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AN EVALUATION OF THE 50 KM/H SPEED LIMITS IN SOUTH EAST QUEENSLAND

by

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Abstract:

A 50 km/h default speed limit was introduced in built-up areas in South East Queensland in March 1999 with the primary aim of reducing the incidence and severity of casualty crashes. An evaluation of this initiative by Queensland Transport (QT), using a control chart style of statistical analysis, revealed significant reductions in the number of both serious and fatal crashes, translating into substantial social cost savings on projected outcomes. QT, in accordance with its adoption of a recommendation by the Parliamentary Travelsafe Committee to obtain ‘independent external evaluations of Queensland Transport’s major road safety countermeasures’, commissioned MUARC to analyse the program effectiveness and assess the internal evaluation undertaken by QT.

This report details the results of this analysis, performed using Poisson log-linear regression, and compares the outcomes of the two evaluations. The MUARC evaluation found that the implementation was associated with statistically significant average yearly reductions of 88%, 23% and 22% for fatal crashes, all casualty crashes and all reported crashes, respectively. Crash reductions appear to have increased with time after program implementation for each crash severity level considered. Analysis of speed survey data associated with the program implementation suggested these crash reductions stemmed largely from a reduction in excessive speeding in 50km/h zones rather than large reductions in mean speeds at the affected sites.

These results showed that QT internal evaluation underestimated the impact of the 50 km/h implementation. This resulted from a poorly specified treatment area that consisted of roads other than those that had changed to 50 km/h. This study also affirmed that the assumptions underlying the control chart method used by QT did not meet the theoretical properties of the crash data and formal statistical evaluation of program effects was better undertaken using Poisson regression techniques. However, the control chart method was endorsed as a satisfactory method for internal monitoring of program performance.

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Preface

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EXECUTIVE SUMMARY

In March 1999, a 50 km/h default speed limit was introduced in built-up areas in South East Queensland with the primary aim of reducing the incidence and severity of casualty crashes. An evaluation of this initiative by Queensland Transport (QT), in December 2001, revealed significant reductions in the number of both serious and fatal crashes, translating into substantial social cost savings on projected outcomes. The methodology employed by QT to evaluate the effectiveness of the program entailed the application of a control chart style of statistical analysis, an analysis technique widely used in road safety program evaluations, due to its ease of application and interpretation.

QT, in accordance with its adoption of a recommendation by the Parliamentary Travelsafe Committee to obtain 'independent external evaluations of Queensland Transport's major road safety countermeasures', commissioned MUARC in July 2002 to assess the methodology used by QT, and undertake an analysis of this countermeasure. This report details the results of this analysis, performed using Poisson log-linear regression, and compares the outcomes of the two methodologies.

Analysis of crash frequency data using 62 months of pre implementation and 39 months of post implementation crash data was performed under a quasi-experimental design framework. Statistically significant estimated crash reductions in 50 km/h zones were obtained, relative to changes observed in crash frequency in all speed zones remaining 60km/h in South East Queensland for various crash severity levels. On average, statistically significant yearly estimated reductions of

- 88% for fatal crashes (cf. 50% reduction found by QT);
- 24% for serious casualty crashes (cf. 7% reduction found by QT);
- 23% for all casualty crashes;
- 20% for all property damage crashes; and
- 22% for ALL reported crashes (cf. 12% reduction found by QT)

were obtained for each post-implementation year when compared to the 5-year pre-implementation period. These results are relative to 60 km/h speed zones and were achieved during the full enforcement period following implementation. Generally, statistically significant results were not achieved during the amnesty period relative to all speed zones greater than 50 km/h.

Compliance of the new legislation was also examined via analysis of speed survey data. It was found that there was an overall small decrease of 2.2 km/h in mean speed and 1.5 km/h decrease in 85th percentile speed. In contrast, there were large reductions in the proportion of drivers exceeding 60, 70 and 80 km/h.

Comparison of the MUARC and QT results suggest that the QT methodology has underestimated the true impact the program has had in reducing road crashes in S.E. Queensland. The main source of inaccuracy was identified as being due to an inappropriate choice of treatment group in the QT evaluation. The Poisson log-linear regression model is recommended as the appropriate analysis tool for formal statistical evaluation in this instance although the control chart technique is endorsed as an adequate tool for internal monitoring of program performance by QT.

1 INTRODUCTION AND BACKGROUND

A default 50 km/h speed limit was introduced in built-up areas in 11 local government areas in South East Queensland on 1 March 1999 in an effort to lower the incidence and severity of casualty crashes. This countermeasure was brought in with the aim of reducing the number of crashes in residential areas after research revealed that up to 30 per cent of casualty crashes occur on residential streets (Austroads, 1996).

An evaluation of this speed management program, conducted by Queensland Transport (QT) in December 2001, revealed significant reductions in both fatal and serious injury crashes, and substantial overall social cost savings. The appraisal method employed involved a control chart analysis technique, widely used by QT in internal road safety program evaluations because of the technique's accessibility to those with limited analytical skills.

One of the recommendations put forward by the Parliamentary Travelsafe Committee in Report 32 was for QT to 'obtain independent external evaluations of all the department's major road safety countermeasures'. In accordance with this, QT commissioned the Monash University Accident Research Centre (MUARC) in July 2002 to evaluate the 50 km/h speed limit in South East Queensland and the methodology used in the QT analysis.

The aims of the MUARC evaluation therefore are as follows:

1. To estimate the net effect of 50 km/h speed limits on crash frequency and severity in South East Queensland via a comprehensive crash analysis using a statistically rigorous technique.

2. To compare and contrast the methods and results of the internal QT evaluation of the same program with those in this study.

3. To investigate the effect of the 50 km/h speed limit on vehicular speeds through a descriptive analysis of South East Queensland speed data collected by several local government areas (LGAs) using five speed parameters as measures of speed trends. These include mean speed, 85^{th} percentile speed, and the proportions of motorists exceeding 60 km/h, 70 km/h and 80 km/h.

Full enforcement of this program has been in effect since 1 June 1999 following a 3-month amnesty period. To investigate the effects of the new speed legislation *without* enforcement, the amnesty period was also considered in the crash analysis. Results for this period for all crash severity levels are also presented.

1.1 OTHER EVALUATIONS OF THE 50 KM/H SPEED LIMITS

With the exception of Queensland, only New South Wales and Victoria have to date evaluated the impact of the 50 km/h speed limit countermeasure on urban crash frequency in their respective states. Both evaluations found statistically significant reductions associated with the introduction of the lower speed limit and reported on the size of the effect for various accident types and severity levels. Effects on speeding behaviour were also investigated and reported in conjunction with the results of the crash analyses.

The implementation of 50 km/h zones in NSW was confined to areas identified in consultation with local councils and the community and was accompanied by the extensive use signage to identify the 50 km/h roads. The evaluation used 2 years of post implementation crash data and reported a 25% decrease in all reported crashes and a 22% decrease in casualty crashes. The study found that these reductions were largely attributable to significant decreases in the proportion of drivers exceeding 60, 70 and 80km/h.

The Victorian 50 km/h implementation differed to that in NSW in that the Victorian speed limit change was introduced as a default speed limit in built up areas where no other signed speed limits applied. It was much wider in its coverage, extending to all local roads in built up areas as well as a number of collector level roads, and was generally not regulated by signage. The interim evaluation considered only 5 months of post implementation crash data and found statistically significant reductions for all casualty crashes in the order of 12%. Due to the relatively short post-implementation period, statistically significant results were not achieved for fatal or serious injury crashes. Further updates of the analyses are planned to establish the effectiveness of the program. Decreases in the mean and 85th percentile speeds determined in a separate study were found to be consistent with the crash reduction estimates. Proportions of drivers speeding excessively were not investigated.

Both evaluations employed Poisson log-linear regression within a quasi-experimental design framework. An important aspect of the methodology common to both evaluations, however, was the identification of the treatment group. Although the technical aspects of identification process differed slightly in the two evaluations, the treatment groups comprised only of crashes from both before and after the implementation that had occurred in areas currently zoned 50 km/h.

2 QUEENSLAND TRANSPORT EVALUATION OF THE 50 KM/H SPEED LIMIT – METHODOLOGY AND FINDINGS

An internal evaluation of the 50 km/h default speed limit, applied to the 11 LGAs in South East Queensland, was conducted by Queensland Transport in December 2001. This evaluation measured the effectiveness of the legislation on crashes using a quasi-experimental design and a control chart style statistical technique. For the purposes of a comparison with the MUARC methodology, it is useful to state, in brief, the methods used in the evaluation of the program.

Under the quasi-experimental design framework, 'treatment' and 'control' groups were selected. The treatment group was defined as those crashes that had occurred on 40km/h to 60 km/h roads in South East Queensland from January 1993 to June 2001. It should be noted that this choice of 'treatment' group encompassed crashes that had occurred on 'untreated' roads, that is, roads on which the change to a 50 km/h speed limit had not been applied. The control group, chosen using identical speed limits and time frames, consisted of crashes that had occurred *outside* of South East Queensland.

Using the control-chart methodology, a regression line was established which summarised the linear trend in the ratio of the treatment to control crash series in the pre-treatment period. Extrapolation of this linear trend line into the post-treatment period provided the basis from which the crash effects could be calculated. These calculations are based on the assumption that the extrapolated trend would continue into the future if the treatment had not been implemented. The measure of treatment crash effect is then the difference between the observed ratio of treatment to control crashes in the after period and that expected from the pre-treatment trend extrapolation.

This analysis resulted in the following findings:

- a 50% reduction in the number of fatal crashes;
- a 7% reduction in the number of crashes resulting in hospitalisation of an occupant; and
- a 12% reduction in the number of crashes overall[1].

Queensland Transport acknowledged that although the assumptions in the methodology used may have compromised the results of the study, it is likely the technique has led to conservative estimates of the program's crash effects (Queensland Transport, 2001). The QT results are discussed in a later section of this report in conjunction with the findings from the MUARC analysis. A comprehensive comparison between the control chart and log-linear analysis methods can be found in Newstead (2000).

[1] It is understood that the projected decrease of 12% in overall social costs (Queensland Transport, 2001) applies to ALL crashes in S.E. Queensland. It is assumed, therefore, that this decrease equally applies to a reduction in all road crashes.

3 STUDY DESIGN AND DATA

3.1 STUDY DESIGN

As with the QT analysis, a quasi-experimental design was also employed in this study, a design commonly adopted in the absence of randomly assigned control and treatment groups. Under this design strategy a control group(s) characteristically similar to the treatment group is chosen to represent the influence of factors other than those related to the intervention. The choice of treatment group is also critical, as shown later in this report.

The treatment group in this study consisted of those crashes that had occurred on roads that had changed from 60 km/h to 50 km/h as a result of the implementation in S.E. Queensland. Identification of these crashes is described in the following sub-section.

Crashes occurring on other roads both within and outside S.E. Queensland served as a basis from which to choose the control groups. Four control groups were selected to serve as a basis for comparison to the treatment group. This also allowed for a means of assessing the robustness of the results. The control groups considered in this study were as follows:

i. All crashes that had occurred on roads that remained 60 km/h in S.E. Queensland;

ii. All crashes that had occurred in speed zones remaining 60 km/h or greater in S.E. Queensland;

iii. All crashes that had occurred in 60 km/h zones outside S.E. Queensland; and

iv. All crashes that had occurred in 40 – 60 km/h speed zones outside S.E. Queensland.

The most appropriate control group was considered to be those crashes that had occurred in 60 km/h speed zones in S.E. Queensland. In terms of traffic and physical characteristics, 60 km/h roads are likely to be relatively the most comparable to 50 km/h roads compared to urban roads with higher speed limits. Control (ii) was chosen on the basis that it might provide equivalent control information but with additional data, thereby enhancing the power of the statistical test. Control (iii) was selected in order to measure the effects of the program in comparison to 60 km/h crashes outside of S.E. Queensland, while control (iv), the same control selected by QT, was chosen to enable a direct comparison of estimates resulting from the QT and MUARC methodologies.

3.2 CRASH DATA

Queensland crash data covering the period January 1994 to June 2002 was supplied to MUARC by QT for use in this study. This data set comprised all Police-reported crashes in Queensland and ranged from property damage crashes through to fatal crashes in severity. Data for June 2002, however, was incomplete and excluded from the analysis.

