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In-depth research into rural road crashes

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ABSTRACT

This report was produced under an agreement between Transport SA and the Road Accident Research Unit formed in the late 1990s. Due to various delays in the publication of this report, Transport SA has since become the Department for Transport, Energy and Infrastructure and the Road Accident Research Unit has become the Centre for Automotive Safety Research.

The report describes a series of 236 rural road crashes investigated between 1 March 1998 and 29 February 2000 in South Australia. Investigations began with immediate attendance at the scene of the crash. The information collected for each crash included: photographs of the crash scene and vehicles involved, video record of the crash scene and vehicles in selected cases, examination of the road environment, a site plan of the crash scene and vehicle movements in the crash, examination and measurements of the vehicles involved, interviews with crash participants, interviews with witnesses, interviews with police, information on the official police report, information from Coroner’s reports, and injury data for the injured crash participants.

The report provides an overall statistical summary of the sample of crashes investigated, followed by a detailed examination of the road infrastructure issues contributing to the crashes. This is done on the basis of crash type, with separate sections concerned with single vehicle crashes, midblock crashes and crashes at intersections. A section is also provided that examines the role of roadside hazards in the crashes.

KEYWORDS

Crash, Rural, Road Infrastructure, Roadside Hazards, Contributing Factors, Single Vehicle, Intersection, Rear End, Head On

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1. INTRODUCTION

1.1 Initiation of this Project

The Road Accident Research Unit (RARU) was funded by Transport SA in 1998 to conduct in-depth investigations into rural road crashes in South Australia to provide information on factors that contribute to crash and injury causation. This report provides a description of the sample of crashes investigated with an emphasis on the road infrastructure factors that were involved in the crash events or outcomes in some way.

The identification of an element of road infrastructure as having has some involvement in a crash does not necessarily imply that the road was below accepted engineering standards. Since these crash locations were first attended and investigated in this study, it is known that at least some have been modified by the road authority. Therefore, even though the present tense is used in crash location descriptions, the reader is reminded that it relates to the circumstances prevailing at the time of attendance at the scene of the crash, which may not be the case now.

Almost all crashes involve one or more errors made by the driver of a vehicle. In the chapters discussing the involvement of road and infrastructure factors in the crashes, obvious driver factors such as driving at excessive speed or with an illegal blood alcohol concentration are mentioned for individually described cases where relevant.

1.2 Data Collection

The data collection phase of the study ran for two years from 1 March 1998 to 29 February 2000. This report describes the information that was collected during these two years.

1.3 Method

Vehicle crashes eligible for inclusion in the study were those to which an ambulance was called and which occurred on public roads outside the metropolitan area but within 100 km of Adelaide. Notification of crashes was obtained by monitoring ambulance radio frequencies and also by pager notification from the South Australian Ambulance Service. At the request of Transport SA, crashes in rural towns were included in the study.

RARU staff members were available on call to attend crash scenes during the day seven days per week and Thursday and Friday nights. These two nights, and during the day on Saturday and Sunday, were selected as on-call periods following an examination of the time of day and day of week distribution of calls for an ambulance to attend vehicle accidents in the study area during the previous year.

The on-call team attempted to reach the scene of the crash before the vehicles involved were moved. As we neither requested, nor desired, permission to exceed posted speed limits when travelling to a crash scene it was not possible to achieve this aim in many cases. Occasionally, further investigation of a crash was abandoned if there was not sufficient evidence available at the scene. Some fatal cases could be investigated on the day following the crash if the scene had been marked up by the Police Major Crash investigators. This enabled the inclusion in the study of some crashes that occurred outside the on-call periods.

The “ambulance called” criterion for admission of a case into the study did not always mean that a participant in the crash was injured seriously enough to be transported to hospital by ambulance. At the other end of the injury outcome scale, the sample of crashes studied was biased towards fatal cases, for the reason noted at the end of the previous paragraph.

The information collected on each case included:

- photographs of the crash scene and vehicles involved
- video record of the crash scene and vehicles in selected cases
- examination of the road environment, including traffic control measures
- a site plan of the crash scene and vehicle movements in the crash
- examination and measurements of the vehicles involved
- interviews with crash participants, witnesses and police
- information on the official police report
- information from Coroner’s reports
- injury data on the injured crash participants

Suitable cases from this study form the basis for a case control study of the effects of travelling speed on crash risk on rural roads. The additional data collection and analysis for that study has been funded by the Federal Office of Road Safety of the Australian Transport Safety Bureau.

2. GENERAL INFORMATION ON THE CRASHES INVESTIGATED

During the course of the study a total of 236 rural crashes were investigated. This section presents a summary of general information on those crashes.

2.1 Type of Crash

The most common type of crash, comprising over 44 per cent of the sample, involved a single vehicle (Table 2.1). Of those crashes in which more than one vehicle was involved, the most common crash types were those in which one of the vehicles was executing a right turn, and those in which the vehicles were involved in a head on collision.

