.g):

9.1. Further exploration of the utility of overtaking rates as a predictive indicator of the relative crash risk of a road would require a longitudinal examination of the change in the overtaking rates for the period of the present study (October 1986 to October 1987) with site specific numbers of crashes or fatalities.

If such a relationship could be shown then changes in overtaking rates may be a more refined indicator of overall road safety than the concept of speed dispersion.

9.2. Further work really needs to be done and overtaking rates promise to be a very attractive indicator of general road safety.

Discussion:

The literature places emphasis on reducing 'speed dispersion' by increasing truck speed limits. In other studies which have examined this issue no safety disbenefits have been discovered.

This study and others in the literature have shown that trucks already exceed legal speed limits. Truck drivers are travelling at speeds they consider safe in respect of their vehicle, the traffic volume, road environment and police activity.

This study has shown that the free speeds could not be analyzed using standard normal distribution based parametric statistics. Nonparametric statistics were used instead.

The sampling methods used in this study are biased towards over sampling of trucks and elevating truck mean speeds. Scant attention has been given to sample design in most of the previous studies cited. All future studies of vehicle speeds must incorporate a rigorous and enforceable sampling strategy. Also, basic population data on vehicle counts by site by time of day and date needs to be gathered as the basis of better sampling design.

Articulated vehicle mean free speeds have increased in four States as has the percentage travelling faster than 90 km/h. The control State for the study, Queensland failed in its purpose as it experienced the same changes in mean free speeds as did other States. Thus there are further, unknown factors confounding articulated vehicle speeds.

Car speeds did act as a stabilising control for articulated vehicle speeds. Car speeds remained stable during the study period.

There has been a large increase in the number of platoons led by cars over the study period. This result is matched by a modest decline in the number of articulated led platoons.

Articulated vehicle speeds are closer to car speeds than ever before and so articulated vehicles may be joining the queues of other vehicles on our roads. The evidence for this is the widening of the speed window for cars and articulated vehicles from 0 to 14 km/h.

Speed differentials have reduced slightly from 10 km/h to 8 km/h for the Artic/ car vehicle mixes. Thus on this score alone a successful decrease in 'speed dispersion' has been accomplished.

The results of the present study are consistent with the three benchmark studies considered in this report. Thus no abberations were discovered which may cast doubt on the study's results.

There are no obvious or significant changes to road crashes and fatalities in the two States examined which could be attributed to the change in truck speed limits.

The question regarding whether radar biases free speeds downward could not be resolved by this study as the results are equivocal. Better research design is indicated to hammer this problem out.

Automatic classifiers are on the whole too immature for use as reliable speed survey instruments. Time and technology will improve the situation no doubt.

Overtaking rates are potentially a much better indicator of road and traffic safety than either aggregated speeds or speed differentials. Further research on this indicator should be funded and encouraged.

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VIII. APPENDICES

APPENDIX A - Site descriptions

Table A1: BEFORE TRUCK SPEED STUDY - TEMPORAL ATTRIBUTES

LOCN	ROAD NAME	DAY	DATE	START	FINISH
[illegible]001	NEW ENGLAND HIGHWAY	SATURDAY	25-10-86	0200	0600
1002	HUME HIGHWAY	MONDAY	27-10-86	1300	1500
1002	HUME HIGHWAY	MONDAY	27-10-86	1030	1230
1003	NEWCASTLE EX	SATURDAY	01-11-86	1045	1245
1003	NEWCASTLE EXPRESSWAY	SATURDAY	01-11-86	1330	1530
1004	HUME HIGHWAY	MONDAY	03-11-86	1800	2200
1005	HUME HIGHWAY	TUESDAY	04-11-86	1415	1815
1006	NEWELL HIGHWAY	FRIDAY	07-11-86	1830	2230
1007	NEWELL HIGHWAY	SATURDAY	08-11-86	0100	0500
1008	F5-SOUTH WESTERN FREEWAY	TUESDAY	11-11-86	1930	0000
1009	F5-SOUTH WESTERN FREEWAY	WEDNESDAY	12-11-86	0000	0430
1010	HUME HIGHWAY	SATURDAY	15-11-86	1930	2400
1011	HUME HIGHWAY	TUESDAY	25-11-86	2400	0415
1012	NEW ENGLAND HIGHWAY	TUESDAY	18-11-86	1030	1430
1110	HUME HIGHWAY	TUESDAY	14-10-86	1800	2301
1110	HUME HIGHWAY	THURSDAY	16-10-86	2400	0400
1110	HUME HIGHWAY	TUESDAY	18-11-86	1800	2300
1110	HUME HIGHWAY	THURSDAY	20-11-86	2400	0400
1110	HUME HIGHWAY	SATURDAY	22-11-86	0600	1000
1120	WESTERN HIGHWAY	TUESDAY	14-10-86	2400	0400
1120	WESTERN HIGHWAY	THURSDAY	16-10-86	0600	1000
1120	WESTERN HIGHWAY	SATURDAY	15-11-86	0600	1000
1120	WESTERN HIGHWAY	TUESDAY	18-11-86	2400	0400
1120	WESTERN HIGHWAY	THURSDAY	20-11-86	0600	1000
1130	PRINCES HIGHWAY EAST	TUESDAY	14-10-86	0600	1000
[illegible]0	PRINCES HIGHWAY EAST	THURSDAY	16-10-86	1800	2200
1130	PRINCES HIGHWAY EAST	SATURDAY	15-11-86	2400	0400
1130	PRINCES HIGHWAY EAST	TUESDAY	18-11-86	0600	1000
1130	PRINCES HIGHWAY EAST	THURSDAY	20-11-86	1800	2200
1140	PRINCES HIGHWAY WEST	TUESDAY	21-11-86	1800	2200
1140	PRINCES HIGHWAY WEST	SATURDAY	25-10-86	2400	0400
1140	PRINCES HIGHWAY WEST	SATURDAY	01-11-86	2400	0400
1140	PRINCES HIGHWAY WEST	TUESDAY	25-11-86	1800	2200
1150	WESTERN HIGHWAY	TUESDAY	21-10-86	1800	2200
1150	WESTERN HIGHWAY	THURSDAY	30-10-86	2400	0400
1150	WESTERN HIGHWAY	FRIDAY	14-11-86	2400	0400
1150	WESTERN HIGHWAY	SATURDAY	15-11-86	0600	1000
1150	WESTERN HIGHWAY	TUESDAY	25-11-86	1800	2200
1150	WESTERN HIGHWAY	THURSDAY	27-11-86	2400	0400
1160	HUME HIGHWAY	SATURDAY	08-11-86	2400	0500
1160	HUME HIGHWAY	SATURDAY	08-11-86	0500	1000
1160	HUME HIGHWAY	WEDNESDAY	12-11-86	2400	0400
1160	HUME HIGHWAY	THURSDAY	13-11-86	1800	2200
1160	HUME HIGHWAY	SATURDAY	29-11-86	0500	1000
1160	HUME HIGHWAY	TUESDAY	02-12-86	2400	0400
1170	MELBA HIGHWAY	SATURDAY	25-10-86	0001	0400
1170	MELBA HIGHWAY	TUESDAY	11-11-86	0600	1000
1170	MELBA HIGHWAY	THURSDAY	13-11-86	1800	2200
1170	MELBA HIGHWAY	TUESDAY	25-11-86	0600	1000
1170	MELBA HIGHWAY	THURSDAY	27-11-86	1800	2200
[illegible]0	BENALLA-TOCUMWAL ROAD	SATURDAY	08-11-86	2400	0400
[illegible]0	BENALLA-TOCUMWAL ROAD	TUESDAY	11-11-86	1800	2200
1180	BENALLA-TOCUMWAL ROAD	SATURDAY	29-11-86	2400	0400
1180	BENALLA-TOCUMWAL ROAD	TUESDAY	02-12-86	1800	2200

BEFORE TRUCK SPEED STUDY - TEMPORAL ATTRIBUTES

LOCN	ROAD NAME	DAY	DATE	START	FINISH
1190	SOUTH GIPPSLAND HIGHWAY	SATURDAY	22-11-86	1800	2200
1190	SOUTH GIPPSLAND HIGHWAY	TUESDAY	25-11-86	0600	1000
1190	SOUTH GIPPSLAND HIGHWAY	THURSDAY	27-11-86	2400	0400
1205	PACIFIC HIGHWAY	SATURDAY	06-12-86	0745	1145
1210	PACIFIC HIGHWAY	TUESDAY	09-12-86	0100	0500
1215	PACIFIC HIGHWAY	WEDNESDAY	03-12-86	1200	1600
1220	PACIFIC HIGHWAY	SATURDAY	06-12-86	2400	0400
1225	MT LINDSAY HIGHWAY	MONDAY	08-12-86	1930	2330
1230	BRUCE HIGHWAY	TUESDAY	28-10-86	1800	2200
1235	BRUCE HIGHWAY	FRIDAY	31-10-86	0045	0445
1240	BRUCE HIGHWAY	SATURDAY	01-11-86	1800	2200
1245	BRUCE HIGHWAY	TUESDAY	04-11-86	1115	1515
1250	BRUCE HIGHWAY	WEDNESDAY	05-11-86	1100	1500
1300	GREAT EASTERN HIGHWAY	MONDAY/TUESDAY	13-10-86	1300	1300
1301	EYRE HIGHWAY	WEDNESDAY/THURSDAY	15-10-86	1000	1000
1302	HASSELL HIGHWAY	THURSDAY/FRIDAY	16-10-86	1600	1600
1303	ALBANY HIGHWAY	SATURDAY/SUNDAY	18-10-86	1230	1230
1304	BRAND HIGHWAY	TUESDAY/WEDNESDAY	21-10-86	0955	0955
1305	GREAT NORTHER HIGHWAY	SUNDAY/MONDAY	26-10-86	1400	1400
1306	NORTH WEST COASTAL	FRIDAY/SATURDAY	24-10-86	1100	1100
1400	STURT HIGHWAY	THURSDAY	16-10-86	0200	0600
1401	PORTH WAKEFIELD ROAD	THURSDAY	16-10-86	1800	2200
1402	PORTH WAKEFIELD ROAD	SATURDAY	18-10-86	0200	0600
1403	SOUTH EAST HIGHWAY	SATURDAY	18-10-86	1900	2300
1404	SOUTH EAST HIGHWAY	TUESDAY	28-10-86	0200	0600
5	STURT HIGHWAY	TUESDAY	28-10-86	1800	2200
1406	SOUTH EAST HIGHWAY	THURSDAY	30-10-86	1200	1600
1407	STURT HIGHWAY	SATURDAY	01-11-86	0800	1200
1408	PORT WAKEFIELD	TUESDAY	04-11-86	1400	1800
1501	MIDLANDS HIGHWAY	TUESDAY	28-10-86	1400	1800
1501	MIDLANDS HIGHWAY	SATURDAY	01-11-86	1800	2200
1503	BASS HIGHWAY	THURSDAY	23-10-86	1225	1625
1503	BASS HIGHWAY	TUESDAY	28-10-86	1800	2200
1503	BASS HIGHWAY	THURSDAY	06-11-86	1000	1400
1601	MAJURA RD	TUESDAY	28-10-86	0700	1100
1601	MAJURA ROAD	TUESDAY	11-11-86	1800	2200
1601	MAJURA ROAD	THURSDAY	13-12-86	1400	1800
1602	BARTON HIGHWAY	THURSDAY	30-09-86	1400	1800
1602	BARTON HIGHWAY	SATURDAY	01-11-86	0700	1055
1602	BARTON HIGHWAY	TUESDAY	28-10-86	1810	2210

NUMBER OF RECORDS is 94

Table A2: BEFORE TRUCK SPEED STUDY - SITE DESCRIPTION

LOCN	DATE	LOCATION	ROAD NAME	ROAD TYPE
1001	25-10-86	TAMWORTH NSW	NEW ENGLAND HIGHWAY	HIGHWAY
1002	27-10-86	BERRIMA NSW	HUME HIGHWAY	HIGHWAY
1002	27-10-86	BERRIMA NSW	HUME HIGHWAY	HIGHWAY
1003	01-11-86	MT WHITE NSW	NEWCASTLE EX	FREEWAY
1003	01-11-86	MT WHITE NSW	NEWCASTLE EXPRESSWAY	FREEWAY
1004	03-11-86	GUNDAGAI NSW	HUME HIGHWAY	HIGHWAY
1005	04-11-86	GUNDAGAI NSW	HUME HIGHWAY	HIGHWAY
1006	07-11-86	FORBES NSW	NEWELL HIGHWAY	HIGHWAY
1007	08-11-86	FORBES NSW	NEWELL HIGHWAY	HIGHWAY
1008	11-11-86	MENANGLE NSW	F5-SOUTH WESTERN FREEWAY	FREEWAY
1009	12-11-86	MENANGLE NSW	F5-SOUTH WESTERN FREEWAY	FREEWAY
1010	15-11-86	BERRIMA NSW	HUME HIGHWAY	HIGHWAY
1011	25-11-86	GOULBURN NSW	HUME HIGHWAY	HIGHWAY
1012	18-11-86	SINGLETON NSW	NEW ENGLAND HIGHWAY	HIGHWAY
1110	14-10-86	KILMORE VIC	HUME HIGHWAY	FREEWAY
1110	16-10-86	KILMORE VIC	HUME HIGHWAY	FREEWAY
1110	18-11-86	KILMORE VIC	HUME HIGHWAY	FREEWAY
1110	20-11-86	KILMORE VIC	HUME HIGHWAY	FREEWAY
1110	22-11-86	KILMORE VIC	HUME HIGHWAY	FREEWAY
1120	14-10-86	BALLAN VIC	WESTERN HIGHWAY	FREEWAY
1120	16-10-86	BALLAN VIC	WESTERN HIGHWAY	FREEWAY
1120	15-11-86	BALLAN VIC	WESTERN HIGHWAY	FREEWAY
1120	18-11-86	BALLAN VIC	WESTERN HIGHWAY	FREEWAY
1120	20-11-86	BALLAN VIC	WESTERN HIGHWAY	FREEWAY
1130	14-10-86	HEARNES OAK VIC	PRINCES HIGHWAY EAST	FREEWAY
0	16-10-86	HEARNES OAK VIC	PRINCES HIGHWAY EAST	FREEWAY
1130	15-11-86	HEARNES OAK VIC	PRINCES HIGHWAY EAST	FREEWAY
1130	18-11-86	HEARNES OAK VIC	PRINCES HIGHWAY EAST	FREEWAY
1130	20-11-86	HEARNES OAK VIC	PRINCES HIGHWAY EAST	FREEWAY
1140	21-11-86	LARA VIC	PRINCES HIGHWAY WEST	FREEWAY
1140	25-10-86	LARA VIC	PRINCES HIGHWAY WEST	FREEWAY
1140	01-11-86	LARA VIC	PRINCES HIGHWAY WEST	FREEWAY
1140	25-11-86	LARA VIC	PRINCES HIGHWAY WEST	FREEWAY
1150	21-10-86	BEAUFORT VIC	WESTERN HIGHWAY	2 LANE UNDIVIDED
1150	30-10-86	BEAUFORT VIC	WESTERN HIGHWAY	2 LANE UNDIVIDED
1150	14-11-86	BEAUFORT VIC	WESTERN HIGHWAY	2 LANE UNDIVIDED
1150	15-11-86	BEAUFORT VIC	WESTERN HIGHWAY	2 LANE UNDIVIDED
1150	25-11-86	BEAUFORT VIC	WESTERN HIGHWAY	2 LANE UNDIVIDED
1150	27-11-86	BEAUFORT VIC	WESTERN HIGHWAY	2 LANE UNDIVIDED
1160	08-11-86	BALMATTUM VIC	HUME HIGHWAY	2 LANE UNDIVIDED
1160	08-11-86	BALMATTUM VIC	HUME HIGHWAY	2 LANE UNDIVIDED
1160	12-11-86	BALMATTUM VIC	HUME HIGHWAY	2 LANE UNDIVIDED
1160	13-11-86	BALMATTUM VIC	HUME HIGHWAY	2 LANE UNDIVIDED
1160	29-11-86	BALMATTUM VIC	HUME HIGHWAY	2 LANE UNDIVIDED
1160	02-12-86	BALMATTUM VIC	HUME HIGHWAY	2 LANE UNDIVIDED
1170	25-10-86	GLENBURN VIC	MELBA HIGHWAY	2 LANE UNDIVIDED
1170	11-11-86	GLENBURN VIC	MELBA HIGHWAY	2 LANE UNDIVIDED
1170	13-11-86	GLENBURN VIC	MELBA HIGHWAY	2 LANE UNDIVIDED
1170	25-11-86	GLENBURN VIC	MELBA HIGHWAY	2 LANE UNDIVIDED
1170	27-11-86	GLENBURN VIC	MELBA HIGHWAY	2 LANE UNDIVIDED
[illegible]	08-11-86	MUCKATAH	BENALLA-TOCUMWAL ROAD	2 LANE UNDIVIDED
[illegible]	11-11-86	MUCKATAH	BENALLA-TOCUMWAL ROAD	2 LANE UNDIVIDED
1180	29-11-86	MUCKATAH VIC	BENALLA-TOCUMWAL ROAD	2 LANE UNDIVIDED
1180	02-12-86	MUCKATAH VIC	BENALLA-TOCUMWAL ROAD	2 LANE UNDIVIDED

BEFORE TRUCK SPEED STUDY - SITE DESCRIPTION

LOCN	DATE	LOCATION	ROAD NAME	ROAD TYPE
1190	22-11-86	LANG LANG VIC	SOUTH GIPPSLAND HIGHWAY	4 LANE DIVIDED
1190	25-11-86	LANG LANG VIC	SOUTH GIPPSLAND HIGHWAY	4 LANE DIVIDED
1190	27-11-86	LANG LANG VIC	SOUTH GIPPSLAND HIGHWAY	4 LANE DIVIDED
1205	06-12-86	CADES COUNTRY	PACIFIC HIGHWAY	FREEWAY
1210	09-12-86	SHAILER PARK	PACIFIC HIGHWAY	4 LAND DIVIDED
1215	03-12-86	PIMPAMA RIVER	PACIFIC HIGHWAY	4 LANE DIVIDED
1220	06-12-86	SOUTH OF TALLEBUDGERRACK	PACIFIC HIGHWAY	2 LANE DIVIDED
1225	08-12-86	NORTH OF LOGAN RIVER	MT LINDSAY HIGHWAY	2 LANE DIVIDED
1230	28-10-86	QUEENSLAND	BRUCE HIGHWAY	FREEWAY
1235	31-10-86	QUEENSLAND	BRUCE HIGHWAY	FREEWAY
1240	01-11-86	QUEENSLAND	BRUCE HIGHWAY	4 LANE
1245	04-11-86	QUEENSLAND	BRUCE HIGHWAY	2 LANE
1250	05-11-86	QUEENSLAND	BRUCE HIGHWAY	2 LANE
1300	13-10-86	WESTERN AUSTRALIA	GREAT EASTERN HIGHWAY	HIGHWAY
1301	15-10-86	BALLADONIA W.A.	EYRE HIGHWAY	HIGHWAY
1302	16-10-86	RAVENSTHORPE W.A.	HASSELL HIGHWAY	HIGHWAY
1303	18-10-86	BEAUFORT W.A.	ALBANY HIGHWAY	HIGHWAY
1304	21-10-86	SOUTH DONGARA W.A.	BRAND HIGHWAY	HIGHWAY
1305	26-10-86	MEEKATHANA W.A.	GREAT NORTHER HIGHWAY	HIGHWAY
1306	24-10-86	PORT HEDLAND W.A.	NORTH WEST COASTAL	HIGHWAY
1400	16-10-86	SOUTH AUSTRALIA	STURT HIGHWAY	2 LANE UNDIVIDED
1401	16-10-86	TWO WELLS SOUTH AUSTRALIA	PORTH WAKEFIELD ROAD	4 LANE DIVIDED
1402	18-10-86	TWO WELLS SOUTH AUSTRALIA	PORTH WAKEFIELD ROAD	4 LANE DIVIDED
1403	18-10-86	CALLINGTON SOUTH AUSTRALIA	SOUTH EAST HIGHWAY	FREEWAY
1404	28-10-86	CALLINGTON SOUTH AUSTRALIA	SOUTH EAST HIGHWAY	FREEWAY
5	28-10-86	NURIOOTPA, SOUTH AUSTRALIA	STURT HIGHWAY	2 LANE UNDIVIDED
1406	30-10-86	CALLINGTON, SOUTH AUSTRALIA	SOUTH EAST HIGHWAY	FREEWAY
1407	01-11-86	NURIOOTPA, SOUTH AUSTRALIA	STURT HIGHWAY	2 LANE UNDIVIDED
1408	04-11-86	TWO WELLS, SOUTH AUSTRALIA	PORT WAKEFIELD	4 LANE DIVIDED
1501	28-10-86	MANGALORE TAS.	MIDLANDS HIGHWAY	HIGHWAY
1501	01-11-86	MANGALORE TAS.	MIDLANDS HIGHWAY	HIGHWAY
1503	23-10-86	TAS	BASS HIGHWAY	HIGHWAY
1503	28-10-86	TAS	BASS HIGHWAY	HIGHWAY
1503	06-11-86	TAS	BASS HIGHWAY	HIGHWAY
1601	28-10-86	ACT	MAJURA RD	MAIN ROAD
1601	11-11-86	ACT	MAJURA ROAD	MAIN ROAD
1601	13-12-86	ACT	MAJURA ROAD	MAIN ROAD
1602	30-09-86	ACT	BARTON HIGHWAY	DIVIDED
1602	01-11-86	ACT	BARTON HIGHWAY	DIVIDED
1602	28-10-86	ACT	BARTON HIGHWAY	DIVIDED

NUMBER OF RECORDS is 94

Table A3: BEFORE TRUCK SPEED STUDY - SITE CHARACTERISTICS

LOCN	SPEED METER	SPEED LIMIT	LAND USE	WEATHER	VISIBILITY
1001	KR11 AMPHOMETER 15M SP.	100	FARMING	FINE	DARK
1002	KR11 AMPHOMETER	100	GRAZING	FINE, OVERCAST	CLEAR
1002	KR11 AMPHOMETER 15M SP.	100	GRAZING	FINE, OVERCAST	CLEAR
1003	KR11 AMPHOMETER 15M SP.	110	BUSHLAND	FINE, SUNNY	CLEAR
1003	KR11 AMPHOMETER	110	BUSHLAND	FINE	CLEAR
1004	KR11 AMPHOMETER	100	GRAZING	FINE/DUSK/2000 DARK	CLEAR
1005	KR11 AMPHOMETER	100	GRAZING/FARMING	FINE/SUNNY	CLEAR
1006	KR11 AMPHOMETER 15M SP.	100	FARMING	FINE	CLEAR
1007	KR11 AMPHOMETER 15M SP.	100	FARMING	FINE	CLEAR
1008	KR11 AMPHOMETER	110	GRAZING	OVERCAST	CLEAR
1009	KR11 AMPHOMETER 15M SP.	110	GRAZING	OVERCAST	CLEAR
1010	KR11 AMPHOMETER 15M SP.	100	GRAZING	OVERCAST	CLEAR
1011	KR11 AMPHOMETER 15M SP.	100	GRAZING	FINE, OVERCAST	CLEAR
1012	KR11 AMPHOMETER 15M SP.	100	FARMLAND	FINE, WINDY	CLEAR
1110	SPEED GUN SIX (RADAR)	100	AGRICULTURAL	INTERMITTENT SHOWER	GOOD
1110	SPEED GUN SIX (RADAR)	100	AGRICULTURAL	FINE	GOOD
1110	SPEED GUN SIX (RADAR)	100	RURAL	OVERCAST	GOOD
1110		100	RURAL	LIGHT RAIN, OVERCAS	
1110	FALCON	100	AGRICULTURAL	FINE/FOGGY	200M/GOOD
1120	SPEED GUN 8	100	RURAL	FAIN WINDY	VERY POOR
1120	SPEED GUN 8	100	RURAL FARMING	FINE	GOOD
1120	SPEEDGUN 6	100	RURAL	OVERCAST	GOOD
1120	SPEEDGUN 6	100	RURAL	RAIN/HAIL/SLEET	APPROX. 500
1120	SPEEDGUN 6	100	RURAL	OVERCAST, MISTY RAI	GOOD
1130	SPEEDGUN 6	100	FARM/RURAL	OVERCAST, RAINING	FAIR
0	SPEEDGUN 6	100	FARM/RURAL	FINE OVERCAST	GOOD
1130	KUSTUM	100	RURAL	GOOD	GOOD
1130	SPEEDGUN 8	100	FARMING	RAIN/OVERCAST	GOOD
1130	SPEEDGUN 8	100	FARMING	FINE	GOOD
1140	SPEEDGUN 6	100	RURAL FARMING	FINE & OVERCAST	GOOD
1140	SPEEDGUN 6 (RADAR)	100	AGRICULTURAL	FINE	GOOD
1140	SPEEDGUN 8	100	AGRICULTURAL	OVERCAST	GOOD
1140	SPEEDGUN 8	100	FARMING	FINE (HOT)	GOOD
1150		100	RURAL FARMING	OVERCAST	GOOD
1150	SPEEDGUN 8	100	AGRICULTURAL	RAIN	GOOD
1150	SPEEDGUN 8	100	FARMING	FINE	GOOD
1150	SPEEDGUN 8	100	FARMING	GOOD	GOOD
1150	FALCON	100	AGRICULTURAL	FINE	GOOD
1150	FALCON	100	AGRICULTURAL	FINE/COLD	GOOD
1160	SPEEDGUN 8	100	FARMING	FINE	GOOD
1160	SPEEDGUN 6	100	FARMING	FINE/MILD/SUNNY	EXCELLENT
1160	SPEEDGUN 8	100	FARMING	GOOD	GOOD
1160	SPEEDGUN/FALCON	100	AGRICULTURAL	FINE	GOOD
1160	RADAR	100	FARM, RURAL	FINE	GOOD
1160	FALCON	100	FARM	FINE	GOOD
1170	SPEEDGUN	100	RURAL	LIGHT RAIN/LITTLE F	FAIR
1170	SPEEDGUN 6	100	RURAL	OVERCAST, LIGHT RAI	GOOD
1170	SPEEDGUN 6	100	RURAL	FINE & MILD	GOOD
1170	SPEEDGUN 8	100	FARM/RURAL	FINE	POOR UNTIL
1170	SPEEDGUN 8	100	FARM	FINE	POOR UNTIL
[illegible]0	SPEEDGUN	100	FARM/GRAZING	FINE	POOR UNTIL
[illegible]60	SPEEDGUN	100			GOOD
1180	SPEEDGUN 6	100	AGRICULTURAL	GOOD	VERY GOOD
1180	SPEEDGUN 8	100	AGRICULTURAL		