To conduct this evaluation, it was necessary to identify the crashes that had occurred on roads that had been changed from 60 km/h to the 50 km/h default speed limit. These crashes would then comprise the treatment group. Ideally, this process would have been undertaken using an inventory of the current speed zoning of all roads in Queensland that could be attached to the crash data records. Unfortunately, such an inventory was not available for this project. Instead, QT identified these crashes for use in this evaluation via the following process.

A unique identifying number identifies roads on which crashes occur in the Queensland crash database. The crash data also gives the speed zone posted at each crash site at the time of the crash. For crashes occurring in 50 km/h zones after the 50 km/h implementation, it was possible to obtain the identifying numbers for the roads on which these crashes occurred. Using these same road identifying numbers, it was then possible to select crashes occurring on the same roads before the 50 km/h implementation. Crashes occurring on roads identified as having changed to 50 km/h were then flagged using an indicator variable. The indicator variable, 'on50kph', consisted of two levels, namely 'yes' and 'no'. Using this variable, roads from the pre implementation period that had undergone the default speed limit change were identified for inclusion in the treatment group.

It should be noted that although all crashes in the 'yes' field of the 'on50kph' variable were chosen to represent the treatment group, there were many S.E. Queensland crashes in 50 km/h zones classified into the 'no' field of the indicator variable. These crashes may also have been candidates for the treatment group. Examination of data classified into the 'on50kph=no' field found that crash frequency on 50 km/h roads increased after the implementation. QT explained that the majority of these crashes occurred at intersections between 50 km/h roads and roads with higher speed zones. It was decided not to include these intersections in the treated area as the speed zone on the intersecting road, which might largely determine crash risk, was unchanged. A graph illustrating the distribution of crashes classified under the 'on50kph=no' field of the indicator variable is presented in Figure 3-1. Crashes in this graph have been categorised into three speed zones to enhance clarity.

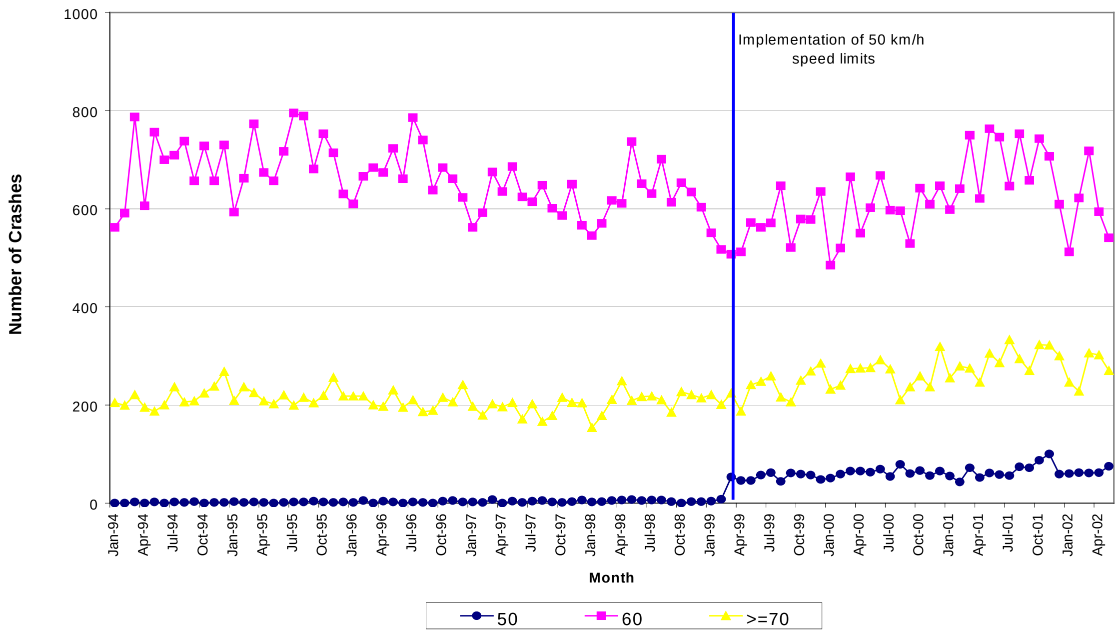

Figure 3-1 **Number of reported crashes in S.E. Queensland classified under the 'on50kph=no' variable between January 1994 to May 2002 by speed zone**

It is possible that not all crashes occurring on roads changed to 50 km/h were captured using the process described above. This situation would have occurred if a road in a 60 km/h speed zone before the change had not recorded any crashes after the implementation. In these circumstances these crashes would be incorrectly identified as belonging to control groups (i) or (ii). This misclassification would serve to produce conservative estimates of the true treatment effect.

Crashes were also classified as having occurred in one of three time periods, that is, (i) before treatment (pre implementation period), (ii) during the amnesty period, or (iii) after treatment after (post-implementation period) using the recorded date of the crash. The before treatment period was defined as January 1994 to February 1999, a period of 62 months. The after period was defined as June 1999 to May 2002, while the amnesty period, lasting 3 months was defined as March 1999 to May 1999.

Five crash severity levels were available in the crash database for analysis and are described in Table 3-1, below.

Level	Crash severity	Description
1.	Fatal	At least one fatality in the crash
2.	Hospitalisation	The most seriously injured person(s) required hospitalisation
3.	Medical attention	The most seriously injured person(s) required medical attention
4.	Minor injury	The most serious injury acquired did not require medical attention
5.	Property damage	Non-injury reported crashes where a car was towed away or property damage exceeded $2500.

Table 3-1 Description of severity levels in Queensland crash data

For the purposes of this analysis, however, the following crash severity level aggregations were considered:

- Fatal crashes;
- Serious casualty crashes (comprising severity levels 1 and 2);
- Casualty crashes (comprising severity levels 1-4); and
- Property damage crashes only.

Fatal crashes typically have low crash count frequencies, even when aggregated on a monthly basis for analytical purposes. For this reason, fatal and serious crashes were pooled to increase sample size and enhance the power of the statistical tests of the presence of an effect on these crashes.

Finally, it is important to note that two years prior to the introduction of the program, a speed limit review in Queensland changed numerous 60 km/h roads to 70 km/h. The affected roads were not identified in the database provided to MUARC whilst dates of these changes are also not known. This information becomes relevant when interpreting crash trends in S.E. Queensland as shown in the Results section of this report.

3.3 SPEED SURVEY DATA

As part of the implementation of 50 km/h zones in South East Queensland, QT undertook speed surveys at selected sites both within and outside the areas of change. The speed survey data collected allowed estimation of five speed parameters from 23 different sites in S.E. Queensland. These parameters include mean speed, 85th percentile speed, and proportions of motorists exceeding 60 km/h, 70 km/h and 80 km/h, respectively. At each of these sites, individual vehicular speeds were surveyed at two or three time periods. These surveys were conducted in 1995, March 1999 and in either July or August 1999. However, not all sites were measured at a third time period and the second time period was inconsistently measured between sites at either the before, implementation or enforcement stage.

A total of 16 treatment sites and 7 control sites were surveyed. These are shown in Table B 1 in Appendix B with the corresponding number of surveys recorded at each site.

4 METHODS

4.1 CRASH FREQUENCY ANALYSIS

4.1.1 Descriptive analysis

Evaluation of the 50 km/h speed limits commenced with descriptive analyses of the crash frequency data. These included comparisons of the total number and average monthly number of crashes for both the pre and post implementation periods for all of Queensland and S.E. Queensland. Descriptive analyses were also conducted for the different severity levels considered in the study as well as for all crashes. The objective of these analyses was to obtain an idea of the general crash trend and highlight any irregularities in the data. The results of these analyses are presented graphically and in tabular format in the next chapter.

4.1.2 Poisson regression analysis

The null hypothesis being tested in this evaluation is that the implementation of the 50 km/h speed limits did not have an effect on crash frequency. This is assessed against the alternative hypothesis that the program brought about some change on crash counts in S.E. Queensland. In this alternative hypothesis, no direction of change is assumed, hence two-tailed tests of significance are used.

To test the above hypothesis, statistical estimates of the crash effects of the program were obtained by applying a Poisson log-linear regression model to the data. This type of model has been applied in many studies evaluating crash data and is based on statistical theory which demonstrates that count data follow a Poisson type distribution (Nicholson 1985, Nicholson 1986, Maher and Summersgill 1996).

Statistical properties of count data include: skewness of the distribution of the events (crashes) over a given time interval, independence of events, a mean that varies with the variance, and restriction to non-negative values. Traditional linear regression requires the data to be symmetric, have a constant variance, and allows negative crash frequencies to be predicted. A Poisson regression model eliminates these problems by applying a log transformation to the crash count data to ensure predicted values are non-negative as well as allowing the error distribution of the crash counts to be Poisson rather than normal. A maximum likelihood method was used to estimate the coefficients of the explanatory variables. Suitable parameterisation of the model allows direct estimation of the program effect estimate. Statistical significance of the program effect estimate is assessed against the corresponding probability value that indicates the likelihood of obtaining the estimate by chance given no reduction in crash frequency. A similar model was used in assessing the crash effects of the Queensland Random Road Watch Program (Newstead et al, 2001).

A Poisson regression model of the following general form was fitted to the monthly series of crash frequency data from the treatment (50km/h) and control (60km/h; or 60km/h and above, etc.) areas.

$$\ln(y_{mtb}) = \alpha + \beta_t + \gamma_b + \delta_t m + \phi_{tb}$$

where

y_{mtb} is the monthly crash count in either treatment or control group

t	is an indicator for treatment or control crash series
b	is an indicator of before, or after 50km/h implementation which can modified depending on the time interval outcome sought (for example, yearly, quarterly, amnesty period)
m	is the sequential month of the crash data count
$\alpha, \beta, \gamma, \delta, \phi$	are parameters of the model

Separate models were fitted to crashes for each severity level (including all casualty crashes) and yearly and quarterly crash effects were obtained for each relative to changes observed in each of the four control groups.

4.1.3 Control chart style analysis

A plot of the ratio of the treatment group selected by MUARC to the control group (iv) was plotted so that it could be compared with the treatment and control group shown in Figure 8 in the QT evaluation report (Queensland Transport, 2001). The purpose of this plot was to graphically depict the impact the choice of treatment group might have on the estimate of the size of the effect. An analysis using this technique was also conducted and the results compared with those obtained from the log-linear model.

4.2 SPEED SURVEY ANALYSIS

Five speed parameters were analysed using descriptive statistical analyses. These parameters include mean speed, 85^{th} percentile speed, and the proportion of motorists exceeding the speed limit by 10 km/h, 20 km/h and 30 km/h respectively. Overall averages for the control and treatment sites were calculated for each of the parameters followed by the overall change for each parameter in the treatment sites relative the control sites. Results are presented graphically in Appendix B and in tabular format in the following section.

5 RESULTS

This section details the results of the analyses conducted on Queensland crash data for the period January 1994 to May 2002. Graphical depictions of the monthly distribution of crashes that occurred in and S.E. Queensland using time series graphs are shown first for all crashes. The total number and monthly average crashes are then presented for pre and post implementation periods followed by the Poisson regression-derived estimates of the net percentage change in crashes for post-implementation yearly and quarterly periods. Following these crash results, findings from the descriptive analyses conducted on the speed survey data are presented.

5.1 CRASH ANALYSIS

5.1.1 Descriptive analyses

Figure 5-1, below, depicts the actual number of crashes of all types that occurred in S.E. Queensland from January 1994 to May 2002 on roads currently speed zoned from 50 km/h to 110 km/h. Crashes that occurred on roads currently signed 90 km/h and over, are collectively displayed under a group titled '≥90 km/h'. Crashes that had occurred on 50 km/h roads (both pre and post implementation) but not identified by QT as having occurred on a road currently operating on a default 50 km/h speed limit (i.e. 'on50kph=no') have not been included in this graph.

Three features are immediately apparent from the chart in Figure 5-1. Firstly, there is a clear decrease in the number of crashes in 50 km/h zones after July 1999, the same point in time full enforcement of the change came into effect. After August 1999, however, crash numbers on these roads appear to have remained stable to May 2002. Secondly, there is a marked increase in the number of crashes in 60 km/h zones around March 2001. Thirdly, crashes in 70 km/h speed zones show an increasing trend beginning around July 1997, which continues to increase steadily after the introduction of the initiative. It is uncertain whether this increase is a result of the Queensland speed limit review. Crash frequency at the higher end of the speed limit spectrum, that is, crashes numbers in speed zones greater than 80 km/h, appear to have remained relatively constant throughout the period under consideration. Crashes on 80 km/h roads appear to have increased only slightly following the implementation. It should be noted that crashes that had occurred on 50 km/h roads (both pre and post implementation) but not identified by QT as having occurred on a road currently operating on a default 50 km/h speed limit, have not been included in this graph.