Table 2.1
Type of Crash

Type of Crash	Number	Per cent
Single vehicle	105	44.5
Right turn	46	19.5
Head on	39	16.5
Right angle	20	8.5
Rear end	17	7.2
U-turn in front	6	2.5
Side swipe	3	1.3
Total	**236**	**100.0**

2.2 When the Crashes Happened

Table 2.2 shows the day of week distribution of crashes investigated during the study and compares it with the distribution of ambulance call outs for road crashes in the same geographical area during the study period. The crashes investigated were not representative by day of week of rural crashes in general, with weekdays over represented and weekend days under represented, as a consequence of the distribution of on-call times (see Section 1.3).

Table 2.2
Crash Frequency by Day of Week

Day of Week	Number	Per cent	Ambulance * Call outs (%)
Monday	33	14.0	9.6
Tuesday	32	13.6	11.3
Wednesday	39	16.5	14.0
Thursday	39	16.5	14.6
Friday	54	22.9	14.8
Saturday	19	8.1	18.6
Sunday	20	8.5	17.1
Total	**236**	**100.0**	**100.0**

* Based on 1476 ambulance call outs in the study area from 1 March 1998 to 28 February 2000 provided by Roslyn Clermont of SA Ambulance Service

Table 2.3 and Figure 2.1 show the time of day distribution of the crashes investigated and again compares it with the ambulance call outs for rural road crashes during the study period. Due, again, to the distribution of on-call times by time of day, an under representation of crashes between 6pm and 6am was apparent in the study sample.

Table 2.3
Crash Frequency by Time of Day

Time of Day	Number	Per cent	Ambulance * Call outs (%)
0000 - 0059	3	1.3	2.7
0100 - 0159	0	0.0	1.8
0200 - 0259	1	0.4	1.2
0300 - 0359	4	1.7	1.1
0400 - 0459	2	0.8	0.9
0500 - 0559	1	0.4	1.2
0600 - 0659	5	2.1	2.6
0700 - 0759	9	3.8	3.4
0800 - 0859	14	5.9	4.9
0900 - 0959	19	8.1	3.5
1000 - 1059	23	9.7	5.2
1100 - 1159	19	8.1	6.0
1200 - 1259	21	8.9	6.4
1300 - 1359	13	5.5	5.2
1400 - 1459	20	8.5	6.6
1500 - 1559	16	6.8	8.3
1600 - 1659	19	8.1	8.1
1700 - 1759	12	5.1	7.6
1800 - 1859	8	3.4	6.0
1900 - 1959	10	4.2	4.5
2000 - 2059	4	1.7	3.9
2100 - 2159	7	3.0	4.0
2200 - 2259	3	1.3	2.2
2300 - 2359	3	1.3	2.7
Total	**236**	**100.0**	**100.0**

* Based on 1476 ambulance call outs in the study area from March 1 1998 to February 28 2000 provided by Roslyn Clermont of SA Ambulance Service.

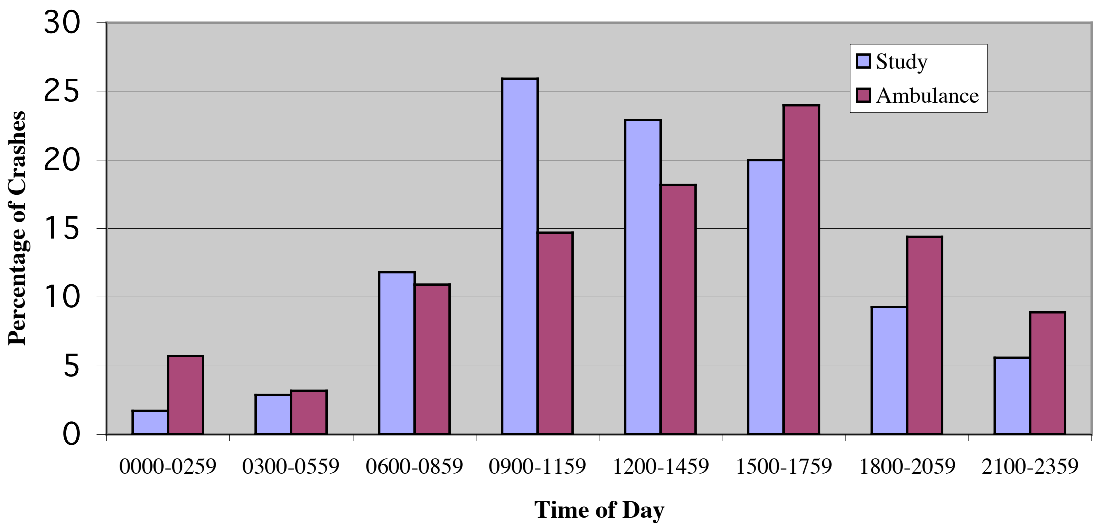

Figure 2.1: Time of Day of Rural Crashes

2.3 Crash Severity

The severity of the crashes investigated is shown in Table 2.4 in terms of the maximum severity of injury to any participant in the crash.