BEFORE TRUCK SPEED STUDY - SITE CHARACTERISTICS

LOCN	SPEED METER	SPEED LIMIT	LAND USE	WEATHER	VISIBILITY
1190	SPEEDGUN 6	100	FARM	FINE	GOOD
1190	SPEEDGUN 6	100	FARM	FOG/FINE	FOG UNTIL 8
1190	SPEEDGUN 6	100	FARM	FINE	CLEAR
1205	RADAR SPEED GUN	100	FOREST	FINE	GOOD
1210	RADAR SPEED GUN	100	RESIDENTIAL	FINE	GOOD
1215	RADAR SPEED GUN	100	RURAL	FINE	GOOD
1220	RADAR SPEED GUN	100	RESIDENTIAL	CLOUDY WITH SHOWERS	POOR
1225	RADAR SPEED GUN	100	RURAL	FINE	FAIR
1230	RADAR SPEED GUN	100	RURAL	FINE	GOOD
1235	RADAR SPEED GUN	100	PINE FOREST	FINE	GOOD
1240	RADAR SPEED GUN	100	SMALL FARMS	FINE	GOOD
1245	RADAR SPEED GUN	100	RURAL	FINE	GOOD
1250	RADAR SPEED GUN	100	FOREST	FINE	GOOD
1300	KR11 - DIGITECTOR	110	SCRUB	FINE	CLEAR
1301	KR11 - DIGITECTOR	110	SCRUB	FINE	CLEAR
1302	KR-11 - DIGITECTOR	110	RURAL	HEAVY RAINS DAY & N	GOOD
1303	DIGITECTOR	110	RURAL/GRAZING	RAIN THEN OVERCAST	GOOD
1304	DIGITECTOR	110	VIRGIN SCRUB	FINE	GOOD
1305	DIGITECTOR	110	STATION GRAZING	GOOD	CLEAR
1306	DIGITECTOR	110	GRAZING	FINE	CLEAR
1400	SPEEDGUN	110	FARMING	CLEAR	CLEAR
1401	SPEEDGUN	110	FARMING	CLEAR	CLEAR
1402	SPEEDGUN	110	FARMING	CLEAR	CLEAR
1403	SPEEDGUN	110	GRAZING	SHOWERS	CLEAR
1404	SPEEDGUN	110	GRAZING	CLEAR	GOOD
.5	SPEEDGUN	110	FARMING	CLEAR	GOOD
1406	SPEEDGUN	110	GRAZING	FINE	GOOD
1407	SPEEDGUN	110	FARMING	FINE	GOOD
1408	SPEEDGUN	110	FARMING	FINE	GOOD
1501	FALCON SPEED GUN	110	GRAZING	FINE/CLEAR	GOOD
1501	FALCON SPEED GUN	110	GRAZING	FINE	GOOD
1503	STARFLITE RADAR GUN		FARMING	FINE, 1515 LT SHOWE	GOOD
1503	RADAR GUN		FARMING	FINE	CLEAR
1503	RADAR GUN		FARMING	FINE, SCATTERED CLO	CLEAR
1601	RADAR SPEED GUN	100	GRAZING	FINE/CLOUDY	CLEAR
1601	RADAR SPEED GUN	100	GRAZING		
1601	RADAR SPEED GUN	100	GRAZING		
1602	RADAR SPEED GUN	100	RURAL(E) RES(N) NO ACCESS	LIGHT OVERCAST	GOOD
1602	RADAR SPEED GUN	100	RURAL	FINE	CLEAR
1602	RADAR SPEED GUN	100	RURAL/URBAN	OVERCAST FINE	CLEAR

NUMBER OF RECORDS is 94

Table A4:

FIRST AFTER TRUCK SPEED STUDY - TEMPORAL ATTRIBUTES

LOC.	ROAD NAME	DAY	DATE	START	FINISH
2001	New England Hwy	Saturday	28/03/87	0145	0545
2002	Hume Hwy	Monday	30/03/87	1100	1540
2003	Newcastle Expressway	Saturday	28/03/87	1015	1430
2004	Hume Hwy	Monday	30/03/87	1800	2200
2005	Hume	Tuesday	31/03/87	1345	1745
2006	Newell Hwy	Friday	03/04/87	1830	2230
2007	Newell Hwy	Saturday	04/04/87	0100	0500
2008	F5-South Western Freeway	Monday	06/04/87	1930	2400
2009	F5-South Western Freeway	Tuesday	07/04/87	0000	0400
2010	Hume Highway	Saturday	04/04/87	1930	2400
2011	Hume Hwy	Tuesday	31/03/87	2400	0415
2012	New England Hwy	Tuesday	07/04/87	1030	1430
2110	Hume Highway	Saturday	14/03/87	0600	1000
2110	Hume Highway	Tuesday	17/03/87	1800	2230
2110	Hume Highway	Thursday	19/03/87	0000	0400
2120	Western Highway	Thursday	19/03/87	0600	1000
2120	Western Highway	Saturday	04/04/87	1800	2200
2120	Western Highway	Tuesday	17/03/87	0000	0400
2130	Princes Highway East	Tuesday	17/03/87	0600	1000
2130	Princes Highway East	Thursday	19/03/87	1800	2200
2130	Princes Highway East	Saturday	04/04/87	0000	0400
2140	Princes Highway West	Tuesday	31/03/87	1800	2200
2150	Western Highway	Saturday	28/03/87	0600	1000
21[illegible]	Western Highway	Tuesday	31/03/87	1800	2200
2150	Western Highway	Thursday	02/04/87	0000	0400
2160	Hume Highway	Saturday	28/03/87	0000	0500
2160	Hume Highway	Saturday	28/03/87	0500	1000
2160	Hume Highway	Tuesday	31/03/87	0000	0400
2160	Hume Highway	Thursday	02/04/87	1800	2200
2170	Melba Highway	Tuesday	24/03/87	0600	1000
2170	Melba Highway	Thursday	26/03/87	1800	2200
2180	Benalla - Tocumwal Rd	Saturday	21/03/87	0000	0400
2180	Benalla - Tocumwal Rd	Tuesday	24/03/87	1800	2200
2190	Sth Gippsland Highway	Tuesday	24/03/87	0600	1000
2190	Sth Gippsland Highway	Saturday	21/03/87	1800	2200
2190	Sth Gippsland Highway	Thursday	26/03/87	0000	0400
2205	Pacific Hwy	Saturday	21/03/87	0745	1145
2210	Pacific Hwy	Tuesday	24/03/87	0100	0500
2215	Pacific Hwy	Wednesday	01/04/87	1200	1600
2220	Pacific Highway	Saturday	04/04/87	0000	0400
2225	Mt Lindesay Hwy	Monday	27/04/87	1930	2330
2230	Bruce Highway	Tuesday	31/03/87	1800	2200
2235	Bruce Highway	Friday	03/04/87	0015	0415
2240	Bruce Highway	Saturday	08/04/87	1800	2200
2245	Bruce Highway	Tuesday	31/03/87	1045	1445
2250	Bruce Highway	Wednesday	08/04/87	1100	1500
2300	Great Eastern Highway	Monday	30/03/87	1200	1200
2301	Eyre Highway	Wednesday	01/04/87	0700	0700
23[illegible]	Hassell Highway	Thursday	02/04/87	1400	1400
23[illegible]	Albany Highway	Saturday	04/04/87	1000	1000
2304	Brand Highway	Monday	06/04/87	1030	1030
2305	North West Coastal Highway	Thursday	09/04/87	0800	0800

FIRST AFTER TRUCK SPEED STUDY - TEMPORAL ATTRIBUTES

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LOC.	ROAD NAME	DAY	DATE	START	FINISH
2306	Great Northern Highway	Saturday	11/04/87	0900	0900
2400	Sturt Highway	Thursday	26/03/87	0200	0600
2401	Port Wakefield Road	Thursday	26/03/87	1800	2200
2402	Port Wakefield Road	Saturday	28/03/87	0200	0600
2403	SouthEast Highway	Saturday	28/03/87	1900	2300
2404	SouthEast Highway	Tuesday	31/03/87	0200	0600
2405	Sturt Highway	Tuesday	31/03/87	1800	2200
2406	SouthEast Highway	Thursday	02/04/87	1200	1600
2407	Sturt Highway	Saturday	04/04/87	0800	1200
2408	Port Wakefield Road	Tuesday	07/04/87	1400	1800
2501	Midlands Highway	Tuesday	31/03/87	1400	1800
2501	Midlands Highway	Saturday	11/04/87	1800	2200
2503	Bass Highway	Thursday	02/04/87	1031	1431
2503	Bass Highway	Tuesday	31/03/87	1800	2200
2601	Majura Road	Tuesday	24/03/87	1400	1800
2601	Majura Road	Thursday	02/04/87	1800	2200
2601	Majura Road	Saturday	28/03/87	0700	1100
2602	Barton Hwy	Tuesday	31/03/87	1800	2200
2602	Barton Hwy	Thursday	26/03/87	1400	1800
2602	Barton Hwy	Tuesday	24/03/87	0700	1100

NUMBER OF RECORDS is 72

Table A5: FIRST AFTER TRUCK SPEED STUDY - SITE DESCRIPTION

LOCN	DATE	LOCATION	ROAD NAME	ROAD TYPE
2001	28/03/87	Tamworth	New England Hwy	Highway
2002	30/03/87	Berrima	Hume Hwy	Highway
2003	28/03/87	Mt White	Newcastle Expressway	Expressway
2004	30/03/87	Gundagai	Hume Hwy	Hwy
2005	31/03/87	Gundagai	Hume	Hwy
2006	03/04/87	Forbes	Newell Hwy	Highway
2007	04/04/87	Forbes	Newell Hwy	Highway
2008	06/04/87	Menangle	F5-South Western Freeway	Freeway
2009	07/04/87	Menangle	F5-South Western Freeway	Freeway
2010	04/04/87	Berrima	Hume Highway	Highway
2011	31/03/87	Goulburn	Hume Hwy	Highway
2012	07/04/87	Singleton	New England Hwy	Highway
2110	14/03/87	VIC	Hume Highway	Highway
2110	17/03/87	VIC Kilmore	Hume Highway	Freeway
2110	19/03/87	VIC Kilmore	Hume Highway	Freeway
2120	19/03/87	VIC Ballan	Western Highway	Freeway
2120	04/04/87	VIC Ballan	Western Highway	Freeway
2120	17/03/87	VIC Ballan	Western Highway	Freeway
2130	17/03/87	VIC Hearnes Oak	Princes Highway East	Freeway
2130	19/03/87	VIC Hearnes Oak	Princes Highway East	Freeway
2130	04/04/87	VIC Hearnes Oak	Princes Highway East	Freeway
2140	31/03/87	VIC Lara	Princes Highway West	Freeway
2150	28/03/87	VIC Beaufort	Western Highway	2 Lane Undivi
2150	31/03/87	VIC Beaufort	Western Highway	2 Lane Undivi
2150	02/04/87	VIC Beaufort	Western Highway	2 Lane Undivi
[illegible]0	28/03/87	VIC Balmattum	Hume Highway	2 Lane Undivi
2160	28/03/87	VIC Balmattum	Hume Highway	2 Lane Undivi
2160	31/03/87	VIC Balmattum	Hume Highway	2 Lane Undivi
2160	02/04/87	VIC Balmattum	Hume Highway	2 Lane Undivi
2170	24/03/87	VIC Glenburn	Melba Highway	2 Lane Undivi
2170	26/03/87	VIC Glenburn	Melba Highway	2 Lane Undivi
2180	21/03/87	VIC Muckatah	Benalla - Tocumwal Rd	2 Lane Undivi
2180	24/03/87	VIC Muckatah	Benalla - Tocumwal Rd	2 Lane Undivi
2190	24/03/87	VIC Lang-Lang	Sth Gippsland Highway	2 Lane Divide
2190	21/03/87	VIC Lang-Lang	Sth Gippsland Highway	2 Lane Divide
2190	26/03/87	VIC Lang-Lang	Sth Gippsland Highway	2 Lane Divide
2205	21/03/87	QLD Cades County	Pacific Hwy	Freeway
2210	24/03/87	QLD Shailer Park	Pacific Hwy	Highway
2215	01/04/87	QLD Pimpama River	Pacific Hwy	Highway
2220	04/04/87	QLD	Pacific Highway	Highway
2225	27/04/87	QLD	Mt Lindesay Hwy	Highway
2230	31/03/87	QLD	Bruce Highway	Freeway
2235	03/04/87	QLD	Bruce Highway	Freeway
2240	08/04/87	QLD	Bruce Highway	4 Lane
2245	31/03/87	QLD	Bruce Highway	2 Lane
2250	08/04/87	QLD	Bruce Highway	2 Lane
2300	30/03/87	WA	Great Eastern Highway	2 Lane Undivi
2301	01/04/87	WA Balladonia	Eyre Highway	2 Lane Undivi
2302	02/04/87	WA Ravensthorpe	Hassell Highway	2 Lane Undivi
2303	04/04/87	WA Beaufort	Albany Highway	2 Lane Undivi
[illegible]4	06/04/87	WA South Dongara	Brand Highway	2 Lane Undivi
[illegible]5	09/04/87	WA Port Hedland	North West Coastal Highway	2 Lane Undivi
2306	11/04/87	WA Meekatharra	Great Northern Highway	2 Lane Undivi
2400	26/03/87	SA Nuriootpa	Sturt Highway	Highway

FIRST AFTER TRUCK SPEED STUDY - SITE DESCRIPTION

LOCN	DATE	LOCATION	ROAD NAME	ROAD TYPE
2401	26/03/87	SA Two Wells	Port Wakefield Road	Highway
2402	28/03/87	SA Two Wells	Port Wakefield Road	Highway
2403	28/03/87	SA Callington	SouthEast Highway	Highway
2404	31/03/87	SA Callington	SouthEast Highway	Highway
2405	31/03/87	SA Nuriootpa	Sturt Highway	Highway
2406	02/04/87	SA Callington	SouthEast Highway	Highway
2407	04/04/87	SA Nuriootpa	Sturt Highway	Highway
2408	07/04/87	Two wells, SA	Port Wakefield Road	Highway
2501	31/03/87	TAS Mangalore	Midlands Highway	Highway
2501	11/04/87	TAS Mangalore	Midlands Highway	Highway
2503	02/04/87	TAS	Bass Highway	Highway
2503	31/03/87	TAS	Bass Highway	Highway
2601	24/03/87	ACT	Majura Road	2 Lane Undivi
2601	02/04/87	ACT	Majura Road	2 Lane Undivi
2601	28/03/87	ACT	Majura Road	2 Lane Undivi
2602	31/03/87	Act	Barton Hwy	4 Lane Divide
2602	26/03/87	ACT	Barton Hwy	4 Lane Divide
2602	24/03/87	ACT	Barton Hwy	4 Lane Divide

NUMBER OF RECORDS is 72

Table A6: FIRST AFTER TRUCK SPEED STUDY - SITE CHARACTERISTICS

LOCN	SPEED METER	SPEED LIMIT	LAND USE	WEATHER	VISIBILITY
2001	KR11 Amphometer	100	Grazing	Fine	Clear
2002	KR11 Amphometer 15m spc	100	Grazing	Fine/Cloudy/V	Clear
2003	Amphometer(Multiphom5m)	110	Bush	Fine/Sunny	Clear
2004	Multiphom (5m spacing)	100	Grazing	Fine	Good
2005	Multiphom (5m spacing)	100	Grazing	Fine	Good
2006	KR11 Amphometer	100	Farmland	Fine	Good
2007	KR11 Amphometer(15m Spc	100	Farmland	Fine	Good
2008	KR11 Amphometer(15m Spc	110	Rural	Night/Misty	Misty/Fog
2009	KR11 Amphometer/15m Spc	110	Rural	Night/Fog	Fog
2010	Multiphom 5m Spacing	100	Grazing	Fine/Dark	Clear
2011	KR11 Amphometer 15m Spc	100	Grazing	Fine,cold	Clear
2012	KR11 Amphometer 15m Spc	100	Grazing	Fine,overcast	Clear
2110	Kustom Falcon,Speedgun6	100	Rural	Fine	Dark -) Fine and C
2110	Speedgun6	100	Agricultural	Fine	Fine and Clear
2110	Speedgun6	100	Farm	Fine	Good (Night)
2120	Speedgun6	100	Agricultural	Rain/Fog	Fair/poor
2120	Speedgun6	100	Farm	Fine	Good
2120	Speedgun6	100	Farm	Fine	Good (Night)
2130	Speedgun6	100	Rural	Fine	Good
2130	Speedgun6	100	Rural	Overcast	Good
2130	Speedgun8	100		Fine	Good
2140	Speedgun8	100	Rural	Fine	Good
2150	Speedgun8	100	Rural	Wet	Good
2150	Speedgun6	100	Rural	Overcast	Dark
2150	Speedgun6	100	Farm	Fog Patches	Variable
0	Speedgun6	100	Rural	Fine	Good
2160	Speedgun6	100	Rural	Overcast	Good
2160	Speedgun6	100	Rural/Farming	Fine	Good
2160	Speedgun8	100	Rural/Farming	Fine	Clear
2170	Speedgun6	100	Rural	Fine	Good
2170	Speedgun6	100		Fine	Light Mist
2180	SpeedGun6	100	Farm	Fine	Good
2180	SpeedGun6	100	Farm	Fine	Good
2190	SpeedGun6	100	Farm	Overcast	Good
2190	SpeedGun6	100	Farm	Overcast	Good Day/Night
2190	SpeedGun6	100	Farm	Foggy	Poor
2205	Radar Hand Gun	100	Rural	Fine	Good
2210	Radar Hand Gun	100	Residential No acces	Fine	Clear
2215	Radar Hand Gun	100	Rural	Cloudy	Clear
2220		100	Residential	Fine	Good (for night ti
2225	Radar Hand Gun	100	Rural	Showers	Poor
2230	Radar Speed Gun	100	Rural	Fine	Good
2235	Radar Speed Gun	100	Pine Forest	Fine	Good
2240	Radar Speed Gun	100	Small Farms	Fine	Good
2245	Radar Speed Gun	100	Rural	Fine	Good
2250	Radar Speed Gun	100	Forest	Fine	Good
2300	Digitector - Light Beam	110	Virgin Scrub	Fine	Clear
2301	Digitector - Light Beam	110	Virgin Scrub	'Hot' - Fine	Clear
2302	Digitector - Light Beam	110	Farms	Fine - Mild	Good
2303	Digitector - Light Beam	110	Rural - Grazing	Rain Periods,O	Good
[illegible]4	Digitector - Light Beam	110	Virgin Scrub	Mainly Fine -	Good
[illegible]5	Digitector - Light Beam	110	Grazing	Fine + Very Ho	Good
2306	Digitector - Light Beam	110	Grazing	Good	Clear
2400	Speed Gun	110	Farming	Clear	

FIRST AFTER TRUCK SPEED STUDY - SITE CHARACTERISTICS

N	SPEED METER	SPEED LIMIT	LAND USE	WEATHER	VISIBILITY
2401	Speed Gun	110	Farming	Clear	
2402	Speed Gun	110	Farming	Continuous Rai	Poor
2403	Speed Gun	110	Farming	Showers	Good
2404	Speed Gun	110	Farming	Light Showers	Good
2405	Speed Gun	110	Farming	Clear	Good
2406	Speed Gun	110	Farming	Fine	Good
2407	Speed Gun	110	Farming	Fine	Good
2408	Speedgun	110	Farming	Fine	Very good
2501	Falcon Speed Gun	110	Grazing	Overcast/Cloud	Good
2501	Falcon Speed Gun	110	Grazing	Fine	Good
2503	Radar Gun	110	Farming	Fine	Clear
2503	Radar Gun	110	Farming	Fine	Clear
2601	Radar Gun	100	Grazing	Fine	Good
2601	Radar Gun	100	Grazing	Fine	Clear
2601	Radar Gun	100	Grazing	Fine	Good
2602	Radar Gun	100	Rural(E) Residential		
2602	Radar Gun	100	Rural (E) Residentia		
2602	Radar Gun	100	Rural (E) Residentia		Good

NUMBER OF RECORDS is 72

Table A7:

SECOND AFTER TRUCK SPEED STUDY - TEMPORAL ATTRIBUTES

LO..	ROAD NAME	DAY	DATE	START	FINISH
3001	New England Hwy	Saturday	17/10/87	0200	0600
3002	Hume Highway	Monday	12/10/87	1145	1615
3003	Newcastle Freeway	Saturday	17/10/87	1130	1715
3004	Hume Highway	Monday	12/10/87	1800	2200
3005	Hume Highway	Tuesday	13/10/87	1400	1800
3006	Newell Highway	Friday	23/10/87	1830	2230
3007	Newell Highway	Saturday	24/10/87	0100	0500
3008	Hume Highway	Tuesday	27/10/87	1829	2400
3009	Hume Highway	Wednesday	28/10/87	2400	0430
3010	Hume Highway	Saturday	31/10/87	1930	2400
3011	Hume Highway	Tuesday	13/10/87	2400	0415
3012	New England Highway	Tuesday	27/10/87	1030	1450
3110	Hume Highway	Tuesday	29.9.87	1800	2330
3110	Hume Highway	Thursday	8.10.87	2400	0400
3110	Hume Highway	Saturday	10.10.87	0600	1000
3120	Western Highway	Tuesday	22.9.87	2400	0400
3120	Western Highway	Thursday	22.10.87	0600	1000
3120	Western Highway	Saturday	24.10.87	1800	2200
3130	Princes Highway East	Thursday	8.10.87	1800	2200
3130	Princes Highway East	Saturday	3.10.87	2400	0400
3140	Princes Highway	Tuesday	29.9.87	1800	2200
3150	Western Highway	Thursday	1.10.87	2400	0400
3150	Western Highway	Tuesday	29.9.87	1800	2200
31[illegible]	Western Highway	Saturday	3.10.87	0600	1000
3160	Hume Highway	Saturday	19.9.87	0600	1000
3160	Hume Highway	Tuesday	22.9.87	2400	0400
3160	Hume Highway	Thursday	17.9.87	1800	2200
3170	Melba Highway	Tuesday	22.9.87	0600	1000
3170	Melba Highway	Thursday	22.10.87	0600	1000
3180	Benalla - Tocumwal Road	Tuesday	22.9.87	1800	2200
3180	Benalla - Tocumwal Road	Saturday	3.10.87	2400	0400
3190	South Gippsland Highway	Saturday	10.10.87	1800	2200
3190	South Gippsland Highway	Thursday	1.10.87	2400	0400
3190	South Gippsland Highway	Tuesday	29.9.87	0600	1000
3205	Pacific Highway	Saturday	17.10.87	0745	1145
3210	Pacific Highway	Tuesday	20.10.87	0100	0500
3215	Pacific Highway	Wednesday	14.10.87	1200	1600
3220	Pacific Hwy	Saturday	24.10.87	0000	0400
3225	Lindsay Highway	Monday	12.10.87	1930	2330
3230	Bruce Highway	Tuesday	13.10.87	1800	2200
3235	Bruce Highway	Friday	16.10.87	0015	0415
3240	Bruce Highway	Saturday	17.10.87	1800	2200
3245	Bruce Highway	Tuesday	13.10.87	1115	1515
3250	Bruce Highway	Wednesday	14.10.87	1100	1500
3300	Great Eastern Highway	Monday/Tuesday	12.10.87	1300	1300
3301	Eyre Highway	Wednesday/Thursday	14.10.87	1000	1000
3302	South Coast Highway	Thursday/Friday	15.10.87	1600	1600
3303	Albany Highway	Saturday/Sunday	17.10.87	1230	1230
33[illegible]	Brand Highway	Tuesday/Wednesday	20.10.87	1000	1000
33[illegible]	North west Coastal	Friday/Saturday	23.10.87	1100	1100
3400	Sturt Highway	Thursday	15.10.87	0200	0600
3401	Port Wakefield Road	Thursday	15.10.87	1800	2200

SECOND AFTER TRUCK SPEED STUDY - TEMPORAL ATTRIBUTES

LOC.	ROAD NAME	DAY	DATE	START	FINISH
3402	Port Wakefield Road	Saturday	17.10.87	0200	0600
3403	Southeast Highway	Saturday	17.10.87	1900	2300
3404	South East Highway	Tuesday	20.10.87	0200	0600
3405	Sturt Highway	Tuesday	20.10.87	1800	2200
3406	South East Highway	Thursday	22.10.87	1200	1600
3407	Sturt Highway	Saturday	24.10.87	0800	1200
3408	Port Wakefield Road	Tuesday	13.10.87	1400	1800
3501	Midlands Highway	Saturday	17.10.87	1800	2200
3501	Midlands Highway	Thursday	15.10.87	1400	1800
3501	Midlands Highway	Tuesday	13.10.87	1400	1800
3503	Bass Highway	Saturday	17.10.87	1100	1500
3503	Bass Highway	Thursday	22.10.87	1100	1500
3503	Bass Highway	Tuesday	20.10.87	1800	2200
3601	Majura Road	Tuesday	13.10.87	1800	2200
3601	Majura Road	Thursday	15.10.87	0700	1100
3601	Majura Road	Saturday	24.10.87	1400	1730
3602	Barton Highway	Tuesday	13.10.87	0650	1050
3602	Barton Highway	Thursday	15.10.87	1750	2150
3602	Barton Highway	Saturday	17.10.87	1350	1730

