EVALUATION OF THE CRASH EFFECTS OF THE CHANGES IN SPEED ZONES IN VICTORIA DURING 1993-1994 (EXCLUDING 100 to 110km/h)

by

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Title and sub-title:
Evaluation of the crash effects of the changes in speed zones in Victoria during 1993-1994 (excluding 100 to 110 km/h)

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Abstract:
During late 1992 and early 1993, a rationalisation of speed limits on Victorian roads was undertaken in order to achieve credible speed limits which were uniform with the rest of Australia. As part of this rationalisation, many speed zoning changes occurred across Victoria, with some of the most notable being the phasing out of 75 km/h speed zones and the introduction of 50, 70 and 80 km/h zones. Under the rationalisation, posted speed limits on some road sections were increased whilst on other road sections the posted speed limits were decreased.

This study evaluates the casualty crash effects of the speed zone changes implemented in Victoria for all speed zone changes other than 100 km/h to 110 km/h. Effects are estimated for the program of speed zone changes as a whole as well as for each particular type of speed zone change. Results are presented for the whole of Victoria as well as for metropolitan Melbourne and the rest of Victoria separately. Estimated effects of speed zone changes on casualty crash frequency are further related to changes in crash type as well as results of speed monitoring.

The evaluation found no statistically significant change in overall casualty crash frequency in Victoria due to speed zone rationalisation. Whilst the results of the evaluation presented here are generally based on limited quantities of data after implementation of speed zone changes, this study has established a framework under which the evaluation could be easily repeated at a later date to more precisely estimate the effects of speed zone rationalisation.

Key Words:
(speed limit, evaluation, injury accident, statistical analysis, traffic regulations, accident type, research report)

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EXECUTIVE SUMMARY

During late 1992 and early 1993, a rationalisation of speed limits on Victorian roads was undertaken in order to achieve credible speed limits which were uniform with the rest of Australia. As part of this rationalisation, many speed zoning changes occurred across Victoria, with some of the most notable being the phasing out of 75 km/h speed zones and the introduction of 50, 70 and 80 km/h zones. Under the rationalisation, posted speed limits on some road sections were increased whilst on other road sections the posted speed limits were decreased. This study evaluates the casualty crash effects of the speed zone changes implemented in Victoria for all speed zone changes other than 100 km/h to 110 km/h.

A pseudo experimental study design was used for the evaluation, examining changes in casualty crash frequency before and after speed zone changes. Only a sample of sites which had undergone speed zone changes were used in the analysis. The analysis also incorporated the use of control sites to represent parallel changes in casualty crash frequency due to other factors.

Analysis of the effects of speed zone changes on casualty crash frequency in metropolitan Melbourne showed an overall increase in casualty crash frequency of 6.9%, although this result was of marginal statistical significance and should be interpreted with caution. This estimated increase represents in the order of 200 extra casualty crashes per annum across Melbourne due to all speed zone changes. Assessment of the general effects on casualty crash frequency of increasing zoned speed or decreasing zoned speed showed no statistically significant change in casualty crash frequency when the zone speed was decreased, and an 8.7% casualty crash increase (with marginal statistical significance) when zone speed was increased. For particular speed zone changes, the change from 60 to 80 km/h showed a statistically significant casualty crash reduction of 47%, translating to a saving of approximately 70 casualty crashes per annum across Melbourne. Increased speed zoning from 75 to 80 km/h showed a marginally statistically significant casualty crash frequency increase of 10.5%, representing an increase of approximately 150 casualty crashes per annum across Melbourne.

The results of analysis of casualty crash frequency in metropolitan Melbourne were generally consistent with the results of speed monitoring.

Most of the speed zone changes which occurred in the rest of Victoria took place on the fringes of country towns in the speed transition zones between 100 km/h zones of the open highway and 60 km/h zones of the built up town area. The overall casualty crash frequency change for all speed zone changes combined in the rest of Victoria was estimated as a 32.9% reduction (representing a saving of approximately 150 casualty crashes per annum across the rest of Victoria), however the statistical significance of this result was marginal.

The net effect of the speed zone rationalisation over Victoria as a whole was no statistically significant change in overall casualty crash frequency.
Whilst the results presented here are generally based on limited quantities of data after implementation of speed zone changes, this study has established a framework under which the evaluation could be easily repeated at a later date to more precisely estimate the effects of speed zone rationalisation.
1.0 INTRODUCTION

1.1 BACKGROUND

During late 1992 and early 1993, a rationalisation of speed limits on Victorian roads was undertaken in order to achieve credible speed limits which were uniform with the rest of Australia. As part of this rationalisation, many speed zoning changes occurred across Victoria, with some of the most notable being the phasing out of 75 km/h speed zones and the introduction of 50, 70 and 80 km/h zones. Under the rationalisation, posted speed limits on some road sections were increased whilst on other road sections the posted speed limits were decreased.

Table 1 from the Parliamentary Inquiry into the Revision of Speed Limits (Road Safety Committee, 1995) details the speed zone changes which were implemented under the rationalisation and the lengths of road to which they apply.

**TABLE 1 : Summary of speed zone changes (from report of the Parliamentary Inquiry into the Revision of Speed Limits).**

<table>
<thead>
<tr>
<th>Previous Limit (km/h)</th>
<th>Revised Limit (km/h)</th>
<th>Length of Roads - Increase (km)</th>
<th>Length of Roads - Decrease (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>110</td>
<td>435</td>
<td>150</td>
</tr>
<tr>
<td>100</td>
<td>80</td>
<td>150</td>
<td>10</td>
</tr>
<tr>
<td>100</td>
<td>70</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>90</td>
<td>80</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>90</td>
<td>70</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>80</td>
<td>1460</td>
<td>350</td>
</tr>
<tr>
<td>75</td>
<td>70</td>
<td></td>
<td>350</td>
</tr>
<tr>
<td>60</td>
<td>80</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>70</td>
<td>415</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>50</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>2360</td>
<td>550</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td></td>
<td>2910</td>
</tr>
</tbody>
</table>

It should be noted that Table 1 includes the speed zone change from 100 to 110 km/h affecting some 435 km of road. This particular speed zone change was not part of this study brief and will not be considered further in this study.

According to Table 1 and the Parliamentary Inquiry (Road Safety Committee, 1995), the total length of road affected by these changes considered in this study was 2475 km, or 9.3% of the total arterial road system. Of this road length, 1925 km saw a speed zoning increase whilst 550 km saw a speed zoning decrease. Of the total length with changed speed zone, 1810 km (94%), changed by 5 km/h, whilst the remaining 6% changed by between 10 and 30 km/h.

Further information contained in the Parliamentary Road Safety Committee's report indicates that 50% of the urban arterial road network has undergone a speed change, compared with only 3% of the rural arterial network. Allowing for the relative lengths of the urban and rural networks, this
represents approximately 482 km of rural road and 1993 km of metropolitan road experiencing a speed zoning change.

1.2 AIMS OF THE EVALUATION

The basic objective of this evaluation study is to determine whether the speed zone changes implemented in Victoria, other than 100 km/h to 110 km/h, have affected casualty crash frequencies on the road segments to which they apply. Analysis will centre on comparing the accident frequency before and after implementation of the speed zone change.

A secondary aim of the study is to determine, on those road segments where a significant casualty crash frequency change was observed due to speed zone changes, the particular casualty crash types which have been responsible for this change. This may enable the possible mechanisms leading to the observed changes to be inferred.