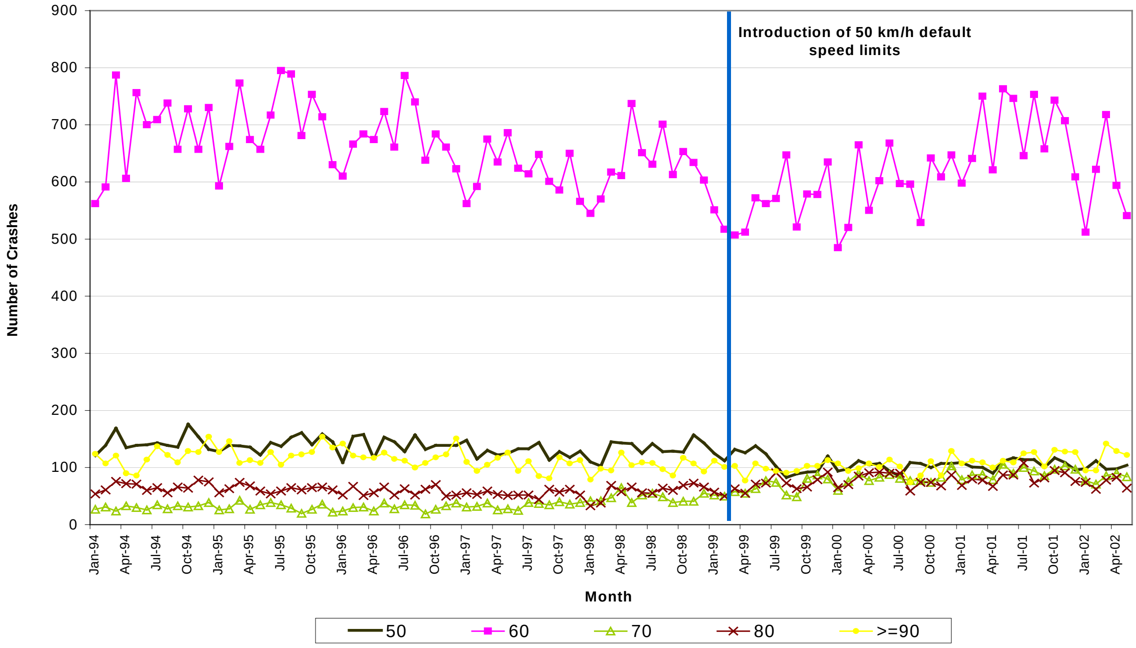

Figure 5-1 **Number of ALL reported crashes in S.E. Queensland by current speed zone – January 1994 to May 2002**

Figure 5-2 depicts the percentage distribution of all crashes using current speed zones. This graph differs from the previous graph in that it shows the change in percentage crash frequency in a particular speed zone, relative to all the other speed zones being considered. Relative to other speed zones, it is crashes on 70 km/h roads *only* that show an obvious upward trend. The most notable aspect of Figure 5-2 compared to Figure 5-1, however, is the relative consistency in percentage crash frequency in 60 km/h speed zones in the period after March 2001.

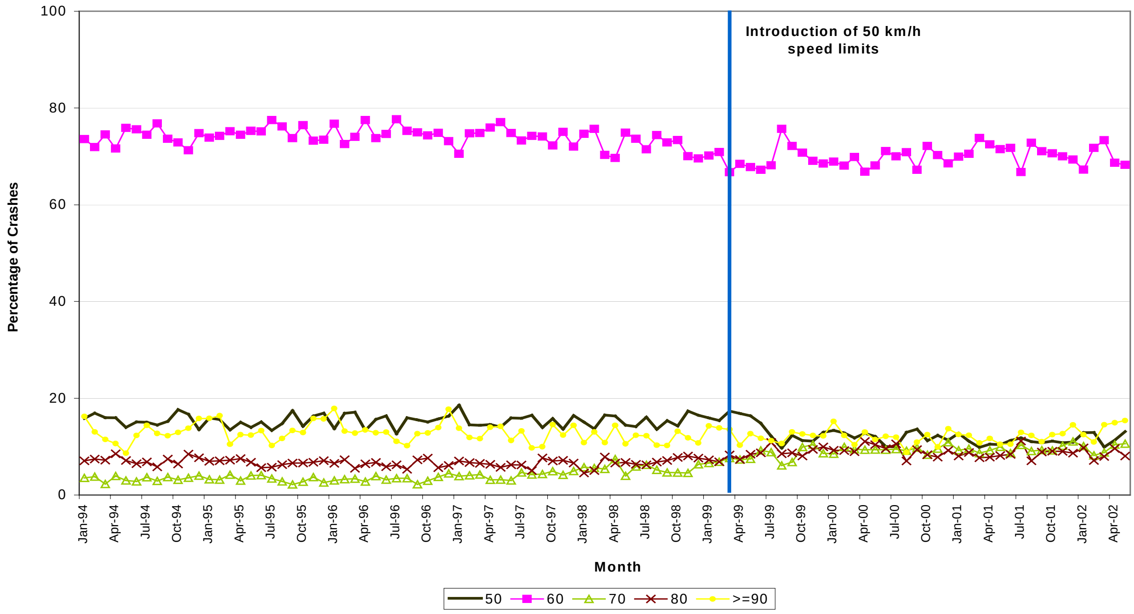

Figure 5-2 **Percentage distribution of ALL reported crashes in S.E. Queensland by current speed zone – January 1994 to May 2002**

The total number of crashes of all severity levels occurring in the period January 1994 to May 2002 for S.E. Queensland are presented in Table 5-1 with corresponding averages for each crash type and period also given. In terms of average monthly crash numbers, Table 5-1 shows that these have declined on current 50 km/h speed zone roads for all crash severity types since the implementation.

	Total Crash Numbers Before and After Introduction of the 50km/h Default Limit		**Average Monthly Crash Numbers Before and After Introduction of the 50km/h Default Limit**	
Crash severity & current speed zone	**Jan-94 to Feb-99 (Before)**	**Mar-99 to May-02 (After)**	**Jan-94 to Feb-99 (Before)**	**Mar-99 to May-02 (After)**
Fatal				
50 km/h	76	27	1.2	0.7
60 km/h	356	151	5.7	3.9
≥ 60 km/h	690	361	11.1	9.3
Serious				
50 km/h	1377	784	22	20
60 km/h	6411	4134	103	106
≥ 60 km/h	9173	6427	148	165
All injury				
50 km/h	4441	2297	72	59
60 km/h	23034	14952	372	383
≥ 60 km/h	30279	21221	488	544
Property damage				
50 km/h	4023	1814	65	47
60 km/h	17848	9064	288	232
≥ 60 km/h	23543	13144	380	337
All crashes				
50 km/h	8464	4111	137	105
60 km/h	40882	24016	659	616
≥ 60 km/h	53822	34365	868	881

Table 5-1 Total and average crash numbers in S.E. Queensland by current speed zone before and after the introduction of the 50 km/h speed limit

5.1.2 Poisson regression analyses

The following tables (Table 5-2, Table 5-3 and Table 5-4) contain program effect estimates of the net percentage change in crashes by severity relative to speed zones that have remained 60 km/h in South East Queensland. Estimates of program effectiveness during the amnesty period and by year and quarter after program implementation have been made. Results relative to 60 km/h zones are shown here as the primary focus amongst the four comparison groups considered as they are considered likely to best represent the effect of other factors on the treatment areas apart from the 50 km/h implementation. Results obtained using zones remaining 60 km/h in South East Queensland for comparison are believed to best represent of the true effect of the program. Program estimate effects obtained using the other three comparison groups are shown in Appendix A (see Table A 1, Table A 2, Table A 3 and Table A 4).

All results were obtained using Poisson regression analysis and are presented with their corresponding statistical significance values. Statistical significance values give the probability of obtaining the estimated crash reduction by chance given the null hypothesis that the implementation has had no real underlying effect on crashes. Low significance probabilities indicate a likely crash effect. Statistically significant results less than 0.05, a point commonly considered to represent a reliable finding, are indicated by shaded regions in the tables. Negative results indicate an estimated net increase in the crash type being considered (relative to changes in crash frequency in 60 km/h zones).

Estimates of the net percentage change in crashes for the three-month amnesty period immediately after implementation, and for each year of the entire full enforcement period of the speed change (ie, June 1999 to May 2002), are shown in Table 5-2. Negative estimates of percentage crash changes in Table 5-2 reflect an estimated crash increase associated with the 50 km/h implementation.

Statistically significant net percentage decreases of at least 84% in fatal crashes were estimated in each of the first three years after the introduction of the 50 km/h limit with no apparent trend to increasing or decreasing effectiveness over time. Significant program effects were not estimated for Year 4 after program implementation. This is most likely due to lack of data, as year 4 after program implementation only comprises the months March 2002 to May 2002. Estimates of effects on fatal crashes were similar for each of the control groups considered in Appendix A in terms of point estimate of effect and statistical significance suggesting the result in Table 5-2 for fatal crashes is robust. With regard to serious crashes, the only statistically significant estimate obtained was for Year 3 of the program with a reduction of 24%.

Analysis of property damage, all crashes and all casualty crashes also showed statistically significant reduction estimates of at least 17% were achieved for every post program year relative to the control group. Crash reduction estimates of between 17% and 30% have been achieved relative to 60 km/h zones. Estimated percentage reductions, by year after program implementation, appear to be relatively consistent across these three crash groups. The estimates also show that the reductions occurred only in the period of full enforcement of the reduced speed limits, after the amnesty period, and appear to be greater in the last two years after implementation.

The only statistically significant crash changes achieved in the amnesty period were for property damage crashes and all crashes, relative to 60 km/h speed zones in S.E. Queensland. It is likely the larger sample sizes associated with these crash types contributed to the increased reliability of the results. These statistically significant changes were indicative of crash increases in 50 km/h zones, relative to crash changes in 60 km/h zones.

	50km/h Zones vs 60km/h Zones in S.E. Queensland	
Crash Severity & Post Program Year	**Crash Reduction Estimate**	**Statistical Significance**
Fatal Crashes		
Amnesty period	29.0%	0.674
Year 1	89.0%	0.0377
Year 2	90.6%	0.0292
Year 3	84.4%	0.0309
Year 4	100.0%	0.9997
Serious Injury Crashes		
Amnesty period	-14.8%	0.3449
Year 1	15.9%	0.121
Year 2	12.0%	0.2497
Year 3	23.7%	0.0317
Year 4	28.5%	0.0674
All Casualty Crashes		
Amnesty period	-11.2%	0.2024
Year 1	17.6%	0.0022
Year 2	21.3%	0.0001
Year 3	29.8%	<.0001
Year 4	24.5%	0.0061
Property Damage Crashes		
Amnesty period	-25.4%	0.0132
Year 1	18.9%	0.002
Year 2	20.9%	0.0008
Year 3	21.7%	0.0019
Year 4	26.7%	0.011
All Crashes		
Amnesty period	-17.6%	0.0085
Year 1	17.4%	<.0001
Year 2	20.9%	<.0001
Year 3	27.2%	<.0001
Year 4	25.6%	0.0002

Table 5-2 Estimated yearly crash reductions in 50km/h zones relative to 60 km/h zones in 70 km/h zones

Figure 5-3 illustrates the fit of the Poisson regression model to the observed monthly crash count in 60 km/h speed zones in S.E. Queensland (control (i)). Predicted crashes are shown for the amnesty period and for each post implementation year. The estimated step change in the monthly level of crashes in the 50 km/h zones and those in the 60 km/h zones in the post implementation period are visible in the fitted model. The differences in the step change at a particular point in the post period represents the net crash effect of the 50 km/h change.

Of note in the graph is the distinct decrease in crash frequency in the 60 km/h speed zones from January 1999 to April 1999. This period coincides with the two months prior to implementation and the first two months of the amnesty period. Similar patterns for the same time period are less obvious in the 50 km/h zones from the graph. Also shown in Figure 5-3 is the increase in observed crashes in 60 km/h zones in 2001 shown earlier in Figure 5-1.