NUMBER OF RECORDS is 71

Table A8:

SECOND AFTER TRUCK SPEED STUDY - SITE DESCRIPTION

LOC	DATE	LOCATION	ROAD NAME	ROAD TYPE
3001	17/10/87	Tamworth	New England Hwy	Highway
3002	12/10/87	Berrima	Hume Highway	4 Lane Divided
3003	17/10/87	Mt White	Newcastle Freeway	4 lane Freeway
3004	12/10/87	Gundagai	Hume Highway	Hwy
3005	13/10/87	Gundagai	Hume Highway	Hwy
3006	23/10/87	Forbes	Newell Highway	Highway
3007	24/10/87	Forbes	Newell Highway	Highway
3008	27/10/87	Menangle	Hume Highway	4 Lane Divided
3009	28/10/87	Menangle	Hume Highway	4 Lane Divided
3010	31/10/87	Berrima	Hume Highway	4 Lane Divided
3011	13/10/87	Goulburn	Hume Highway	4 lane divided
3012	27/10/87	Singleton	New England Highway	2 Lane
3110	29.9.87	Kilmore Victoria	Hume Highway	Freeway
3110	8.10.87	Kilmore Victoria	Hume Highway	Freeway
3110	10.10.87	Kilmore Victoria	Hume Highway	Freeway
3120	22.9.87	Ballan Victoria	Western Highway	Freeway
3120	22.10.87	Ballan Victoria	Western Highway	Freeway
3120	24.10.87	Ballan Victoria	Western Highway	Freeway
3130	8.10.87	Hearnes Oak Victoria	Princes Highway East	Freeway
3130	3.10.87	Hearnes Oak Victoria	Princes Highway East	Freeway
3140	29.9.87	Lara Victoria	Princes Highway	Freeway
3150	1.10.87	Beaufort Victoria	Western Highway	2 lane undivided
3150	29.9.87	Beaufort Victoria	Western Highway	2 lane undivided
31[illegible]	3.10.87	Beaufort Victoria	Western Highway	2 lane undivided
3160	19.9.87	Balmattum Victoria	Hume Highway	2 lane undivided
3160	22.9.87	Balmattum Victoria	Hume Highway	2 lane undivided
3160	17.9.87	Balmattum Victoria	Hume Highway	2 lane undivided
3170	22.9.87	Glenburn Victoria	Melba Highway	2 lane divided
3170	22.10.87	Glenburn Victoria	Melba Highway	2 lane undivided
3180	22.9.87	Muckatah Victoria	Benalla - Tocumwal Road	2 lane divided
3180	3.10.87	Muckatah Victoria	Benalla - Tocumwal Road	2 lane divided
3190	10.10.87	Lang Lang Victoria	South Gippsland Highway	2 lane divided
3190	1.10.87	Lang Lang Victoria	South Gippsland Highway	2 lane divided
3190	29.9.87	Lang Lang Victoria	South Gippsland Highway	2 lane divided
3205	17.10.87	Cades County Queensland	Pacific Highway	Freeway
3210	20.10.87	Shailer Park Queensland	Pacific Highway	Highway
3215	14.10.87	Pimpama River Queensland	Pacific Highway	Highway
3220	24.10.87	QLD	Pacific Hwy	Highway
3225	12.10.87	Queensland	Lindsay Highway	
3230	13.10.87	Caboolture Queensland	Bruce Highway	
3235	16.10.87	(Beerburrum dev) Queensland	Bruce Highway	
3240	17.10.87	Woombye Queensland	Bruce Highway	
3245	13.10.87	Queensland	Bruce Highway	
3250	14.10.87	Queensland	Bruce Highway	2 lane
3300	12.10.87	Western Australia	Great Eastern Highway	2 lane undivided
3301	14.10.87	Balladonia Western Australia	Eyre Highway	2 lane undivided
3302	15.10.87	Western Australia	South Coast Highway	2 lane undivided
3303	17.10.87	Beaufort Western Australia	Albany Highway	2 lane undivided
33[illegible]	20.10.87	Dongara Western Australia	Brand Highway	Highway
33[illegible]	23.10.87	Port Hedland Western Australia	North west Coastal	Highway
3400	15.10.87	Nuriootpa South Australia	Sturt Highway	Highway
3401	15.10.87	Two Well South Australia	Port Wakefield Road	Highway

SECOND AFTER TRUCK SPEED STUDY - SITE DESCRIPTION

LOC	DATE	LOCATION	ROAD NAME	ROAD TYPE
3402	17.10.87	Two Well South Australia	Port Wakefield Road	Highway
3403	17.10.87	Callington South Australia	Southeast Highway	Highway
3404	20.10.87	Callington South Australia	South East Highway	Highway
3405	20.10.87	Nuriootpa South Australia	Sturt Highway	Highway
3406	22.10.87	Callington South Australia	South East Highway	Highway
3407	24.10.87	Nuriootpa South Australia	Sturt Highway	Highway
3408	13.10.87	Two Wells south Australia	Port Wakefield Road	Highway
3501	17.10.87	Mangalore Tasmania	Midlands Highway	Highway
3501	15.10.87	Mangalore Tasmania	Midlands Highway	Highway
3501	13.10.87	Mangalore Tasmania	Midlands Highway	Highway
3503	17.10.87	Tasmania	Bass Highway	Highway
3503	22.10.87	Tasmania	Bass Highway	Highway
3503	20.10.87	Tasmania	Bass Highway	Highway
3601	13.10.87	A.C.T.	Majura Road	2 lane undivided
3601	15.10.87	A.C.T.	Majura Road	2 lane undivided
3601	24.10.87	A.C.T.	Majura Road	2 lane undivided
3602	13.10.87	A.C.T.	Barton Highway	4 lane divided
3602	15.10.87	A.C.T.	Barton Highway	4 lane divided
3602	17.10.87	A.C.T.	Barton Highway	4 lane divided

NUMBER OF RECORDS is 71

Table A9:

SECOND AFTER TRUCK SPEED STUDY - SITE CHARACTERISTICS

LOC.	SPEED METER	SPEED LIMIT	LAND USE	WEATHER	VISIBILITY
3001	KR11 Amphometer 15m spa	100kph	Grazing	Fine night	Dark night
3002	KR11 Amphometer 15m Spa	100kph	Grazing	Fine,Overcast,Win	Clear
3003	Slant Radar	110kmh	Bushland	Overcast,Windy	Clear
3004	Multiphon (5m spacing)	100kph	Grazing	Fine	Good
3005	Multiphon (5m spacing)	100kph	Grazing	Fine	Good
3006	KR11 Amphometer 15m Spa	100 kph	Farming	Fine	Clear
3007	KR11 Amphometer	100 kph	Farming	Fine	
3008	KR11 Amphometer 15m Spa	110 kph	Grazing	Fine	Clear
3009	KR11 Amphometer 15m Spa	110 kph	Grazing	Fine	Clear
3010	KR11 Amphometer 15m Spa	100 kph	Grazing	Fine	Clear
3011	KR11 Amphometer 15m Spa	100 kph	Grazing	Fine,V Cold	Clear
3012	Multiphom (5m Spacing)	100 kph	Grazing	Fine,Sunny	Clear
3110	Speed Gun 8	110	Rural	Fine/Rain	Good
3110	SpeedGun 6	100		Fine	
3110	Speedgun 6	100		Fine	
3120	Speed Gun 6	110	Agricultural	Fine	Good
3120	Speedgun6	100		Fine	Fine
3120	Speedgun6	110	Agricultural	O'cast	Fair
3130	Speedgun	100	Farm	Good Fine	Good
3130	Speedgun 6	110	Rural	Light Fog	Fair
3140	Speedgun 6	110	Rural/Agriculture	wet	fair
3150	Speed Gun	100	Farm	Good	Good
3150	Speedgun	100		Light Rain	Good
31[illegible]	Speedgun 8	100	Rural	Fine	Good
3160	Speed Gun	100	Rural	Fine	Good
3160	Speed Gun	100	Rural	Fine	Good
3160	Speed Gun	100	Rural	Fine	Good
3170	Speedgun	100	Rural	O'cast	Good
3170	Speedgun 6	100	Rural	Fine	Good
3180	Speedgun 8	100	Farm	Fine	Excellent
3180	Speedgun	100	Farm	Good Fine	Good
3190	Speedgun	100	Rural Farming	Fine	Good
3190	Speedgun 6	100	Rural	Fine	Good
3190	Speedgun 6	100	Rural	O'cast and fine	Good
3205	Radar Hand Gun	100	Rural		
3210	Radar Speed Gun	100	Residential (no acce	Fine	Good
3215	Radar Hand Gun	100	Rural	Showers	Clear
3220		100	Residential	Fine	Good
3225	Radar HandGun(Speedgun)	100	Rural	Fine some cloud -	Good
3230	Speed Gun	100	Rural	Rain	Good
3235	Speed Gun	100	Pine Forrest	Rain	Good
3240	Radar Speed Gun	100	Small Farms	Fine	Good
3245	Speed Gun	100	Rural	Fine	Good
3250	Speed Gun	100	Forrest	Rain	Good
3300	Digitector-sick l.beams	110	Native Scrub	Heavy rain- clear	Good
3301	Digitector-sick l/beams	110	Natural Scrub	Overcast	Good
3302	Digitector-sick l/beams	110	Farm Land	Fine, mild	Good
3303	Digitector w. light bms	110	Rural - Grazing		Good
330[illegible]	Digitector-sick l/beams	110	Virgin Scrub	Fine	Good
33[illegible]	Digitector-sick l/beams	110	Grazing	Fine and hot	Good
3400	Speedgun	110	Farming	Clear	Fair
3401	Speedgun	110	Farming	Heavy rain and wi	Poor

SECOND AFTER TRUCK SPEED STUDY - SITE CHARACTERISTICS

LC	SPEED METER	SPEED LIMIT	LAND USE	WEATHER	VISIBILITY
3402	Speedgun	110	Farming	Cold wet windy	Poor
3403	Speedgun	110	Farming	Cloudy	Good
3404	Speedgun	110	Farming	Clear (Fog 0500 -	Good
3405	Speedgun	110	Farming	Cloudy	Good
3406	Speedgun	110	Farming	Cloudy	Good
3407	Speedgun	110	Farming	Fine	Very Good
3408	Speedgun	110	Farming	Cloudy fine	Very good
3501	Falcon Speed Gun	110	Grazing	Fine	Good
3501	Falcon Speed Gun	110	Grazing	Fine	Good
3501	Falcon Speed Gun	110	Grazing	Fine	Good
3503	Radar Gun	110	Farming	Rain until 1300	Fair
3503	Radar Gun	110	Farming	Fine	Clear
3503	Radar Gun	110	Farming	Fine	Good
3601	Radar Gun	100	Grazing	Good/fine/dry	Fine/clear
3601	Radar Gun	100	Grazing	Fine	Good
3601	Radar Gun	100	Grazing	Intermittant rain	Good
3602	Radar Gun	100	Rural (E) Residentia	Fine / Dry	Good
3602	Radar Gun	100	Rural (E) Residentia	Light rain/interm	Good
3602	Radar Gun	100	Rural (E) Residentia	Gen. fine - sligh	Good

NUMBER OF RECORDS is 71

APPENDIX B - Total & Sample Traffic Volumes
Mean free speeds by site
Q-flow rates by site

Table B1: TOTAL TRAFFIC VOLUMES observed at study sites by vehicle type, STAGE 1 (Before)

loc	date	start	finish	car	artic	truck	bus	cartow	mcyc	lvan	tot
1001	251086	200	600	81	36	9	3	0	1	0	130
1002	271086	1300	1500	398	47	27	8	0	10	73	563
1002	271086	1030	1230	369	80	28	10	0	7	48	542
1003	11186	1045	1245	2441	38	43	6	0	28	43	2599
1003	11186	1330	1530	1547	22	30	11	0	22	214	1846
1004	31186	1800	2200	297	253	43	3	0	3	48	647
1005	41186	1400	1815	741	199	61	26	0	12	108	1147
1006	71186	1830	2230	211	51	11	7	0	12	0	292
1007	81186	100	500	35	61	2	8	0	0	0	106
1008	111186	1930	2400	356	228	37	10	0	7	0	638
1009	121186	0	430	83	154	51	1	0	0	0	289
1010	151186	1930	2400	246	21	20	9	0	0	0	296
1011	251186	0	415	32	258	14	8	0	1	0	313
1012	181186	1030	1430	932	173	141	10	0	15	271	1542
1110	141086	1800	2301	402	441	35	11	0	1	2	892
1110	161086	0	400	48	85	16	0	85	0	0	234
1110	181186	1800	2300	333	404	43	15	5	5	5	810
1110	201186	0	400	77	79	13	0	1	0	0	170
1110	221186	600	1000	1231	40	30	56	6	8	43	1414
1120	141086	0	400	52	25	12	0	1	0	0	90
1120	161086	600	1000	531	59	49	15	0	3	32	689
1120	151186	1800	2200	595	15	8	12	2	3	16	651
1120	181186	0	400	69	23	11	2	0	0	0	105
1120	201186	600	1000	602	65	70	5	0	0	36	778
1130	141086	600	1000	1539	75	96	22	0	20	60	1812
1130	161086	1800	2200	1007	43	24	2	0	13	19	1108
1130	151186	0	400	279	15	8	3	5	2	11	323
1130	181186	600	1000	1926	98	118	22	1	30	72	2267
1130	201186	1800	2200	1066	45	18	4	45	14	0	1192
1140	211086	1800	2200	1450	97	41	7	0	17	44	1656
1140	251086	0	400	328	33	17	4	1	1	1	385
1140	11186	0	400	418	12	11	2	0	0	0	443
1140	251186	1800	2200	1705	95	42	5	0	10	10	1867
1150	211086	1800	2200	171	124	18	0	0	2	14	329
1150	301086	0	400	15	30	13	0	0	0	0	58
1150	141186	0	400	17	47	7	1	0	0	0	72
1150	151186	600	1000	174	30	12	1	1	2	4	224
1150	251186	1800	2200	236	127	14	3	12	0	15	407
1150	271186	0	400	14	50	7	2	2	0	2	77
1160	81186	0	500	64	92	11	3	69	0	3	242
1160	81186	500	1000	312	126	15	13	0	4	14	484
1160	121186	0	400	21	211	14	1	0	0	1	248
1160	131186	1800	2200	207	62	17	8	0	2	16	312
1160	291186	500	1000	334	128	19	16	10	5	13	525
1160	21286	0	400	31	236	20	1	2	0	6	296
1170	251086	0	400	22	3	1	0	0	0	1	27
1170	111186	600	1000	198	17	16	3	4	1	0	239
1170	131186	1800	2200	228	26	18	4	0	8	12	296
1170	251186	600	1000	94	43	11	1	3	2	5	159
1170	271186	1800	2200	120	18	10	0	5	0	2	155
1180	81186	0	400	12	9	2	0	0	0	0	23
1180	111186	1740	2200	124	63	10	0	0	0	4	201
1180	291186	0	400	9	8	0	0	2	0	0	19
1180	21286	1800	2200	63	23	6	0	0	0	0	92
1190	221186	1800	2200	728	5	11	3	8	6	32	793

1190	251186	600	1000	651	44	40	5	8	6	37	791
1190	271186	0	400	25	11	12	0	0	0	0	48
1205	61286	745	1145	3825	92	177	53	0	32	212	4391
1210	91286	100	500	168	40	30	0	0	4	15	257
1215	31286	1200	1600	2817	207	273	41	0	29	221	3588
1220	61286	0	400	153	17	12	0	0	1	12	195
1225	81286	1930	2330	144	16	11	1	0	5	14	191
1230	281086	1800	2200	624	70	45	9	0	9	0	757
1235	311086	45	445	53	31	16	0	0	1	0	101
1240	11186	1800	2200	870	18	28	9	0	6	0	931
1245	41186	1115	1515	1054	96	103	6	0	9	0	1268
1250	51186	1100	1500	894	109	125	12	0	7	0	1147
1300	131086	1300	1300	344	161	40	12	0	9	19	585
1301	151086	1000	1000	134	134	12	15	0	7	9	311
1302	161086	1600	1600	163	33	13	7	0	2	14	232
1303	181086	1230	1230	501	43	9	0	0	0	3	556
1304	211086	955	955	528	206	61	13	0	2	21	831
1305	261086	1400	1400	41	14	6	0	0	0	0	61
1306	241086	1100	1100	178	21	4	9	0	1	10	223
1400	161086	200	600	26	46	11	1	0	0	0	84
1401	161086	1800	2200	704	102	29	9	0	4	0	848
1402	181086	200	600	88	29	11	4	0	4	0	136
1403	181086	1900	2300	480	28	7	9	0	0	0	524
1404	281086	200	600	109	176	24	5	0	2	0	316
1405	281086	1800	2200	186	56	19	3	0	5	0	269
1406	301086	1200	1600	959	205	108	9	0	12	0	1293
1407	11186	800	1200	640	41	10	19	0	3	0	713
1408	41186	1400	1800	869	112	78	9	0	11	1	1080
1501	281086	1400	1800	0	0	0	0	0	0	0	0
1501	11186	1800	2200	0	0	0	0	0	0	0	0
1503	231086	1225	1625	0	0	0	0	0	0	0	0
1503	281086	1800	2200	0	0	0	0	0	0	0	0
1503	61186	1000	1400	0	0	0	0	0	0	0	0
1601	281086	700	1100	333	46	67	5	0	4	9	464
1602	111186	1800	2200	51	26	8	3	1	0	6	95
1601	131186	1400	1800	155	22	22	8	6	0	5	218
1602	301086	1400	1800	711	14	67	15	17	7	55	886
1602	11186	700	1055	964	21	71	5	37	20	56	1174
1602	281086	1810	2210	360	6	16	1	4	3	13	403

Table B2: TOTAL TRAFFIC VOLUMES observed at study sites by vehicle type, STAGE 2 (1st after)

loc	date	start	finish	car	artic	truck	bus	cartow	mcyc	lvan	tot
2001	280387	145	545	54	40	9	4	2	1	1	111
2002	300387	1100	1540	1397	334	117	23	68	22	231	2192
2003	280387	1015	1430	4169	62	98	12	135	51	534	5061
2004	300387	1800	2200	264	386	17	1	8	1	23	700
2005	310387	1345	1745	471	188	50	10	22	3	96	840
2006	30487	100	500	30	61	4	13	3	0	1	112
2007	40487	1830	2230	184	45	8	3	11	2	4	257
2008	60487	1930	2400	311	234	49	8	10	5	9	626
2009	70487	0	420	92	108	41	0	0	1	0	242
2010	40487	1930	2400	425	51	24	23	19	3	59	604
2011	310387	0	415	25	237	13	9	1	0	0	285
2012	70487	1030	1430	1155	183	121	10	22	17	216	1724
2110	140387	600	1000	964	59	35	30	75	9	46	1218
2110	170387	1800	2230	384	437	45	10	5	6	3	890
2110	190387	0	400	52	95	16	0	4	1	0	168
2120	190387	600	1000	581	57	38	8	19	5	36	744
2120	40487	1800	2200	659	7	5	6	23	3	12	715
2120	170387	0	400	27	25	5	0	0	0	0	57
2130	170387	600	1000	2091	122	110	35	48	38	100	2544
2130	190387	1800	2200	1052	58	19	1	21	13	33	1197
2130	40487	0	400	189	7	9	3	6	1	5	220
2140	310387	1800	2200	1538	100	45	9	34	17	62	1805
2150	280387	600	1000	156	7	5	2	12	1	9	192
2150	310387	1800	2210	121	125	9	2	10	2	7	276
2150	20487	0	400	14	46	6	1	1	0	0	68
2160	280387	0	500	65	107	14	4	3	0	0	193
2160	280387	500	1000	409	128	13	16	36	2	21	625
2160	310387	0	400	21	233	31	1	4	0	1	291
2160	20487	1800	2200	226	84	7	5	13	3	12	350
2170	260387	1800	2200	109	35	11	0	9	1	1	166
2170	240387	600	1000	199	11	14	4	14	1	8	251
2180	210387	0	400	29	18	0	1	2	0	2	52
2180	240387	1800	2200	117	66	10	0	9	0	5	207
2190	240387	600	1000	636	37	35	8	22	7	25	770
2190	210387	1800	2200	679	1	3	21	25	0	13	742
2190	260387	0	400	25	13	15	2	1	0	3	59
2205	210387	745	1145	3739	62	138	56	85	48	204	4332
2210	240387	100	500	110	24	22	1	5	4	13	179
2215	10487	1200	1600	2657	201	272	30	41	24	195	3420
2220	40487	0	400	164	5	8	1	1	3	9	191
2225	270487	1930	2330	172	16	6	0	2	1	5	202
2230	310387	1800	2200	668	66	46	7	15	15	0	817
2235	30487	15	415	44	41	14	0	3	0	0	102
2240	80487	1800	2200	968	13	12	10	21	16	0	1040
2245	310387	1045	1445	1037	78	115	7	35	9	0	1281
2250	80487	1100	1500	878	68	87	7	43	11	0	1094
2300	300387	1200	1200	336	188	45	11	40	11	24	655
2301	10487	700	700	143	128	4	4	35	6	11	331
2302	20487	1400	1400	176	101	13	3	24	5	5	327
2303	40487	1000	1000	509	27	22	3	34	6	7	608
2304	60487	1030	1030	595	140	59	4	80	11	8	897
2305	90487	800	800	201	42	7	9	19	3	1	282
2306	110487	900	900	63	19	7	1	10	0	0	100
2400	260387	200	600	18	58	5	1	1	0	1	84
2401	260387	1800	2200	760	101	31	10	46	11	3	962
2402	280387	200	600	100	29	4	2	13	0	0	148

2403	280387	1900	2300	424	23	8	9	33	1	0	498
2404	310387	200	600	45	153	14	3	7	0	0	222
2405	310387	1800	2200	197	64	16	4	12	2	0	295
2406	20487	1200	1600	909	140	111	7	46	6	4	1223
2407	40487	800	1200	702	41	23	16	84	4	7	877
2408	70487	1400	1800	1071	127	73	10	78	11	6	1376
2501	310387	1400	1800	0	0	0	0	0	0	0	0
2501	110487	1800	2200	0	0	0	0	0	0	0	0
2503	20487	1031	1431	574	46	66	3	16	4	27	736
2503	310387	1800	2200	267	19	11	1	5	1	8	312
2601	240387	1400	1800	183	37	32	5	6	7	0	270
2601	20487	1800	2200	67	11	8	0	3	1	3	93
2601	280387	700	1100	150	9	14	0	8	1	9	191
2602	310387	1800	2200	333	12	21	0	3	8	11	388
2602	260387	1400	1800	718	22	57	15	24	15	68	919
2602	240387	700	1100	2048	45	95	12	13	44	69	2326

Table B3: TOTAL TRAFFIC VOLUMES observed at study sites by vehicle type, STAGE 3 (2nd After)

loc	date	start	finish	car	artic	truck	bus	cartow	mcyc	lvan	tot
3001	171087	200	600	81	71	13	4	0	1	0	170
3002	121087	1145	1615	799	142	63	18	32	13	150	1217
3003	171087	1130	1715	5228	47	137	10	178	58	509	6167
3004	121087	1800	2200	246	417	33	2	5	7	19	729
3005	131087	1400	1800	404	194	46	11	17	5	93	770
3006	231087	1830	2230	200	41	2	4	6	4	0	257
3007	241087	100	500	49	75	1	10	5	0	0	140
3008	271087	1829	2400	397	248	38	7	7	3	0	700
3009	281087	0	430	77	186	54	2	2	1	0	322
3010	311087	1930	2400	249	33	13	13	13	5	21	347
3011	131087	0	415	19	253	15	7	0	0	0	294
3012	271087	1030	1450	996	213	131	3	14	15	264	1636
3110	290987	1800	2330	480	437	38	13	24	4	42	1038
3110	81087	0	400	56	82	12	1	3	6	3	163
3110	101087	600	1000	1331	57	30	26	102	21	38	1605
3120	241087	1800	2200	636	11	11	12	24	4	23	721
3120	221087	600	1000	584	82	49	8	13	1	25	762
3120	220987	0	400	36	28	10	0	3	0	3	80
3130	81087	1800	2200	1216	50	12	0	10	2	9	1299
3130	31087	0	400	193	15	6	0	2	0	10	226
3140	290987	1800	2200	1470	76	40	5	27	9	71	1698
3150	11087	0	400	36	64	5	0	4	0	2	111
3150	290987	1800	2200	148	109	7	0	6	3	3	276
3150	31087	600	1000	242	23	8	2	29	5	10	319
3160	190987	600	1000	524	72	17	7	26	2	19	667
3160	220987	0	400	27	172	18	0	0	0	3	220
3160	170987	1800	2200	302	76	15	6	19	0	12	430
3170	221087	1800	2200	133	25	10	3	2	2	4	177
3170	220987	600	1000	262	15	13	1	19	0	47	357
3180	220987	1800	2200	103	42	4	0	8	0	4	161
3180	31087	0	400	28	10	0	1	0	0	0	39
3190	101087	1800	2200	673	2	7	8	28	2	18	738
3190	11087	0	400	12	5	7	0	1	0	3	28
3190	290987	600	1000	628	48	42	2	39	8	123	890
3205	171087	745	2345	3861	72	149	72	89	51	194	4488
3210	201087	100	500	130	9	3	0	22	41	12	217
3215	141087	1200	1600	2794	151	252	42	65	10	1	3315
3220	241087	0	400	139	18	7	1	5	2	7	179
3225	121087	1930	2330	143	17	3	0	3	3	4	173
3230	131087	1800	2200	544	101	35	8	10	4	0	702
3235	161087	15	415	62	37	8	2	2	0	0	111
3240	171087	1800	2200	861	12	19	12	16	17	0	937
3245	131087	1115	1515	1285	97	125	10	58	7	0	1582
3250	141087	1100	1500	1048	80	89	9	22	5	0	1253
3300	121087	1300	1300	405	269	63	17	57	19	21	851
3301	141087	1000	1000	165	152	16	7	38	6	7	391
3302	151087	1600	1600	171	50	12	5	48	5	10	301
3303	171087	1230	1230	659	97	25	6	54	1	6	848
3304	201087	1000	1000	498	167	60	11	84	5	21	846
3305	231087	1100	1100	184	40	15	10	33	4	8	294
3400	151087	200	600	27	49	8	0	4	0	2	90
3401	151087	1800	2200	573	84	39	10	36	6	13	761
3402	171087	200	600	88	30	10	2	10	0	1	141
3403	171087	1900	2300	427	35	9	9	29	5	14	528
3404	201087	200	600	52	184	25	3	5	0	1	270
3405	201087	1800	2200	102	31	9	2	4	3	3	154