2.0 STUDY DESIGN

2.1 EVALUATION METHOD

The primary aim of the evaluation is to assess the change in crash frequency attributable to the rationalisation of speed zones. It is not, however, sufficient just to compare crash frequency in the periods before and after speed zone changes to determine the effects of the change. This is because, during the period of implementation of the speed zone changes, a number of other major road safety campaigns have been under way in Victoria which, along with changes in social and economic conditions, have had a large impact on road trauma in the state (see Newstead et al, 1995, for a description of some of these programs and an estimate of their effects on casualty crash frequency). Any attempt to measure the effects of speed zone changes on crash frequency must also take into account changes due to other programs or influences.

Use of the casualty crash history at a set of control sites in the analysis allows for adjustment of other time varying factors which may have affected crash frequency, such as changes in economic factors or operation of other road safety programs. Appropriately chosen control groups will provide a measure of the crash frequency changes associated with these other factors, leaving any further changes associated with the speed zone rationalisation alone. The measure of the effect of speed zone changes on crash frequency is made by comparing the before and after crash frequencies at the treated sites adjusting for the parallel changes in crash frequency at the control sites from the corresponding before and after treatment time periods. This evaluation format is known as a quasi-experimental design as it follows the format of a fully randomised treatment-control type experiment but differs in that the treatment sites are not chosen at random. In the context of this study, a “treated site” constitutes a road length which has undergone a speed zone change.

The quasi-experimental study design using treatment and controls is often used in the evaluation of the effectiveness of accident black-spot treatments (Corben et al 1990, BTCE 1993). One issue which often arises as part of these studies is that of regression-to-the-mean which can be a problem in analysis when treatment sites are selected on the basis of high accident frequency as in the case of accident black-spot treatments. Regression to the mean should not be an issue in this study as sites chosen for speed zone changes were not generally chosen on the basis of accident history.
2.2 SITE SAMPLING

The program of speed zone changes in Victoria has involved rezoning a large number of discrete lengths of road. Given the size and scope the project, it was considered impractical to include every length of road on which a speed zone change had occurred because of the large number of these. It is therefore decided that a sample of the sites with speed zone changes be taken for analysis, with the view that the results obtained from analysis of the sample are representative of all speed zone changes in Victoria.

Choice of an appropriate sampling frequency was critical for the efficiency and accuracy of the study as sample size is related to the statistical power of the analysis. Statistical power of an analysis determines the minimum sample size required to detect a statistically significant effect of a given magnitude. Power calculations for sampling frequency have been calculated for this project and are detailed in Table 2 based on the assumption that one year’s after treatment data will be available. The power calculations shown assume the analysis methods detailed below will be employed.

**TABLE 2 : Percentage of treated sites to be sampled to allow statistically significant detection of given treatment effects.**

<table>
<thead>
<tr>
<th>Area</th>
<th>Minimum overall crash frequency change to be detected</th>
<th>Percentage of treated sites to be sampled (by length)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metropolitan</td>
<td>10%</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>15%</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>20%</td>
<td>7%</td>
</tr>
<tr>
<td>Rest of Victoria</td>
<td>10%</td>
<td>&gt;100%</td>
</tr>
<tr>
<td></td>
<td>20%</td>
<td>55%</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>40%</td>
<td>15%</td>
</tr>
</tbody>
</table>

From preliminary inspection of the quantity of treatment site data it was considered appropriate to sample 10% of the treated sites in the metropolitan area given the project size. Table 2 shows that this will be able to reliably detect a minimum 15% percent change in overall crash frequency at the treated sites in total.

Table 2 highlights potential problems in the analysis of speed zone changes in the rest of Victoria. It is evident from Table 2 that, even sampling 100% of the treated sites in this area, the smallest crash frequency change which could be reliably detected is somewhat greater than 10%. This is caused by the relatively small percentage of roads in this region with changed speed zone combined with the low accident rate per kilometre on these roads. Even to reliably detect a minimum 20% crash frequency change would require 55% of the treated sites to be sampled, which was inconsistent with the magnitude of the project given the number and nature of treated sites in the rest of Victoria (many of the treated sites in the rest of Victoria are in buffer zones between open highways and built up rural towns, which can typically be as short as 600m). Considering this, it was decided to sample 15% of the treated sites in the rest of Victoria, enabling a minimum 40% change in crash frequency to be reliably detected.
2.3 ANALYSIS STRATIFICATION

To provide maximum detail on the effects of speed zone changes on crash frequency, the analysis has been graduated into a number of levels. The analysis stratification levels to be used, from coarsest to finest, are:

1. *All speed zone changes in all LGAs aggregated*: This is an overall measure of the influence of the speed zone rationalisation program on casualty crash frequency.

2. *Speed zones where speed limits increased and speed zones where speed limits decreased*: All the speed zone changes are categorised into one of two broad categories; speed limit increase and speed limit decrease. This level of analysis will measure the broad average casualty crash effects of the speed limit increases and decreases that were undertaken.

3. *Each individual type of speed zone change*: This level of analysis will attempt to measure the average casualty crash frequency change due to each type of speed zone change (eg. 75-70 km/h, 60-70 km/h) across all road lengths with each particular speed zone change.

4. *Each individual type of speed zone change within each individual LGAs*: This is similar to 3 above but will attempt to measure any differences in speed zone change effects for each type of speed zone change between one LGA and another.

It was not certain whether the quantity of data available for analysis would allow the assessment of graduation level 4. It is, in theory, possible to proceed to one finer level of analysis, being the assessment of crash frequency change on each individual road length which experienced a speed zone change. Given the relatively short period of after treatment crash data available, this finest level of analysis, assessing speed zone changes at individual sites, was not considered likely to produce conclusive results and hence not attempted.

Because of the known differences between roads and crash patterns in metropolitan Melbourne and the rest of Victoria the analysis has been performed at each of the 4 graduated levels for metropolitan Melbourne and the rest of Victoria separately as well as for Victoria as a whole.

2.4 HYPOTHESES TESTED

The aim of the statistical analysis undertaken in this study was to determine whether speed zone changes had significantly influenced casualty crash frequency. Hence, the global null hypothesis being tested in all the analyses presented is that of no casualty crash frequency change due to the program of speed zone rationalisation. In formulating an alternative hypothesis for the statistical test procedure, there is no clear a-priori reason to expect speed zone changes may increase or decrease casualty crash frequency for either speed increases or decreases. This is because crash risk is not merely a function of absolute traffic speed but also factors such as variance in vehicle speeds within a traffic flow. Consequently, a two tailed alternative hypothesis was appropriate to use for determining the statistical significance levels of the tests presented here. This statistical test structure has been used in hypothesis testing at all the levels of analysis discussed in section 2.3 above.
3.0 DATA

3.1 SPEED ZONE CHANGES

Each VicRoads regional office in Victoria prepared a summary of speed zone changes in their region which had been undertaken as part of the rationalisation program. This information was supplied to MUARC for the evaluation in hard copy format. In order to accurately determine the type, location and exact timing of each speed zone change in Victoria, the following information was required in the data supplied:

1. Municipality of change (LGA)
2. Location start and end points on the road of each speed zone change
3. Speed zoning before and after the change
4. Date of speed zone change

Examination of the data supplied revealed no uniform or consistent method of recording such details. Of the seven VicRoads regions, only the Northern and Eastern Regions were able to supply all relevant details within the one spreadsheet in a readily useable form. For three of the remaining five VicRoads regions, the required information could, in most cases, be obtained by manual processing of the supplied information. Manual processing of these cases generally consisted of determining zone change start and end points from details of speed sign placement on the road. For the remaining two VicRoads regions (Western and North-East Regions), information supplied was incomplete and could not be used for the purpose of this study.