Table 2.4
Maximum Severity of Injury

Injury Severity	Number	Per cent
Fatal	54	22.9
Hospital Admission	76	32.2
Hospital Treated	66	28.0
Private Doctor	6	2.5
Minor Injury	12	5.1
No Injury	22	9.3
Total	**236**	**100.0**

As noted previously (section 1.3), there is a trend towards the inclusion of more serious crashes in the study. The private doctor, minor injury and non-injury cases are included because an ambulance was called to the scene but no ambulance transport to a hospital was actually required.

2.4 Speed Limit Zones

In most of these cases (65%) the speed limit at the site of the crash was 100 km/h or greater, as would be expected in a study of rural crashes (Table 2.5). The lower speed limit cases are those crashes occurring in or near rural towns or in the Adelaide Hills. In some of the cases, vehicles involved in the crash approached from different speed limit zones. The speed limit zone reported here is the higher one in these cases.

Table 2.5
Speed Limit at the Crash Location

Speed Limit	Number	Per cent
60	34	14.4
70	6	2.5
80	34	14.4
90	9	3.8
100	100	42.4
110	53	22.5
Total	**236**	**100.0**

Over 17 per cent of the crashes occurred on sections of road with an Advisory Speed sign indicating a speed lower than the legal speed limit (Table 2.6).

Table 2.6
Advisory Speed Signs at the Crash Location

Speed Advisory	Number	Per cent
None	195	82.6
25	2	0.8
35	2	0.8
45	6	2.5
55	12	5.1
65	8	3.4
75	5	2.1
80	1	0.4
85	5	2.1
Total	**236**	**100.0**

2.5 Road Characteristics

Most of the crashes in this study (67%) happened on rural highways (defined here as main rural roads under the control of Transport SA) with a significant proportion on minor rural roads and national highways and a small number on local rural town roads (Table 2.7). Where the crash happened at the intersection of a rural road or rural street with a rural highway, the road type was classified as being a rural highway.

Table 2.7
Road Type at the Crash Location

Road Type	Number	Per cent
National Highway	30	12.7
Rural Highway	159	67.4
Rural Road	37	15.7
Rural Street	10	4.2
Total	**236**	**100.0**

About 12 per cent of the crashes occurred on a divided road (Table 2.8).

Table 2.8
Road Layout at the Crash Location
by Presence or Absence of Median

Median Present	Number	Per cent
No	207	88.1
Yes	29	11.9
Total	**236**	**100.0**

The great majority of the crashes occurred on two lane roads with only 11 per cent on roads with more than one lane in each direction (Table 2.9).

Table 2.9
Road Layout at the Crash Location
by Number of Traffic Lanes

No. of Lanes	Number	Per cent
Two	207	87.7
Three	3	1.3
Four	25	10.6
Six	1	0.4
Total	**236**	**100.0**

As would be expected, most of the crashes occurred on sealed roads (Table 2.10). Five of the crashes listed as being on sealed roads were at an intersection of a sealed road with an unsealed road.

Table 2.10
Road Surface at the Crash Location

Road Surface	Number	Per cent
Sealed	220	93.2
Unsealed	16	6.8
Total	**236**	**100.0**

Over 58 per cent of the crashes happened on straight sections of road (Table 2.11). In the remaining crashes, the involvement of a right hand bend was far more common than a left hand bend (from the point of view of the driver who initially lost control, experienced difficulty or was travelling straight through an intersection).

Table 2.11
Road Layout at the Crash Location:
Horizontal Alignment

Horizontal Alignment	Number	Per cent
Straight	138	58.5
Curve Right	59	25.0
Curve Left	39	16.5
Total	**236**	**100.0**

The vertical alignment of the road from the point of view of the driver who initially lost control, experienced difficulty or was travelling straight through an intersection is shown in Table 2.12. While the majority of crashes (74%) happened on a level section of road, the next most common vertical alignment feature was a down slope.

Table 2.12
Road Layout at the Crash Location:
Vertical Alignment

Vertical Alignment	Number	Per cent
Level	175	74.2
Slope Down	32	13.6
Slope Up	18	7.6
Crest	10	4.2
Dip	1	0.4
Total	**236**	**100.0**

2.6 Intersection Collisions

In this study, a crash was classified as an intersection collision only if it involved vehicles that approached, or turned into, different roads. Using this definition most of the crashes in the study were non-intersection crashes (Table 2.13). Among the intersection crashes, those that occurred at cross roads and T-junctions were nearly equally represented.