3406	221087	1200	1600	863	151	88	15	51	5	18	1191
3407	241087	800	1200	665	23	13	22	77	7	13	820
3408	131087	1400	1800	1291	139	93	8	187	12	45	1775
3501	171087	1800	2200	133	0	3	0	1	0	0	137
3501	151087	1400	1800	248	17	10	4	3	0	4	286
3501	131087	1400	1800	332	26	15	8	2	2	2	387
3503	171087	1100	1500	372	17	16	4	17	1	23	450
3503	221087	1100	1500	327	51	48	3	16	1	24	470
3503	201087	1800	2200	213	16	19	2	5	0	10	265
3601	241087	1400	1730	196	2	6	4	5	1	4	218
3601	151087	700	1100	362	39	43	1	3	3	19	470
3601	131087	1800	2200	59	15	12	0	1	0	2	89
3602	171087	1350	1730	907	5	4	9	26	6	54	1011
3602	131087	650	1050	1539	50	71	16	7	29	120	1832
3602	151087	1750	2150	360	17	13	2	5	2	0	399

Table B4: SAMPLE TRAFFIC VOLUMES observed at study sites by vehicle type, STAGE 1 (Before)

loc	date	start	finish	car	artic	truck	bus	cartow	mcyc	lvan	tot
1001	251086	200	600	42	23	7	1	2	0	6	81
1002	271086	1300	1500	263	37	19	8	12	7	44	390
1002	271086	1030	1230	187	46	16	7	7	3	34	300
1003	11186	1045	1245	485	28	25	1	20	12	54	625
1003	11186	1330	1530	457	9	15	4	20	8	62	575
1004	31186	1800	2200	199	180	26	1	1	0	25	432
1005	41186	1400	1815	290	93	20	17	0	7	39	466
1006	71186	1830	2230	139	42	9	7	7	3	13	220
1007	81186	100	500	29	56	2	8	2	0	0	97
1008	111186	1930	2400	193	127	20	6	3	5	11	365
1009	121186	0	430	78	137	41	1	1	0	0	258
1010	151186	1930	2400	196	22	15	8	8	1	7	257
1011	251186	0	415	26	179	9	8	2	1	0	225
1012	181186	1030	1430	276	84	64	3	12	6	98	543
1110	141086	1800	2301	105	318	26	8	6	0	0	463
1110	161086	0	400	33	85	14	1	2	0	0	135
1110	181186	1800	2300	53	304	36	10	5	3	1	412
1110	1186	0	400	40	77	9	0	1	0	0	127
1110	1186	600	1000	64	36	26	38	6	0	10	180
1120	1086	0	400	17	19	8	0	0	0	0	44
1120	1086	600	1000	107	57	42	10	8	0	15	239
1120	1186	1800	2200	77	14	8	12	2	1	0	114
1120	1186	0	400	15	23	11	2	0	0	0	51
1120	1186	600	1000	67	56	63	5	0	0	6	197
1130	1086	600	1000	93	61	77	13	0	0	1	245
1130	1086	1800	2200	189	36	16	2	0	0	0	243
1130	1186	0	400	24	10	6	3	5	0	3	51
1130	1186	600	1000	64	86	74	13	1	0	0	238
1130	1186	1800	2200	35	45	17	2	0	0	0	99
1140	1086	1800	2200	153	91	30	5	0	0	0	279
1140	1086	0	400	46	29	17	4	1	0	0	97
1140	186	0	400	30	12	11	2	0	0	0	55
1140	1186	1800	2200	26	88	37	5	0	0	0	156
1150	1086	1800	2200	41	106	14	0	0	1	4	166
1150	1086	0	400	7	30	13	0	0	0	0	50
1150	1186	0	400	13	44	6	1	0	0	0	64
1150	1186	600	1000	31	29	11	0	4	0	1	76
1150	251186	1800	2200	36	90	10	3	12	0	3	154
1150	271186	0	400	15	49	4	2	2	0	0	72
1160	81186	0	500	14	69	8	2	2	0	0	95
1160	81186	500	1000	51	101	12	11	5	0	2	182
1160	121186	0	400	9	116	7	1	0	0	1	134
1160	131186	1800	2200	38	53	14	8	3	0	2	118
1160	291186	500	1000	55	77	17	10	10	1	10	180
1160	21286	0	400	17	131	14	1	2	0	5	170
1170	251086	0	400	20	3	1	0	3	0	1	28
1170	111186	600	1000	55	15	15	3	4	0	0	92
1170	131186	1800	2200	25	27	12	4	4	0	2	74
1170	251186	600	1000	37	38	8	1	3	0	2	89
1170	271186	1800	2200	26	18	7	0	5	0	1	57
1180	81186	0	400	7	8	2	0	0	0	0	17
1180	111186	1740	2200	33	57	9	0	1	0	4	104
1180	291186	0	400	9	8	0	0	2	0	0	19
1180	21286	1800	2200	14	22	5	0	0	0	0	41
1190	221186	1800	2200	75	4	11	3	8	4	5	110
1190	251186	600	1000	68	43	36	5	8	3	11	174

1190	271186	0	400	20	10	12	0	0	0	2	44
1205	61286	745	1145	1477	82	116	32	64	9	101	1881
1210	91286	100	500	168	41	28	0	5	4	9	255
1215	31286	1200	1600	1912	182	227	32	47	26	144	2570
1220	61286	0	400	125	15	12	0	4	1	10	167
1225	81286	1930	2330	130	14	8	1	0	4	12	169
1230	281086	1800	2200	307	66	40	6	6	9	0	436
1235	311086	45	445	53	31	14	0	3	1	0	102
1240	11186	1800	2200	349	16	12	8	12	6	0	403
1245	41186	1115	1515	183	52	54	7	16	4	0	316
1250	51186	1100	1500	143	34	60	7	5	2	0	251
1300	131086	1300	1300	344	161	40	12	51	10	18	636
1301	151086	1000	1000	134	135	12	14	43	7	8	353
1302	161086	1600	1600	162	34	13	7	51	2	13	282
1303	181086	1230	1230	500	44	9	0	32	0	3	588
1304	211086	955	955	528	205	63	13	60	2	21	892
1305	261086	1400	1400	178	21	4	9	23	1	10	246
1306	241086	1100	1100	41	14	6	0	4	0	0	65
1400	161086	200	600	22	43	11	0	0	0	0	76
1401	161086	1800	2200	473	94	24	8	0	0	0	599
1402	181086	200	600	76	27	10	5	0	0	0	118
1403	181086	1900	2300	355	28	6	9	0	0	0	398
1404	281086	200	600	71	124	11	3	0	0	0	209
1405	281086	1800	2200	160	55	16	3	0	0	0	234
1406	301086	1200	1600	574	170	73	9	0	0	0	826
1407	11186	800	1200	466	36	10	15	0	0	0	527
1408	41186	1400	1800	638	104	66	9	0	0	0	817
1501	281086	1400	1800	0	10	41	5	0	0	0	56
1501	11186	1800	2200	0	10	17	3	0	0	0	30
1503	231086	1225	1625	0	55	53	0	0	0	0	108
1503	281086	1800	2200	0	13	18	0	0	0	0	31
1503	61186	1000	1400	0	54	50	0	0	0	0	104
1601	281086	700	1100	198	30	50	3	4	2	6	293
1601	111186	1800	2200	51	25	9	3	1	0	3	92
1601	131186	1400	1800	143	22	20	7	6	0	5	203
1602	301086	1400	1800	677	12	80	14	16	7	51	857
1602	11186	700	1055	852	19	68	6	37	15	56	1053
1602	281086	1810	2210	345	6	16	1	4	3	12	387

Table B5: SAMPLE TRAFFIC VOLUMES observed at study sites by vehicle type, STAGE 2 (1st After)

loc	date	start	finish	car	artic	truck	bus	cartow	mcyc	lvan	tot
2001	280387	145	545	47	38	9	4	2	1	0	101
2002	300387	1100	1540	385	100	36	11	21	5	77	635
2003	280387	1015	1430	661	13	21	2	7	13	74	791
2004	300387	1800	2200	111	200	9	1	3	0	8	332
2005	310387	1345	1745	226	102	25	9	7	2	46	417
2006	30487	100	500	28	52	3	13	3	0	1	100
2007	40487	1830	2230	162	38	7	2	10	1	4	224
2008	60487	1930	2400	204	128	34	4	5	5	13	393
2009	70487	0	420	79	92	35	0	0	1	5	212
2010	40487	1930	2400	187	18	8	7	0	3	22	245
2011	310387	0	415	22	170	10	8	1	0	3	214
2012	70487	1030	1430	304	72	58	6	7	9	94	550
2110	140387	600	1000	100	51	30	28	6	0	3	218
2110	170387	1800	2230	36	311	29	10	1	2	4	393
2110	190387	0	400	15	78	13	0	0	0	0	106
2120	190387	600	1000	69	50	37	8	6	1	6	177
2120	40487	1800	2200	51	7	5	6	4	0	9	82
2120	170387	0	400	10	21	5	0	0	0	0	36
2130	170387	600	1000	201	136	78	22	9	5	7	458
2130	190387	1800	2200	0	0	0	0	0	0	0	0
2130	40487	0	400	25	6	9	3	5	0	4	52
2140	310387	1800	2200	31	84	42	8	4	2	5	176
2150	280387	600	1000	15	7	5	3	7	1	7	45
2150	310387	1800	2210	35	98	7	1	5	1	3	150
2150	20487	0	400	10	35	4	1	0	0	0	50
2160	280387	0	500	31	97	11	4	0	0	0	143
2160	280387	500	1000	29	96	10	13	13	2	8	171
2160	310387	0	400	13	154	13	1	0	0	0	181
2160	20487	1800	2200	17	57	6	3	2	0	3	88
2170	260387	1800	2200	11	25	15	0	1	0	0	52
2170	240387	600	1000	90	11	14	3	10	1	4	133
2180	210387	0	400	27	17	0	0	1	0	2	47
2180	240387	1800	2200	33	47	8	0	3	0	1	92
2190	240387	600	1000	40	42	33	6	4	0	7	132
2190	210387	1800	2200	48	1	3	18	6	0	5	81
2190	260387	0	400	14	14	14	2	1	0	2	47
2205	210387	745	1145	1464	44	106	35	58	9	104	1820
2210	240387	100	500	105	22	22	1	6	2	13	171
2215	10487	1200	1600	1557	155	191	29	27	10	109	2078
2220	40487	0	400	131	4	6	1	1	3	9	155
2225	270487	1930	2330	151	15	6	0	2	1	5	180
2230	310387	1800	2200	266	59	37	7	11	10	0	390
2235	30487	15	415	47	38	11	0	3	0	0	99
2240	80487	1800	2200	329	11	9	9	13	13	0	384
2245	310387	1045	1445	208	35	55	3	8	2	0	311
2250	80487	1100	1500	344	41	59	4	24	6	0	478
2300	300387	1200	1200	334	189	46	11	40	11	24	655
2301	10487	700	700	144	128	3	4	35	6	11	331
2302	20487	1400	1400	176	101	13	3	24	5	5	327
2303	40487	1000	1000	506	26	23	3	37	6	7	608
2304	60487	1030	1030	594	141	59	4	70	11	8	887
2305	90487	800	800	200	43	7	9	19	3	1	282
2306	110487	900	900	63	19	7	1	10	0	0	100
2400	260387	200	600	17	56	5	1	1	0	1	81
2401	260387	1800	2200	577	98	27	10	39	11	3	765
2402	280387	200	600	96	29	4	2	12	0	0	143

2403	280387	1900	2300	357	21	9	9	20	1	0	417
2404	310387	200	600	30	124	11	2	2	0	0	169
2405	310387	1800	2200	162	60	16	4	12	2	0	256
2406	20487	1200	1600	498	125	94	7	35	3	4	766
2407	40487	800	1200	466	42	20	14	71	3	7	623
2408	70487	1400	1800	585	115	58	9	56	7	3	833
2501	310387	1400	1800	183	19	30	6	12	0	4	252
2501	110487	1800	2200	189	5	13	7	5	1	2	222
2503	20487	1031	1431	378	38	46	2	11	2	23	500
2503	310387	1800	2200	214	18	10	1	4	1	5	253
2601	240387	1400	1800	129	28	31	4	3	4	11	210
2601	20487	1800	2200	62	14	8	0	3	1	5	93
2601	280387	700	1100	136	9	13	0	11	1	7	177
2602	310387	1800	2200	334	12	21	0	2	8	10	387
2602	260387	1400	1800	645	22	53	15	19	11	51	816
2602	240387	700	1100	740	28	50	6	11	14	57	906

Table B6: SAMPLE TRAFFIC VOLUMES observed at study sites by vehicle type, STAGE 2 (2nd After)

loc	date	start	finish	car	artic	truck	bus	cartow	mcyc	lvan	tot
3001	171087	200	600	67	53	10	3	0	0	0	133
3002	121087	1145	1615	367	79	23	8	9	7	61	554
3003	171087	1130	1715	595	19	38	2	24	4	103	785
3004	121087	1800	2200	138	223	21	1	2	6	7	398
3005	131087	1400	1800	265	115	32	7	8	3	43	473
3006	231087	1830	2230	138	35	2	3	4	1	2	185
3007	241087	100	500	45	68	3	9	4	0	0	129
3008	271087	1829	2400	242	153	26	6	3	1	7	438
3009	281087	0	430	66	137	42	1	2	1	1	250
3010	311087	1930	2400	204	26	13	13	9	4	12	281
3011	131087	0	415	15	168	10	6	0	0	2	201
3012	271087	1030	1450	212	65	45	2	2	4	52	382
3110	290987	1800	2330	27	311	29	12	6	1	4	390
3110	81087	0	400	15	79	8	1	0	0	0	103
3110	101087	600	1000	58	62	33	34	30	9	29	255
3120	241087	1800	2200	52	11	11	12	16	0	8	110
3120	221087	600	1000	57	80	49	9	14	0	16	225
3120	220987	0	400	19	25	10	0	3	0	3	60
3130	81087	1800	2200	80	45	11	0	3	1	3	143
3130	31087	0	400	58	15	6	0	2	0	5	86
3140	290987	1800	2200	32	75	35	4	9	0	14	169
3150	11087	0	400	22	54	3	0	1	0	0	80
3150	290987	1800	2200	42	100	5	0	2	1	1	151
3150	31087	600	1000	40	21	8	2	13	2	5	91
3160	190987	600	1000	61	58	12	5	4	0	0	140
3160	220987	0	400	17	152	14	0	0	0	2	185
3160	170987	1800	2200	38	63	11	6	7	0	2	127
3170	221087	1800	2200	39	23	8	1	0	0	2	73
3170	220987	600	1000	39	14	12	1	11	0	17	94
3180	220987	1800	2200	45	37	5	0	3	0	3	93
3180	31087	0	400	26	9	0	1	0	0	0	36
3190	101087	1800	2200	66	2	7	6	5	1	3	90
3190	11087	0	400	12	5	7	0	1	0	2	27
3190	290987	600	1000	65	46	35	2	3	0	5	156
3205	171087	745	2345	1768	56	88	56	50	21	82	2121
3210	201087	100	500	118	43	26	0	8	3	12	210
3215	141087	1200	1600	1458	136	160	39	30	7	120	1950
3220	241087	0	400	141	18	7	1	5	2	7	181
3225	121087	1930	2330	124	17	4	0	3	3	4	155
3230	131087	1800	2200	253	76	26	8	13	4	0	380
3235	161087	15	415	62	36	9	2	3	0	0	112
3240	171087	1800	2200	266	12	17	10	5	14	0	324
3245	131087	1115	1515	340	42	51	4	21	2	1	461
3250	141087	1100	1500	354	46	58	7	15	1	0	481
3300	121087	1300	1300	405	269	63	17	57	19	21	851
3301	141087	1000	1000	165	152	16	7	38	6	7	391
3302	151087	1600	1600	171	50	12	5	48	5	10	301
3303	171087	1230	1230	659	97	25	6	54	1	6	848
3304	201087	1000	1000	498	167	60	11	84	5	21	846
3305	231087	1100	1100	184	40	15	10	33	4	8	294
3400	151087	200	600	24	47	8	0	4	0	2	85
3401	151087	1800	2200	417	79	28	7	33	5	8	577
3402	171087	200	600	85	30	9	2	8	0	1	135
3403	171087	1900	2300	327	33	6	9	29	4	13	421
3404	201087	200	600	40	158	21	3	5	0	1	228
3405	201087	1800	2200	162	45	17	4	9	5	5	247

3406	221087	1200	1600	475	128	64	14	33	2	12	728
3407	241087	800	1200	442	20	10	17	57	6	8	560
3408	131087	1400	1800	644	121	77	6	116	9	25	998
3501	171087	1800	2200	133	0	3	0	1	0	0	137
3501	151087	1400	1800	248	17	10	4	3	0	4	286
3501	131087	1400	1800	332	26	15	8	2	2	2	387
3503	171087	1100	1500	372	17	16	4	17	1	23	450
3503	221087	1100	1500	327	51	48	3	16	1	24	470
3503	201087	1800	2200	213	16	19	2	5	0	10	265
3601	241087	1400	1730	196	3	6	3	5	1	4	218
3601	151087	700	1100	229	32	36	1	3	2	21	324
3601	131087	1800	2200	52	14	10	0	1	0	2	79
3602	171087	1350	1730	763	9	3	9	26	4	28	842
3602	131087	650	1050	783	37	54	9	10	20	60	973
3602	151087	1750	2150	346	17	8	2	2	2	3	380

Table B7: MEAN FREE SPEEDS based on sampled vehicles, observed at study sites by vehicle type, STAGE 1 (Before)

loc	date	start	finish	car	artic	truck	bus	cartow	mcyc	lvan	tot
1001	251086	200	600	103	103	102	90	86	0	88	101
1002	271086	1300	1500	104	88	86	102	100	101	96	100
1002	271086	1030	1230	105	94	89	99	87	109	98	101
1003	11186	1045	1245	112	101	96	99	99	119	105	110
1003	11186	1330	1530	103	96	90	92	94	110	95	102
1004	31186	1800	2200	104	97	92	87	99	0	92	100
1005	41186	1400	1815	105	96	89	98	0	103	97	101
1006	71186	1830	2230	104	96	82	100	107	109	94	101
1007	81186	100	500	106	104	100	107	92	0	0	104
1008	111186	1930	2400	107	94	95	101	93	110	98	102
1009	121186	0	430	108	97	90	90	81	0	0	99
1010	151186	1930	2400	101	88	94	101	88	93	93	99
1011	251186	0	415	102	105	96	108	103	113	0	105
1012	181186	1030	1430	95	89	82	93	82	103	89	91
1110	141086	1800	2301	101	85	84	87	99	0	0	89
1110	161086	0	400	103	92	101	86	87	0	0	96
1110	181186	1800	2300	108	88	86	91	104	100	100	91
1110	201186	0	400	106	90	100	0	111	0	0	96
1110	221186	600	1000	104	84	88	88	93	0	93	93
1120	141086	0	400	104	82	94	0	0	0	0	93
1120	161086	600	1000	101	83	86	84	91	0	95	93
1120	151186	1800	2200	108	91	96	94	99	158	0	104
1120	181186	0	400	111	93	97	85	0	0	0	99
1120	201186	600	1000	102	87	86	81	0	0	95	92
1130	141086	600	1000	95	79	86	82	0	0	91	88
1130	161086	1800	2200	96	84	90	91	0	0	0	94
1130	151186	0	400	99	85	87	82	92	0	96	93
1130	181186	600	1000	95	87	88	86	95	0	0	89
1130	201186	1800	2200	98	85	85	80	0	0	0	90
1140	211086	1800	2200	103	89	91	92	0	0	0	97
1140	251086	0	400	99	87	93	84	83	0	0	94
1140	11186	0	400	102	82	91	89	0	0	0	95
1140	251186	1800	2200	102	87	89	88	0	0	0	90
1150	211086	1800	2200	100	81	84	0	0	81	101	86
1150	301086	0	400	99	97	100	0	0	0	0	98
1150	141186	0	400	105	95	81	101	0	0	0	96
1150	151186	600	1000	100	91	85	0	98	0	81	94
1150	251186	1800	2200	103	84	83	92	90	0	97	89
1150	271186	0	400	106	83	85	101	110	0	0	89
1160	81186	0	500	103	89	89	82	95	0	0	91
1160	81186	500	1000	101	87	91	89	93	0	106	92
1160	121186	0	400	104	83	88	88	0	0	83	85
1160	131186	1800	2200	98	85	84	87	77	0	88	89
1160	291186	500	1000	106	84	89	86	96	126	105	93
1160	21286	0	400	101	86	90	78	101	0	97	88
1170	251086	0	400	87	99	105	0	91	0	75	89
1170	111186	600	1000	106	86	92	85	93	0	0	99
1170	131186	1800	2200	104	87	85	88	95	0	101	93
1170	251186	600	1000	90	88	78	40	91	0	68	87
1170	271186	1800	2200	101	86	92	0	88	0	85	94
1180	81186	0	400	107	101	95	0	0	0	0	103
1180	111186	1740	2200	103	84	78	0	114	0	112	91
1180	291186	0	400	95	92	0	0	96	0	0	94
1180	21286	1800	2200	102	90	79	0	0	0	0	93
1190	221186	1800	2200	107	94	88	88	99	103	98	103

1190	251186	600	1000	103	92	84	91	94	113	97	95
1190	271186	0	400	105	89	90	0	0	0	88	96
1205	61286	745	1145	94	93	88	94	85	91	89	93
1210	91286	100	500	99	95	93	0	83	108	91	97
1215	31286	1200	1600	98	89	87	95	86	95	93	96
1220	61286	0	400	93	87	85	0	92	90	91	92
1225	81286	1930	2330	96	89	94	93	0	102	93	95
1230	281086	1800	2200	100	91	91	97	98	109	0	98
1235	311086	45	445	107	90	97	0	104	96	0	100
1240	11186	1800	2200	92	86	91	94	79	87	0	91
1245	41186	1115	1515	91	84	80	86	84	98	0	87
1250	51186	1100	1500	90	88	85	85	86	84	0	88
1300	131086	1300	1300	108	99	94	103	90	113	98	103
1301	151086	1000	1000	106	103	100	108	90	105	95	102
1302	161086	1600	1600	105	92	87	97	86	123	94	98
1303	181086	1230	1230	106	90	88	0	92	0	86	104
1304	211086	955	955	108	95	96	98	90	108	97	103
1305	261086	1400	1400	103	90	88	103	90	112	92	100
1306	241086	1100	1100	107	99	87	0	99	0	0	103
1400	161086	200	600	104	83	95	0	0	0	0	82
1401	161086	1800	2200	104	85	86	94	0	0	0	100
1402	181086	200	600	105	92	89	103	0	0	0	100
1403	181086	1900	2300	104	92	87	93	0	0	0	102
1404	281086	200	600	110	88	90	91	0	0	0	95
1405	281086	1800	2200	100	85	88	105	0	0	0	96
1406	301086	1200	1600	104	86	87	88	0	0	0	98
1407	11186	800	1200	99	85	82	93	0	0	0	98
1408	41186	1400	1800	101	88	84	93	0	0	0	98
1501	281086	1400	1000	0	81	79	75	0	0	0	79
1501	11186	1800	2200	0	96	81	88	0	0	0	87
1503	231086	1225	1625	0	86	86	0	0	0	0	86
1503	281086	1800	2200	0	86	84	0	0	0	0	85
1503	61186	1000	1400	0	86	83	0	0	0	0	85
1601	281086	700	1100	100	86	90	86	91	113	89	96
1601	111186	1800	2200	103	90	88	92	78	0	97	87
1601	131186	1400	1800	97	86	90	78	87	0	94	93
1602	301086	1400	1800	91	81	79	82	86	93	87	90
1602	11186	700	1055	97	80	84	87	87	109	90	96
1602	281086	1810	2210	95	78	82	79	78	105	88	94