Contact with the VicRoads regional offices was made in an attempt to obtain the required missing data items. Apart from limited assistance with some implementation dates in certain regions, in general the VicRoads regional offices were unable to supply in a timely manner the missing information required to make the data useable in the evaluation. Table 3 summarises the useable information supplied by each VicRoads region.

TABLE 3: Summary of the relevant information on speed zone changes supplied by each VicRoads region.

<table>
<thead>
<tr>
<th>VicRoads Region</th>
<th>Local Govt. Area</th>
<th>Location (Start and End point)</th>
<th>Speed Zone Changes</th>
<th>Implementation Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>North-East</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Western</td>
<td>✔</td>
<td></td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Eastern</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>South-West</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>South-East Metro</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>some</td>
</tr>
<tr>
<td>North-West Metro</td>
<td>✔</td>
<td>some</td>
<td>✔</td>
<td>some</td>
</tr>
</tbody>
</table>

For the LGAs within the metropolitan VicRoads regions where the installation date of the speed zone change was available, date of installation was often only given within a six month period. In order to maximise the amount of after-treatment crash data available, it was decided to restrict analysis to those Local Government Areas that had speed zone changes between July 1993, the
beginning of the program implementation, and December 1993. The majority of metropolitan LGAs had speed zone change implementation dates falling within this time frame. Most of those with implementation dates falling in the time frame and with all the required information supplied by VicRoads were used in the evaluation. Table 4 lists those LGAs satisfying the inclusion criteria. For the purpose of this analysis, the LGAs used were those which existed in Victoria prior to the progressive restructuring of LGAs which began in 1993.

TABLE 4: Metropolitan LGAs selected for evaluation of speed zone changes

<table>
<thead>
<tr>
<th>VicRoads Region</th>
<th>South East Metropolitan</th>
<th>North West Metropolitan</th>
</tr>
</thead>
<tbody>
<tr>
<td>LGAs Selected</td>
<td>Berwick</td>
<td>Bulla</td>
</tr>
<tr>
<td></td>
<td>Brighton</td>
<td>Sunshine</td>
</tr>
<tr>
<td></td>
<td>Camberwell</td>
<td>Keilor</td>
</tr>
<tr>
<td></td>
<td>Cranbourne</td>
<td>Chelsea</td>
</tr>
<tr>
<td></td>
<td>Croydon</td>
<td>Melbourne</td>
</tr>
<tr>
<td></td>
<td>Dandenong</td>
<td>Collingwood</td>
</tr>
<tr>
<td></td>
<td>Doncaster and Templestowe</td>
<td>Richmond</td>
</tr>
<tr>
<td></td>
<td>Knox</td>
<td>Eltham</td>
</tr>
<tr>
<td></td>
<td>Waverley</td>
<td>Diamond Valley</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Preston</td>
</tr>
</tbody>
</table>

Table 4 shows the spread of metropolitan Melbourne LGAs included in the analysis, ranging from inner city LGAs, such as Camberwell, Collingwood and Melbourne, to urban fringe LGAs such as Diamond Valley, Bulla and Cranbourne. A map of the metropolitan LGAs used in the analysis can be found in Appendix A.

The three rural VicRoads regions which had supplied sufficient site data for use in the evaluation were further examined to reveal that the implementation dates of the speed zone changes occurred from August 1993 through to December 1994, with most occurring in the time frame January 1994 to December 1994. In order to have at least one year’s after-treatment crash data for analysis, it was necessary to only consider those regions that had speed zone changes from January to June 1994. Analysis then centred on all rural LGAs with sufficient site description provided by VicRoads that had speed zone changes implemented from January to June 1994. Table 5 lists those rural LGAs meeting these criteria.

Table 5 shows the coverage of the selected LGAs across each of the three rural VicRoads regions included in the analysis. The selected LGAs include a mix of large population centres, such as Sale and Geelong West, as well as largely rural LGAs, such as Maffra and Otway. A map of Victoria showing the LGAs included in the analysis for the rest of Victoria is given in Appendix B.
Analysis of the length of road with speed zone changes in those LGAs selected in each of Melbourne and the rest of Victoria showed sufficient coverage to meet the statistical analysis power requirements discussed in section 2.2 above.

3.2 CRASH DATA

3.2.1 Crash database

The crash database used in the analysis was the VicRoads database of Police reported casualty accidents in Victoria. Analysis centred on data from the complete years 1992, 1993 and 1994. Due to the timing of the study, the 1995 crash data for the complete year was not available. Discussions with VicRoads revealed crash data for 1995 to be available from January to about October, with the data being complete to June 1995. Hence a preliminary 1995 crash data file was obtained for the analysis with data from this file being used for the period January to June 1995.

The VicRoads Police reported crash database records many variables describing crash details (Green 1991). Of those available, the following were relevant to this study;

- Road Reference Point (RRP) : describes crash location for crashes occurring at road intersections
- Road Segment (RS) : describes crash location for crash occurring away from intersections
- Date of crash
- Recorded speed zone of road on which crash occurred
- Definition for Classifying Accidents (DCA) describing crash
- Crash severity (fatal, serious injury or other injury)

For those LGAs listed in section 3.1 there was a total of 22,314 crashes over the period 1992 to June 1995.
3.2.2 Study periods

As described in section 2.1 above, the study design which has been chosen for this evaluation is a pseudo-experimental design utilising treatment and control sites. Under this study design, suitable periods before and after implementation of the speed zone changes must be defined on which to base the analysis. These periods must be defined with reference to the available crash data (January 1992 to June 1995) and the treatment implementation dates.

As described in section 3.1, speed zone changes in the sampled metropolitan Melbourne LGAs were implemented over the period July to December 1993. It was therefore decided to define the study “before” period as January 1992 to June 1993 and the study “after” period as January 1994 to June 1995. Rural Victoria speed zone changes for those LGAs sampled occurred over the period July 1993 to June 1994. For these LGAs the before period was July 1992 to June 1993 and the after period was July 1994 to June 1995. This provided crash data spanning a period of 18 months before and after treatment for the metropolitan Melbourne analysis and a period of 12 months before and after treatment for analysis in the rest of Victoria.

These choices of before and after period offer a number of benefits to both the metropolitan Melbourne and rest of Victoria analyses. Firstly the before and after periods were equal length hence providing a balanced analysis. Secondly, the before and after periods cover the same calendar months eliminating possible confounding effects of seasonal bias which are known to exist in the crash data. Finally, the periods chosen make maximum use of the available after treatment crash data hence maximising the power of the analysis for the available data. The choice of identical before and after treatment periods for every treated site in the analysis is also convenient for data extraction and manipulation.

4.0 ANALYSIS METHODS

4.1 SITE IDENTIFICATION

As VicRoads were not able to supply a specific file of crash data at treated sites for use in the project, one critical task involved in the project was the identification of crashes at treated sites and the subsequent identification of control crashes. After selection of the sample of treated sites to include in the analysis, the appropriate accidents were identified using a Geographical Information System (GIS) computer package in conjunction with crash location data supplied by VicRoads.