Table 2.13
Road Layout at the Crash Location:
Presence and Type of Intersection

Road Layout	Number	Per cent
Non-intersection	161	68.2
Cross Road	31	13.1
T-Junction	29	12.3
Driveway [1]	11	4.7
Multi-leg junction	2	0.8
Level crossing	2	0.8
Total	**236**	**100.0**

1 Elsewhere in this report, driveway crashes were classified as midblock crashes (see Chapter 7)

Over half of the intersection collisions investigated had no signs or signals relevant to any of the vehicles involved (Table 2.14). In most of the no control cases the priority of vehicles was designated by the road layout and road rules. However, two of the crashes involved vehicles approaching an uncontrolled intersection from intersecting roads. The most common traffic control that was present and relevant was a Give Way sign. Of the two level crossing crashes not shown in Table 2.14, one had railway crossing lights and one had a sign indicating a railway crossing.

Table 2.14
Traffic Controls Relevant to Vehicles
Involved in Intersection Collisions

Traffic Controls	Number	Per cent
Priority designated [1]	42	57.5
Give Way sign	20	27.4
Stop sign	6	8.2
Traffic lights	3	4.1
Uncontrolled [2]	2	2.8
Total	**73**	**100.0**

1 priority indicated by road layout (eg: T-junction) or road rules (eg: give way to approaching traffic when turning)
2 no controls and priority not indicated by road layout

2.7 Non-Intersection Road Characteristics

More than 40 per cent of the non-intersection crashes on sealed roads occurred on roads with no edge lining of the side of the road (Table 2.15). Approximately ten per cent of these roads with no edge lining were in rural towns (speed limit less than 80 km/h).

Table 2.15
Edge Lining at the Crash Location:
Non-Intersection Crashes

Edge Lining	Number	Per cent
Yes	82	55.4
Kerb	5	3.4
No	61	41.2
NA (unsealed road)	13	-
Total	**161**	**100.0**

Very few of the crashes on mid-block sections of road occurred on roads with a sealed shoulder (Table 2.16). While this is mainly a reflection of the small proportion of roads in the study area with sealed shoulders, data presented later in this report confirms that unsealed shoulders are one of the major contributing factors to rural road crashes.

Table 2.16
Sealed Shoulders at the Crash Location:
Non-Intersection Crashes

Sealed Shoulder	Number	Per cent
Yes	9	6.3
Kerb	8	5.6
Partial	12	8.5
No	113	79.6
NA (unsealed road)	13	-
No shoulder	6	-
Total	**161**	**100.0**

In non-intersection crashes on sealed, undivided roads less than five per cent had no centre line while 53 per cent had lines prohibiting overtaking (Table 2.17).

Table 2.17
Centre Line Type at the Crash Location:
Non-Intersection Crashes

Centre Line Type	Number	Per cent
None	6	4.5
Broken	57	43.2
Single line	28	21.2
Double line	37	28.0
Rumble Strip	4	3.0
NA (divided road)	16	-
NA (unsealed road)	13	-
Total	**161**	**100**

3. VEHICLE INVOLVEMENT

A vehicle was only classified as being involved in the crash if it was the sole vehicle or it came into physical contact with another vehicle in the crash (trains are not counted as vehicles). Table 3.1 shows the number of vehicles involved per crash.

Table 3.1
Number of Vehicles per Crash

No. of Vehicles per Crash	Frequency	Per cent of Total Crashes	Total Vehicles
One	107	45.3	107
Two	121	51.3	242
Three	8	3.4	24
Total	**236**	**100.0**	**373**

3.1 Vehicle Type

Cars and car derivatives (station wagons, utilities and panel vans) accounted for three quarters of all of the vehicles involved in this set of rural road crashes (Table 3.2). Trucks were defined as large or small according to the Australian Design Rules definition.

Table 3.2
Type of Vehicle

Vehicle Type	Number	Per cent
Car	225	60.3
4WD	34	9.1
Station Wagon	28	7.5
Utility	22	5.9
Semi Trailer	16	4.3
Motorcycle	14	3.8
Van	12	3.2
Small Truck	8	2.1
Large Truck	7	1.9
Panel Van	4	1.1
B Double	1	0.3
Tractor & Trailer	1	0.3
Tandem Bicycle	1	0.3
Total	**373**	**100.0**

3.2 Vehicle Age

More than half of the vehicles involved in these rural road crashes were 10 or more years old but this is generally reflective of the South Australian vehicle age profile (Table 3.3).