Table 08: MEAN FREE SPEEDS based on sampled vehicles, observed at study sites by vehicle type, STAGE 2 (1st After)

loc	date	start	finish	car	artic	truck	bus	cartow	mcyc	lvan	tot
2001	280387	145	545	99	102	94	104	85	94	0	99
2002	300387	1100	1540	104	91	88	95	93	100	98	100
2003	280387	1015	1430	112	103	96	100	108	112	104	110
2004	300387	1800	2200	104	99	90	99	88	0	98	100
2005	310387	1345	1745	105	100	91	100	98	116	97	102
2006	30487	100	500	103	102	87	106	91	0	84	102
2007	40487	1830	2230	103	96	89	110	94	115	88	101
2008	60487	1930	2400	109	100	93	104	94	111	97	104
2009	70487	0	420	105	97	89	0	0	124	98	99
2010	40487	1930	2400	105	98	97	101	0	112	100	104
2011	310387	0	415	110	107	105	109	95	0	94	107
2012	70487	1030	1430	95	90	84	84	82	100	91	93
2110	140387	600	1000	101	88	82	89	103	0	90	94
2110	170387	1800	2230	104	86	87	96	98	98	97	88
2110	190387	0	400	104	87	88	0	0	0	0	89
2120	190387	600	1000	106	90	90	86	95	105	96	96
2120	40487	1800	2200	105	101	91	90	98	0	97	101
2120	170387	0	400	111	86	88	0	0	0	0	93
2130	170387	600	1000	98	90	89	92	88	105	98	94
2130	190387	1800	2200	0	0	0	0	0	0	0	0
2130	40487	0	400	101	89	88	92	88	0	95	95
2140	310387	1800	2200	106	93	90	90	101	103	95	95
2150	280387	600	1000	107	87	87	94	92	115	90	96
2150	310387	1800	2210	102	92	90	96	97	124	84	95
2150	20487	0	400	98	91	82	88	0	0	0	92
2160	280387	0	500	102	87	84	84	0	0	0	90
2160	280387	500	1000	105	89	90	95	94	107	96	93
2160	310387	0	400	100	87	89	81	0	0	0	88
2160	20487	1800	2200	108	89	87	92	99	0	101	93
2170	260387	1800	2200	103	91	92	0	99	0	0	94
2170	240387	600	1000	103	97	95	81	94	105	100	100
2180	210387	0	400	100	88	0	0	117	0	109	97
2180	240387	1800	2200	104	87	84	0	88	0	72	92
2190	240387	600	1000	100	90	86	94	92	0	98	93
2190	210387	1800	2200	101	88	88	90	92	0	92	96
2190	260387	0	400	93	96	93	96	96	0	103	94
2205	210387	745	1145	96	91	86	92	87	106	92	94
2210	240387	100	500	101	95	86	91	87	103	99	98
2215	10487	1200	1600	99	90	87	97	90	101	95	97
2220	40487	0	400	95	89	87	86	80	123	90	95
2225	270487	1930	2330	93	84	85	0	78	75	90	92
2230	310387	1800	2200	99	93	91	98	88	100	0	97
2235	30487	15	415	110	94	93	0	93	0	0	101
2240	80487	1800	2200	94	92	98	98	87	97	0	94
2245	310387	1045	1445	90	90	87	80	86	110	0	89
2250	80487	1100	1500	90	90	86	92	81	96	0	89
2300	300387	1200	1200	110	100	98	103	94	114	99	105
2301	10487	700	700	106	104	95	112	95	106	93	103
2302	20487	1400	1400	108	91	91	81	90	103	97	100
2303	40487	1000	1000	107	95	96	85	96	113	92	105
2304	60487	1030	1030	107	93	94	105	93	122	95	103
2305	90487	800	800	103	71	103	106	93	94	101	98
2306	110487	900	900	109	90	100	119	100	0	0	104
2400	260387	200	600	102	89	87	104	60	0	90	91

2401	260387	1800	2200	105	90	89	104	92	112	85	102
2402	280387	200	600	100	92	83	87	95	0	0	98
2403	280387	1900	2300	105	89	89	96	98	119	0	103
2404	310387	200	600	107	96	94	97	86	0	0	97
2405	310387	1800	2200	100	87	86	102	85	106	0	95
2406	20487	1200	1600	105	89	86	93	92	109	107	99
2407	40487	800	1200	99	86	78	92	86	96	91	95
2408	70487	1400	1800	104	89	85	98	93	115	86	100
2501	310387	1400	1800	91	79	76	70	81	0	84	87
2501	110487	1800	2200	97	79	84	86	89	102	100	96
2503	20487	1031	1431	92	86	83	83	79	103	87	91
2503	310387	1800	2200	97	90	81	74	75	124	98	96
2601	240387	1400	1800	99	87	90	94	89	100	101	96
2601	20487	1800	2200	99	92	95	0	82	103	96	97
2601	280387	700	1100	100	92	91	0	89	92	90	98
2602	310387	1800	2200	96	85	81	0	84	104	88	95
2602	260387	1400	1800	95	81	84	87	90	109	89	93
2602	240387	700	1100	95	78	81	84	89	99	90	93

Table B9: MEAN FREE SPEEDS based on sampled vehicles, observed at study sites by vehicle type, STAGE 3 (2nd After)

loc	date	start	finish	car	artic	truck	bus	cartow	mcyc	lvan	tot
3001	171087	200	600	103	104	101	107	0	0	0	103
3002	121087	1145	1615	105	96	90	101	105	229	98	103
3003	171087	1130	1715	104	92	86	102	92	119	99	102
3004	121087	1800	2200	105	100	93	107	79	117	98	102
3005	131087	1400	1800	104	97	89	91	101	105	99	100
3006	231087	1830	2230	106	98	87	105	97	116	99	104
3007	241087	100	500	109	104	103	104	109	0	0	106
3008	271087	1829	2400	109	100	91	94	110	118	103	104
3009	281087	0	430	105	98	91	113	85	126	89	99
3010	311087	1930	2400	103	94	90	94	89	107	93	100
3011	131087	0	415	104	107	99	107	0	0	84	106
3012	271087	1030	1450	97	92	103	118	99	99	91	96
3110	290987	1800	2330	110	91	93	97	95	96	100	93
3110	81087	0	400	103	92	95	98	0	0	0	94
3110	101087	600	1000	110	92	87	90	98	107	94	96
3120	241087	1800	2200	110	88	82	93	102	0	96	101
3120	221087	600	1000	103	94	91	86	94	0	107	96
3120	220987	0	400	123	92	101	0	102	0	104	105
3130	81087	1800	2200	97	88	91	0	83	103	87	93
3130	31087	0	400	104	97	98	0	101	0	92	101
3140	290987	1800	2200	105	88	86	91	88	0	101	92
3150	11087	0	400	104	94	91	0	87	0	0	96
3150	290987	1800	2200	100	88	82	0	98	107	87	91
3150	31087	600	1000	109	90	88	90	94	96	91	99
3160	190987	600	1000	101	89	89	91	92	0	0	94
3160	220987	0	400	105	88	89	0	0	0	94	90
3160	170987	1800	2200	100	89	91	93	93	0	97	93
3170	221087	1800	2200	102	89	85	93	0	0	102	96
3170	220987	600	1000	107	94	98	102	106	0	98	102
3180	220987	1800	2200	101	89	97	0	91	0	104	96
3180	31087	0	400	98	97	0	85	0	0	0	98
3190	101087	1800	2200	102	90	84	90	89	95	97	99
3190	.11087	0	400	104	97	92	0	71	0	82	97
3190	290987	600	1000	103	92	87	93	98	0	96	96
3205	171087	745	2345	94	90	87	93	88	102	91	94
3210	201087	100	500	101	96	92	0	89	123	96	98
3215	141087	1200	1600	99	90	89	97	84	104	93	97
3220	241087	0	400	92	83	90	98	84	92	92	91
3225	121087	1930	2330	95	90	84	0	100	98	64	93
3230	131087	1800	2200	101	94	95	96	91	104	0	99
3235	161087	15	415	106	94	88	99	87	0	0	100
3240	171087	1800	2200	95	87	82	98	79	100	0	94
3245	131087	1115	1515	87	82	84	82	73	92	72	86
3250	141087	1100	1500	91	93	88	89	81	107	0	90
3300	121087	1300	1300	109	100	96	101	100	115	96	104
3301	141087	1000	1000	109	107	101	106	92	126	87	106
3302	151087	1600	1600	108	97	98	100	92	109	90	102
3303	171087	1230	1230	107	95	91	89	97	103	99	105
3304	201087	1000	1000	108	94	96	99	90	115	91	102
3305	231087	1100	1100	108	94	104	102	97	119	95	104
3400	151087	200	600	105	92	90	0	103	0	95	96
3401	151087	1800	2200	105	91	85	94	95	109	92	101
3402	171087	200	600	105	94	90	99	96	0	101	101
3403	171087	1900	2300	108	92	97	99	96	116	96	105
3404	201087	200	600	108	100	92	93	96	0	115	100

3405	201087	1800	2200	102	94	84	95	99	114	99	99
3406	221087	1200	1600	107	94	91	96	91	123	102	102
3407	241087	800	1200	99	88	81	97	90	105	86	97
3408	131087	1400	1800	104	89	84	92	92	104	96	99
3501	171087	1800	2200	90	0	75	0	91	0	0	90
3501	151087	1400	1800	88	77	74	70	75	0	74	86
3501	131087	1400	1800	88	78	75	77	76	81	80	87
3503	171087	1100	1500	89	86	78	79	83	93	83	88
3503	221087	1100	1500	91	89	82	82	82	107	86	89
3503	201087	1800	2200	96	89	83	88	85	0	98	94
3601	241087	1400	1730	93	83	83	98	81	93	97	93
3601	151087	700	1100	99	88	89	76	73	110	98	96
3601	131087	1800	2200	101	89	91	0	80	0	100	97
3602	171087	1350	1730	93	84	77	82	87	124	92	92
3602	131087	650	1050	93	74	79	78	84	96	88	91
3602	151087	1750	2150	89	66	75	74	92	92	82	87

Table B10: TOTAL TRAFFIC FLOW RATES (vehicles/ hour) observed at study sites by vehicle type, STAGE 1 (Before)

loc	date	start	finish	car	artic	truck	bus	cartow	mcyc	lvan	tot
1001	251086	200	600	20.25	9.00	2.25	.75		.25		32.50
1002	271086	1300	1500	199.00	23.50	13.50	4.00		5.00	36.50	281.50
1002	271086	1030	1230	184.50	40.00	14.00	5.00		3.50	24.00	271.00
1003	11186	1045	1245	1220.50	19.00	21.50	3.00		14.00	21.50	1299.50
1003	11186	1330	1530	773.50	11.00	15.00	5.50		11.00	107.00	923.00
1004	31186	1800	2200	74.25	63.25	10.75	.75		.75	12.00	161.75
1005	41186	1400	1815	178.55	47.95	14.70	6.27		2.89	26.02	276.39
1006	71186	1830	2230	52.75	12.75	2.75	1.75		3.00		73.00
1007	81186	100	500	8.75	15.25	.50	2.00				26.50
1008	111186	1930	2400	75.74	48.51	7.87	2.13		1.49		135.74
1009	121186	0	430	19.30	35.81	11.86	.23				67.21
1010	151186	1930	2400	52.34	4.47	4.26	1.91				62.98
1011	251186	0	415	7.71	62.17	3.37	1.93		.24		75.42
1012	181186	1030	1430	233.00	43.25	35.25	2.50		3.75	67.75	385.50
1110	141086	1800	2301	80.24	88.02	6.99	2.20		.20	.40	178.04
1110	161086	0	400	12.00	21.25	4.00		21.25			58.50
1110	181186	1800	2300	66.60	80.80	8.60	3.00	1.00	1.00	1.00	162.00
1110	201186	0	400	19.25	19.75	3.25		.25			42.50
1110	221186	600	1000	307.75	10.00	7.50	14.00	1.50	2.00	10.75	353.50
1120	141086	0	400	13.00	6.25	3.00		.25			22.50
1120	161086	600	1000	132.75	14.75	12.25	3.75		.75	8.00	172.25
1120	151186	1800	2200	148.75	3.75	2.00	3.00	.50	.75	4.00	162.75
1120	181186	0	400	17.25	5.75	2.75	.50				26.25
1120	201186	600	1000	150.50	16.25	17.50	1.25			9.00	194.50
1130	141086	600	1000	384.75	18.75	24.00	5.50		5.00	15.00	453.00
1130	161086	1800	2200	251.75	10.75	6.00	.50		3.25	4.75	277.00
1130	151186	0	400	69.75	3.75	2.00	.75	1.25	.50	2.75	80.75
1130	181186	600	1000	481.50	24.50	29.50	5.50	.25	7.50	18.00	566.75
1130	201186	1800	2200	266.50	11.25	4.50	1.00	11.25	3.50		298.00
1140	211086	1800	2200	362.50	24.25	10.25	1.75		4.25	11.00	414.00
1140	251086	0	400	82.00	8.25	4.25	1.00	.25	.25	.25	96.25
1140	11186	0	400	104.50	3.00	2.75	.50				110.75
2140	251186	1800	2200	426.25	23.75	10.50	1.25		2.50	2.50	466.75
1150	211086	1800	2200	42.75	31.00	4.50			.50	3.50	82.25
1150	301086	0	400	3.75	7.50	3.25					14.50
1150	141186	0	400	4.25	11.75	1.75	.25				18.00
1150	151186	600	1000	43.50	7.50	3.00	.25	.25	.50	1.00	56.00
1150	251186	1800	2200	59.00	31.75	3.50	.75	3.00		3.75	101.75
1150	271186	0	400	3.50	12.50	1.75	.50	.50		.50	19.25
1160	81186	0	500	12.80	18.40	2.20	.60	13.80		.60	48.40
1160	81186	500	1000	62.40	25.20	3.00	2.60		.80	2.80	96.80
1160	121186	0	400	5.25	52.75	3.50	.25			.25	62.00
1160	131186	1800	2200	51.75	15.50	4.25	2.00		.50	4.00	78.00
1160	291186	500	1000	66.80	25.60	3.80	3.20	2.00	1.00	2.60	105.00
1160	21286	0	400	7.75	59.00	5.00	.25	.50		1.50	74.00
1170	251086	0	400	5.50	.75	.25				.25	6.75
1170	111186	600	1000	49.50	4.25	4.00	.75	1.00	.25		59.75
1170	131186	1800	2200	57.00	6.50	4.50	1.00		2.00	3.00	74.00
1170	251186	600	1000	23.50	10.75	2.75	.25	.75	.50	1.25	39.75
1170	271186	1800	2200	30.00	4.50	2.50		1.25		.50	38.75
1180	81186	0	400	3.00	2.25	.50					5.75
1180	111186	1740	2200	26.96	13.70	2.17				.87	43.70
1180	291186	0	400	2.25	2.00			.50			4.75
1180	21286	1800	2200	15.75	5.75	1.50					23.00
1190	221186	1800	2200	182.00	1.25	2.75	.75	2.00	1.50	8.00	198.25
1190	251186	600	1000	162.75	11.00	10.00	1.25	2.00	1.50	9.25	197.75

1190	271186	0	400	6.25	2.75	3.00					12.00
1205	61286	745	1145	956.25	23.00	44.25	13.25		8.00	53.00	1097.75
1210	91286	100	500	42.00	10.00	7.50			1.00	3.75	64.25
1215	31286	1200	1600	704.25	51.75	68.25	10.25		7.25	55.25	897.00
1220	61286	0	400	38.25	4.25	3.00			.25	3.00	48.75
1225	81286	1930	2330	36.00	4.00	2.75	.25		1.25	3.50	47.75
1230	281086	1800	2200	156.00	17.50	11.25	2.25		2.25		189.25
1235	311086	45	445	13.25	7.75	4.00			.25		25.25
1240	11186	1800	2200	217.50	4.50	7.00	2.25		1.50		232.75
1245	41186	1115	1515	263.50	24.00	25.75	1.50		2.25		317.00
1250	51186	1100	1500	223.50	27.25	31.25	3.00		1.75		286.75
1300	131086	1300	1300	14.33	6.71	1.67	.50		.38	.79	24.38
1301	151086	1000	1000	5.58	5.58	.50	.63		.29	.38	12.96
1302	161086	1600	1600	6.79	1.38	.54	.29		.08	.58	9.67
1303	181086	1230	1230	20.88	1.79	.38				.13	23.17
1304	211086	955	955	22.00	8.58	2.54	.54		.08	.88	34.63
1305	261086	1400	1400	1.71	.58	.25					2.54
1306	241086	1100	1100	7.42	.88	.17	.38		.04	.42	9.29
1400	161086	200	600	6.50	11.50	2.75	.25				21.00
1401	161086	1800	2200	176.00	25.50	7.25	2.25		1.00		212.00
1402	181086	200	600	22.00	7.25	2.75	1.00		1.00		34.00
1403	181086	1900	2300	120.00	7.00	1.75	2.25				131.00
1404	281086	200	600	27.25	44.00	6.00	1.25		.50		79.00
1405	281086	1800	2200	46.50	14.00	4.75	.75		1.25		67.25
1406	301086	1200	1600	239.75	51.25	27.00	2.25		3.00		323.25
1407	11186	800	1200	160.00	10.25	2.50	4.75		.75		178.25
1408	41186	1400	1800	217.25	28.00	19.50	2.25		2.75	.25	270.00
1501	281086	1400	1800		2.50	10.25	1.25				14.00
1501	11186	1800	2200		2.50	4.25	.75				7.50
1503	231086	1225	1625		13.75	13.25					27.00
1503	281086	1800	2200		3.25	4.50					7.75
1503	61186	1000	1400		13.50	12.50					26.00
1601	281086	700	1100	83.25	11.50	16.75	1.25		1.00	2.25	116.00
1601	111186	1800	2200	12.75	6.50	2.00	.75	.25		1.50	23.75
1601	131186	1400	1800	38.75	5.50	5.50	2.00	1.50		1.25	54.50
1602	301086	1400	1800	177.75	3.50	16.75	3.75	4.25	1.75	13.75	221.50
1602	11186	700	1055	271.55	5.92	20.00	1.41	10.42	5.63	15.77	330.70
1602	281086	1810	2210	90.00	1.50	4.00	.25	1.00	.75	3.25	100.75

Table B11: TOTAL TRAFFIC FLOW RATES (vehicles/ hour) observed at study sites by vehicle type, STAGE 2 (1st After)

loc	date	start	finish	car	artic	truck	bus	cartow	mcyc	lvan	tot
2001	280387	145	545	13.50	10.00	2.25	1.00	.50	.25	.25	27.75
2002	300387	1100	1540	317.50	75.91	26.59	5.23	15.45	5.00	52.50	498.18
2003	280387	1015	1430	1004.58	14.94	23.61	2.89	32.53	12.29	128.67	1219.52
2004	300387	1800	2200	66.00	96.50	4.25	.25	2.00	.25	5.75	175.00
2005	310387	1345	1745	117.75	47.00	12.50	2.50	5.50	.75	24.00	210.00
2006	30487	100	500	7.50	15.25	1.00	3.25	.75		.25	28.00
2007	40487	1830	2230	46.00	11.25	2.00	.75	2.75	.50	1.00	64.25
2008	60487	1930	2400	66.17	49.79	10.43	1.70	2.13	1.06	1.91	133.19
2009	70487	0	420	21.90	25.71	9.76			.24		57.62
2010	40487	1930	2400	90.43	10.85	5.11	4.89	4.04	.64	12.55	128.51
2011	310387	0	415	6.02	57.11	3.13	2.17	.24			68.67
2012	70487	1030	1430	288.75	45.75	30.25	2.50	5.50	4.25	54.00	431.00
2110	140387	600	1000	241.00	14.75	8.75	7.50	18.75	2.25	11.50	304.50
2110	170387	1800	2230	89.30	101.63	10.47	2.33	1.16	1.40	.70	206.98
2110	190387	0	400	13.00	23.75	4.00		1.00	.25		42.00
2120	190387	600	1000	145.25	14.25	9.50	2.00	4.75	1.25	9.00	186.00
2120	40487	1800	2200	164.75	1.75	1.25	1.50	5.75	.75	3.00	178.75
2120	170387	0	400	6.75	6.25	1.25					14.25
2130	170387	600	1000	522.75	30.50	27.50	8.75	12.00	9.50	25.00	636.00
2130	190387	1800	2200	263.00	14.50	4.75	.25	5.25	3.25	8.25	299.25
2130	40487	0	400	47.25	1.75	2.25	.75	1.50	.25	1.25	55.00
2140	310387	1800	2200	384.50	25.00	11.25	2.25	8.50	4.25	15.50	451.25
2150	280387	600	1000	39.00	1.75	1.25	.50	3.00	.25	2.25	48.00
2150	310387	1800	2210	29.51	30.49	2.20	.49	2.44	.49	1.71	67.32
2150	20487	0	400	3.50	11.50	1.50	.25	.25			17.00
2160	280387	0	500	13.00	21.40	2.80	.80	.60			38.60
2160	280387	500	1000	81.80	25.60	2.60	3.20	7.20	.40	4.20	125.00
2160	310387	0	400	5.25	58.25	7.75	.25	1.00		.25	72.75
2160	20487	1800	2200	56.50	21.00	1.75	1.25	3.25	.75	3.00	87.50
2170	240387	600	1000	49.75	2.75	3.50	1.00	3.50	.25	2.00	62.75
2170	260387	1800	2200	27.25	8.75	2.75		2.25	.25	.25	41.50
2180	210387	0	400	7.25	4.50		.25	.50		.50	13.00
2180	240387	1800	2200	29.25	16.50	2.50		2.25		1.25	51.75
2190	240387	600	1000	159.00	9.25	8.75	2.00	5.50	1.75	6.25	192.50
2190	210387	1800	2200	169.75	.25	.75	5.25	6.25		3.25	185.50
2190	260387	0	400	6.25	3.25	3.75	.50	.25		.75	14.75
2205	210387	745	1145	934.75	15.50	34.50	14.00	21.25	12.00	51.00	1083.00
2210	240387	100	500	27.50	6.00	5.50	.25	1.25	1.00	3.25	44.75
2215	10487	1200	1600	664.25	50.25	68.00	7.50	10.25	6.00	48.75	855.00
2220	40487	0	400	41.00	1.25	2.00	.25	.25	.75	2.25	47.75
2225	270487	1930	2330	43.00	4.00	1.50		.50	.25	1.25	50.50
2230	310387	1800	2200	167.00	16.50	11.50	1.75	3.75	3.75		204.25
2235	30487	15	415	11.00	10.25	3.50		.75			25.50
2240	80487	1800	2200	242.00	3.25	3.00	2.50	5.25	4.00		260.00
2245	310387	1045	1445	259.25	19.50	28.75	1.75	8.75	2.25		320.25
2250	80487	1100	1500	219.50	17.00	21.75	1.75	10.75	2.75		273.50
2300	300387	1200	1200	14.00	7.83	1.88	.46	1.67	.46	1.00	27.29
2301	10487	700	700	5.96	5.33	.17	.17	1.46	.25	.46	13.79
2302	20487	1400	1400	7.33	4.21	.54	.13	1.00	.21	.21	13.63
2303	40487	1000	1000	21.21	1.13	.92	.13	1.42	.25	.29	25.33
2304	60487	1030	1030	24.79	5.83	2.46	.17	3.33	.46	.33	37.38
2305	90487	800	800	8.38	1.75	.29	.38	.79	.13	.04	11.75
2306	110487	900	900	2.63	.79	.29	.04	.42			4.17
2400	260387	200	600	4.50	14.50	1.25	.25	.25		.25	21.00
2401	260387	1800	2200	190.00	25.25	7.75	2.50	11.50	2.75	.75	240.50
2402	280387	200	600	25.00	7.25	1.00	.50	3.25			37.00

2403	280387	1900	2300	106.00	5.75	2.00	2.25	8.25	.25		124.50
2404	310387	200	600	11.25	38.25	3.50	.75	1.75			55.50
2405	310387	1800	2200	49.25	16.00	4.00	1.00	3.00	.50		73.75
2406	20487	1200	1600	227.25	35.00	27.75	1.75	11.50	1.50	1.00	305.75
2407	40487	800	1200	175.50	10.25	5.75	4.00	21.00	1.00	1.75	219.25
2408	70487	1400	1800	267.75	31.75	18.25	2.50	19.50	2.75	1.50	344.00
2501	310387	1400	1800	45.75	4.75	7.50	1.00	3.00		1.00	63.00
2501	110487	1800	2200	47.25	1.25	3.25	1.75	1.25	.25	.50	55.50
2503	20487	1031	1431	94.50	9.50	11.50	.50	2.75	.50	5.75	125.00
2503	310387	1800	2200	53.50	4.50	2.50	.25	1.00	.25	1.25	63.25
2601	240387	1400	1800	45.75	9.25	8.00	1.25	1.50	1.75		67.50
2601	20487	1800	2200	16.75	2.75	2.00		.75	.25	.75	23.25
2601	280387	700	1100	37.50	2.25	3.50		2.00	.25	2.25	47.75
2602	310387	1800	2200	83.25	3.00	5.25		.75	2.00	2.75	97.00
2602	260387	1400	1800	179.50	5.50	14.25	3.75	6.00	3.75	17.00	229.75
2602	240387	700	1100	512.00	11.25	23.75	3.00	3.25	11.00	17.25	581.50