The desktop mapping package ArcView 2.1b was used to identify sites with speed zone changes in the LGAs mentioned in section 3.1. This process involved identifying treatment sites from the hardcopy information and entering this information into ArcView. In the process of identifying the treated sites, the sites were also labelled as undergoing a specific speed zone change, for example 75km to 80km, for use in the analysis phase. As a result of processing of the treatment site information in ArcView, a list of location details in the form of Road Reference Points numbers (RRPs) and Road Segment numbers (RSs) were obtained, each labelled with the treatment site to which they related and the speed zone change type which occurred at that site.
4.2 CRASH DATA EXTRACTION

4.2.1 Treatment Crash Data

Having obtained the location details, the RRP and RS numbers were used to identify crashes at the sites with speed zone changes, before and after implementation. This process involved merging the RRP and RS numbers obtained from ArcView onto the Police recorded crash database. Crash records whose RRP or RS numbers matched those of treated sites were then labelled as occurring at specific treatment sites, including the type of speed zone change which occurred at each site. Crashes whose RRP and RS numbers did not match were then labelled as suitable for use as control crashes. The date of each accidents within the treatment groups was then examined, labelling the accident as before or after the speed zone change.

4.2.2 Control Crash Data

Having labelled those crashes occurring at speed zone change sites, the remaining crashes were suitable for use as control crashes. As discussed, the basic reason for using control crashes is to adjust in the analysis for other factors, apart from the speed zone changes, which have influenced crash frequency in the study period. Hence the sites selected for controls should be as similar as possible to the treatment sites apart from undergoing the change of interest (viz. a speed zone change).

Treatment site descriptions provided by VicRoads provided very little basis for exact matching of control sites. Consistent information provided for each treatment site which may have been useful for control matching consisted only of the LGA in which the change occurred and the speed zone before and after the change. Noting this, it was decided that control crashes would be matched on two criteria; (1) LGA of treatment site, and (2) broad speed zoning before and after crash. Criteria 1 controls for the effects of broad road safety programs (such as speed camera usage and Random Breath Testing) as well as economic effects in the local district, whilst criteria 2 controls for specific features such as road type and adjacent land usage which are factors which determine the broad speed zone of a particular road. Given the range of speed zone changes recorded at the treatment sites, this control matching strategy allowed all of the remaining crashes not occurring at treated sites in each LGA to be used as controls which was useful in maximising the power of the analysis.

Interrogation of the crash database showed the majority (approximately 90%) of pre 1993 crashes occurred in either 60 or 100 km/h zones in both Melbourne and the rest of Victoria with most of the remainder occurring in 75 km/h zones (which have, of course, changed) and a few in 80 and 90 km/h zones. To ensure sufficient crash numbers in each control group, it is essential that each control group selected includes crashes in either 60 or 100 km/h zones. Given this, Table 1 details the proposed matching criteria with relation to speed zone for each specific type of speed zone change being evaluated.
TABLE 6: Speed zone changes and proposed control matching speed zones of crashes in the same LGA

<table>
<thead>
<tr>
<th>Speed Zone Change Number</th>
<th>Speed Zone Change (km/h)</th>
<th>Proposed control crash speed zones (km/h) within same LGA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>90 to 80</td>
<td>80, 90, 100</td>
</tr>
<tr>
<td>2</td>
<td>75 to 70</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>100 to 80</td>
<td>80, 90, 100</td>
</tr>
<tr>
<td>4</td>
<td>80 to 90</td>
<td>80, 90, 100</td>
</tr>
<tr>
<td>5</td>
<td>60 to 70</td>
<td>60</td>
</tr>
<tr>
<td>6</td>
<td>75 to 80</td>
<td>80, 90, 100 (+ 60 in metropolitan Melbourne)</td>
</tr>
<tr>
<td>7</td>
<td>75 to 100</td>
<td>80, 90, 100</td>
</tr>
<tr>
<td>8</td>
<td>80 to 90</td>
<td>80, 90, 100</td>
</tr>
<tr>
<td>9</td>
<td>60 to 80</td>
<td>80, 90, 100 (+ 60 in metropolitan Melbourne)</td>
</tr>
<tr>
<td>10</td>
<td>100 to 90</td>
<td>90, 100</td>
</tr>
<tr>
<td>11</td>
<td>75 to 60</td>
<td>60</td>
</tr>
<tr>
<td>Other</td>
<td>100 to 60, 100 to 70, 70 to 50, 75 to 90, 70 to 60, 70 to 80, 80 to 100, 60 to 100</td>
<td>60, 80, 90, 100</td>
</tr>
</tbody>
</table>

The “other” category in Table 6 contains speed zone changes which have occurred at only 1 to 2 sites in the state. Given their small number it was not considered possible to evaluate these speed zone change types individually so they were aggregated into a residual category, labelled “other”, for analysis. 100 km/h sites which had been rezoned to 110 km/h, whilst not the subject of this evaluation, were excluded as potential controls for this study.

Once all accidents have been labelled as occurring before or after the speed zone change (time) and to the particular treatment and control groups (group), the file was then aggregated by the speed zone change type, time and group to obtain a crash frequency for each combination, ready for analysis.

4.3 STATISTICAL ANALYSIS METHODS

The most widely used method of evaluating countermeasure effectiveness when control groups are used for comparison, and one which would seem appropriate for use here, is that proposed by Tanner (1958). Tanner's method has been used in many previous evaluations of accident black-spot treatments, for example by Corben et al. (1990), Bui et al. (1991) and Tziotis (1993). In summary, Tanner's method assumes that accidents at a treatment site are assigned to the before and after treatment periods according to a Binomial distribution. Under the null hypothesis of no
treatment effect the ratio of accidents in the before to after period in the treatment group should be the same as that in the control group. A chi-squared test for differences in the control versus treatment group is then applied to test the null hypothesis of no treatment effect. Tanner's method includes a test of equal treatment effect across a number of treated sites. The main advantage in using Tanner's test is that it makes good use of information from control groups in the analysis.

A test equivalent in philosophy to that proposed by Tanner has been described by Bruhning and Ernst (1985). This test procedure uses the much newer and more elegant theory of Generalised Linear Models, techniques which were not widely available at the time Tanner devised his method. This new method also makes good use of information in the control group but is not restricted by the assumption that the control group crash frequencies are error free as Tanner assumes. The method of Bruhning and Ernst recognises that the crash frequencies at the control sites will also be subject to variation. A brief outline of the test proposed in Bruhning and Ernst (1985) follows.

The accident data for a particular treatment site and control site in a simultaneous before and after comparison can be summarised in a 2x2 contingency table, as in Figure 1.

**FIGURE 1**: 2x2 crash data contingency table for a single treated site and its control

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>( n_{11} )</td>
<td>( n_{12} )</td>
</tr>
<tr>
<td>Treatment group</td>
<td>( n_{21} )</td>
<td>( n_{22} )</td>
</tr>
</tbody>
</table>

where \( n_{ij} \) is the number of crashes in cell \( ij \) of the table.

For \( L \) treatment sites, this may be summarised in a series of \( L \) 2x2 contingency tables as in Figure 2.

**FIGURE 2**: 2x2 crash data contingency table for \( L \) treated sites and controls

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Control Group</th>
<th>Treatment Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>1</td>
<td>( n_{111} )</td>
<td>( n_{112} )</td>
</tr>
<tr>
<td>2</td>
<td>( n_{211} )</td>
<td>( n_{212} )</td>
</tr>
<tr>
<td>( \ldots )</td>
<td>( \ldots )</td>
<td>( \ldots )</td>
</tr>
<tr>
<td>( L )</td>
<td>( n_{L11} )</td>
<td>( n_{L22} )</td>
</tr>
</tbody>
</table>

A log-linear model with Poisson error structure, appropriate for the variability in the count data, of the form

\[
\ln(n_{ijk}) = \beta_0 + \beta_i + \beta_j + \beta_{ik} + \beta_{ijk}
\]

where \( i \) is the site number, \( j \) is the treatment or control group index and \( k \) is the before or after treatment index, is then fitted to the data in Figure 2. Significant treatment effect in each group, \( i \), is then assessed by testing the significance of the \( \beta_{ijk} \) parameter for each group. The magnitude of the treatment effect is also assessed by the magnitude of this parameter and suitable confidence limits can be calculated. Subtle modifications of the above model can be used to test for
homogeneity of treatment effect across a group of sites as well as each of the analysis levels described in section 2.3. These modifications are described in Bruhning and Ernst (1985).