Table 3.3
Age of Vehicle

Vehicle Age (Years)	Number	Per cent	Cumulative Per cent
<1	7	1.9	1.9
1	22	6.0	7.9
2	13	3.5	11.4
3	22	6.0	17.4
4	20	5.4	22.9
5	16	4.4	27.2
6	10	2.7	30.0
7	17	4.6	34.6
8	16	4.4	39.0
9	21	5.7	44.7
10	17	4.6	49.3
11	16	4.4	53.7
12	15	4.1	57.8
13	14	3.8	61.6
14	16	4.4	65.9
15	21	5.7	71.7
16	20	5.4	77.1
17	7	1.9	79.0
18	11	3.0	82.0
19	14	3.8	85.8
20	9	2.5	88.3
21	6	1.6	89.9
22	6	1.6	91.5
23	9	2.5	94.0
24	7	1.9	95.9
Over 24	15	4.1	100.0
Unknown	6	-	-
Total	**373**	**100.0**	**100.0**

4. VEHICLE DRIVERS AND RIDERS

All of the 373 vehicles involved in these crashes were occupied by at least a driver or rider. One of the vehicles was a tandem bicycle that was being ridden by two riders.

In the section that follows (4.1), the sex and age of drivers of vehicles involved in the sample of rural crashes are presented, excluding motorcyclists, bicyclists and tractor drivers. The details of these crash participants are presented in Section 4.2.

4.1 Sex and Age of Drivers

Over 60 per cent of the drivers in this sample of rural crashes were male (Table 4.1).

Table 4.1
Sex of Drivers and Riders

Sex	Number	Per cent
Male	221	61.9
Female	136	38.1
Total	**357**	**100.0**

The distribution of the ages of the drivers in these crashes shows that the highest levels of involvement were for those in their teens, gradually decreasing until a plateau was reached extending from the thirties to the mid fifties. Lower levels of involvement occurred after that age range, with only 19 per cent of drivers being over 54 years of age (Table 4.2). The age of one driver involved in a single vehicle crash remained unknown (the driver was taken from the scene by the police for an evidentiary breath test, and there was no police report for the crash).

Table 4.2
Age of Drivers

Age (years)	Number	Per cent	Cumulative %
16-19	53	14.9	14.9
20-24	45	12.6	27.5
25-29	36	10.1	37.7
30-34	28	7.9	45.5
35-39	34	9.6	55.1
40-44	36	10.1	65.2
45-49	36	10.1	75.3
50-54	22	6.2	81.5
55-59	14	3.9	85.4
60-64	11	3.1	88.5
65-69	10	2.8	91.3
70-74	9	2.5	93.8
75-79	12	3.4	97.2
80-84	7	2.0	99.2
85-89	2	0.6	99.7
90+	1	0.3	100.0
Unknown	1	-	-
Total	**357**	**100.0**	

The age distributions of male and female drivers were very similar given the limitations of small numbers at this level of breakdown (Table 4.3).

Table 4.3
Sex and Age of Drivers

Age (Years)	Male (Number)	Female (Number)	Male (Per cent)	Female (Per cent)
16-19	27	26	12.3	19.1
20-24	30	15	13.6	11.0
25-29	22	14	10.0	10.3
30-34	19	9	8.6	6.6
35-39	21	13	9.5	9.6
40-44	22	14	10.0	10.3
45-49	23	13	10.5	9.6
50-54	13	9	5.9	6.6
55-59	10	4	4.5	2.9
60-64	8	3	3.6	2.2
65-69	6	4	2.7	2.9
70-74	6	3	2.7	2.2
75-79	7	5	3.2	3.7
80-84	5	2	2.3	1.5
85-89	1	1	0.5	0.7
90	0	1	0.0	0.7
Unknown	1	0		
Total	**221**	**136**	**100.0**	**100.0**

4.2 Sex and Age of Riders

All 14 of the motorcyclists involved in the sample of rural crashes were male. Of the two riders of the tandem cycle, one was male and one was female. The remaining driver of a vehicle involved in the sample of rural crashes was a male tractor driver.

The ages of motorcycle riders are shown in Table 4.4. Six of the riders (over 40 per cent) were under the age of 25, indicating that the motorcycle riders involved in rural crashes were likely to be younger than drivers involved in rural crashes.

The two riders of the tandem cycle were both 26 years of age and the driver of the tractor was 40 years of age.

4.3 Alcohol Use by Drivers and Riders

Table 4.5 shows the proportion of drivers and riders who had been drinking and the blood alcohol levels of those who had. Three of the unknown blood alcohol concentrations (BAC) are for those drivers who died as a result of the crash but for whom the Coroner's reports have yet to be obtained. The other unknown BAC was for a driver who was known to have been over the legal BAC limit (0.05 gm/L) but for whom the exact level was unable to be obtained. The number of drivers and riders who were known not to have been tested at all was much greater than the number known to have been drinking. Of the fourteen motorcycle riders, ten had a measured BAC of zero, one had a BAC of 0.019 and three remained unknown.