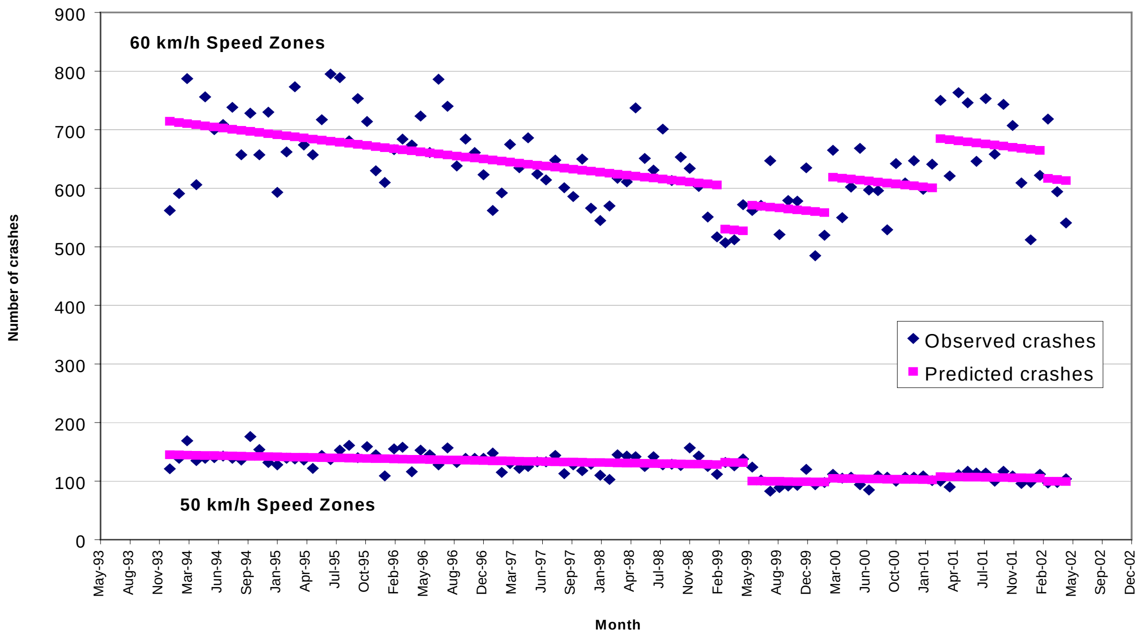

Figure 5-3 Observed and predicted monthly crash frequency for ALL reported crashes in 50 km/h zones and 60 km/h zones – Yearly analysis

Table 5-3 and Table 5-4 present estimates of the net percentage change in crashes for the amnesty period following implementation, and for the entire full enforcement period of the speed change, in quarterly intervals by crash severity. Immediately apparent from these tables is the lack of statistically significant reductions associated with fatal crashes even though the estimates of program crash effects are generally consistent with the yearly analysis results presented above. It is likely that the number of fatal crashes by quarter is not large enough to yield statistically reliable program effect estimates.

For the broader groups of crashes, results of the quarterly crash effects of the 50 km/h implementation are generally consistent with those from the annual analysis presented above in terms of estimated magnitude of effect. Again, however, statistical significance is not obtained for many of the estimates because of the smaller quantities of data present in each analysis cell when analysed in quarterly intervals.

One of the aims of analysing the crash effects of the 50 km/h implementation by quarterly intervals was to better identify trends in the effect estimates than could be done in the annual analysis. Unfortunately, due to the loss of precision in the estimates of program effects when considering quarterly intervals, no definitive conclusions on trends in effects could be identified beyond what has been observed from the annual analysis above.

	50km/h Zones vs 60km/h Zones in S.E. Queensland		50km/h Zones vs 60km/h Zones in S.E. Queensland		50km/h Zones vs 60km/h Zones in S.E. Queensland	
Crash Severity	**Crash Reduction Estimate**	**Crash Severity**	**Crash Reduction Estimate**	**Statistical Significance**	**Crash Reduction Estimate**	**Statistical Significance**
Quarter	**Fatal Crashes**		**Serious Injury Crashes**		**All Injury Crashes**	
Jun-99	27.9%	0.687	-14.9%	0.341	-11.6%	0.190
Sep-99	100%	1.000	-1.5%	0.922	12.8%	0.133
Dec-99	100%	1.000	31.9%	0.033	25.1%	0.003
Mar-00	69.8%	0.271	16.6%	0.272	14.0%	0.116
Jun-00	100%	1.000	-5.3%	0.734	14.0%	0.101
Sep-00	100%	1.000	30.3%	0.042	28.6%	0.001
Dec-00	31.3%	0.745	-0.7%	0.967	14.1%	0.103
Mar-01	100%	1.000	22.4%	0.138	26.3%	0.001
Jun-01	100%	1.000	31.4%	0.032	33.6%	<0.0001
Sep-01	71.2%	0.271	30.0%	0.040	33.8%	<0.0001
Dec-01	100%	1.000	30.0%	0.044	30.3%	0.000
Mar-02	50.5%	0.549	-1.0%	0.953	18.1%	0.045
May-02	100%	1.000	28.3%	0.071	24.0%	0.008

Table 5-3 **Estimated quarterly crash reductions in 50km/h zones relative to 60 km/h zones in S.E. Queensland for fatal, serious and all casualty crashes**

	50km/h Zones vs 60km/h Zones in S.E. Queensland		50km/h Zones vs 60km/h Zones in S.E. Queensland	
Crash Severity	**Crash Reduction Estimate**	**Statistical Significance**	**Crash Reduction Estimate**	**Statistical Significance**
Quarter	**Property Damage Crashes**		**All Crashes**	
Jun-99	-26.3%	0.011	-18.1	0.007
Sep-99	24.6%	0.005	17.7	0.004
Dec-99	21.4%	0.021	22.7	0.000
Mar-00	7.9%	0.410	10.1	0.121
Jun-00	19.3%	0.038	15.9	0.011
Sep-00	26.6%	0.004	27.1	<0.0001
Dec-00	21.1%	0.032	17.1	0.009
Mar-01	12%	0.242	21.1	0.001
Jun-01	33.1%	0.001	33.9	<0.001
Sep-01	9.7%	0.338	24.7	<0.001
Dec-01	23.0%	0.021	27.8	<0.001
Mar-02	16.1%	0.149	18.1	0.010
May-02	25.5%	0.016	24.9	0.000

Table 5-4 Estimated quarterly crash reductions in 50km/h zones relative to 60 km/h zones in S.E. Queensland for property damage and ALL crashes

Figure 5-4 shows predicted crashes for quarterly periods in the post implementation period. Interpretation is analogous to Figure 5-3.

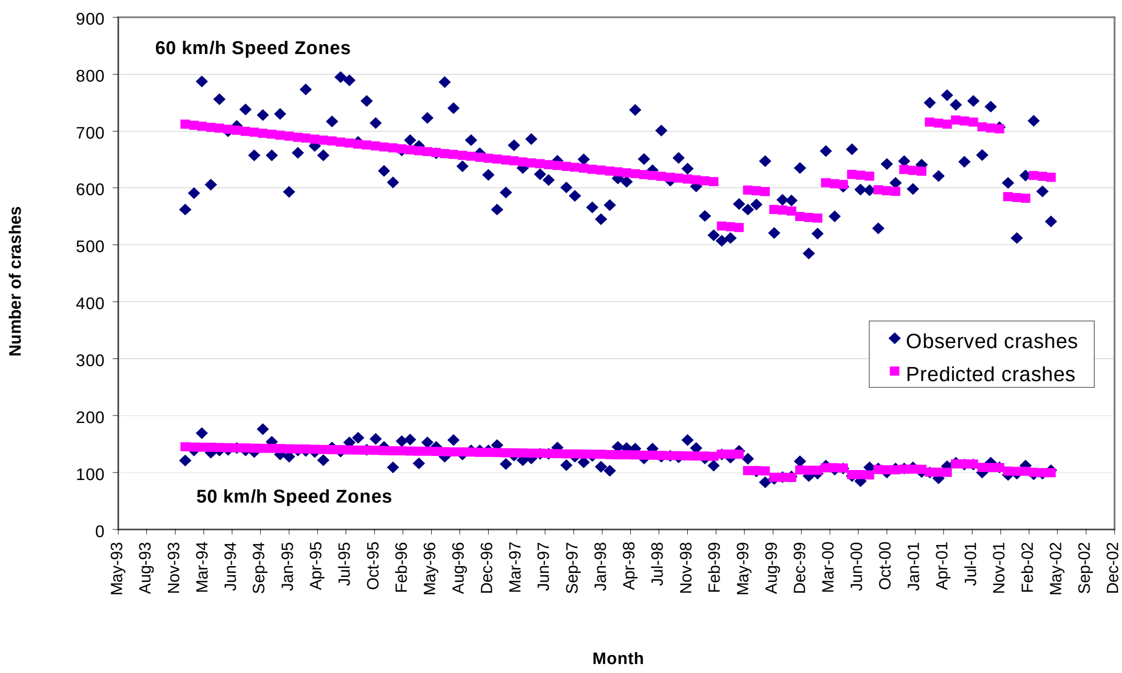

Figure 5-4 **Observed and predicted monthly crash frequency for ALL reported crashes in 50 km/h zones and 60 km/h zones in S.E. Queensland – Quarterly analysis**

5.1.3 Control chart style analysis

One of the aims of this evaluation was to compare the estimates of 50 km/h implementation crash effects obtained in this study with those obtained by QT in its internal evaluation of the same program. One of the difficulties in doing this directly is that the definition of treatment and control areas in this study is quite different to that used in the QT internal evaluation. In order to make a direct comparison between methods, a control chart style of analysis has been carried out on the data as defined in this study.

Figure 5-5 shows a plot of the ratio of the MUARC treatment group to control group (iv) for the period January 1994 to May 2002. All crashes are represented in both groups. Also shown is a plot of the regression line modelled on the ratio of crashes in these two groups and the extrapolation of this estimated regression line to represent projected outcomes had the new speed limit not been implemented. Using the control chart method, the net percentage change between the average number of predicted crashes (obtained from the projected regression line) and the average of the ratio MUARC 'treated' crashes to control group (iv) in the post period, was found to be in the order of 19%. This result falls within the range of estimated reductions (i.e., 17% to 27%) obtained for all crashes in the yearly analysis shown in Table 5-2.

Figure 5-5 is essentially identical to that shown in Figure 8 of the QT evaluation report (Queensland Transport, 2001), the only difference being the selection of the treatment group. It can be seen that the decrease in crashes after implementation is considerably more evident in Figure 5-5 than in Figure 8 of the QT evaluation report. This analysis demonstrates the impact an appropriately chosen treatment group can have on the results of an evaluation.

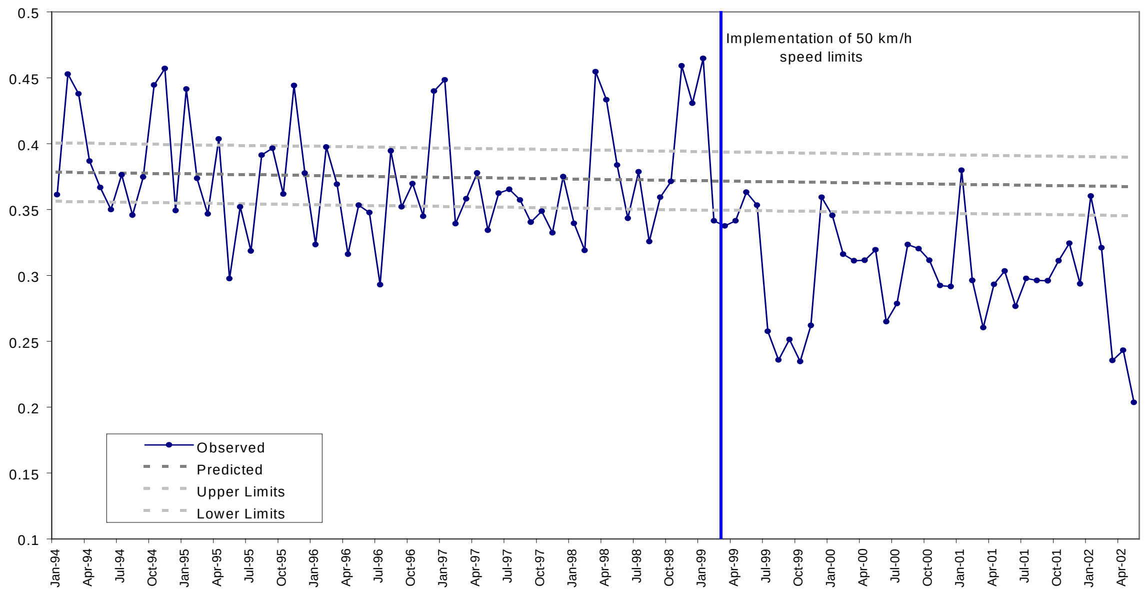

Figure 5-5 **Comparison of projected outcomes using control chart analysis to actual outcome using MUARC treatment group and control group (iv)**

5.2 RESULTS OF SPEED SURVEY ANALYSIS

Estimates for five different speed parameters are presented in Table 5-5 as measures of speed trends for both control and treatment roads in South East Queensland (SEQ). These parameters include the mean speed, 85th percentile speed, and the proportions of motorists checked exceeding 60km/h, 70 km/h and 80 km/h, respectively. Control roads are those that have remained 60 km/h while treatment roads are those on which speed limits have been reduced from 60 km/h to 50 km/h as part of the implementation of the program being studied. The overall change in 50 km/h speed zones relative to the control zones is also shown. A negative value indicates a reduction for the parameter being measured. Detailed charts of each of these parameters for each control and treated site are shown in Appendix B.