4.4 POST HOC ANALYSIS

Having established any significant change in casualty crash rates associated with the implemented speed zone changes, further post-hoc analysis of the data to determine the specific nature of the changes was undertaken. The analysis presented is descriptive, examining differences in the profiles of various crash descriptors before and after the speed zone change at the treated sites. The key variables examined is DCA type, which describes the type of crash recorded in terms of vehicle movement. The level of detail in the analysis will be determined by the findings of the crash frequency analysis.

In addition, results of the crash frequency analysis have been compared to the summary of speed monitoring data at sites with changed speed zoning, detailed in the Parliamentary Inquiry report (Road Safety Committee, 1995), Appendices F and G.

5.0 RESULTS

5.1 METROPOLITAN MELBOURNE

5.1.1 Crash Frequency

Results of the analysis of the effects of the speed zone rationalisation on casualty crash frequency in metropolitan Melbourne are presented here. The analysis methods of Section 4 above were employed to obtain the results.

Table 7 details the results of the casualty crash frequency analysis performed for metropolitan Melbourne. Results are presented for the first three levels of analysis detailed in Section 2.3. That is, the total program effect across all speed zone changes, general effects of speed zone increases and speed zone decreases and the effects of each type of speed zone change across all LGAs of metropolitan Melbourne. The amount of before and after crash data available was not sufficient to allow the fourth level of testing proposed in Section 2.3 which examines each type of speed change within each LGA.

The estimated percentage change in casualty crash frequency for each hypothesis tested are shown in Table 7 along with 95% confidence limits on each estimate. In interpreting these results, a negative sign on the result indicates casualty crash frequency reduction whilst positive estimates indicate crash frequency increase. As well as the 95% confidence limits and point estimates, the significance level of the test of the null hypothesis is given. The significance level value is the probability that the null hypothesis is true, viz. no change in crash frequency due to speed zone changes, given the data tested. Small values of the significance level indicate significant casualty crash frequency change due to speed re-zoning. For completeness, Table 7 also shows the number of crashes in the combined before and after treatment study periods for both the treatment and control sites. The number of cases in each of these cells gives an indication of the statistical power available in each analysis, with more cases giving greater power to identify statistically significant casualty crash frequency change.
Examination of the results presented in Table 7 shows only one statistically significant hypothesis test result at the 5% level of significance for speed changes in metropolitan Melbourne. Of the individual speed zone changes, only the change from 60 to 80 km/h resulted in a casualty crash change significant at the 5% level. For this speed zone change, a decrease in casualty crash frequency of 47.01% was associated with the speed zone change, with a null hypothesis significance probability of 0.0265. In the first instance, this result may seem counter intuitive. Examination of the particular sites where this speed zone change had taken place, however, revealed that the change was typically made to bring small lengths of high standard, dual carriageway urban arterial roads up to a speed zoning consistent with the surrounding road segments. These small sections of road were previously zoned 60 km/h where the surrounding road segments were zoned 75 km/h. The speed zone rationalisation brought all the contiguous sections of the road to a uniform 80 km/h speed zoning.

Of the other individual speed zone changes analysed, one other showed a result worthy of note. The increased speed zoning from 75 to 80 km/h was associated with an increase in casualty crash...
frequency of 10.54% percent, with a null hypothesis significance probability of 0.0805. Whilst this significance probability is not less than 5% it is sufficiently small to be described as marginally statistically significant (significance probability between 0.05 and 0.1), indicating a likely effect associated with this speed zone change.

It is interesting to note that for the individual speed zone changes aggregated into the category labelled ‘other’, a 70% reduction in casualty crash frequency was estimated with significance probability of 0.074. Table 6 lists the individual speed zone changes which have been aggregated in this category. From the analysis it is not clear what contribution each of these particular changes has made to the estimated overall reduction.

All of the other individual speed zone change tested had null hypothesis test significance probability greater than 0.19 indicating that no statistically significant changes in crash frequency due to speed zone changes was found, despite some having large point estimates of casualty crash frequency change. As with all hypothesis testing of this kind, a non significant hypothesis test result does not necessarily indicate there was no real change in crash risk, but rather that a statistically significant change could not be identified given the available data.

Table 7 also shows the results of testing the effects of speed zone changes in metropolitan Melbourne, broadly classified by zones with increased speeds and zones with decreased speeds. For roads where speed zoning decreased, no statistically significant change in casualty crash frequency was found (significance probability = 0.7249). Increasing speed zoning was estimated to increase casualty crash frequency by 8.7%, with a significance probability of 0.0757 which is not less than the nominal level of 0.05 but is small enough to be described as marginal, suggestive of a real effect.

The final result presented in Table 7 is an estimate of the overall effect of all speed zone changes on casualty crashes in metropolitan Melbourne. The estimate of the overall program effect, shown in Table 7, is a 6.85% increase in casualty crash frequency with a significance probability of 0.1073. The significance probability of this result is sufficiently high to be classed as marginal, leaving doubt regarding whether the estimated change is real or due to chance. Whilst the estimated change is consistent with the other results of Table 7, more crash data would be necessary to confirm whether the estimated overall program effect of 6.85% crash increase was real.

Using the proportion of sites sampled for analysis in Melbourne and the before treatment crash rate, the estimated 6.85% increase in casualty crashes numbers across all Melbourne represents an estimated increase in the order of 200 casualty crashes per annum due to all speed zone changes. Similarly, the increase of 10.54% in casualty crash frequency estimated for the 75 to 80 km/h speed zone change represents in the order of 150 crashes per annum across all of Melbourne, whilst the 47% reduction in casualty crash frequency for the 60 to 80 km/h speed zone change represents approximately 70 casualty crashes per annum across all Melbourne.

In summary, analysis of the effects of speed zone changes on casualty crash frequency in metropolitan Melbourne led to the following results. Overall, speed zone changes were estimated to increase casualty crash frequency by 6.85%, although this result was not statistically significant. No statistically significant change in casualty crash frequency was found overall at sites where the zone speed decreased whilst an 8.7% casualty crash increase (with marginal statistical significance)
was observed overall at sites where zone speed increased. For particular speed zone changes, the change from 60 to 80 km/h showed a statistically significant casualty crash reduction of 47%. Increased speed zoning from 75 to 80 km/h showed a marginally statistically significant casualty crash frequency increase of 10.5%.

5.1.2 Post Hoc Analyses

Having analysed the changes in casualty crash frequencies above, further analysis has been undertaken in attempt to better understand these results. Further analysis for the metropolitan Melbourne area has centred in two areas; (1) Examination of the changes in the profile of crash types by Definition for Classifying Accident (DCA) grouping before and after speed zone change for those sites with significant crash frequency changes, and (2) Relationship of the crash frequency analysis results to results of speed monitoring reported in the Parliamentary Inquiry report (Road Safety Committee, 1995), Appendices F and G.