Table 4.4
Age of Motorcycle Riders

Age (years)	Number	Per cent	Cumulative %
16-19	3	21.4	21.4
20-24	3	21.4	42.8
25-29	2	14.3	57.1
30-34	2	14.3	71.4
35-39	1	7.1	78.5
40-44	1	7.1	85.7
45-49	1	7.1	92.8
50-54	1	7.1	100.0
55-59	-	-	
60-64	-	-	
65-69	-	-	
70-74	-	-	
75-79	-	-	
80-84	-	-	
85-89	-	-	
90+	-	-	
Unknown	-	-	
Total	**14**	**100.0**	

Table 4.5
Blood Alcohol Level of Drivers and Riders

Blood Alcohol Concentration	Number	Per cent
Zero	254	90.4
0.001-0.049	6	2.1
0.050-0.149	9	3.2
0.150+	12	4.3
Blood Denatured	3	-
Not tested	85	-
Refused test	1	-
Unknown	4	-
Total	**374**	**100.0**

From the known cases, over seven per cent of the drivers and riders had a BAC above the legal limit. Also, there were two drivers with only Provisional licences who recorded BACs that were below 0.05 gm/L but which were above the level permitted for a driver holding such a licence (0.00 gm/L).

4.4 Licence Status of Drivers and Riders

Licence checks on these drivers and riders have revealed that over 17 per cent did not have a full licence (Table 4.6). Of the eight unlicensed drivers, one (a 19 year old) had never had a licence, two (aged 19 and 21 respectively) had expired Learner's permits, four (aged 22, 22, 23 and 34) had had their licences cancelled, and one (aged 28) was without a licence for a reason that remained unknown. The finding that over 17 per cent of the drivers and riders held either Provisional licences, Learner's permits, or were young and unlicensed, shows that inexperienced drivers are greatly over represented in rural road crashes in South Australia.

Table 4.6
Licence Status of Drivers and Riders

Licence Status	Number	Per cent
Full	310	82.9
P-Plate	53	14.2
L-Plate	3	0.8
Unlicensed	8	2.1
Total	**374**	**100.0**

4.5 Familiarity with Road

Drivers or riders were asked in an interview how familiar they were with the road on which they crashed, and their responses, in terms of frequency of use of the road, are summarised in Table 4.7. Due to some drivers and riders being unable to be located or refusing to participate in the study, in addition to some drivers and riders having been killed in the crashes, information on familiarity with the road was not available for all drivers and riders.

Table 4.7
Familiarity With the Road of Drivers and Riders

Frequency of Use of Road	Number	Per cent
Daily	50	24.8
Regularly	109	54.0
Rarely	28	13.9
First Time Used	15	7.4
Unknown	172	-
Total	**202**	**100.0**

As shown in Table 4.7, approximately a quarter of drivers and riders interviewed claimed that they drove on the road where they crashed every day. An additional 54 per cent claimed regular use. Just over seven per cent had never driven on the road before. However, it is important to take into account that this sample of interviewed drivers is biased against drivers from interstate or overseas who often could not be interviewed. Given that this latter group of drivers would be less likely to be familiar with the road, the figures in Table 4.7 could represent an over estimate of the degree of familiarity with the road by the drivers and riders involved in these rural road crashes. Also, due to the open ended nature of the questioning, it is possible that differences between drivers and riders in how they reported their level of familiarity with the road would introduce a degree of error into the results. It is possible, for example, that some drivers and riders who used the road on which they crashed every day responded to the question by saying that they used the road "regularly", whilst others who used the road rarely may have given a response suggesting that their frequency of usage of the road should most accurately be classified as being regular.

5. VEHICLE OCCUPANTS

This section presents information about the occupants of the vehicles involved in this sample of rural road crashes. The relevant characteristics of the 14 motorcyclists, two cyclists and the tractor driver are presented separately at the end of the chapter.

Table 5.1 shows the number of occupants per vehicle involved in this set of crashes. Most of the vehicles were occupied by only the driver at the time of the crash.

Table 5.1
Number of Occupants per Vehicle

No. of Occupants	Number	Per cent	Total Occupants
One	218	61.1	218
Two	93	26.1	186
Three	19	5.3	57
Four	16	4.5	64
Five	10	2.8	50
Six	1	0.3	6
Total	**357**	**100.0**	**581**

5.1 Occupant Seated Positions

The seated positions that were occupied at the time of the crash are presented in Table 5.2.

Table 5.2
Occupant Position in Vehicle

Occupant Position	Number	Per cent
Driver	357	61.4
Left front	130	22.4
Left rear	32	5.5
Right rear	30	5.2
Centre rear	21	3.6
Unknown rear	5	0.9
Unknown	6	1.0
Total	**581**	**100.0**

5.2 Occupant Sex

The sex of the vehicle occupants is shown in Table 5.3. While there was a greater proportion of female occupants compared to female drivers, there were still many more male occupants than females. This primarily reflects the large proportion of single male occupant vehicles in this sample of crashes.