Table B12: TOTAL TRAFFIC FLOW RATES (vehicles/ hour) observed at study sites by vehicle type, STAGE 3 (2nd After)

loc	date	start	finish	car	artic	truck	bus	cartow	mcyc	lvan	tot
3001	171087	200	600	20.25	17.75	3.25	1.00	.00	.25	.00	42.50
3002	121087	1145	1615	170.00	30.21	13.40	3.83	6.81	2.77	31.91	258.94
3003	171087	1130	1715	893.68	8.03	23.42	1.71	30.43	9.91	87.01	1054.19
3004	121087	1800	2200	61.50	104.25	8.25	.50	1.25	1.75	4.75	182.25
3005	131087	1400	1800	101.00	48.50	11.50	2.75	4.25	1.25	23.25	192.50
3006	231087	1830	2230	50.00	10.25	.50	1.00	1.50	1.00	.00	64.25
3007	241087	100	500	12.25	18.75	.25	2.50	1.25	.00	.00	35.00
3008	271087	1829	2400	69.53	43.43	6.65	1.23	1.23	.53	.00	122.59
3009	281087	0	430	17.91	43.26	12.56	.47	.47	.23	.00	74.88
3010	311087	1930	2400	52.98	7.02	2.77	2.77	2.77	1.06	4.47	73.83
3011	131087	0	415	4.58	60.96	3.61	1.69	.00	.00	.00	70.84
3012	271087	1030	1450	237.14	50.71	31.19	.71	3.33	3.57	62.86	389.52
3110	290987	1800	2330	90.57	82.45	7.17	2.45	4.53	.75	7.92	195.85
3110	81087	0	400	14.00	20.50	3.00	.25	.75	1.50	.75	40.75
3110	101087	600	1000	332.75	14.25	7.50	6.50	25.50	5.25	9.50	401.25
3120	220987	0	400	9.00	7.00	2.50	.00	.75	.00	.75	20.00
3120	221087	600	1000	146.00	20.50	12.25	2.00	3.25	.25	6.25	190.50
3120	241087	1800	2200	159.00	2.75	2.75	3.00	6.00	1.00	5.75	180.25
3130	81087	1800	2200	304.00	12.50	3.00	.00	2.50	.50	2.25	324.75
3130	31087	0	400	48.25	3.75	1.50	.00	.50	.00	2.50	56.50
3140	290987	1800	2200	367.50	19.00	10.00	1.25	6.75	2.25	17.75	424.50
3150	11087	0	400	9.00	16.00	1.25	.00	1.00	.00	.50	27.75
3150	290987	1800	2200	37.00	27.25	1.75	.00	1.50	.75	.75	69.00
3150	31087	600	1000	60.50	5.75	2.00	.50	7.25	1.25	2.50	79.75
3160	190987	600	1000	131.00	18.00	4.25	1.75	6.50	.50	4.75	166.75
3160	220987	0	400	6.75	43.00	4.50	.00	.00	.00	.75	55.00
3160	170987	1800	2200	75.50	19.00	3.75	1.50	4.75	.00	3.00	107.50
3170	220987	600	1000	65.50	3.75	3.25	.25	4.75	.00	11.75	89.25
3170	221087	1800	2200	33.25	6.25	2.50	.25	.50	.50	1.00	44.25
3180	220987	1800	2200	25.75	10.50	1.00	.00	3.00	.00	1.00	41.25
3180	31087	0	400	7.00	2.50	.00	.25	.00	.00	.00	9.75
3190	101087	1800	2200	168.25	.50	1.75	2.00	7.00	.50	4.50	184.50
3190	11087	0	400	3.00	1.25	1.75	.00	.25	.00	.75	7.00
3190	290987	600	1000	157.00	12.00	10.50	.50	9.75	2.00	30.75	222.50
3205	171087	745	2345	241.31	4.50	9.31	4.50	5.56	3.19	12.13	280.50
3210	201087	100	500	32.50	2.25	.75	.00	5.50	10.25	3.00	54.25
3215	141087	1200	1600	698.50	37.75	63.00	10.50	16.25	2.50	.25	828.75
3220	241087	0	400	34.75	4.50	1.75	.25	1.25	.50	1.75	44.75
3225	121087	1930	2330	35.75	4.25	.75	.00	.75	.75	1.00	43.25
3230	131087	1800	2200	136.00	25.25	8.75	2.00	2.50	1.00	.00	175.50
3235	161087	15	415	15.50	9.25	2.00	.50	.50	.00	.00	27.75
3240	171087	1800	2200	215.25	3.00	4.75	3.00	4.00	4.25	.00	234.25
3245	131087	1115	1515	321.25	24.25	31.25	2.50	14.50	1.75	.00	395.50
3250	141087	1100	1500	262.00	20.00	22.25	2.25	5.50	1.25	.00	313.25
3300	121087	1300	1300	16.88	11.21	2.63	.71	2.38	.79	.88	35.46
3301	141087	1000	1000	6.88	6.33	.67	.29	1.58	.25	.29	16.29
3302	151087	1600	1600	7.13	2.08	.50	.21	2.00	.21	.42	12.54
3303	171087	1230	1230	27.46	4.04	1.04	.25	2.25	.04	.25	35.33
3304	201087	1000	1000	20.75	6.96	2.50	.46	3.50	.21	.88	35.25
3305	231087	1100	1100	7.67	1.67	.63	.42	1.38	.17	.33	12.25
3400	151087	200	600	6.75	12.25	2.00	.00	1.00	.00	.50	22.50
3401	151087	1800	2200	143.25	21.00	9.75	2.50	9.00	1.50	3.25	190.25
3402	171087	200	600	22.00	7.50	2.50	.50	2.50	.00	.25	35.25
3403	171087	1900	2300	106.75	8.75	2.25	2.25	7.25	1.25	3.50	132.00
3404	201087	200	600	13.00	46.00	6.25	.75	1.25	.00	.25	67.50
3405	201087	1800	2200	25.50	7.75	2.25	.50	1.00	.75	.75	38.50

3406	221087	1200	1600	215.75	37.75	22.00	3.75	12.75	1.25	4.50	297.75
3407	241087	800	1200	166.25	5.75	3.25	5.50	19.25	1.75	3.25	205.00
3408	131087	1400	1800	322.75	34.75	23.25	2.00	46.75	3.00	11.25	443.75
3501	171087	1800	2200	33.25	.00	.75	.00	.25	.00	.00	34.25
3501	151087	1400	1800	62.00	4.25	2.50	1.00	.75	.00	1.00	71.50
3502	131087	1400	1800	83.00	6.50	3.75	2.00	.50	.50	.50	96.75
3503	171087	1100	1500	93.00	4.25	4.00	1.00	4.25	.25	5.75	112.50
3503	221087	1100	1500	81.75	12.75	12.00	.75	4.00	.25	6.00	117.50
3503	201087	1800	2200	53.25	4.00	4.75	.50	1.25	.00	2.50	66.25
3601	131087	1800	2200	14.75	3.75	3.00	.00	.25	.00	.50	22.25
3601	151087	700	1100	90.50	9.75	10.75	.25	.75	.75	4.75	117.50
3601	241087	1400	1730	59.39	.61	1.82	1.21	1.52	.30	1.21	66.06
3602	131087	650	1050	384.75	12.50	17.75	4.00	1.75	7.25	30.00	458.00
3602	151087	1750	2150	90.00	4.25	3.25	.50	1.25	.50	.00	99.75
3602	171087	1350	1730	238.68	1.32	1.05	2.37	6.84	1.58	14.21	266.05

APPENDIX C - Weighting procedures

1. Matching for production of weights.

Tables A1 to A9 (Appendix A) contains a complete description of each of the sites surveyed in the all stages of the study.

There were 94 sites surveyed in the before study, 72 in the first after study and 71 in the 2nd after study. The before study ran from 30.9.1986 through to 9.12.1986. By comparison, the first after study ran from 17.3.1987 through to 27.4.1987. Thus the first after study was carried out over a shorter elapsed time than the first before study. The 2nd after study was shorter still, from 29.9.87 to 31.10.87.

No new sites were introduced in the first after study. A number of the sites which were surveyed in the before study were not subsequently surveyed in the first and second after studies. This led to a matching problem for the creation of across study stage weights.

2. Matching the first After Sites to the Before Study Sites:

Because only 72 sites were studied in the first after study compared to 94 in the before study, 72 sites in the first after study had to be matched with 72 in the before study. This proved interesting.

A first attempt at matching the first after to the before study sites was based on the site location number and the start and finish times as specified in the specifications for the study. This yielded matches for all the first after sites except for 21 sites. For these remaining 21 a matching table was constructed which included matches to the nearest start and finish time and where necessary day of week match.

The main reason for these mis-matches was that a number of the sites in the before study had been surveyed more than once. At the end of this matching exercise the entire 72 sites were matched with their corresponding sites in the before study.

This matching was only carried out on stages 1 and 2 because the q-flow weighting was shown to have no significant effect on the statistical analysis.

3. Q-flow and total volume weights

A number of factors need to be considered in relationship to this weighting.

a. The literature, especially the paper by Farthing (Farthing,1977), notes that there is a correlation between the flow rates and the speed of vehicles. Thus the flow rate (veh/hr) versus the total traffic volumes need to be examined as potential weights. The question arises: What should we use as the weight? Just the total traffic volumes or some indication of the flow rate?

b. Irrespective of the weighting procedure used it is important to note that there is a potential correlation between these weights and the dependent variable, i.e. the speed of the vehicles. The weighting factor could potentially be confounding the results of the analysis. Thus it is important that an analysis be done of these weights vs speed to determine whether any confounding exists.

4. Definitions used in this discussion of weights:

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1. the term "Q-flow rate" (or flow rate) refers to the rate of traffic flow (in vehicles per hour) passing a survey site. The flow rate is computed for the direction of travel used to obtain the sample traffic volumes. The Q-flow rate is defined as the total traffic volume observed divided by the time period of that observation period for vehicles travelling in the sampling volume direction .

2. The "percentage of heavy vehicles (Pcthv)" is defined as the total volume of articulated vehicles divided by the total volume of all vehicles. The percentage of heavy vehicles also equals the flow rate of the articulated vehicles divided by the total flow rate.

The aim of the flow analysis was to see what effect flow rates had on the average vehicle speeds. Also of interest was the effect of the mix of vehicles, especially the percentage of heavy vehicles on the flow rate and mean free speeds.

5. Weighting functions considered.

Two types of weights were computed and tested for this study.

<u>Raw weights: Total Traffic Volumes</u>

The raw weight was computed by the division of the observed total traffic volume by the observed sample traffic volume at each site within vehicle type and stage. Thus, for any one site there were seven different weights produced, one for each vehicle type. These weights were then linked back across to the free speed data and matched against every free speed observation by vehicle type and site.

These weights were superseded by the Q-flow weights below.

<u>Q-flow weights: Q-flow rates</u>

The Q-flow weights were calculated by dividing the Q-flow rate of the before study for each site by that site's corresponding Q-flow rate during the first after study for each site within vehicle type. The site matching across stages was achieved using the relationship QLINK12 for stage 1 to 2 (table E.1). Thus seven different weights were produced for each site pair (six vehicle types and one all vehicle weight) and these were assigned as the weights for stage 2. Stage 1 weights were set to 1.0.

An example: for site 2602 and 1602 in the first after and before study, the Q-flow weight for cars would have been 177.75 divided by 179.50 which creates a weight for the first after study of 0.99. By default the weight for the before study is 1.

The Q-flow weights were better than the raw weights because they took into account the speed recoding session length and the total traffic volume. They were only computed for the stage 1 to 2 match.

The basic data used to compute both weights are included in Appendix B, tables B1 to B12.

6. Summary of the Traffic Flow Analysis

1. The relationship between the total flow rate and the mean free speeds of vehicles seem to be very low indeed. Looking at table C2 row 1, the correlations between the total flow rates and each of the mean free speeds for each vehicle type are all below 0.2 and none are significant.

2. The correlation between total flow rate and percentage of heavy vehicles is -0.32 (table C2). It is significant and accounts for less that 16% of the variance. The corresponding plots (plot C1) show that the relationship is effectively hyperbolic. This result conflicts with the findings of Farthing (Farthing,1977).

3. The relationship between the mean free speed of articulated vehicles and the mean free speed of other vehicles is high as indicated by correlation coefficients in excess of .38 (table C2).

4. Similarly, there is a high correlation between the mean free speed of cars and all other vehicles as indicated by the size of the correlation and the significance of these correlation coefficients in table C2.

5. An analysis of variance of the percentage of heavy vehicles and stage of the study indicated no significant relationship. We can conclude from this that the percentage of heavy vehicles on the roads remained unchanged between the two stages (see table C1).

Plot C1: Q-flow plot matrix

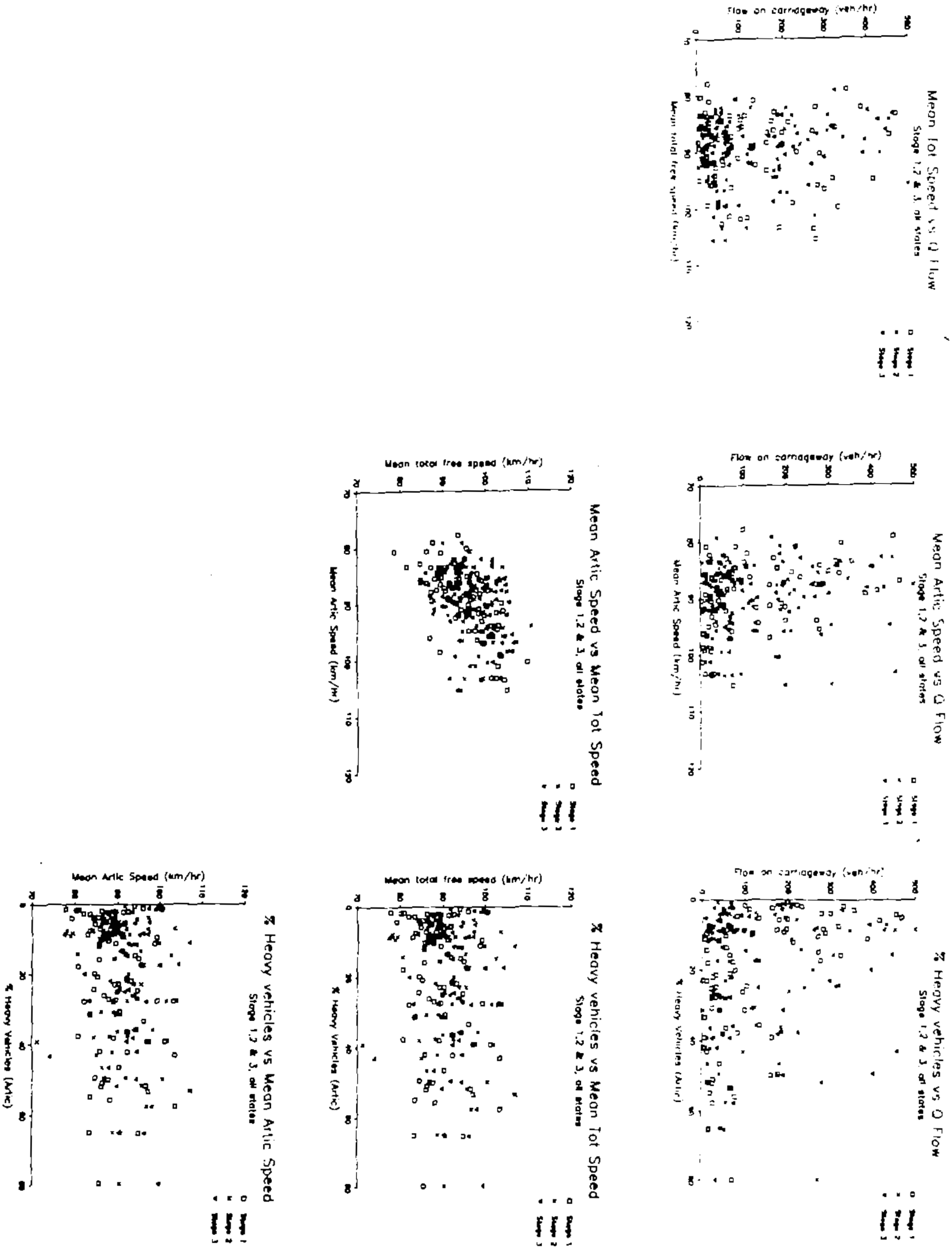


Table C1: Percentage of Heavy vehicle, Mean free speeds and Flow rates observed at Traffic survey sites, stages 1,2 & 3

State	Stage	% Heavy Vehicles Mean	% Heavy Vehicles Std	% Heavy Vehicles N	Free Speed (km/hr) (all vehicles) Mean	Free Speed Std	Free Speed N	Q Flow (veh/hr) (all vehicles) Mean	Q Flow Std	Q Flow N
NSW	1	26.8%	24.1%	14	101	12.8	4214	290.9	372.1	14
	2	32.2%	24.1%	12	102	13.1	4211	253.5	340.2	12
	3	36.0%	25.8%	12	101	12.2	4037	213.4	284.8	12
Vic	1	24.8%	22.2%	43	92	12.3	3110	130.1	139.5	43
	2	24.9%	23.9%	24	93	11.2	2884	141.3	153.6	24
	3	21.0%	21.1%	22	95	11.4	5735	133.5	122.7	22
Qld	1	10.0%	8.3%	10	94	11.9	6066	320.7	374.7	10
	2	9.3%	11.4%	10	95	11.7	6375	316.5	364.6	10
	3	9.2%	9.4%	10	94	11.8	6554	239.8	244.6	10
Wa	1	21.4%	12.3%	7	102	14.3	3193	16.7	11.1	7
	2	21.7%	11.6%	7	103	15.1	3598	19.0	11.4	7
	3	22.0%	10.9%	6	104	13.0	3064	24.5	11.9	6
Sa	1	22.4%	19.4%	9	98	14.4	4053	146.2	106.8	9
	2	24.4%	25.9%	9	99	14.3	3979	157.9	122.0	9
	3	22.0%	22.9%	9	100	13.0	3805	159.2	141.9	9
Tas	1	39.2%	14.1%	5	84	11.0	1227	16.5	9.5	5
	2	6.1%	2.6%	4	92	14.7	1995	76.7	32.4	4
	3	5.6%	3.6%	6	89	12.4	329	83.1	31.7	6
Act	1	8.7%	10.0%	6	93	12.7	2588	141.2	114.8	6
	2	6.3%	5.2%	6	94	12.1	2817	174.5	212.2	6
	3	5.6%	6.2%	6	92	12.1	2889	171.6	162.8	6
Total	1	22.8%	20.4%	94	96	13.5	24451	162.1	227.8	94
	2	21.0%	21.4%	72	97	13.6	25859	173.7	233.6	72
	3	19.2%	20.2%	71	97	13.2	33074	155.0	181.4	71

Note:
(1) Tasmania didn't record any cars during stage 1. This explains the anomaly high % HV in Stage 1.

Table C2: Correlation matrix of selected mean free speeds and traffic flow rates (after Farthing, 1977). All stages combined

	Mean Free Speed (Mfs) in km/h									
	Tot flow	% h veh	Car	Artic	Truck	Bus	Cartow	Mcyc	1van	All veh
Total flow rate	1.00	-.32	-.10	-.03	-.14	-.02	-.05	.05	-.00	-.02
% heavy vehicles		1.00	.46	.45	.41	.47	.26	.15	.19	.19
Mfs: cars			1.00	.68	.67	.53	.69	.32	.58	.79
Mfs: articulated				1.00	.60	.57	.44	.38	.35	.75

Note:
(1) Significance level of correlations: __ <= 0.01

The overall conclusion to be drawn from the Q-flow analysis is that the weights computed from flow rates would not confound the analysis of free speed. This conclusion is provisional and would require deeper analysis to verify this conclusion.

6. Neither weight type statistically altered the results of any of the major analyses i.e. free speeds by State and stage. Thus ALL results reported henceforth in this report are UN-WEIGHTED.

7. Database cleaning

Appendix D contains a copy of the free speed data collection form used in all stages of the study.

Appendix G contains a comprehensive list of the major problems encountered in the editing of the study stages.

8. Problems encountered - all stages

The major problem encountered with the data was with the congruence between the total traffic volume counts and sample volume counts. From the perspective of weighting, it is important to ensure that the direction of the traffic stream sampled corresponds to the total traffic volume tally for that direction.

Some States had tallied the total volume in both directions, but only sampled in one direction. Others had sampled and tallied in one direction only. Tables G.1 through G.3 in Appendix G illustrate these differences.

What made all this the more difficult was the sometimes unavailability of the tally sheets for verification.

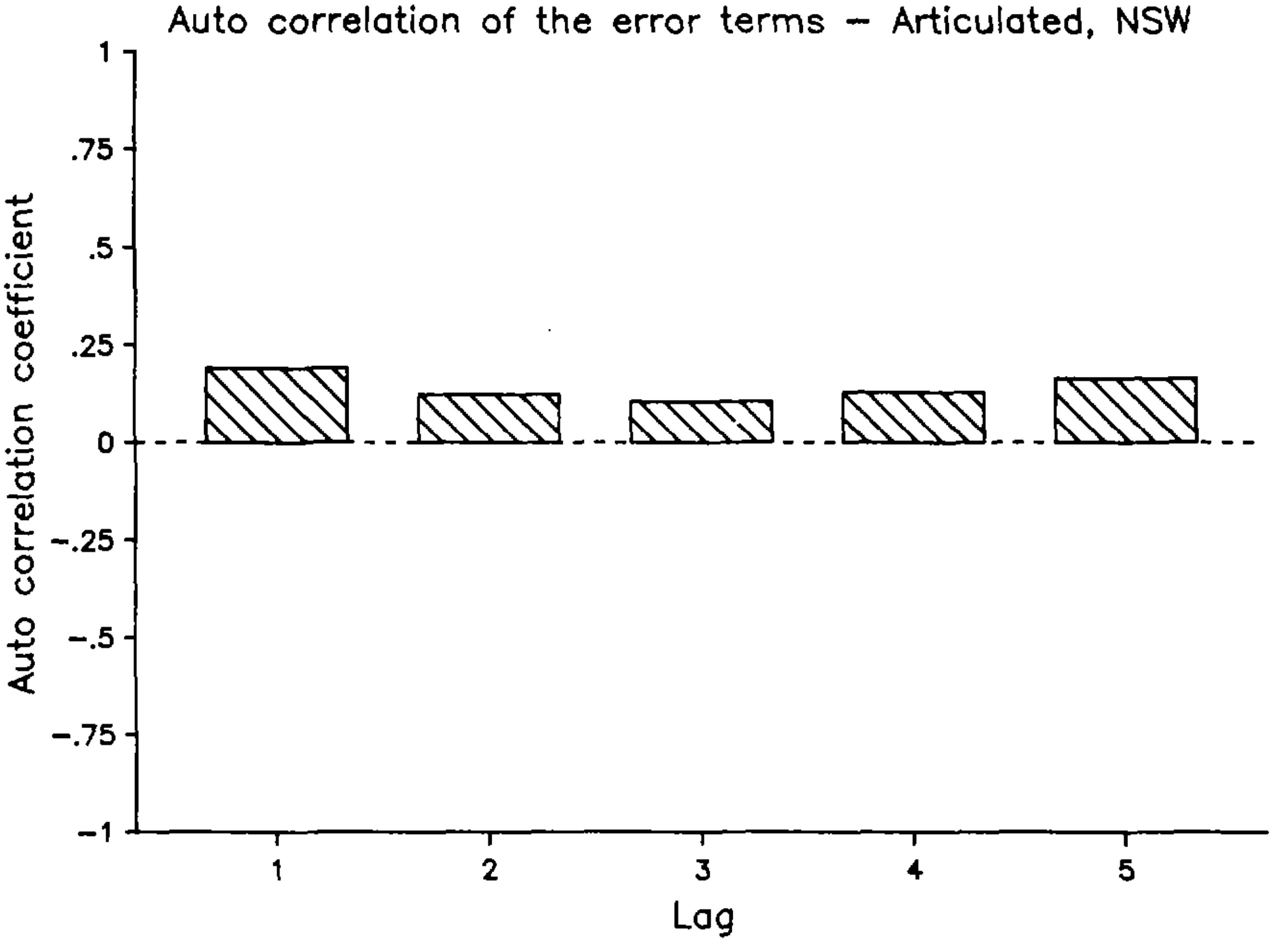
Site numbers, dates of recording and start and finish times often differed between the free speed records (which were numerous) and the single covering header sheet. The relational facilities of the ZIM database proved invaluable in overcoming these problems.

The layout of the header sheet was not ideal and if used in future studies should be simplified and redesigned.

The sample volume information requested on the header sheet was unnecessary as it was computed directly from the free speed data. Ruled lines on the free speed data sheets would facilitate speedier data punching.

Lastly, no attempt has been made by the consultant to check on the quality of all the data collected by the field teams. FORS staff accompanied a small number of NSW field teams during data logging and the consulatant attended a recording session with an ACT team. A blind retest would be needed to establish the level of experimenter variability induced by the data coding procedures.

Plot C2: Correlogram of error terms



APPENDIX D - Forms used in the surveys

VEHICLE SPEED SURVEY 1005

Location GUNDAGAI N.S.W.	Locn. No. 0002-006
Road name HUME HIGHWAY	Type of road HIGHWAY
Distance from identifing point 1.3km SOUTH OF BEREMBA TURNOFF, 10 km SOUTH OF MURRUMBIDGEE RIVER km	
Day TUESDAY	Date 4-11-86
Time start 14.15	Time finish 1815
Road width 7.9 m	No. of lanes 2 (ONE EACH WAY)
Road surface BITUMEN	Road condition FAIR
Median width N/A m	Median type N/A
Shoulder width 1.5/2.0 m	Shoulder surface GRAVEL/BITUMEN
Speed limit 100 km/h	Direction of traffic N/S
Grade < 1 %	Adjacent land use FARMING/GRAZING
Weather FINE/SUNNY	Visibility CLEAR.
Speed meter used AMPHOMETER/KR11 (PNEUMATIC)	
Police activity 1 HWY PT. CAR.	

Traffic volume:	191/550	Car/car derivatives	6/14	Cars towing	
43/65 (108)	Light vans	23/38	Trucks	43/156	Articulateds
3/9	Motor cycles	6/20	Buses	315/852 (1167)	Total
Sample size:		Car/car derivatives		Cars towing	
	Light vans		Trucks		Articulateds
	Motor cycles		Buses		Total

Description of approaches to survey site:

SLIGHT BENDS AT EACH END OF STRAIGHT.

ROADWORKS AT GUNDAGAI.

Remarks: NUMEROUS VEHICLES BRAKE ONCE THE TUBES WERE SEEN. (MAINLY VICTORIAN REGOS)

Speed readings by: P. JOHANSEN

Traffic counts by: T. SZYMANSKA

P.T.O.