Changes in Crash Type Profiles

Examination of changes in DCA patterns before and after speed zone changes for sites with significant changes in casualty crash frequency has been carried out to determine if speed zone changes have been responsible for changes in all crash types generally or only specific crash types. DCA groups are specified by the first two digits of the DCA code. It should be noted that the analysis here looks at only DCA changes at the sites where speed zones have statistically significant changes and makes no reference to the control sites. To overcome the absence of reference to control groups, the analysis examines changes in the proportion of crashes in each DCA group before and after treatment.

FIGURE 3: Percentage of DCA groupings for crashes occurring in the treatment areas of metropolitan Melbourne before and after speed zone changes: All speed zone changes.
Figure 3 shows the distribution of crashes by DCA grouping for all speed zone change sites in metropolitan Melbourne before and after speed zone changes. It can be seen from Figure 3 that the distribution of DCAs has changed little as a result of the speed zone changes with the proportion of crashes in each group essentially the same before and after treatment. The analysis of crash frequency change in Section 5.1.1. above estimated an overall casualty crash frequency increase of 6.85%, although this result was not statistically significant. The DCA analysis in Figure 3 shows that, if this increase is real, it has likely been uniform across all crash types rather than affecting any specific crash types.

Of the individual speed zone changes analyses for metropolitan Melbourne, only two showed evidence of significant crash frequency change; 75 to 80 km/h and 60 to 80 km/h. Figures 4 and 5 show the results of DCA analysis for each of these two speed zone changes respectively.

Figure 4 shows the results of DCA analysis for the 75 to 80 km/h speed zone change where a marginally statistically significant crash frequency increase of 10.5% was observed. Figure 4 shows the observed increases are likely due to increases in the proportion of crashes of the types opposing direction manoeuvres (DCA 120-129), and other manoeuvres (DCA 150-159). It is worth noting that the proportion of pedestrian crashes in Figure 4 has reduced after this speed zone change.

**FIGURE 4**: Percentage of DCA groupings for crashes occurring in the treatment areas of metropolitan Melbourne before and after speed zone changes: 75-80km/h speed zone change.

For the change from 60 to 80 km/h, Figure 5 shows casualty crashes of the types overtaking manoeuvres (DCA 150-159), hitting objects on path (DCA 160-169) and crashes on curves (DCA 180-189) being eliminated subsequent to treatment, along with opposing manoeuvre crashes (DCA 120-129) being reduced. These gains are perhaps consistent with the fact that this speed zone change was applied to bring lengths of divided arterial road to a uniform speed zoning and hence may be expected to also create more uniform traffic flows, potentially reducing the incidence of
manoeuvres such as overtaking. Figure 5 also shows some increases in the proportion of crashes at intersections and crashes off straight. This is also consistent with the fact that sites undergoing speed zone change from 60 to 80 km/h were often located across or near intersections with the higher speed zoning potentially increasing the risk of intersection crashes as well as off straight crashes on approach to the intersection.

**FIGURE 5**: Percentage of DCA groupings for crashes occurring in the treatment areas of metropolitan Melbourne before and after speed zone changes: 60-80km/h speed zone change

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**Relation to Speed Monitoring**

As part of the submissions made to the Parliamentary Inquiry into the revision of Victoria's speed limits (Road Safety Committee, 1995), both the RACV and VicRoads submitted speed monitoring data at a sample of sites where the speed limit had changed. Data was collected both before and after the change. Appendices F and G in the Parliamentary Inquiry report detail the results of analysis of the speed monitoring data. Whilst the data presented is representative of a limited number of sites, it was considered useful to compare the published findings to the results of the analysis undertaken here in an attempt to link any recorded speed changes with the estimated changes in crash frequency.

Table 8 summarises the results of the speed monitoring data presented in the Parliamentary Inquiry report along with the key results from the casualty crash frequency analysis described above. The RACV state explicitly the sites monitored, with all being located in metropolitan Melbourne. The exact location of the VicRoads sites, however, is unclear, and it was presumed these also lie in metropolitan Melbourne. Hence it was considered relevant to compare all the speed monitoring results available to the results of the Melbourne casualty crash analysis.
### Table 8: Summary of speed monitoring results presented in the Parliamentary Inquiry report and related casualty crash frequency analysis results. Metropolitan Melbourne.

<table>
<thead>
<tr>
<th>Zone Change</th>
<th>Mean Speed / Compliance</th>
<th>Speed Distribution</th>
<th>Casualty Crash Frequency Analysis Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-70 Divided</td>
<td>RACV: Speeds relatively unchanged. Majority complying to new limit and less exceeding the limit. VicRoads: Speeds unchanged. Greater compliance.</td>
<td>RACV: Distribution narrowed in 7 out of 8 locations. VicRoads: Distribution narrowed.</td>
<td>11.81% increase (-5.48, 32.26)</td>
</tr>
<tr>
<td>75-80 Divided</td>
<td>RACV: Speeds remain unchanged at 80-85 km/h. Less below the limit but proportion of high risk drivers (&gt;20 km/h over) remained the same. VicRoads: Speeds unchanged, less drivers below limit. Same number of excessive speeders (&gt;20 km/h over).</td>
<td>RACV: Slight widening in distribution for 6 of 8 locations. VicRoads: Not stated.</td>
<td>10.54% increase (-1.20, 23.68)</td>
</tr>
<tr>
<td>75-80 Undivided</td>
<td>RACV: Increase in speeds. VicRoads: Speed increases; mean up 9 km/h, 85th percentile up 14 km/h.</td>
<td>RACV: Half sites narrowed and half sites widened. VicRoads: Not stated.</td>
<td>0.0805 significance</td>
</tr>
<tr>
<td>75-70 Divided</td>
<td>VicRoads: Slight decrease in speeds with notable number exceeding limit excessively.</td>
<td>VicRoads: Not stated.</td>
<td>5.91% increase (-11.29, 26.44)</td>
</tr>
<tr>
<td>75-70 Undivided</td>
<td>RACV: Speeds unchanged. Reduction in complying to new limit and increase in exceeding the limit.</td>
<td>RACV: Slight widening or no change in distribution for 7 of 8 locations.</td>
<td>0.5253 significance</td>
</tr>
</tbody>
</table>

As shown in Table 8, the results of VicRoads and RACV speed monitoring are generally consistent in their conclusions. These results are also consistent with the results of the casualty crash frequency change analysis also detailed in Table 8.

For the speed zone change from 60 to 70 km/h, there was small speed increases observed on undivided roads and no speed increases on divided roads. Whilst speed distributions narrowed on the divided roads, the effects on the undivided roads were less clear with some distributions widening and others narrowing. No significant changes in casualty crash frequency were observed for this speed zone change which is consistent with the results of speed monitoring finding little speed change and mostly distributional narrowing of speeds.
Casualty crash analysis of the speed zone change from 75 to 80 km/h in metropolitan Melbourne found a marginally statistically significant 10.5% increase in crash frequency. Results of speed monitoring suggest this may be due to the observed slight speed increases, particularly on undivided roads, along with the a continued number of vehicles exceeding the speed limit excessively even at the new higher speed limit. In addition there is a suggestion of widened speed distributions, again particularly on undivided roads, which is known to contribute to higher crash risks.

From speed monitoring at sites with a speed zone change from 75 to 70 km/h, little or no change was recorded in mean travel speeds resulting in a reduced compliance with the new speed limit. There was also little change in the distribution of speeds. These are both consistent with the casualty crash analysis results finding no statistically significant change in crash frequency at sites with this speed zone change.