Table 5.3
Sex of Occupants of Vehicles

Occupant Sex	Number	Per cent
Male	337	58.4
Female	240	41.6
Unknown	4	-
Total	**581**	**100.0**

5.3 Occupant Age

Over ten per cent of the vehicle occupants were children (under the age of 15 years) and 12 per cent were 65 years or older (Table 5.4). The 15 to 19 year age group was by far the most frequently involved, followed by those aged between 20 and 24.

Table 5.4
Age of Occupants of Vehicles

Age (years)	Number	Per cent	Cumulative %
00-04	16	3.0	3.0
05-09	21	4.0	7.0
10-14	19	3.6	10.6
15-19	93	17.6	28.1
20-24	58	11.0	39.1
25-29	42	7.9	47.0
30-34	32	6.0	53.1
35-39	38	7.2	60.3
40-44	44	8.3	68.6
45-49	39	7.4	76.0
50-54	29	5.5	81.4
55-59	21	4.0	85.4
60-64	16	3.0	88.4
65-69	14	2.6	91.1
70-74	15	2.8	93.9
75-79	17	3.2	97.1
80-84	9	1.7	98.8
85-89	4	0.8	99.6
90-94	2	0.4	100.0
Unknown	52	-	-
Total	**581**	**100.0**	**100.0**

5.4 Occupant Seatbelt Use

Judgement of seatbelt use was determined by a combination of marks on the seatbelt webbing from impact loading, observation of belt use for those still in the crashed vehicle when investigators arrived and reports from police and the Coroner. While most of the occupants were judged to have been wearing their seatbelts, 13 per cent were not (Table 5.5).

Table 5.5
Seatbelt Use by Occupants of Vehicles

Seatbelt Use	Number	Per cent
Yes	421	86.6
No	65	13.4
Unknown	95	-
Total	**581**	**100.0**

5.5 Occupant Ejection

Very few of the occupants were ejected from their vehicle during the crash (Table 5.6). Of the 12 occupants who were fully ejected, 10 were not wearing seatbelts. One was wearing a seatbelt that failed during the crash and in another case, seatbelt usage was unknown but it is suspected that the seatbelt was worn. This was a case in which a car was struck by a prime mover and it is possible that the driver of the car was ejected, despite seatbelt usage, due to the great force of the impact and the extensive damage done to the car. Of the seven cases in which seatbelt usage was known for occupants partially ejected from their vehicles, four of the occupants were wearing seatbelts and three were not.

Table 5.6
Ejection of Occupants from Vehicles

Occupant Ejection	Number	Per cent
No	539	96.3
Partial	9	1.6
Yes	12	2.1
Unknown	21	-
Total	**581**	**100.0**

5.6 Occupant Injury Severity

Table 5.7 shows the overall severity of the injuries sustained by the occupants of vehicles involved in these crashes, expressed mainly in terms of the nature of the treatment provided. The "Taken to Hospital" category represents cases where we know the occupant was taken to hospital but were unable to determine whether they were treated and discharged or were admitted.

Table 5.7
Severity of Injury to Occupants of Vehicles

Injury Severity	Number	Per cent
Fatal	59	10.3
Hospital admission	156	27.3
Taken to hospital	2	0.4
Hospital treated	147	25.7
Private doctor treated	13	2.3
Minor injury	38	6.7
No injury	156	27.3
Unknown	10	-
Total	**581**	**100.0**

Table 5.7 reveals that two thirds of the occupants in the rural crashes investigated were injured severely enough to require at least hospital attendance. Twenty seven per cent required admission to hospital and more than one in every ten vehicle occupants were killed. These figures must be read, however, in the context of the sampling bias towards the inclusion of fatal cases in the study (see section 1.3).

Those not wearing seatbelts were found to have been more likely to have sustained fatal injuries than those who were wearing seatbelts. Of the 65 vehicle occupants known to have not been wearing seatbelts at the time of the crash, 19 (29%) died as a result of the crash, compared to 35 of the 421 occupants (8%) who had been wearing a seatbelt. This difference was found to be statistically significant ($\chi^2_{df=1}$= 12.03, $p < .001$, two-tailed).

There was no obvious correlation between seating position and injury severity in these crashes (Table 5.8).