FS 160986/TA

Vehicle Free Speed Survey

DATE 4-11-86 LOCN. NO. ______ SHEET 1 OF 19

LOCATION GUNDAGAI

TIME	SPEED (km/h)	VEH. CODE	OTHER CODE	DIRECTION N	DIRECTION S	VEHICLES FOLLOWING
1405	76	36		✓		0
	110	36			✓	0
	113	30			✓	0
	117	30		✓		1
	84	30			✓	0
	90	36			✓	0
	96	36	1		✓	0
	100	36			✓	5
	89	30		✓		0
	102	30			✓	0
	88	30			✓	0
	82	35		✓		0
	94	30			✓	2
	95	30			✓	1
	113	30			✓	
1420.	117	36			✓	1
1430	105	30			✓	0
	120	30			✓	0
	113	30			✓	1
	124	30			✓	0
	96	35			✓	1
	113	30			✓	1
	95	30			✓	0
	76	35		✓		0
	104	30			✓	0

VEHICLE CODE

Cars	30
Cars towing	31
Motorcycles	32
Bus (>4 whls)	33
Light van	34
Truck (>4 whls)	35
Semi & Artic.	36

OTHER CODE

TRAILER

Box trailer	1
Caravan	2
Folding caravan	3
Car trailer	4
Bike trailer	5
Boat trailer	6
Horse trailer	7
Other trailer	8

LOADING OF TRUCKS & SEMIS

Loaded	1
Unloaded	2
Unknown	Blank

MOTORCYCLES

Rider only	Blank
Pillion	0

TRAFFIC VOLUME SURVEY

LOCATION GANDAGAI **LOCN. NO.** 0002-006 **DATE** 4.11.86

TRAFFIC DIRECTION N ◄——— ———► S

Time	N: Cars etc.	N: Cars etc. towing	N: Light vans	N: Trucks	N: Artic-ulated	N: Motor cycles RO	N: Motor cycles +P	N: Buses	S: Cars etc.	S: Cars etc. towing	S: Light vans	S: Trucks	S: Artic-ulated	S: Motor cycles RO	S: Motor cycles +P	S: Buses
1415 - 1430	12	–	4	3	4	–	–	–	35	1	7	3	9	1	–	–
1430 - 1445	19	–	5	6	6	–	–	–	70	3	10	5	16	2	–	2
1445 - 15.00	35	1	7	6	7	–	–	1	107	4	12	6	36	3	–	6
15.00 - 15.15	47	1	10	7	10	–	–	2	143	5	17	6	44	3	–	10
15.15 - 15.30	54	1	13	9	13	1	–	2	162	6	21	7	47	3	–	11
15.30 - 15.45	64	2	15	9	16	2	–	3	196	7	25	8	58	3	–	15
15.45 - 16.00	81	3	18	9	19	2	–	4	234	8	28	11	63	3	–	16
1600 - 16.15	100	3	21	13	22	2	–	5	298	10	34	18	81	4	–	16
1615 - 16.30	112	3	25	13	23	2	–	5	341	11	37	18	87	4	–	17
1630 - 1645	125	5	26	13	29	2	–	6	389	11	41	23	103	4	–	17
1645 - 17.00	143	5	29	14	33	3	–	6	420	11	46	27	110	5	–	17
17.00 - 17.15	152	5	31	14	33	3	–	6	453	12	51	28	118	5	–	19
17.15 - 17.30	164	6	35	17	35	3	–	6	480	12	55	22	124	5	–	19
1730 - 1745	170	6	39	21	38	3	–	6	500	12	59	34	132	5	–	19
1745 - 1800	183	6	40	22	41	3	–	6	518	14	61	35	141	4	1	19
1800 - 1815	191	6	43	23	43	3	–	6	550	14	65	38	156	8	1	20
TOTAL	191	6	43	23	43	3	–	6	550	14	65	38	156	8	1	20

APPENDIX E - Database schematics

Table E.1: DATABASE schematics for the Truck Speed Study, Stage 1,2 & 3

Database software; ZIM ver 2.53

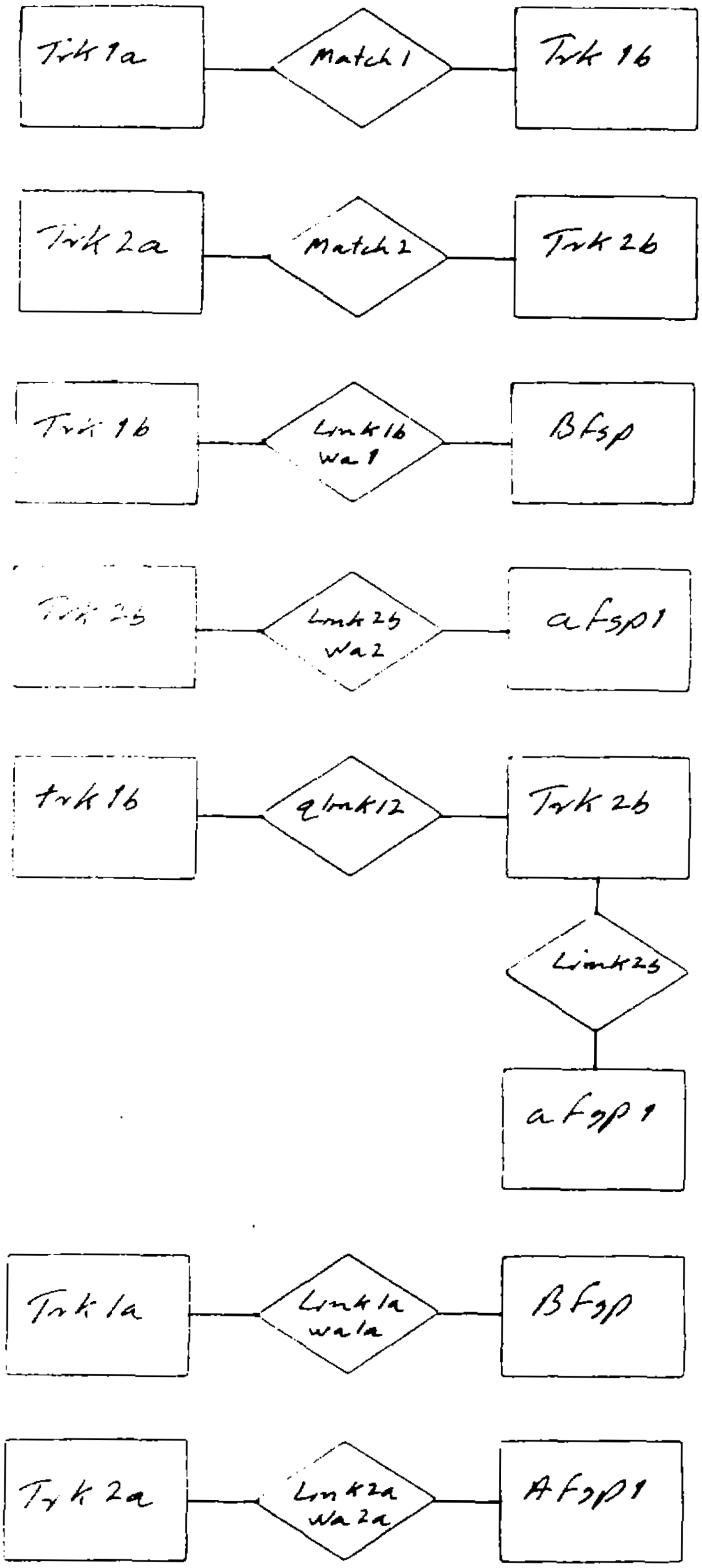
<u>Entity names</u>

bfsp	Before survey free speed data
afsp1	1st After survey free speed data
afsp2	2nd After survey free speed data
trk1a	Before survey header sheet part 1 - site descriptors
trk1b	Before survey header sheet part 2 - Total and Sample traffic volumes
trk2a	1st After survey header sheet part 1 - site descriptors
trk2b	1st After survey header sheet part 2 - Total and Sample traffic volumes
trk3a	2nd After survey header sheet part 1 - site descriptors
trk3b	2nd After survey header sheet part 2 - Total and Sample traffic volumes

<u>Relationships</u>

RelName	RelCondition
link1a	trk1a.loc=bfsp.loc and trk1a.sdate=bfsp.sdate and bfsp.time >= trk1a.sstart and bfsp.time <= trk1a.sfinish
link1b	trk1b.loc=bfsp.loc and trk1b.sdate=bfsp.sdate and bfsp.time >=trk1b.sstart and bfsp.time <= trk1b.sfinish
link2a	trk2a.loc=afsp1.loc and trk2a.sdate=afsp1.sdate and afsp1.time >=trk2a.sstart and afsp1.time <= trk2a.sfinish
link2b	trk2b.loc=afsp1.loc and trk2b.sdate=afsp1.sdate and afsp1.time >=trk2b.sstart and afsp1.time <= trk2b.sfinish
link3a	trk3a.loc=afsp2.loc and trk3a.sdate=afsp2.sdate and afsp2.time >=trk3a.sstart and afsp2.time <= trk3a.sfinish
link2b	trk3b.loc=afsp2.loc and trk3b.sdate=afsp2.sdate and afsp2.time >=trk3b.sstart and afsp2.time <= trk3b.sfinish
match1	trk1a.loc=trk1b.loc and trk1a.sdate=trk1b.sdate and trk1a.sstart=trk1b.sstart and trk1a.sfinish=trk1b.sfinish
match2	trk2a.loc=trk2b.loc and trk2a.sdate=trk2b.sdate and trk2a.sstart=trk2b.sstart and trk2a.sfinish=trk2b.sfinish
match3	trk3a.loc=trk3b.loc and trk3a.sdate=trk3b.sdate and trk3a.sstart=trk3b.sstart and trk3a.sfinish=trk3b.sfinish
qlink12	trk1b.stg11=qlink12.stg1 and trk2b.stg21=qlink12.stg2
wa1	trk1b.loc=bfsp.loc and bfsp.loc >=1300 and bfsp.loc <=1399
wa1a	trk1a.loc=bfsp.loc and bfsp.loc >=1300 and bfsp.loc <=1399
wa2	trk2b.loc=afsp1.loc and afsp1.loc >=2300 and afsp1.loc<=2399
wa2a	trk2a.loc=afsp1.loc and afsp1.loc >=2300 and afsp1.loc<=2399
wa3	trk3b.loc=afsp2.loc and afsp3.loc >=3300 and afsp2.loc<=3399
wa3a	trk3a.loc=afsp2.loc and afsp2.loc >=3300 and afsp2.loc<=3399

Table E.2: Database structures/schematics: stage 1+2.



① Header sheet matching

② weight 1 transfer

③ weight 2 computation and transfer to afsp1.

④ Header sheet to Free speed data linkage.

APPENDIX F - Data transfer specifications

Dept of Transport Truck Speed Study - Jan 1987 to Dec 1987.

Contract #: 86/506/074/4

14 December, 1987

Data file transfer to NMDS

Consultants:

R W Fitzgerald & Associates,
Po Box 125, Queanbeyan,
NSW 2620 AUSTRALIA

Telephone: (062) 972 697
Electronic mail: MCI mail 3367164
Dialmail 16342
Telex 650-3367164

Raw data files on enclosed floppies:

Speed123.dta	-	raw free speeds for stages 1,2 & 3
Head123.dta	-	Site description information from header sheets for stages 1,2 & 3

Number of records expected: Speed123.dta - 77,551. Head123.dta - 237.
Format of floppies: IBM PC/XT, dsdd, 360 kb
File format: fixed field ASCII

References:
(1) See major report on this project and appendices for further details of data and database structures.
(2) See enclosed ZIM program Sampva8 which contains a complete field layout guide to datasets.
(3) Coding for the header sheet file HEAD123.dta is as follows:

Roadtype	-	1=Freeway or any 4 lane road, 2=2 lane and other roads
Speedmeter	-	1=Radar, 2=amphometer or infra red beams
Direction	-	1=North, 2=East, 3=South, 4=West
Weather	-	1=Fine, 2=Showers/overcast
Visibility	-	1=good/clear, 2=Poor/fair

Coding for other header sheet fields and the free speed data is to be found on the data collection form.
(4) Missing data has been set to blank.

```
% DOT/ FORS Truck Speed study raw data dump.

% SAMPVA8 : outputs ALL trk1/2/3 and bfsp/afsp1/2 for ASCII transfer to DOT
% ver 1.0, 14-Dec-87
% by R W Fitzgerald & Associates, (062) 972697
% database software: ZIM ver 2.53
```

```
% First - Raw speed data from tally sheets

% FORMAT of ASCII raw speed data:
% field     columns
% location  1-4
% time      5-8
% speed     9-11
% vehicle code  12-13
% direction     14
% date          15-20
% vehicle follow 21-22

% For coding, see speed recording tally sheets in report appendix
% For file linkage, also see report appendix.


% Stage 1 output

set columnspacing 0
set headings off
set pause off
set output temp3

list all bfsp format $tocharacter(loc,4) \
$tocharacter(time,4) $tocharacter(speed,3) $tocharacter(vehcod,2) \
$tocharacter(bfsp.direct,1) $tocharacter(sdate,6) \
$tocharacter(vehfoll,2)

% Stage 2 output
set output temp3 append

list all afsp1 format $tocharacter(loc,4) \
$tocharacter(time,4) $tocharacter(speed,3) $tocharacter(vehcod,2) \
$tocharacter(afsp1.direct,1) $tocharacter(sdate,6) \
$tocharacter(vehfoll,2)

% Stage 3 output
set output temp3 append

list all afsp2 format $tocharacter(loc,4) \
$tocharacter(time,4) $tocharacter(speed,3) $tocharacter(vehcod,2) \
$tocharacter(afsp2.direct,1) $tocharacter(sdate,6) \
$tocharacter(vehfoll,2)

set columnspacing 0
set headings off
set pause off
set output temp4


% Second, output part 1 of header sheets
% which contains all the site descriptions

% FORMAT of header sheet data:
% field     column
% location  1-4
% roadtype  5
% date      6-11
% start time 12-15
```

```
% finish time 16-19
% speedlimit  20-22
% weather     23
% visibility  24
% speedmeter  25


% Stage 1 output
set output temp4

list all trk1a format $tocharacter(loc,4) \
$tocharacter(roadtype,1) $tocharacter(sdate,6) $tocharacter(sstart,4) \
$tocharacter(sfinish,4) $tocharacter(speedlimit,3) \
$tocharacter(weather,1)                          $tocharacter(visibility,1)
$tocharacter(speedmeter,1)

% Stage 2 output
set output temp4 append

list all trk2a format $tocharacter(loc,4) \
$tocharacter(roadtype,1) $tocharacter(sdate,6) $tocharacter(sstart,4) \
$tocharacter(sfinish,4) $tocharacter(speedlimit,3) \
$tocharacter(weather,1)                          $tocharacter(visibility,1)
$tocharacter(speedmeter,1)

% Stage 3 output
set output temp4 append

list all trk3a format $tocharacter(loc,4) \
$tocharacter(roadtype,1) $tocharacter(sdate,6) $tocharacter(sstart,4) \
$tocharacter(sfinish,4) $tocharacter(speedlimit,3) \
$tocharacter(weather,1)                          $tocharacter(visibility,1)
$tocharacter(speedmeter,1)

set output terminal
```

Crash Data Specification.

An examination of each of the States' coding manuals for their crash statistics has led me to the following conclusions in relationship to the specification for the data I require for the crash data in this study.

Each of the States has collected their own idiosyncratic set of data. There is no common data specification for the States. Therefore the most practical way for us to collect the crash data from the States is not by specifying which variables I want extracted but by asking them for a complete in situ dump of their existing databases for the vehicle types and time periods which specified below.

This approach i.e. a complete dump of their data sets, has been confirmed in conversation with Mr David Wigley of I.P. Sharp Computers in relationship to their experience of State traffic data vis-a-vis the fatal file. In their experience the most practical and most expedient method is a straight dump of the data. It will then be up to myself and David to extract from these dumps the common sets of crash variables. This will be done on the I.P. Sharp system.

Specifications which should be issued to the States include.

I. Time Frame

The time period for which I would like the crash data provided would be from June 1981 through to their most current online data. In relationship to New South Wales I currently hold June 1981 through to June 1985 and thus I am requesting data from 1 July 1985 through to their most current online data.

In my experience the State's crash data is at least one year behind the current date. It is imperative that the crash data that they provide be inclusive of the dates that they decide upon. I realise that in most States there will not be any crash data overlap with the Free speed dates of this study.

II. For all States except New South Wales and Western Australia, I am only interested in FATAL CRASHES. For NSW and WA I would like all crashes - Fatal and Casualty (admitted to hospital only).

III. Vehicle Types to be included in the Specification

I would like from each State a complete dump of all crashes (as specified in I. and II. above) which involve at least one truck.
The definition of truck that I have used in the past and will continue to use is based currently on the New South Wales Traffic Accident Authority's specification.

The vehicle codes which were included in the original time series analysis of New South Wales were code numbers 7, 9 through to 18 inclusive. These codes denominate the following vehicle types:

Code No. Description

7	Light trucks/lorry/panel van/utility not based on car design
9	Rigid or unspecified tanker
10	Articulated tanker
11	Large rigid lorry
12	Semi-trailers
13	Low loaders/goose neck float
14	Public Transport Authority bus
15	Large distance tourist buses
16	School buses
17	Other buses
18	Unspecified buses

Please note that with the crash data I am interested in all vehicles involved in every crash in which at least one truck was involved. Thus if a crash involved one truck and five cars then I want that one truck and the five cars. Similarly, if it only involved one truck and one car then I want the one truck and the one car.

IV. Database Linking Method.

It is important that each of the States provide a full description of the method by which the various sections of their database are linked together. For instance, in New South Wales they have a three file system; a crash file, a traffic unit file, and a person file.

For a crash which is recorded in the crash file there is a unique crash ID number. That crash ID number links all the traffic units in the traffic unit file which were involved in that crash and also links all the persons in the person file who were involved in that crash.

Thus the method of linking is very important. I would like a full description of how that linking works because I will have to implement that linking procedure.

In New South Wales there were some peculiarities in the way in which the linking occurred. That is, you required not only the crash ID number but also a traffic unit ID number and a date. The combination of those three pieces of information facilitated the unique linking of the three data sets together. Thus if there are any idiosyncracies like that I would like them explained in detail.

If such details are provided it will save me calling the respective individuals in each of the States and hassling them.

Contact Person.

It is terribly important that each State designate a person in their organization who will be their computing contact person who I can call for details and questions on each of the data sets. That person must have an intimate knowledge of the databases, the computing systems and the linking procedures.

The Tape Format for transfer of the Data.

The magnet tape format which I would like the data written in by each State for transfer is:

1600 BPI density
9 track

EBCDIC or ASCII
Unlabelled
Blocking factor (number of records per block)
to be specified by each organization
Number of characters per record

It is terribly important that the organizations providing this information on magnetic tape fully specify the writing characteristics of each tape. This information should be on a letter accompanying the tape.

I would also like a full description of what is on the tape in terms of files and also the record structure. Specifically:

1. a file map of the tape.

2. a listing of the first one hundred records of the first file and the last one hundred records of the last file so that I can verify that I have got the information the way it ought to be.

3. a record map, i.e. which variables are written in which columns on each record in each file type.

I do appreciated that in some years the format of the data in the records and also within the files will have changed. If there are different formats for different years I would like to know.

One other important point is that I need to have a complete table which has the following columns in it:

the year, the number of crashes, the number of vehicles, the number of persons.

In other words the expected N's for each of the file groups, so that if your State has a three file structure then for each year I would like to know how many crashes, how many vehicles and how many persons were involved so that when I read these files I can confirm the N's.

I realise that in many instances the volume of data require a large number of magnetic tapes. I am quite happy to read these tapes and return them to the individuals concerned as quickly as possible.

The end of the year and the ATAC meeting is accelerating at us very rapidly. Thus your speedy attention to this data transfer would be most appreciated.

Trucking along,

R W Fitzgerald

R W Fitzgerald & Associates,
Po Box 125, Queanbeyan,
NSW 2620 AUSTRALIA

APPENDIX 1: Vehicle Variables and Codes defining "TRUCKS" for each State

NEW South Wales: As specified above

VICTORIA:	VTYPE - page 2-73 of Code book. Vehicle codes 6-9
QUEENSLAND:	TYPE of traffic unit involved - page 29 of code book. Codes 3,4 and Buses
SOUTH AUSTRALIA:	UNIT TYPE - page 21 of code book. Codes 7-9
WESTERN AUSTRALIA:	UNIT TYPE - page 9 of code book. Codes 5-7, 81-84 ?
TASMANIA:	UNIT TYPE - Card type 2 # 45. Codes 6,9,10
ACT:	TYPE - page 37 of code book. Codes 5-7,15,25-27

APPENDIX G - Free Speed data sheet problems

APPENDIX G - Free Speed data sheet problems.

1. STAGE 1 - Data Problems

a. The documentation (tally sheets) were quite often unavailable within the States. These tally sheets were used where available to check the total traffic volumes vs the sample traffic volumes and also the direction of the sampling and how that matched the total traffic volumes. Thus the two parameters we were interested in were:

i. the relationship between the total volumes and the sample volumes.

ii. we wanted to make sure that the direction in which the samples were taken matched those of the total traffic volumes. Table G.1 outlines the discrepancies noted.

Table G.1: Total traffic volume vs Sampled volume direction match

State	Tally Sheet	Sample Type	Total Volume Type	Status
NSW	•	A	A	* bias
VIC	•	B	A,B	•
QLD		B	?	?
WA		A	A	• 24 hr
SA	*	A	A	*
TAS		B	B	*
ACT				?

Sample Type: A - both directions recorded
B - only one direction recorded
Tally sheet: * - available
Status: * - acceptable
? - questionable

2. Detailed notes by State

NSW - The survey strategy used by New South Wales was different from all other States. A mix of two hours sampling in one direction and then two hours sampling in the opposite direction and sampling both directions at the same time were found. Sites 1002 and 1003 had doubled up on their total volumes. Thus the tally sheets were invaluable in checking the accuracy of the total traffic volumes recorded on the header sheet.

TAS - Tasmania claimed that they did a 100 per cent sample of articulated trucks and buses only in Stage 1. The Stage 2 data suggests that this was not the case.

NSW, VIC, ACT & SA -

The dates or times on the header sheets had errors requiring a 100 per cent verification check of the headers. The dates and times on the header sheets had to be accurate because they were used for matching to the free speed data.

3. Linking Validation

Once the header sheets and the free speed data had been cleaned and verified internally, a checked was then carried out on the ability of the header sheet data to link completely to all the free speed data that was available. The points that emerged were:

3.1 That we found 528 free speeds which could not be linked to their corresponding header sheet.

3.2 The final check revealed that 46 had weights which were zero. This indicated that they had no vehicle type recorded against the free speed.

Conclusion - The above successful linking indicated that our thorough editing had paid great dividends.

4. STAGE 2 - Data Problems

4.1. Total Volume Directions versus Sample Directions

Table G.2: Total traffic volume vs Sampled volume direction match

State	Tally Sheet	Sample Type	Total Volume Type	Status
NSW	*	A	A	*
VIC	*	A,B	A,B	*
QLD	*	B	B	*
WA		A	A	*
SA	*	A	A	*
TAS		B	B	*
ACT	*	B	B	*

Sample Type: A - both directions recorded
B - only one direction recorded
Tally sheet: * - available
Status: * - acceptable
? - questionable

4.2. Data Problems by State

NSW - The free speed data provided were raw amphometer readings and needed numerical conversion to km/h.

VIC - All the total traffic volumes were transcribed from the tally sheets so that it matched the sample volumes thus forcing consistency. A major consistency problem experienced was in the direction of the sample volume versus the total volume.

QLD - Queensland had no light vans. The digitector may not have recorded them, they just were purposely ignored or there was some definitional mix up.

ACT - The free speed sheets need ruled lines. Punching and matching the speed data to the vehicle type was tedious. Because there were no ruled lines the corresponding columns tended to wander.

WA - Western Australia had no tally sheets.

TAS - Dr Mark Leggett claims that Tasmania did a 100 per cent sample of all vehicles at their sites in Stage 2. Site 2503 for which total traffic volumes were listed on the header sheet show that the sample volumes were not 100 per cent, i.e. that the computed weights came to one. Most of the weights were around about 1.2 and 1.5 thus indicating that in Stage 2 the sample traffic volumes were not 100 per cent.

NSW, VIC and SA -
New South Wales, Victoria and South Australia had a number of date/time errors on the header sheets which were edited and checked.

4.3. Linking validation

We found 4,180 unlinkable speed records. We were able to fix all these bar one. The final check revealed two with weights of zero.

Conclusion - all up, the Stage 2 data is a cleaner file than Stage 1.

5. STAGE 3 - Data Problems

5.1. Total Volume Directions versus Sample Directions

Table G.3: Total traffic volume vs Sampled volume direction match

State	Tally Sheet	Sample Type	Total Volume Type	Status
NSW	*	B	B	*
VIC	•	A	A	*
QLD	*	B	B	*
WA	*	B	B	*
SA	*	A	A	*
TAS		B	B	*
ACT	•	B	B	*

Sample Type: A - both directions recorded
B - only one direction recorded
Tally sheet: • - available
Status: • - acceptable

? - questionable

5.2. Data Problems by State

TAS — Once again, 100 % sampling was implemented.

ACT — No ruled lines on the free speed sheets made punching interesting. No times were recorded against the speed data.

NSW — NSW had changed to direct data acquisition using NEC laptop PC's. The speed data and header sheets were recorded directly to disc by the field staff. The data supplied was on a Macintosh II disc and need to be translated to IBM standard. The data transfer was clean and expedient. Full marks to NSW.

5.3. Linking validation

We found 5 unlinkable speed records.

Conclusion - the Stage 3 data was the cleanest data of all stages.