5.2 REST OF VICTORIA

5.2.1 Crash Frequency

Results of the casualty crash frequency analysis for speed zone changes in the rest of Victoria are presented in Table 9. The format and interpretation of the results presented in Table 9 are the same as for Table 7 above which details the results of the metropolitan Melbourne analysis.

TABLE 9: Results of crash frequency analysis - rest of Victoria

<table>
<thead>
<tr>
<th>Speed Zone Changes Across All LGAs</th>
<th>Number of casualty crashes in analysis</th>
<th>Treatment</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>75-70</td>
<td>4</td>
<td>109</td>
<td></td>
</tr>
<tr>
<td>60-70</td>
<td>15</td>
<td>122</td>
<td></td>
</tr>
<tr>
<td>75-80</td>
<td>56</td>
<td>786</td>
<td></td>
</tr>
<tr>
<td>60-80</td>
<td>3</td>
<td>88</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Increase or Decrease Speed Zone Changes</th>
<th>Number of casualty crashes in analysis</th>
<th>Treatment</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease Zone Change</td>
<td>4</td>
<td>109</td>
<td></td>
</tr>
<tr>
<td>Increase Zone Change</td>
<td>74</td>
<td>978</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Across all LGAs for all Speed Zone Changes</th>
<th>Number of casualty crashes in analysis</th>
<th>Treatment</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Accidents</td>
<td>78</td>
<td>1085</td>
<td></td>
</tr>
</tbody>
</table>

* : Net percentage change after adjusting for control group crash trend
From the treated sites sampled in the rest of Victoria, only four individual types of speed zone changes were identified. Each of these is given in Table 9. Most of the speed zone changes which occurred in the rest of Victoria took place on the fringes of country towns in the speed transition zones between 100 km/h zones of the open highway and 60 km/h zones of the built up area. Consequently the individual continuous lengths of road with changed speed zone were typically of very short length, often being of the order of only 300m. This feature, combined with generally lower accident densities when compared to metropolitan Melbourne, and shorter before and after study periods (12 months) meant the number of crashes at the treated sites available for analysis was limited. Only 78 casualty crashes were recorded at sampled sites with speed zone changes in the rest of Victoria over the study period. Of these, the majority (56) occurred in sites with a speed zone change from 75 to 80 km/h. Consequently, power available in the statistical analysis was limited.

Table 9 shows the overall casualty crash frequency change for all speed zone changes combined in the rest of Victoria to be estimated as a 32.87% reduction, with a null hypothesis significance probability of 0.0971. The significance probability of the result is sufficiently small to be described as statistically marginal, making it uncertain whether the estimated reduction is real or merely chance variation. Power calculations detailed in section 2.2 showed that the sampling frame used for the rest of Victoria would only be able to identify a minimum overall 40% change in casualty crash frequency with significance probability of 0.05. Given a 32% change was estimated, a calculated significance probability of 0.097 is consistent with the power calculations. These results show that if a reliable estimate of casualty crash frequency change is to be estimated for the rest of Victoria either more sites will need to be sampled (subject to sufficient site description data being available from VicRoads) or greater after treatment crash data will need to be accumulated. If the estimated 32% reduction in casualty crashes for the rest of Victoria is real, this represents an estimated saving in the order of 150 casualty crashes per annum across the whole region.

Although results for individual speed zone change types, and for combinations of sites with speed limit increases or decreases are presented in Table 9, the results are generally uninformative. This is shown by the generally large significance values and correspondingly large 95% confidence limits on the point estimates of casualty crash frequency change. It should be noted however that, for all but the 60 to 80 km/h speed zone change, large reductions were estimated for all other change types, consistent with the overall estimated percentage reduction of 32.87%. This suggests that, on first evidence, the speed zone rationalisation in the rest of Victoria has reduced casualty crash frequency.

5.2.2 Post Hoc Analyses

Given the limited success of the crash frequency analysis for the rest of Victoria due to limited data quantities, it was considered unlikely that further post-hoc analysis would be informative. Figure 6 details the results of DCA profile analysis for all speed zone changes combined. Examination of Figure 6 shows no clear patterns in DCA changes. It should be noted in interpreting this analysis that the proportion for each DCA category is calculated from only four crashes on average and hence it is not possible to make any meaningful conclusion from the results of Figure 6.
5.3 WHOLE OF VICTORIA

For completeness, the crash frequency analysis was also carried out for Victoria as a whole to assess the casualty crash frequency effect overall. The results of the combined analysis are presented in Table 10. Interpretation of the results in Table 10 is the same as Tables 7 and 9.

As expected from the relative number of crashes available for analysis in Tables 7 and 9, the estimated casualty crash effects shown in Table 10 for the whole of Victoria are dominated by the metropolitan Melbourne results. Hence the results of Table 10 closely follow those of Table 7 and there were no different conclusions to those detailed for the analysis of speed zone changes in metropolitan Melbourne.
TABLE 10: Results of crash frequency analysis - All of Victoria

<table>
<thead>
<tr>
<th>Speed Zone Changes Across All LGAs</th>
<th>Number of casualty crashes in analysis</th>
<th>Treatment</th>
<th>Control</th>
<th>Percentage Change</th>
<th>95% Confidence Limits</th>
<th>Sig. Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>75-70</td>
<td>695</td>
<td>1797</td>
<td>6.57%</td>
<td>-10.56%</td>
<td>26.98%</td>
<td>0.4768</td>
</tr>
<tr>
<td>100-80</td>
<td>78</td>
<td>67</td>
<td>-26.32%</td>
<td>-61.91%</td>
<td>42.52%</td>
<td>0.3643</td>
</tr>
<tr>
<td>60-70</td>
<td>748</td>
<td>2278</td>
<td>8.81%</td>
<td>-7.78%</td>
<td>28.38%</td>
<td>0.3172</td>
</tr>
<tr>
<td>75-80</td>
<td>1688</td>
<td>5665</td>
<td>10.48%</td>
<td>-0.92%</td>
<td>23.20%</td>
<td>0.0728</td>
</tr>
<tr>
<td>60-80</td>
<td>132</td>
<td>151</td>
<td>-34.64%</td>
<td>-59.18%</td>
<td>4.63%</td>
<td>0.0766</td>
</tr>
<tr>
<td>100-90</td>
<td>7</td>
<td>2</td>
<td>-60.00%</td>
<td>-98.40%</td>
<td>901.79%</td>
<td>0.5771</td>
</tr>
<tr>
<td>75-60</td>
<td>26</td>
<td>29</td>
<td>4.35%</td>
<td>-74.70%</td>
<td>330.37%</td>
<td>0.9531</td>
</tr>
<tr>
<td>OTHERS</td>
<td>25</td>
<td>16</td>
<td>-70.00%</td>
<td>-91.99%</td>
<td>12.39%</td>
<td>0.074</td>
</tr>
</tbody>
</table>

Increase or Decrease Speed Zone Changes

| Decrease Zone Change | 806 | 1895 | 3.74% | -12.30% | 22.71% | 0.6686 |
| Increase Zone Change  | 2568| 8094 | 7.92% | -1.29%  | 17.98% | 0.0943 |

Across all LGAs for all Speed Zone Changes

| All Accidents | 3399 | 10005 | 6.47% | -1.58%  | 15.18% | 0.1181 |

*: Net percentage change after adjusting for control group crash trend

6.0 DISCUSSION

Selection of sites where speed zone changes had taken place for use in the analysis presented here was largely dictated by the quality of the data describing the sites supplied the VicRoads regional offices. Of those sites with suitable data, the majority have been included in the analysis. Ideally, when sampling sites for analysis, a completely random sampling mechanism is necessary from a statistical point of view in order to eliminate any possibility of systematic bias in the data affecting the results of analysis. As it was not possible to apply a completely random sampling procedure for site selection, it has been assumed that the sites analysed are generally representative of all sites of the same type and hence the analysis is representative of the true effects of speed zone changes in Victoria.