Table 5-5 shows a net reduction for all of the speed parameters considered in the speed survey analysis. Relatively small reductions were found in the mean speed and 85^{th} percentile speed in the order of 2.2 km/h and 1.5 km/h, respectively. Substantial reductions, however, were found in the proportion of drivers exceeding 60, 70 and 80 km/h, since the speed limit change. Also of note is the decrease in the proportion of drivers exceeding 60 km/h in the control sites from the before period to the amnesty period and the subsequent increase in the after period. This finding coincides with the fall and rise in crashes in 60 km/h zones in Figure 5-3 around the amnesty period.

Period	Road Type	Mean (km/h)	85th %ile (km/h)	Prop>60	Prop>70	Prop>80
Before Implementation	Control	54.4	62.1	23.0%	3.2%	0.3%
	Treatment	49.2	57.7	11.6%	1.4%	0.2%
Amnesty Period	Control	53.5	61.7	18.6%	4.6%	0.7%
	Treatment	42.8	52.6	3.5%	0.1%	0.0%
After Implementation	Control	49.0	56.4	22.4%	3.6%	0.4%
	Treatment	42.3	51.0	5.3%	0.5%	0.1%
Relative change from before to after periods		-2.2	-1.5	-53.1%	-68.3%	-62.5%

Table 5-5 Speed parameter estimates for before implementation, during amnesty and after implementation of 50 km/h speed limits

6 DISCUSSION

This evaluation has found statistically significant reductions for crashes of all severity levels associated with the 50 km/h implementation. Results for *all* crashes relative to all comparison groups provide compelling evidence in support of the success of the program. Significant reductions, however, were achieved only after the initiative was fully enforced and not in the amnesty period after initial program implementation.

6.1 FACTORS AFFECTING CRASH ESTIMATES

6.1.1 Introduction of the program

Few statistically significant estimates of crash effects were obtained during the amnesty period, most of which indicated an increase in crash frequency in 50 km/h zones. It is highly likely that these estimates are attributable to the fact that the magnitude of crash reduction in 60 km/h zones was greater than that in 50 km/h zones during this period. In terms of the analysis, any decreases in the 50 km/h zones would have been offset by the greater reduction in 60 km/h zones, the net effect of which would be to produce a positive net change.

This sudden reduction in 60 km/h zones, illustrated in Figure 5-3, coincided with the two months prior to implementation and the first two months of the amnesty period. A possible reason for this observed drop on those roads remaining 60 km/h may be associated with mass media publicity campaigns and promotions of the new legislation both prior to and during the implementation. It is possible this publicity caused confusion as to precisely where the new speed limits applied, prompting drivers to reduce speed on roads other than those defined as local roads, resulting in a reduction in crashes in both the defined treatment and control areas. Trends in crashes on roads remaining 60 km/h further suggested that increased familiarity over time reduced uncertainty and drivers resumed normal driving habits, and correspondingly higher crash rates, on 60 km/h roads around May 1999.

Analysis of speed survey data (see Table 5-5) showed that the proportion of drivers exceeding 60 km/h in the control sites (sites that remained 60 km/h) fell by 4.4% from the pre period to the amnesty period and rose by 3.8% soon after the amnesty period. These results also support the theory of a reduction in speed in 60 km/h zones as a result of confusion brought about by the introduction of the speed management program. Interestingly, these results also suggest there may be further substantial crash reduction benefits to be gained from extending the 50 km/h zones beyond those currently defined to areas that remained 60 km/h.

6.1.2 Crash trends in 2001

Most of the larger statistically significant crash reductions seem to have occurred in 2001. These reductions appear to have stemmed more from the increase in crashes on 60 km/h roads than a further decrease in absolute crash numbers in the 50 km/h zones beyond that observed at commencement of the program. Hence, estimated reductions are larger than would be expected if crash numbers in the 60 km/h zone had remained constant. Figure 5-3 and Figure 5-4 clearly illustrate the trends in crash numbers on the two types of roads. It can be seen in these figures that crashes in 50 km/h zones remained relatively constant after the step change in July 1999. The study design assumes the crash count would have also increased proportionally on the current 50 km/h zoned roads had the initiative not been introduced. However, as 60 km/h roads make up a greater percentage of the road network, external changes are likely to manifest themselves more obviously on these sections of roads. Three likely reasons for the increase in crashes on 60 km/h roads include:

a) *An amendment to the Motor Accident Insurance Act:* The Motor Accident Insurance Act was amended in October 2000 to provide that Compulsory Third Party (CTP) claims would not be considered without a police report. Previously, CTP insurers accepted injury claims without a police report. It is highly likely that this legislative change strongly influenced motorists to report injury crashes that would otherwise have remained unreported. The sharp increase in crash numbers

b) *Increased economic activity*: The association between increased travel and increases in economic activity is well established. To determine the possibility that economic growth contributing to increased crash counts from October 2000 and particularly throughout 2001, Figure C 1 was constructed to identify any economic trends during the period in question. Using Australian Bureau of Statistics State Final Demand (ABS SFD) figures as a measure of economic growth, the monthly net percentage change in consumption was plotted against the backdrop of actual spending for the period December 1993 to June 2002. Figure C 1 clearly shows that a net increase in economic activity occurred just after the September 2000 quarter, the timing of which coincided with the aforementioned increase in crash frequency. The hypothesis of economic growth contributing to increase crash frequency is supported by these findings.

c) *Exposure transfer*: One of the possible effects of the initiative may have been the migration of traffic from ‘treatment’ roads to roads unaffected by the initiative, including those used as controls, with perceived savings in travel time the likely incentive. It would not be unreasonable to expect this effect in the period following implementation. The increase in 60 km/h zones, however, began to occur around October 2000 – a year and a half after the introduction of the initiative - and continued through to November 2001. A pure crash migration effect would also be reflected in continued decreases in crash numbers in the 50 km/h zones with the total crashes remaining roughly constant. This was not observed in the charts of crash trends presented. Under these circumstances, the hypothesis of traffic migration is unlikely.

6.2 POTENTIAL BIASES AFFECTING CRASH REDUCTION ESTIMATES

Two sources of potential bias may have influenced the net change in the monthly level of crashes between the 50 km/h speed zones and other speed zones. The first of these biases pertains to the method employed in the identification of crashes on roads currently zoned 50 km/h. This process identified crashes on current 50 km/h roads in the pre period *only* if crashes had occurred on the same roads in the post period. Hence, if a crash had not occurred on a 50 km/h road since the change, it will not have been identified as belonging to the treatment group. Correctly identified, these crashes would have constituted a 100% reduction in the post period and consequently contributed to the effect size. Incorrectly excluding them from the treatment group would have introduced bias to the analysis giving lower crash reduction estimates than really occurred.

The second possible bias involves the considerable number of crashes in 50 km/h speed zones coded as ‘on50kph=no’. These crashes generally represent those occurring at the intersection between a 50 km/h road and one of higher speed limit. Figure 3-1 showed, as expected, a significant number of crashes in this category after the speed management program was introduced. Although this was not anticipated at the time of defining the initial study design and data specification, if the 50 km/h limit has had significant crash reduction effects at these intersections, these effects will not have been included in the analysis here. Consequently, program effect estimates obtained here will be conservative.

6.3 EVALUATION OF QUEENSLAND TRANSPORT METHODOLOGY

Queensland Transport, in its approach to evaluating many of the state's road safety programs, has adopted a control chart style statistical analysis tool (Newstead, 2000). Although readily implemented and interpreted, the assumptions underpinning the linear regression model used in this technique are questionable when applied in the context of a study such as the evaluation of the 50 km/h speed limits. In employing this model, it is assumed that (a) the ratio of treatment crashes to control crashes follows a Normal distribution and, (b) the relationship between the ratio of the treatment crashes and control crashes over time is linear. There is a widely accepted view, however, that crash count data follow a Poisson distribution. Further, it is much more reasonable to assume that the outcome variable interacts with the explanatory variables multiplicatively rather than linearly. It follows therefore that if the linear model does not adequately describe the crash data, the resulting estimates and predicted values will be biased. Clearly, both of the above assumptions are potentially violated in the control chart method.

A further assumption made in using the control chart method is that the crash trend, extrapolated from the pre-treatment period, will continue into the future. This assumption can also lead to biased estimates if other factors influencing crash outcomes change.

Despite these concerns about the efficacy of the control chart analysis technique, Newstead (2000) has demonstrated that if the relationship between the trends in the treatment and control series is sufficiently close, both the Poisson regression and control chart techniques will produce estimates of program effectiveness that are essentially equivalent. A comparison of the reduction estimates obtained from the two techniques showed the control chart derived estimate to have the same order of magnitude as those derived using the Poisson log-linear model.

One issue emphasised by Newstead (2000) is that, because of the violation of the normal distribution assumption in crash data, its is likely that estimates of statistical significance of estimated program effects made from the control chart analysis will be incorrect. This is true despite the equivalence of point estimates from the Poisson regression and control chart techniques. This is will also be the case for this study. Consequently, the conclusion of Newstead (2000) that the control chart analysis technique is suitable for program performance monitoring, subject to the required relationship between treatment and control series, but is not suitable for definitive program evaluation, still stands.

6.3.1 Definition of treatment group

Probably the biggest difference between the evaluation presented here and that undertaken internally by QT evaluation is the specification of the treatment group. In the QT study, the treatment group was defined as comprising all reported crashes on 40-60 km/h roads in S.E. Queensland, from January 1993 to June 2001. In comparison, this evaluation confined the treatment group to only roads with an identified change in speed limit to 50 km/h under the program. The selection of treatment crashes made by QT inevitably 'contaminates' the treatment group, leading to the lower estimates of program effectiveness obtained in the QT analysis compared to that presented here.

6.3.2 Definition of control group

It is unlikely that the control group used in the QT internal 50 km/h evaluation contributed to biased estimates of program crash effects. Of the four control groups used in the MUARC analysis, one identical to that used by QT was chosen by MUARC for a direct comparison of method outcomes. Results obtained using this control group were in the same order of magnitude as those achieved with the other three control groups showing the results obtained were robust for choice of control group. Overall, this suggests that the choice of treatment group rather than the control group led to the largest bias in program effect estimates in the QT evaluation.

6.4 COMPARISON OF S.E. QUEENSLAND, N.S.W. AND VICTORIAN SPEED MONITORING DATA WITH CRASH DATA

Table 6-1 compares the net reduction estimates for five speed parameters with the casualty crash reduction estimates achieved in S.E. Queensland, NSW and Victoria. Casualty crash reduction estimates are used here instead of reduction estimates for *all* crashes because non-injury crashes in Victoria are not available in the Victorian crash database.

Table 6-1 shows that the S.E. Queensland net reduction estimates for both crash frequency and speeding are most comparable with those estimated in NSW. Estimates for the reduction in the proportion of drivers speeding excessively in Victoria were not available at the time of writing. Although, the Victorian and S.E. Queensland estimated reductions in mean speed are similar in magnitude, the S.E. Queensland crash reduction estimates are twice that achieved in Victoria. NSW analyses reported an even smaller reduction in mean speed and yet achieved an almost identical reduction in casualty crash frequency to S.E. Queensland. A comparison of the estimated reductions in 85th percentile speeds across the three states also does not explain the relatively large reduction in casualty crashes in S.E. Queensland and Victoria. It is more likely that the crash reductions have come about as a result of the substantial reductions in excessive speeding. It is believed that similar reductions in the proportion of drivers exceeding 60, 70 and 80 km/h in NSW as in Queensland contributed to the significant estimated reductions in casualty crashes.