6. Conclusions

6.1. The tally sheets are needed to verify the direction match of sample and total traffic volumes. The tally sheet are needed for two reasons:

1. We want to know how the total traffic volumes were recorded i.e. one direction or both.
2. We want to ensure that the direction of the sample volume and total traffic volume are identical.

6.2. We do not need the sample volume data on the header sheets. This is computed from the free speed data itself.

6.3. The header sheet needs redesign and simplification.

6.4. Better quality control of the speed recording by the field team. The field team should get some direct feedback via a brief report on how their sites compared to others. Having spent time sitting in a field vehicle with the field staff from the ACT I can appreciate how in the dark they are.

APPENDIX H - Statistical distribution and Assumption testing

1. Aptness of the parametric ANOVA model

Small departures from normality of the error terms do not create serious problems for ANOVA, however major departures can be of considerable concern and would therefore require the abandonment of the ANOVA model. The normality of the error terms can be studied by a number of methods and these are:

a. Construction of a histogram of residuals to see if gross departures from normality are indicated.

b. determine what percentage of the standardised residuals fall with the range plus or minus one standard deviation. The percentage ought to be 68%.

c. A further possibility is to plot the residuals on normal probability paper to see whether a straight line is produced.

d. Use statistical tests such as Kolmogorov-Smirnov (K-S) to test the residuals against the standard normal distributions. (Neter & Wasserman 1974, 107)

The six major points which need to be considered when deciding on the aptness of the ANOVA model are the following:

a. In this instance is the regression function linear?

b. Do the error terms have constant variance?

c. Are the error terms independent?

d. Does the model fit all points and how many out-liars are there?

e. Are the error terms normally distributed?

f. How well does the model fit overall and should other variables be added?

ANOVA makes a series of six assumptions regarding the underlying statistical distribution of the variable in question. These are: (Neter & Wasserman 1974, 427)

1. the ANOVA model is Y_{ij} = $mean_{ij}$ + error $term_{ij}$.

2. the expected value of the error terms is zero and therefore the expected value of all the Y_{ij} is equal to the $mean_i$.

3. Since all the factor levels have a constant $mean_i$ therefore the variance at each factor level should also be exactly the same.

4. Since the error terms are normally distributed so are the observations Y_{ij}. This follows because the observations Y_{ij} are a linear function of the error terms. Thus the error terms are normally distributed with mean zero, variance S^2.

5. The error terms are assumed to be independent. Thus since the error terms are independent so are the observations Y_{ij}.

A consequence of the features mentioned above is that the Y_{ij}s are independently and normally distributed with a mean of $mean_i$, variance S^2.

Thus the major departures which have to be examined are

* the non-independence of the error terms.
* constancy of the error terms variance across the factor levels.
* the independence of the error terms.

Because of the demonstrable departures of the free speed data from the ANOVA assumptions above we abandoned the parametric ANOVA model and instead opted for the nonparametric equivalents - the K-W and K-S test.

The major nonparametric test which have been used are the K-S test of goodness of fit and the Kruskal-Wallis (K-W) one-way analysis of variance.

The assumptions made by the K-S goodness of fit test (Daniel 1978, 268) are that the data consist of independent observations constituting a random sample of size N from some unknown distribution function designated by F(X). The important feature of the K-S is that it does not make any assumption about the normality of the distribution.

By comparison the K-W ANOVA by ranks makes the following assumptions:[25]

i. That the data for the analysis consist of K random samples.
ii. The observations are independent both within and among samples.
iii. The variable of interest is continuous.
iv. The measurement scale is at least ordinal and the populations are identical except for a possible difference in location for at least one population. Thus the assumptions are nowhere near as stringent as the parametric ANOVA specifically in relationship to the normality of the distribution or the constancy of variance.

2. *Testing the normality of the speed distributions with the K-S test.*

Tables 4.8 and 4.9, contain the tests of the two major assumptions, that is the normality of and independence of the error terms. They contain a complete test assumption matrix for all the levels of significance testing that referred to in the results analysis. The following points need clarification:

a. there are a large number of tests. The question of simultaneous testing probabilities is covered in parametric statistics by using and adjusted and conservative alpha level. There is unfortunately no similar adjustment procedure for lots of non-parametric tests.

b. a large number of the speed distributions when tested by K-S show significant results i.e. they are not normal. Looking at a plot of the corresponding distribution would not readily lead one to that conclusion. Thus doubt is cast on the conclusions of the K-S test.

---

[25] (Daniel 1978, 200)

Plot H.2 contains a frequency distribution for the residuals of articulated vehicles in New South Wales. The corresponding K-S tests gives an alpha level of 0.042 and with a decision alpha level of 0.05 you conclude that the distribution is not normal.

It is important to note here that the residuals are a real continuous variable as distinct from the speed values which are continuous but discrete, i.e. they can only assume integer values.

By comparison if we examine the residuals for articulated vehicles in the ACT (plot H.3) the departure from normality seems more extreme. The K-S tests produces an alpha value of 0.412 and thus you conclude the distribution is normal.

We decided to reassure ourselves of veracity of the K-S tests in deducing the normality of distributions.

3. Kolmogorov-Smirnov accuracy testing

The question which began to emerge was that a lot of the K-S tests seem to produce results which gave probability levels of 0.05 and less, thus suggesting that the distributions were non-normal when in actual fact a visual inspection seems to suggest that the departures were not gross.
What was the ability of the K-S test to differentiate between a normal and non-normal distribution?. To this end we generated four samples of random normal deviates to test the K-S ability to differentiate between normal and non-normal distributions.

Sample 1 consisted of 2,000 integer normal random deviates. Sample 2 consisted of 2,000 normal random deviates as real numbers and sample 3 consisted of 4,000 normal random deviates as integers. Finally sample 4 consisted of 2,000 poisson distributed random deviates (integers).

Table H.1 summarises the corresponding K-S values for these four different sets of random samples.

The ability of K-S to test the poisson distributions departure from normality was excellent. The alpha value of 0.967 for the poisson test, was very comforting indeed. The point to note here is that the error distribution is discrete and this matches exactly with the theoretical distribution (poisson) which is also discrete (integer). Thus where there is an exact correspondence between the numerical characteristics of the sample and theoretical distributions the K-S performs very well.

The K-S for the real values of the normal random deviates (sample 2) gave a value of 0.507 which successfully concludes that sample 2 in normal. Note the correspondence between the numerical characteristics of the sample and theoretical distributions.

For sample 1 (integer valued normal random deviates) the K-S performed poorly. It gave a value of 0.053 which could be interpreted as marginally rejecting the null hypothesis and conclude that this distribution was non-normal (plot H.1).

It was precisely this situation with integer speed values being tested against a real continuous distribution using K-S that was producing a lot of K-S significance values with alpha values of 0.1 or less.

Interestingly enough, if you then increase the sample size to 4,000 (sample 3) the K-S value rose marginally to 0.072.

Conclusion:

If the numerical characteristics of the sample and theoretical distributions are not matched then use a very low decision alpha value before for rejecting the null hypothesis. Thus all of the assumption results recorded in tables 4.8 and 4.9 are based on alpha levels of 0.01 or less.

Table H.1: Testing of Kolmogorov-Smirnov one sample test against a Pseudo Normal random number generator.

Dataset	Type	N	K-S sig level
Normal	int	2000	0.053
Normal	real	2000	0.507
Normal	int	4000	0.072
Poisson	int	2000	0.967

Notes:

(1) The K-S test used was that contained within the NPAR TESTS procedure in SPSS/PC, ver 1.0.

(2) The pseudo random number generator used was derived from the journal "Applied Statistics", Fortran subroutines AS111, AS183, 1982. Also, see "The Computer generation of Beta, Gamma and Normal random variables", JRSS A, pg 431-447.

(3) K-S sig level is the reported significance level for the K-S test. Thus if our alpha level was set at 0.05, then we would accept the null hypothesis (H_0: that the observed distribution function is normally distributed).

PH.1: Pseudo Random Normal deviates - integer values

```
    Count   Midpoint
       6          67  :X
       6          69  X:
      10          71  XX:
      22          73  XXX:XX
      20          75  XXXX:
      17          77  XXXX .
      44          79  XXXXXXX:XXX
      19          81  XXXXX     .
      46          83  XXXXXXXXXXX.
      60          85  XXXXXXXXXXXXXX.
      78          87  XXXXXXXXXXXXXXXXXX:X
      78          89  XXXXXXXXXXXXXXXXXXX.
     104          91  XXXXXXXXXXXXXXXXXXXXXXX:XX
     103          93  XXXXXXXXXXXXXXXXXXXXXXXXX.
     128          95  XXXXXXXXXXXXXXXXXXXXXXXXXXX:XXXX
     134          97  XXXXXXXXXXXXXXXXXXXXXXXXXXXXX:XXXX
     107          99  XXXXXXXXXXXXXXXXXXXXXXXXXXX   .
     102         101  XXXXXXXXXXXXXXXXXXXXXXXXXX    .
     105         103  XXXXXXXXXXXXXXXXXXXXXXXXXX   .
     128         105  XXXXXXXXXXXXXXXXXXXXXXXXXXX:XXXX
     113         107  XXXXXXXXXXXXXXXXXXXXXXXXX:XX
     103         109  XXXXXXXXXXXXXXXXXXXXXXX:XX
      90         111  XXXXXXXXXXXXXXXXXXXX:XX
      76         113  XXXXXXXXXXXXXXXXXX:
      57         115  XXXXXXXXXXXXXX .
      66         117  XXXXXXXXXXXX:XXXX
      36         119  XXXXXXXXX .
      42         121  XXXXXXX:XXX
      25         123  XXXXX:
      24         125  XXXX:X
      13         127  XXX.
      10         129  XX:
      10         131  X:X
                     I....+....I....+....I....+....I....+....I....+....I
                     0         40        80        120       160       200
                               Histogram Frequency
Random Normal
Mean          99.984      Std Err         .291      Median      100.000
Mode          94.000      Std Dev       13.014      Variance    169.369
Kurtosis        .042      S E Kurt       1.999      Skewness       .037
S E Skew        .055      Range         98.000      Minimum      56.000
Maximum      154.000      Sum       199967.000
Number of cases  2000
```

Notes: (1) the "." on the plot are the expected normal frequencies overlayed on the observed frequencies.

PH.2: Plot of residual values for Articulated vehicles in NSW

```
    Count   Midpoint
        4      -23.5  :
        5      -22.0  X.
        5      -20.5  X.
       10      -19.0  XX:
       17      -17.5  XXX:
       21      -16.0  XXXXX.
       21      -14.5  XXXXX .
       40      -13.0  XXXXXXXX:X
       55      -11.5  XXXXXXXXXXX:XX
       70      -10.0  XXXXXXXXXXXXX:XXXX
       42       -8.5  XXXXXXXXXXX    .
       91       -7.0  XXXXXXXXXXXXXXXXXX:XXXX
       54       -5.5  XXXXXXXXXXXXXX      .
      119       -4.0  XXXXXXXXXXXXXXXXXXXXXX:XXXXXXX
      100       -2.5  XXXXXXXXXXXXXXXXXXXXXXX:X
      120       -1.0  XXXXXXXXXXXXXXXXXXXXXXXX:XXXXX
       77         .5  XXXXXXXXXXXXXXXXXXX     .
      110        2.0  XXXXXXXXXXXXXXXXXXXXXXX:XXXX
       87        3.5  XXXXXXXXXXXXXXXXXXXXXX.
       98        5.0  XXXXXXXXXXXXXXXXXXXX:XXXX
       55        6.5  XXXXXXXXXXXXXX    .
       73        8.0  XXXXXXXXXXXXXXXX:X
       37        9.5  XXXXXXXXX     .
       55       11.0  XXXXXXXXXXX:XX
       38       12.5  XXXXXXXXX:
       35       14.0  XXXXXXX:X
       29       15.5  XXXXX:X
       17       17.0  XXXX.
       10       18.5  XX:
       13       20.0  X:X
        5       21.5  X.
                     I....+....I....+....I....+....I....+....I....+....I
                     0         40        80        120       160       200
                               Histogram Frequency
```

Articulated vehicles - NSW

```
Mean              .001     Std Err          .237     Median          -.260
Mode             -.260     Std Dev         9.296     Variance       86.423
Kurtosis          .306     S E Kurt        1.999     Skewness         .052
S E Skew          .062     Range          66.900     Minimum       -33.160
Maximum         33.740     Sum             1.600
Valid Cases       1538     Missing Cases       1
```

Notes: (1) the "." on the plot are the expected normal frequencies overlayed on the observed frequencies.

PH.3: Plot of residual values for Articulated vehicles in ACT

```
    Count   Midpoint
        0      -25.0  .
        1      -23.5  :X
        0      -22.0  .
        1      -20.5  X:
        1      -19.0  XX.
        1      -17.5  XX .
        0      -16.0      .
        5      -14.5  XXXXXX:XXX
        4      -13.0  XXXXXXX:
       10      -11.5  XXXXXXXXXX:XXXXXXXXX
        1      -10.0  XX          .
        7       -8.5  XXXXXXXXXXXXXX.
        7       -7.0  XXXXXXXXXXXXXX  .
       18       -5.5  XXXXXXXXXXXXXXXXXX:XXXXXXXXXXXXXXXXX
        7       -4.0  XXXXXXXXXXXXXX      .
       22       -2.5  XXXXXXXXXXXXXXXXXXXXX:XXXXXXXXXXXXXXXXXXXXXX
        9       -1.0  XXXXXXXXXXXXXXXXXX    .
       11         .5  XXXXXXXXXXXXXXXXXXXXXX.
        3        2.0  XXXXXX               .
       15        3.5  XXXXXXXXXXXXXXXXXXXX:XXXXXXXXX
       10        5.0  XXXXXXXXXXXXXXXXXXXX:
       13        6.5  XXXXXXXXXXXXXXXXX:XXXXXXXX
        7        8.0  XXXXXXXXXXXXXX .
        4        9.5  XXXXXXXX    .
        3       11.0  XXXXXX    .
        3       12.5  XXXXXX  .
        2       14.0  XXXX  .
        1       15.5  XX   .
        0       17.0     .
        3       18.5  XX:XXX
        2       20.0  X:XX
        3       21.5  X:XXXX
        0       23.0  .
        1       24.5  :X
                     I....+....I....+....I....+....I....+....I....+....I
                     0         5         10        15        20        25
                                   Histogram Frequency
```

Articulated vehicles - ACT

```
Mean           -.001     Std Err          .697     Median        -1.210
Mode          -2.210     Std Dev         9.245     Variance      85.466
Kurtosis       1.500     S E Kurt        1.989     Skewness        .640
S E Skew        .183     Range          62.180     Minimum      -22.940
Maximum       39.240     Sum             -.230
Valid Cases      176     Missing Cases       1
```

Notes: (1) the "." on the plot are the expected normal frequencies overlayed on the observed frequencies.

APPENDIX I - Radar, Amphometers and Automatic counters

1. Bias induced by Radar vs Amphometer speed measurement.

There is considerable controversy over the bias that using a speed deterrent device has on free speeds. The argument suggests that speeds measured with radar will be reduced because radar can be detected by radar detectors in vehicles.

Truck drivers have radar speed detectors of considerable sensitivity and complexity. They often travel in a convoy with the "detector" up front. CB radio is also used extensively by truck drivers for social contact, making other drivers aware of driving hazards ahead and to warn of the presence of either police enforcement or other suspicious roadside activity, i.e. speed surveys.

Police forces have responded to these detectors by

* having them banned
* switching to other undetectable (for the moment) radar bands
* using "slant" radar which because it slants acutely across the road is virtually undetectable until it is too late.

Thus it is reasonable to assume that if radar (which is used by Police as an enforcement tool) is used for measuring speeds as part of a speed survey that truck drivers driving behaviour will be affected. Field team experience suggests that as soon as a radar beam is detected, a truckie will measurably put on the "anchors" (brake and slow down). However, this is not always the case.

Equally, the proponents of automatic classifiers suggest that automated speed recording is unobtrusive and indicates higher mean free speeds than recorded by radar (Wells 1987). Automatic classifiers however are not as accurate and reliable as their proponents suggest.

In Norrish's (Norrish 1985) paper on automatic classifiers and their accuracy he found that the amphometer speeds were all <u>higher</u> than the automatic classifier speeds.

Armour found (Armour 1984) in a paper which examined the effect of police presence on urban driving speeds that the number of vehicles exceeding the speed limit can be reduced by two thirds by visible police activity. However, drivers returned to their normal driving behaviour very soon after passing the police. She also noted a "memory effect" of the police presence for a period of less than two days.

There is little evidence to suggest that these enforcement effects can be generalised to rural drivers with the exception of the immediate speed reduction in the obvious presence of police.

The work by Johnston & Fraser (Johnston & Fraser 1983) suggested that visible vehicle detectors did not influence driver behaviour. Thus there is contradictory evidence regarding the drivers' response to the presence of a speed detector.

Very few studies have met this controversy head on. One such is by Croft (Croft 1985) when reviewing speed limit differentials for HCVs. In table 3 (Croft 1985, 9) he presents the results of "a series of replicated measurements" taken on a rural freeway in mid 1985 using both radar and amphometers. The recordings occurred in two blocks, one at night and the other during the day.

Croft concluded that:

1. there was no difference in car speeds as measured by either instrument during either time period.
2. night time truck speeds as measured by amphometers were higher than the radar speeds. There was no difference during the day. (Croft 1985, 9).

In interpreting these results, Croft has not outlined the method by which these "replications" were carried out. Were the radar and amphometer readings concurrent at the same location or were they separated? Was the amphometer placed two or three kilometres up road from the radar or vice versa? Without any description of the experimental design adopted, the results cannot be relied upon.

All the studies reviewed on this question lack a good discussion of experimental design. Could a repeated measures design be implemented? Would some sort of blocking help differentiate the treatment effect ? And which are the factors and which the treatment effects? The research question to be asked may not be whether radar biases speed but how good are radar detectors at detecting radar and how many drivers use them?

This present study was not designed to address the radar bias question. However, some overall results may add further fuel to the debate.

Table I1 summarises the results of this study's observations regarding the radar induced bias of free speeds. The following conclusions and cautions can be drawn:

1. Over all study stages radar recorded speeds (94.9 km/h) were LOWER than non radar recorded speeds[26] (102.2 km/h). This difference was statistically significant.

   An ANOVA to test and remove the State by Radar and State by speed limit interactions is required to test whether the observed effect is confounded by these interactions.

2. The table has aggregated all study stages together thus smoothing the speed limit increases for trucks from 80 to 90 km/h. It has also aggregated cars and trucks together. Croft suggested (Croft 1985, 9) there were differences between vehicle types. These effects may be confounding the results.

---

[26] No automatic recording data was used in this study. Thus "non radar" recorded speeds refer to amphometer and infra-red beams.

Table I1 : Speed measurement devises and their effect on mean free speeds. All study stages combined.

	Mean (kph)	Std dev	Sample size
RADAR measurement			
NSW	101.7	12.8	867
VIC	93.1	11.8	11181
QLD	94.6	11.7	18656
SA	99.4	14.2	11833
TAS	89.4	13.3	3551
ACT	93.0	12.3	7701
Total	94.9	12.8	53789
Amphometers or Digitectors beams			
NSW	101.4	12.7	12237
WA	103.1	14.2	9855
Total	102.2	13.4	22092
Grand total	97.0	13.4	75881

Notes:

(1) The difference between the total mean for Radar (94.9) and that for other devises (102.2) is statistically significant (one way ANOVA, alpha < 0.05)

(2) The above difference may be confounded by the inter state differences in speed limits. Thus WA had speed limits of 100kph which increased to 110kph for articulates.

3. A contra indication for the bias argument is present in NSW where they used both devices. There was NO difference in the mean free speeds recorded. The sample sizes are small.

Summary:

1. The argument that radar induces bias in speeds cannot be confirmed or denied by the results from table I1. The results contain too many confounding factors.

2. Better experimental designs are required to fully assess the question of radar induced bias.

2. Automatic traffic counters - Victoria and New South Wales

The use of automatic traffic counters is a long and thorny debate. It also arises in regard to the induced bias of using radar speedguns to record vehicle speeds.

Automatic traffic loggers such as the "Saratosa traffic classifier" consist of two 2.5m rectangular loops which are either taped or embedded in the road surface. The loops are connected to the classifier which controls the resonate frequency in the loops and logs both the vehicle length and its speed into counting "bins". Thus for vehicle length there are two bins into which all vehicles passing over the loops are placed. These bins are usually set to less than or equal to 6m and greater than 6m.

The classifier can be "interrogated" by another portable computer such as a NEC 8201A laptop which is used to both program the classifier and download the contents of the bins for latter analysis.

3. Victoria

An analysis of truck speed data obtained from automatic classification counters was sent to FORS after the October 1986 stage 1 surveys. It is a draft paper produced in February 1987 by Lynette Wells of the Victorian RTA.

The methodology adopted by the RTA consisted of overlapping automatic counting operations with the FORS speed surveys in October 1986 at a small number of the sites.

The thrust of Lynette Wells' paper is that when the radar was present during these automatic data counting periods the speeds recorded were significantly reduced. The point that has been completely missed is just how accurate is the automatic data whether the radar is present or not.

Victoria propose the automatic counters should be used as the only source of measuring both vehicle type and speeds. Yet it does not present any evidence as to the accuracy of these automatic devices in measuring either vehicle type or speed.

Interestingly enough the engineer's comments on this study make no note of these points at all but says (note 5.4)

> "A previous study conducted using this technique, i.e. using radar and monitoring driver reaction using CB radios, was conducted by a firm of consultants in 1978". This refers to the Callaghan study (Callaghan 1978) "and no problems in the use of radar are reported in that survey."

Two quite separate hypotheses arise regarding the automatic counting data presented by Victoria. These are:

1. What calibration results are available for the automatic data provided. Two sets of calibration variables at least are required:

   a. how accurate is the automatic counter in classifying articulated vehicles/trucks (> 6m in length) from other vehicles such as cars. The sum of the two length bins also addresses the question of straight vehicle counts. The evidence from other States such as NSW (both TA and recently the Department of Main Roads) suggests that their accuracy is not as high as the manufacturers maintain and can be in error by as much as 15 per cent.

   b. how accurate is the automatic counter data at classifying the speeds of the vehicles passing over the loops.

   The calibration data could either come from laboratory research under tightly controlled circumstances or from matched experimental designs in which another fully calibrated speed and vehicle counting instrument (such as the infra-red light beams with human counters) was used.

2. Assuming that the automatic counters are accurate and fully calibrated (which they are not), what bias is induced by the presence or absence of radar speed recording.

   It has been shown elsewhere by Croft (Croft 1985) and above that radar does induce bias.

The paper by Lynette Wells addresses this bias hypothesis, not the calibration problem. The paper assumes that the base measuring instrument (the automatic counter) is fully calibrated and is a totally accurate measuring instrument upon which to compare the radar results. There is no evidence presented in this paper that substantiates the calibration or accuracy of the automatic counter.

Thus the results quoted in this paper are seriously confounded. Does the bias come from the radar or from the automatic counter? The question becomes: Which is in error, the radar or the automatic counter? Wells implies that because the automatic counter is accurate the error is induced by the presence of radar.

In summary what is needed to resolve the issue regarding automatic counters is:

1. A calibration study of the automatic counters.
2. A matched experimental design of radar and automatic counters with controls.
3. An evaluation of field team induced error i.e. recording errors.

Because the data provided by Victoria did not address the calibration hypothesis no further analysis was justified.

4. New South Wales

A brief paper titled "Comparison of vehicle speed measuring equipment" by Norrish (Norrish 1985) of the Traffic Authority of NSW produced equivocal results. The study was designed to address the calibration hypothesis cited above.

Some interesting points emerged.

1. The "Saratosa VC1900" traffic classifier costs some $6000 and is used in conjunction with a NEC 8201A laptop computer for interrogation of the classifier.

2. The classifier collects the length and speed data into bins which are dumped to the data logger every 15 minutes. Thus individual vehicle free speeds with time stamping is unavailable for any calibration research.

3. The test equipment was set up by the Australian supplier "Australasian Traffic Surveys". Tuning the loops is considered a delicate "black art" by the supplier.

4. This loop frequency tuning required the use of a radar speedgun to calibrate the classifier.

5. No calibration data for the classifier is available from the supplier.

Table I2 outlines the comparison between the automatic classifier's total traffic count compared to simultaneous manual counts. There were seven separate samples taken and in every case except one (sample 3) the two counts differ. A goodness of fit test using the manual count totals as the expected frequency indicated that the classifier count totals were not significantly different from the manual expected frequencies.

The results of Norrish's comparison were "disappointing". The study did not recommend the adoption of the classifier.

Table **I2:** *NSW Traffic Authority automatic counter data vs manual traffic counts validation tests.*

Sample	*Automatic counter*			*Manual counts*		
	< 6 m	*> 6 m*	*Total*	*Cars, 1van, mcyc*	*Artic*	*Buses, Trucks Total*
1	80	74	154	69	71	140
2	63	104	167	56	94	150
3	60	93	153	61	92	153
4	36	91	127	36	79	115
5	7	19	26	8	20	28
6	13	33	46	12	38	50
7	27	49	76	35	42	77

Notes:
(1) A chi-squared test of goodness of fit between the totals for the automatic (observed) and manual data (expected) gives:
Chi-squared = 5.05, df = 6 with an alpha level of 0.54. Thus the test indicates that the observed frequencies are not significantly different from the expected frequencies.
(2) The automatic counter used was a 'Saratosa' traffic classifier installed by 'Australasian Traffic Surveys' for the NSW TA.
(3) Manual counts were carried out by an experienced field team from the NSW TA.
(4) The samples were conducted on 28-29 May, 1985, 23 km south of Berrima on the Hume highway.
(5) Data supplied by the NSW TA, paper F733.
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IX. INDEX

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