Improvement in the quality of the supplied data would have improved the results of the evaluation undertaken here. The issue of data quality and collection methods should be pursued for evaluation
studies of this type in the future. It appears that, for the data collected for this study, only a broad specification of the information required was given to the VicRoads regional offices with no set format of data required. This resulted in the inconsistent format of the data returned. The data collection process, and hence the efficiency of evaluation, could have been enhanced in this instance by providing the VicRoads regional offices with standard forms, into which they could enter all the required data in the exact format required. This would have enabled much easier data quality and completeness auditing and integration than was the case.

Overall, the results of the evaluation presented here give indications of the effects that the revision of Victoria’s speed zone limits have had on casualty crash frequency. Results of analysis in metropolitan Melbourne indicate that the increased speed zoning, with no co-incidental road geometry changes, is associated with an increase in casualty crash frequency, demonstrated particularly for the 75 to 80 km/h speed zone change. Speed monitoring results suggest this may be a result of higher mean speeds, plus a wider distribution of speeds in some of these zones. The only exception to this is the change from 60 to 80 km/h zoning on certain road sections which appears to have reduced casualty crash frequency. Whilst being a zoned speed increase, this speed zone change was generally made to achieve uniform speed zoning along high quality, major arterial roads. Hence the positive benefits of this change can most likely be ascribed to reducing variance in traffic speed and perhaps even reducing driver confusion about the posted limit on a stretch of road.

Conversely, decreased speed zoning appears to be associated with little effect on mean speeds and speed distributions and was found to have no significant effects on casualty crash frequency. This suggests a ready willingness amongst drivers to increase travel speed when zoned speed is increased, but a reluctance to reduce travel speeds to which they have become accustomed when the speed zoning is lowered. More comprehensive speed monitoring data at a wider range of sites than currently available is needed to confirm these observations.

If these general observations are correct, they may have some important implications for road authorities when considering speed zoning in the future. Firstly detrimental casualty crash effects may be likely when considering increasing zoned speeds even by as little as 5km/h. There appears to be a reluctance for drivers to increase travel speed when zoned speed is increased, but a reluctance to reduce travel speeds to which they have become accustomed when the speed zoning is lowered. More comprehensive speed monitoring data at a wider range of sites than currently available is needed to confirm these observations.

Results of analysis for the rest of Victoria indicate that the speed zone revision may have been largely effective in reducing casualty crash frequency in this region although no statistically significant crash reductions were found. As noted, the speed revisions in this area generally have been implemented in transition zones between 100 km/h open roads and 60 km/h rural towns. It is not clear why speed zone changes in these sections of road might have been as effective in reducing crashes in comparison to similar speed zone changes in metropolitan Melbourne areas. Perhaps the revised speed limits in the transition zones provide a better graduated reduction of speeds on approach to built up areas. This would require further investigation to confirm.

Whilst it has been possible to make some general comments on the results of this evaluation, overall the results are not absolutely definitive in estimating the crash effects of Victoria’s speed zone revisions. Part of the reason for this is the relatively limited quantities of crash data after the
change available for analysis, with only 18 and 12 months of after change data available for Melbourne and the rest of Victoria respectively. Given the near statistical significance of many of the results obtained here it is considered that more definitive results could be obtained by analysis of crash data collected from a longer after treatment period. Inclusion of an extra one or two year’s data would significantly enhance the results obtained, particularly if more complete treated site description data could be provided to allow more sites to be included in the analysis.

7.0 CONCLUSIONS

Analysis of the effects of speed zone changes on casualty crash frequency in metropolitan Melbourne showed an overall increase in casualty crash frequency of 6.9%, although this result was of marginal statistical significance and should be interpreted with caution. This estimated increase represents in the order of 200 extra casualty crashes per annum across Melbourne due to all speed zone changes. Assessment of the general effects on casualty crash frequency of increasing zoned speed or decreasing zoned speed showed no statistically significant change in casualty crash frequency when the zone speed was decreased, and an 8.7% casualty crash increase (with marginal statistical significance) when zone speed was increased. For particular speed zone changes, the change from 60 to 80 km/h showed a statistically significant casualty crash reduction of 47%, translating to a saving of approximately 70 casualty crashes per annum across Melbourne. Increased speed zoning from 75 to 80 km/h showed a marginally statistically significant casualty crash frequency increase of 10.5%, representing an increase of approximately 150 casualty crashes per annum across Melbourne.

The results of analysis of casualty crash frequency in metropolitan Melbourne were generally consistent with the results of speed monitoring.

Most of the speed zone changes which occurred in the rest of Victoria took place on the fringes of country towns in the speed transition zones between 100 km/h zones of the open highway and 60 km/h zones of the built up town area. The overall casualty crash frequency change for all speed zone changes combined in the rest of Victoria was estimated as a 32.9% reduction (representing a saving of approximately 150 casualty crashes per annum across the rest of Victoria), however the statistical significance of this result was marginal. Whilst this result suggests that the speed zone rationalisation in the rest of Victoria has been overall successful in reducing casualty crash frequency, insufficient crash history after the speed zone review cannot support this conclusion with statistical reliability.

The evaluation found no statistically significant change in overall casualty crash frequency in Victoria due to speed zone rationalisation. Whilst the results of the evaluation presented here are generally based on limited quantities of data after implementation of speed zone changes, this study has established a framework under which the evaluation could be easily repeated at a later date to more precisely estimate the effects of speed zone rationalisation.

8.0 RECOMMENDATIONS

From the results of the analysis presented in this report, two major recommendations are made.

1. Re-analysis of the effects of speed zone changes on casualty crash frequency after longer post-treatment experience.
The results presented in this evaluation are far from definitive in estimating the crash effects of Victoria's speed zone revisions. Many of the results obtained indicate likely effects but have crash frequency change estimates of only marginal statistical significance, which reduces confidence in the conclusions. The reason for this lies largely in the relatively limited quantities of crash data after the change available for analysis.

In order to obtain more definitive results it is recommended that the analysis be carried out again at a later date including data collected from a longer after treatment period. Inclusion of an extra one or two years' data would significantly enhance the results obtained. Re-analysis incorporating additional crash data would be efficient and rapid if carried out as an extension to the study detailed here given that the analysis framework has been established, including the particularly time consuming task of identifying the speed zone change site locations.

2. Standardisation and review of data collection and reporting procedures used by VicRoads regional offices.

A second problem for the evaluation presented here was the lack of detail of some data supplied describing the speed zone changes which were carried out. This limited the number of sites with speed zone changes which could be included in the analysis, and hence the limited statistical power of the analysis.

It is recommended that the issue of data collection methods be addressed for any future work on this subject which may be carried out and for other prospective evaluation studies of this type. For this study, this may involve re-extraction of the required data for those sites for which the supplied data was inadequate. For prospective studies it may involve the design and implementation of standard data forms and data collection procedures across all regions from which data is supplied.

9.0 REFERENCES


APPENDIX A
Sample of speed zone change sites used in analysis: Metropolitan Melbourne
APPENDIX B
Sample of speed zone change sites used in analysis: Rest of Victoria
RURAL VICTORIA
Local Government Areas Used in Analysis

MONASH UNIVERSITY
Accident Research Centre
1996