State	Crash Reduction for Casualty Crashes	Reduction in Mean Speed (km/h)	Reduction in 85th Percentile Speed (km/h)	Reduction in prop exceeding 60 km/h	Reduction in prop exceeding 70 km/h	Reduction in prop exceeding 80 km/h
S.E. Qld	23%	2.2	1.5	53.1%	68.3%	62.5%
NSW[2]	22%	1.0	1.2	38%	70%	74%
Victoria	12%	1	1	n/a	n/a	n/a

Table 6-1 Comparison of S.Q. Queensland casualty crash and speed parameter reduction estimates with those of NSW and Victoria

[2] The speed parameter results presented for NSW pertain to Series 3, described in the RTA report (RTA, 2000).

7 CONCLUSIONS AND RECOMMENDATIONS

This report details the results of this analysis of the crash effects of the introduction of a default 50 km/h speed limit in South East Queensland. Analysis found that the implementation was associated with statistically significant average yearly reductions of 88%, 23% and 22% for fatal crashes, all casualty crashes and all reported, crashes respectively. Crash reductions appear to have increased with time after program implementation for each crash severity level considered. Analysis of speed survey data associated with the program implementation suggested these crash reductions stemmed largely from a reduction in excessive speeding in 50km/h zones rather than large reductions in mean speeds at the affected sites.

The findings of this evaluation concur with those found in the QT evaluation in so far as detecting an association between the implementation of the 50 km/h speed limits and a reduction in crashes in S.E. Queensland. A comparison of the reduction estimates obtained from the two methodologies, however, showed that the methodology employed by QT underestimated the impact of the speed management program. It is believed that the outcome in the QT evaluation was influenced significantly by the choice of treatment group.

The evaluation also found that the assumptions underlying the control chart style methodology did not support the theoretical properties of the crash data. The theoretical assumptions underlying the Poisson regression technique are more applicable in the context of a formal evaluation of this road safety countermeasure. However, the control chart methodology was endorsed as a means for internal monitoring of program performance.

7.1 RECOMMENDATIONS

The findings of this evaluation prompted the following recommendations for internal QT program evaluation:

1. Specification of the treatment group is defined as tightly as possible so that crashes having occurred on ‘untreated’ roads are excluded.

2. The control group is selected to be as similar as possible in physical and geographical characteristics to the treatment group.

3. Control chart analysis is suitable for monitoring program effectiveness, subject to suitable choice of treatment and control groups. However, more appropriate statistical methods should be employed for formal and definitive program evaluation.

7.2 QUALIFYING REMARKS

The findings of this evaluation are based on the following qualifications and assumptions:

- Crash reduction estimates derived in this evaluation rely on the assumption that crashes that occurred on current 50 km/h roads both before and after the implementation were correctly identified.

- No assumption about the direction of change has been assumed. The hypothesis tested was based on a two-tailed test of significance. To obtain a one-tailed level of significance, the significance levels should be halved.

8. REFERENCES

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APPENDIX A

Table A 1, Table A 2, Table A 3 and Table A 4 show the net percentage change in crashes relative to control groups (ii) to (iv). Set out and interpretation of the results is identical to that of Table 5-2 and Table 5-3. Although individual estimates may vary to some degree, it can be seen that the estimates relative to each control group generally have the same order of magnitude. These results serve to confirm the robustness of the results obtained relative to control group (i).

	50km/h Zones vs Speed Zones ≥ 50 km/h in S.E. Qld		50km/h Zones vs Speed Zones ≥ 50 km/h outside S.E. Qld		50km/h Zones vs 40-60km/h Zones outside SE Qld	
Crash Severity & Post Program Year	**Crash Reduction Estimate**	**Statistical Significance**	**Statistical Significance**	**Crash Reduction Estimate**	**Statistical Significance**	**Crash Reduction Estimate**
Fatal Crashes						
Amnesty period	10.3%	0.89	58.5%	0.2853	56.6%	0.3046
Year 1	89.6%	0.031	89.6%	0.0353	89.5%	0.0356
Year 2	91.9%	0.0186	94.1%	0.0096	93.0%	0.0149
Year 3	85.0%	0.0243	89.3%	0.0111	87.4%	0.0176
Year 4	100.0%	0.9994	100.0%	0.9997	100.0%	0.9997
Serious Injury Crashes						
Amnesty period	-9.2%	0.5324	-1.8%	0.9092	0.6%	0.9687
Year 1	22.8%	0.0171	21.5%	0.0402	23.3%	0.0239
Year 2	19.0%	0.0501	17.1%	0.1119	20.5%	0.0496
Year 3	30.3%	0.0032	20.0%	0.095	22.3%	0.0585
Year 4	34.2%	0.0195	36.7%	0.018	41.2%	0.0057
All Casualty Crashes						
Amnesty period	-5.1%	0.5414	6.6%	0.4419	7.7%	0.3646
Year 1	23.7%	<.0001	25.2%	<.0001	25.6%	<.0001
Year 2	26.9%	<.0001	21.4%	0.0003	22.8%	0.0001
Year 3	34.2%	<.0001	22.4%	0.0007	23.0%	0.0005
Year 4	30.9%	0.0002	33.7%	0.0002	37.1%	<.0001
Property Damage Crashes						
Amnesty period	-18.6%	0.053	4.2%	0.6435	4.8%	0.5957
Year 1	23.4%	<.0001	18.6%	0.0038	18.9%	0.003
Year 2	25.3%	<.0001	9.8%	0.1639	10.1%	0.1464
Year 3	24.9%	0.0002	13.1%	0.0902	14.1%	0.0657

Year 4	33.2%	0.0007	39.8%	<.0001	42.4%	<.0001
All Crashes						
Amnesty period	-11.2%	0.0757	5.6%	0.3673	6.5%	0.2972
Year 1	22.9%	<.0001	22.2%	<.0001	22.6%	<.0001
Year 2	26.0%	<.0001	16.1%	0.0004	17.1%	0.0002
Year 3	30.9%	<.0001	17.9%	0.0004	18.7%	0.0002
Year 4	31.8%	<.0001	36.0%	<.0001	39.0%	<.0001

Table A 1 Estimated yearly crash reductions in 50km/h zones relative to comparison groups (ii), (iii) and (iv)

	50km/h Zones vs Speed Zones ≥ 50 km/h in S.E. Qld		50km/h Zones vs Speed Zones ≥ 50 km/h outside S.E. Qld		50km/h Zones vs 40-60km/h Zones outside SE Qld	
Crash Severity & Post Program Year	**Crash Reduction Estimate**	**Statistical Significance**	**Crash Reduction Estimate**	**Statistical Significance**	**Crash Reduction Estimate**	**Statistical Significance**
Fatal Crashes						
Jun-99	9.4%	0.900	58.2%	0.291	56.2	0.311
Sep-99	100%	1.000	100%	1.000	100.0	1.000
Dec-99	100%	0.999	100%	1.000	100.0	1.000
Mar-00	68.9%	0.274	64.2%	0.367	65.8	0.336
Jun-00	100%	0.999	100%	1.000	100.0	1.000
Sep-00	100%	0.999	100%	1.000	100.0	1.000
Dec-00	57.2%	0.437	75.0%	0.225	67.2	0.327
Mar-01	100%	0.999	100%	1.000	100.0	1.000
Jun-01	100%	0.999	100%	1.000	100.0	1.000
Sep-01	68%	0.304	76.7%	0.213	72.1	0.270
Dec-01	100%	0.999	100%	1.000	100.0	1.000
Mar-02	65.7%	0.343	82.2%	0.142	77.8	0.198
May-02	100%	0.999	100%	1.000	100.0	1.000
Serious Injury rashes						
Jun-99	-9.5%	0.519	-2.4%	0.876	-0.1	0.995
Sep-99	7.3%	0.615	11.2%	0.468	12.4	0.418
Dec-99	38.5%	0.006	44.3%	0.002	45.7	0.001
Mar-00	21.3%	0.135	1.2%	0.945	4.1	0.813
Jun-00	3.5%	0.807	-7.9%	0.639	-1.8	0.910
Sep-00	37.4%	0.007	36.2%	0.015	38.0	0.010
Dec-00	9.9%	0.508	16.3%	0.295	20.1	0.186
Mar-01	24.0%	0.099	18.9%	0.250	21.8	0.172
Jun-01	37.8%	0.005	30.6%	0.049	32.8	0.031
Sep-01	34.0%	0.014	24.6%	0.125	26.4	0.096
Dec-01	35.9%	0.010	27.0%	0.094	29.7	0.059
Mar-02	9.6%	0.548	-12.2%	0.536	-10.5	0.590
May-02	33.8%	0.022	35.8%	0.022	40.3	0.007

Table A 2 **Estimated quarterly crash reductions in 50km/h zones relative to comparison groups (ii), (iii) and (iv) for fatal and serious crashes**

Crash Severity & Post Program Year	50km/h Zones vs All Other Speed Zones in S.E. Qld		50km/h Zones vs All Other Speed Zones outside S.E. Qld		50km/h Zones vs 40-60 km/h Speed Zones outside S.E. Qld	
	Crash Reduction Estimate	Statistical Significance	Crash Reduction Estimate	Statistical Significance	Crash Reduction Estimate	Statistical Significance
All Casualty Crashes						
Jun-99	-5.3%	0.526	6.0%	0.486	7.1	0.404
Sep-99	17.9%	0.027	21.5%	0.012	21.1	0.014
Dec-99	31.2%	<0.0001	38.3%	<0.0001	39.1	<0.0001
Mar-00	21.6%	0.010	10.5%	0.284	11.3	0.245
Jun-00	21.1%	0.008	14.8%	0.103	17.0	0.057
Sep-00	33.3%	<0.0001	28.1%	0.002	28.5	0.001
Dec-00	20.0%	0.014	20.3%	0.022	21.7	0.013
Mar-01	31.8%	<0.0001	19.4%	0.036	21.2	0.020
Jun-01	36.4%	<0.0001	25.7%	0.004	26.7	0.002
Sep-01	38.3%	<0.0001	29.7%	0.001	29.6	0.001
Dec-01	35.2%	<0.0001	18.9%	0.048	19.7	0.036
Mar-02	24.6%	0.004	9.0%	0.383	9.8	0.342
May-02	30.6%	<0.0001	32.8%	<0.001	36.2	<0.0001
Property Damage Crashes						
Jun-99	19.4%	0.045	3.6%	0.692	4.2	0.643
Sep-99	27.7%	0.001	26.3%	0.003	26.4	0.003
Dec-99	25.2%	0.004	23.9%	0.011	24.0	0.011
Mar-00	15.4%	0.084	1.7%	0.873	2.6	0.798
Jun-00	25.4%	0.003	11.1%	0.277	12.0	0.234
Sep-00	29.4%	0.001	13.0%	0.214	12.4	0.235
Dec-00	23.0%	0.016	9.2%	0.408	9.6	0.385
Mar-01	19.6%	0.040	1.8%	0.876	2.6	0.819
Jun-01	34.4%	0.000	17.7%	0.111	17.7	0.109
Sep-01	13.6%	0.159	7.3%	0.496	9.6	0.364
Dec-01	27.1%	0.004	8.7%	0.444	10.1	0.371
Mar-02	20.7%	0.051	16.2%	0.165	16.4	0.156
May-02	32.3%	0.001	39.0%	<0.0001	41.7	<0.0001

Table A 3 **Estimated quarterly crash reductions in 50km/h zones relative to comparison groups (ii), (iii) and (iv) for casualty and property damage crashes**

	50km/h Zones vs All Other Speed Zones in S.E. Qld		50km/h Zones vs All Other Speed Zones outside S.E. Qld		50km/h Zones vs 40-60 km/h Speed Zones outside S.E. Qld	
Crash Severity & Post Program Year	**Crash Reduction Estimate**	**Statistical Significance**	**Crash Reduction Estimate**	**Statistical Significance**	**Crash Reduction Estimate**	**Statistical Significance**
All Crashes						
Jun-99	-11.6%	0.066	5.0%	0.423	5.9	0.345
Sep-99	22.0%	0.000	23.9%	<0.0001	23.7	<0.0001
Dec-99	28.0%	<0.0001	31.9%	<0.0001	32.4	<0.0001
Mar-00	17.8%	0.004	6.6%	0.352	7.4	0.291
Jun-00	22.6%	0.000	13.0%	0.056	14.6	0.029
Sep-00	31.1%	<0.0001	21.4%	0.002	21.4	0.002
Dec-00	21.3%	0.001	15.1%	0.030	16.2	0.019
Mar-01	27.1%	<0.0001	11.6%	0.106	13.1	0.066
Jun-01	36.0%	<0.0001	21.6%	0.002	22.2	0.001
Sep-01	29.0%	<0.0001	20.0%	0.003	20.8	0.002
Dec-01	32.2%	<0.0001	14.0%	0.057	15.1	0.038
Mar-02	23.6%	<0.0001	11.1%	0.152	11.6	0.132
May-02	31.2%	<0.0001	35.1%	<0.0001	38.2	<0.0001

Table A 4 Estimated quarterly crash reductions in 50km/h zones relative to comparison groups (ii), (iii) and (iv) for ALL crashes

APPENDIX B

Speed Survey Data

Table B 1 presents the control sites (i.e., those sites that remained 60 km/h) and the treatment sites (i.e., those sites that changed from 60 km/h to 50 km/h).

Treatment Sites	# Surveys
Highcrest Ave	3
Allan St, Kedron	3
Foster St, Newmarket	3
Gracemere St, Newmarket	3
Kinnaird St, Ashgrove	3
Mareeba Rd, Ashgrove	3
Eton St, Wavell Heights	2
Pellinore St, Bracken Ridge	3
Hoffman Street, McDowall	3
Hackman St, McDowall	3
Leicester St, Coorparoo	2
Kilmorey St, Carindale	2
Bridgenorth St, Carindale	2
Station St, Sunnybank	3
Sydney St, Newfarm	2
Ijong St, Kenmore	3

Control Sites	# Surveys
Leslie St	3
Frasers Rd	3
Alderley Terrace, Newmarket	3
Empress Terrace, Bardon	2
Dixon St, Sunnybank	2
Ridgewood Rd, Algester	3
Marshall Lane, Kenmore	3

Table B 1 Treatment and Control sites used in speed analysis

Mean and 85th Percentile Speeds

Figure B 1 and Figure B 2 graphically depict before and after measurements of the mean and 85th percentile speeds in the control sites.

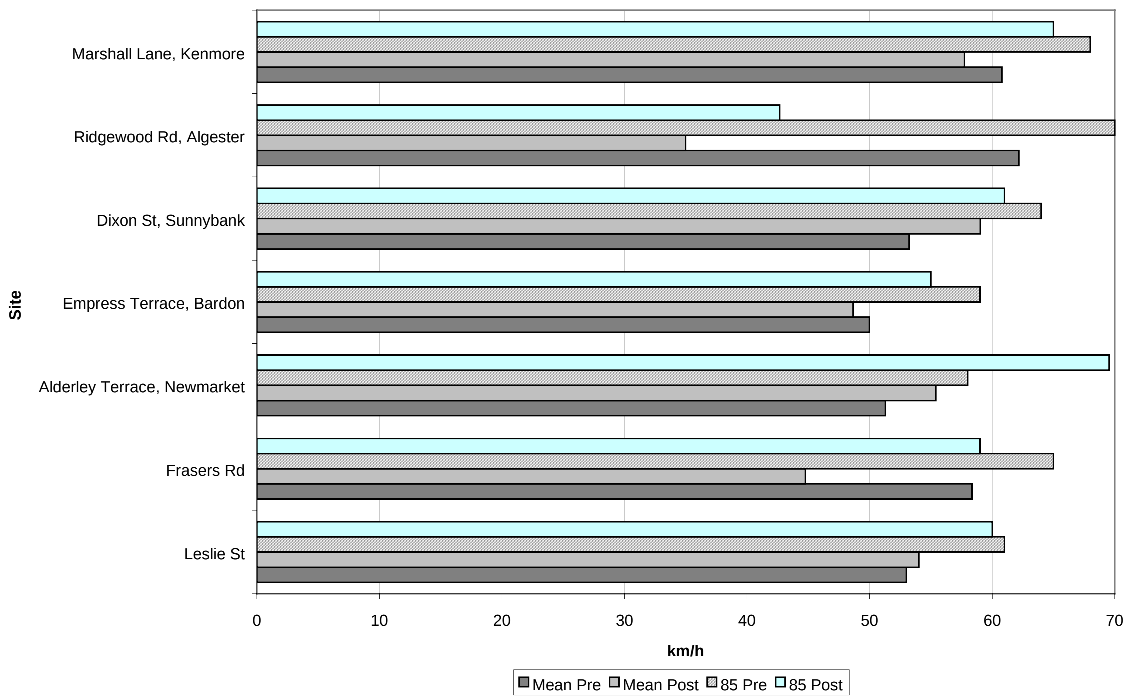


Figure B 1 Before and after mean speed, 85th percentile speed for 'Control' sites

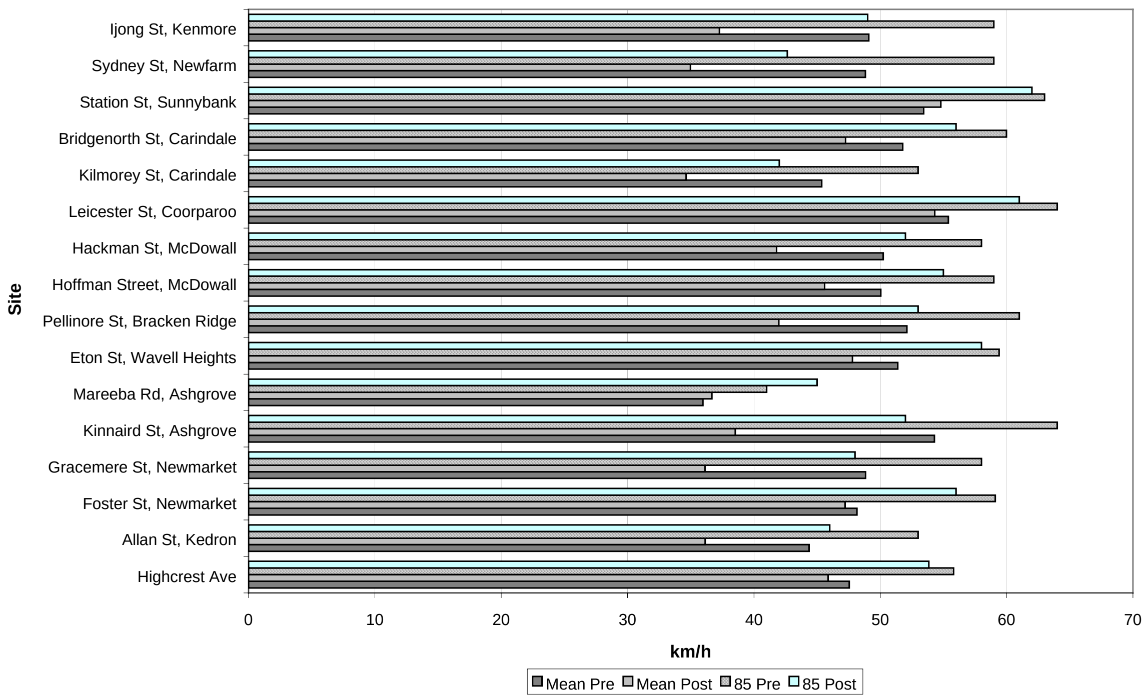


Figure B 2 Before and after mean speed, 85th percentile speed for 'Treated' sites

Graphical representations of the proportion of drivers exceeding 60, 70 and 80 km/h in control and treatment groups

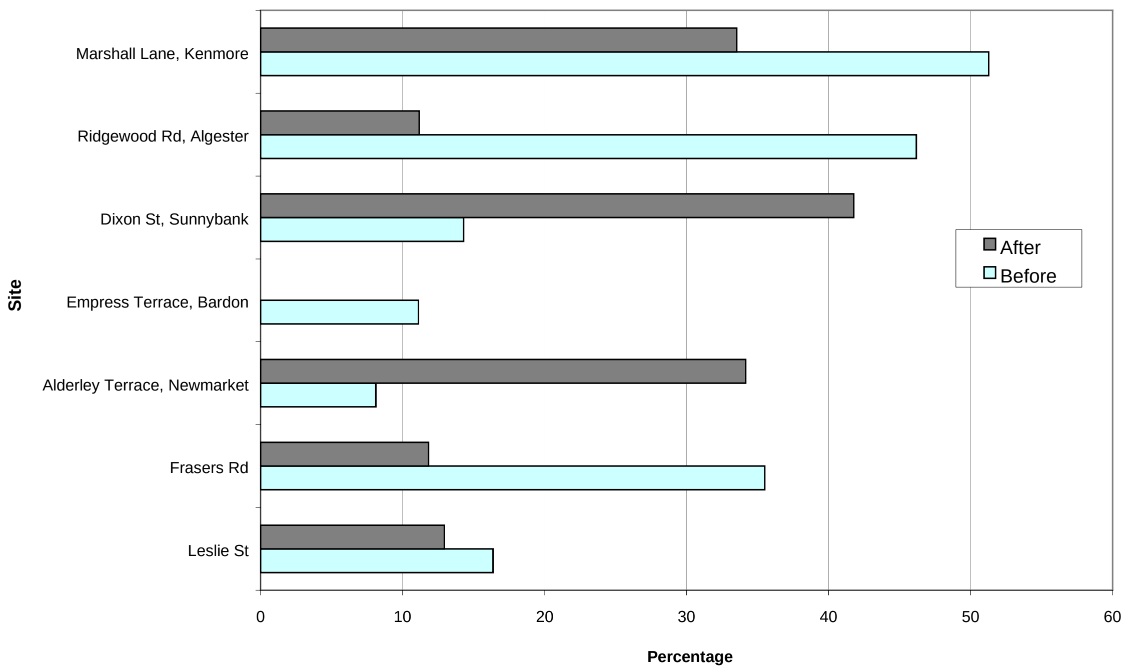


Figure B 3 Proportion of drivers exceeding 60 km/h in control sites in S.E. Queensland

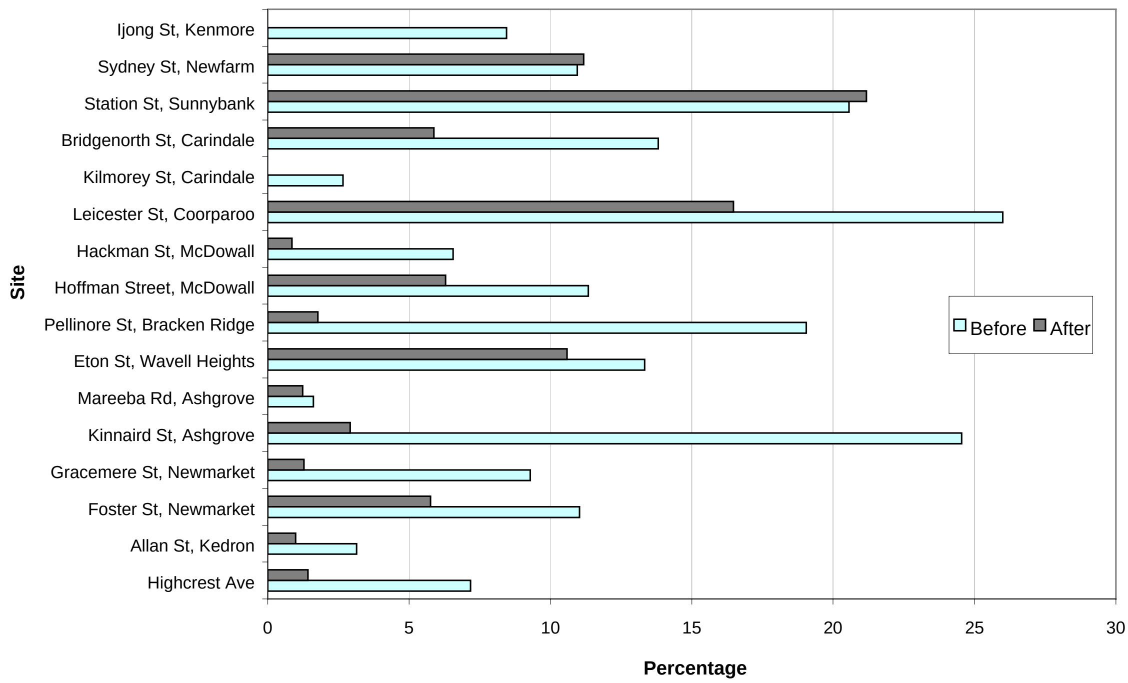


Figure B 4 **Proportion of drivers exceeding 60 km/h in treatment sites in S.E. Queensland**

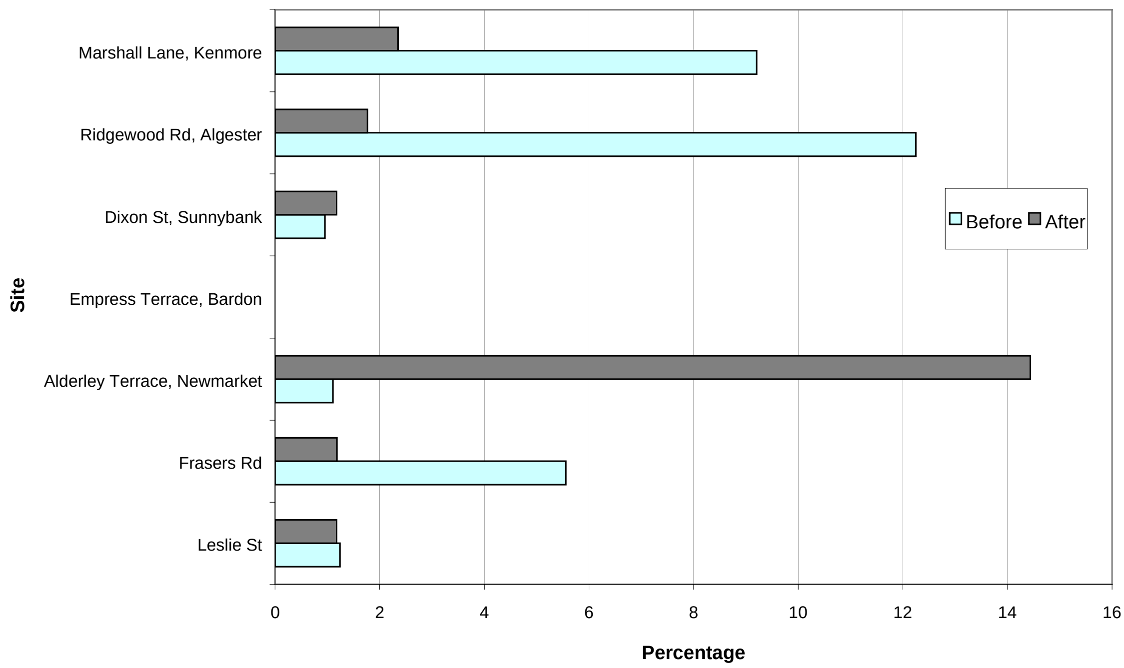


Figure B 5 **Proportion of drivers exceeding 70 km/h in control sites in S.E. Queensland**

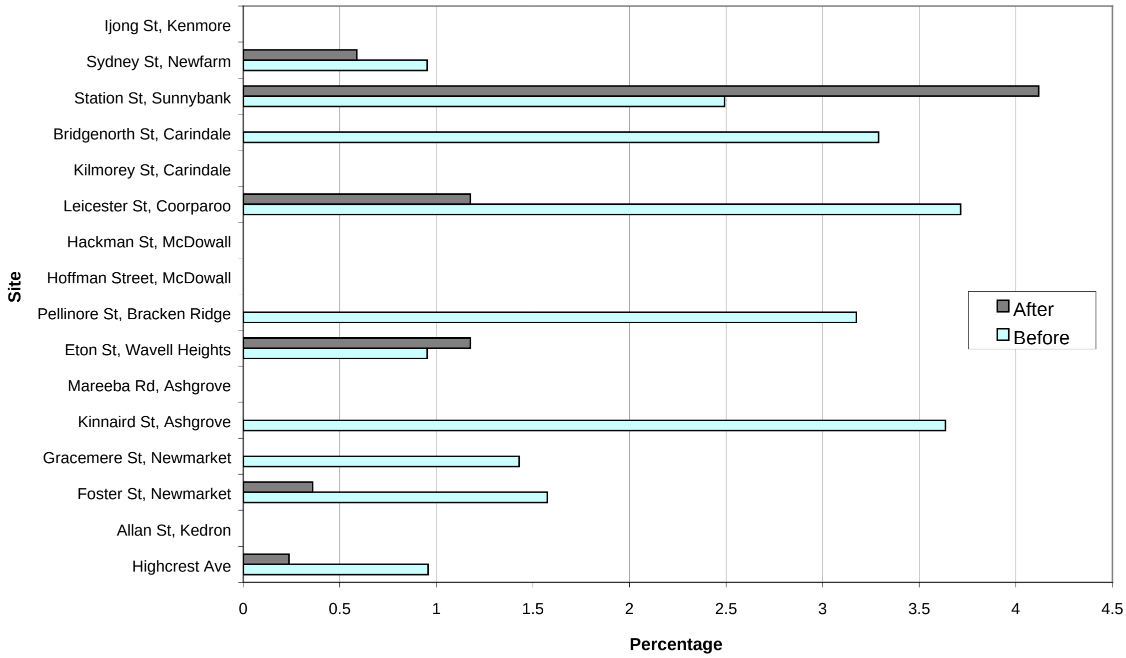


Figure B 6 **Proportion of drivers exceeding 70 km/h in treatment sites in S.E. Queensland**

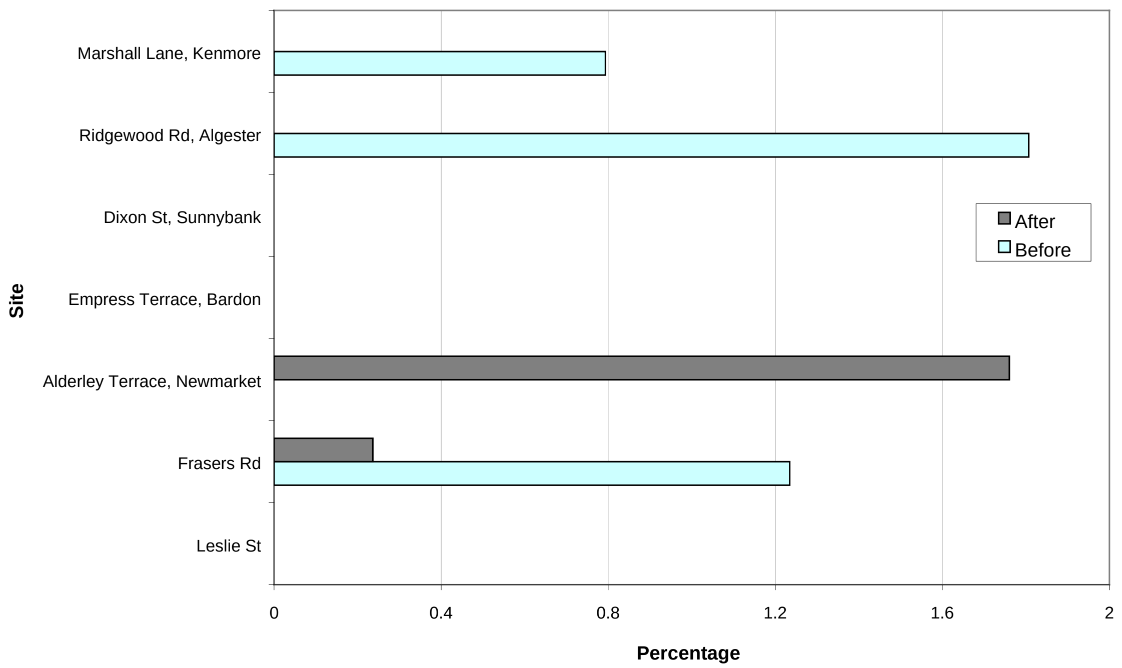


Figure B 7 **Proportion of drivers exceeding 80 km/h in control sites in S.E. Queensland**

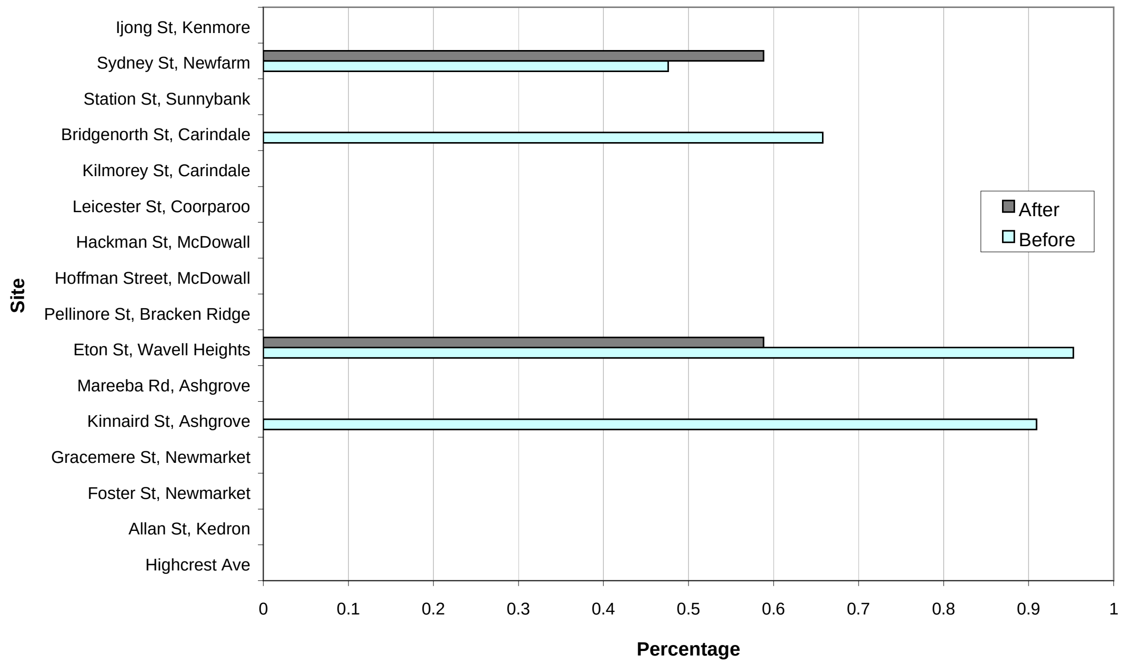
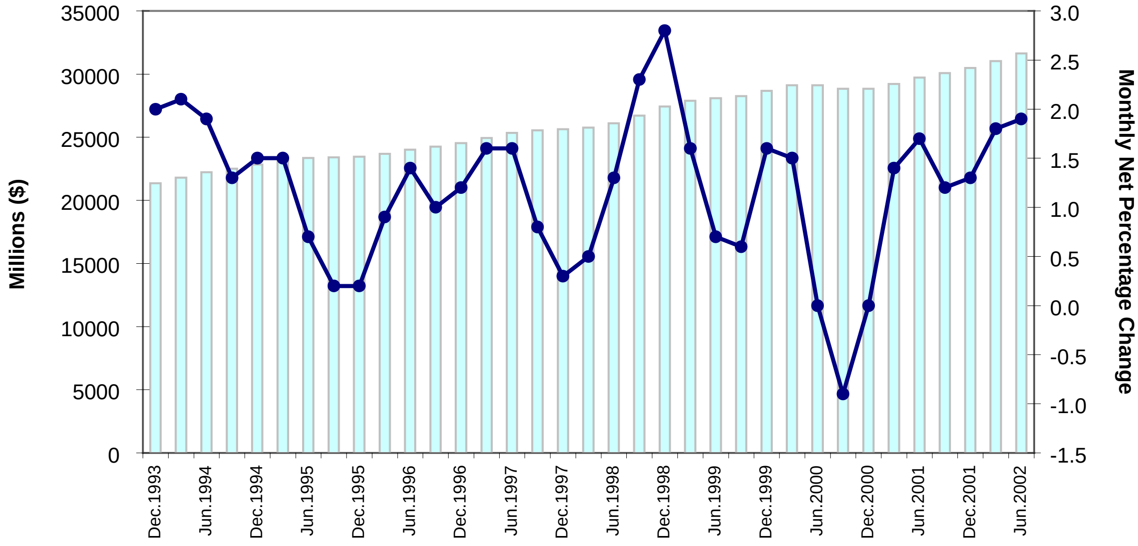


Figure B 8 Proportion of drivers exceeding 80 km/h in treatment sites in S.E. Queensland

APPENDIX C

Queensland State Final Demand



Source: ABS

Figure C 1 Queensland state final demand figures ($M) and monthly net percentage change