Table 5.8
Severity of Injury to Occupants by Seating Position

	Injury Severity								
Seating Position	**Fatal**	**Admitted**	**Taken to Hospital**	**Hospital Treated**	**Private Doctor**	**Minor Injury**	**No Injury**	**Unknown**	**Total**
Driver	39	86	-	89	12	27	104	0	**357**
Left front	11	43	1	35	-	8	29	3	**130**
Left rear	3	9	-	10	-	-	8	2	**32**
Right rear	4	11	1	6	-	-	6	2	**30**
Centre rear	2	6	-	4	1	3	3	2	**21**
Unknown rear	-	-	-	1	-	-	4	-	**5**
Unknown	-	1	-	2	-	-	2	1	**6**
Total	**59**	**156**	**2**	**147**	**13**	**38**	**156**	**10**	**581**

5.7 Participants in Other Vehicles

There were two pedal cyclists on one tandem bicycle. The front rider was a 26 year old male and the rear rider was a 26 year old female.

A tractor driven by a 40 year old male was involved in one crash.

There were 14 crashes involving a motorcycle. All of the motorcycle riders were males and there were no pillion passengers. The ages of the motorcycle riders are listed in Chapter 4.2.

The severity of injuries sustained by the motorcyclists is presented in Table 5.9.

Table 5.9
Severity of Injury to Motorcycle Riders

Injury Severity	Number	Per cent
Fatal	4	28.6
Hospital admission	7	50.0
Taken to hospital	-	-
Hospital treated	2	14.3
Private doctor treated	1	7.1
Minor injury	-	-
No injury	-	-
Unknown	-	-
Total	**14**	**100.0**

Motorcycle riders tended to sustain severe injuries with greater likelihood than the occupants of other vehicles. Four of the fourteen motorcycle riders (29 per cent) sustained fatal injuries, with an additional seven riders (50 per cent) being admitted to hospital.

The two pedal cyclists were both admitted to hospital, while the driver of the tractor was uninjured.

In the remainder of the report, when reference is made to the percentage of vehicle occupants who were fatally injured or admitted to hospital as a result of a crash, this refers to all crash participants, including those on motorcycles, the tandem bicycle and the tractor.

6. SINGLE VEHICLE CRASHES

The sample of 236 rural crashes included 105 crashes (44%) in which only one driver or rider was actively involved in the crash. In the following section selected characteristics of the single and multiple vehicle crashes are compared.

6.1 Comparison of Single and Multiple Vehicle Crashes

6.1.1 Time of crash by number of vehicles

Most of the crashes in this study occurred during daylight hours because the on-call periods were mainly during the day. The single vehicle crashes differed from crashes involving more than one vehicle by time of day with the difference being most marked between midnight and 6 am. Single vehicle crashes were more common than multiple vehicle crashes between midnight and 6am (11 crashes, or 10% of all single vehicle crashes, compared with no multiple vehicle crashes.). This difference would seem to be, at least partially, due to less traffic at these times and therefore, less chance of a driver error resulting in a collision with another vehicle. A comparison of time of day for the occurrence of single vehicle and multiple vehicle crashes investigated in the study is shown in Table 6.1.

Table 6.1
Time of Day of Rural Road Crashes
by Number of Vehicles Involved

Time of Day	**Number of Vehicles Involved**			
	Single Vehicle		**Multiple Vehicle**	
	Number	**Per Cent**	**Number**	**Per Cent**
0000 - 0059	3	2.9	-	-
0100 - 0159	-	-	-	-
0200 - 0259	1	1.0	-	-
0300 - 0359	4	3.8	-	-
0400 - 0459	2	1.9	-	-
0500 - 0559	1	1.0	-	-
0600 - 0659	4	3.8	1	0.8
0700 - 0759	6	5.7	3	2.3
0800 - 0859	2	1.9	12	9.2
0900 - 0959	10	9.5	9	6.9
1000 - 1059	9	8.6	14	10.7
1100 - 1159	7	6.7	12	9.2
1200 - 1259	8	7.6	13	9.9
1300 - 1359	4	3.8	9	6.9
1400 - 1459	4	3.8	16	12.2
1500 - 1559	6	5.7	10	7.6
1600 - 1659	9	8.6	10	7.6
1700 - 1759	4	3.8	8	6.1
1800 - 1859	4	3.8	4	3.1
1900 - 1959	6	5.7	4	3.1
2000 - 2059	3	2.9	1	0.8
2100 - 2159	4	3.8	3	2.3
2200 - 2259	2	1.9	1	0.8
2300 - 2359	2	1.9	1	0.8
Total	**105**	**100.0**	**131**	**100.0**

6.1.2 Speed limit at crash location by number of vehicles involved

Single vehicle crashes were more likely to occur on roads with a speed limit of 100 or 110 km/h than were multiple vehicle crashes (73 versus 58%), which in turn were more likely than single vehicle crashes to have occurred on roads with a speed limit of 60 km/h (18 versus 11%). This difference in the distribution of speed limits for the roads on which the two sets of crashes occurred was statistically significant ($\chi^2_{(2)}$= 6.04, $p< .05$). The speed limits for the roads on which the two sets of crashes occurred are shown in Table 6.2.

Table 6.2
Speed Limit at the Crash Location
by Number of Vehicles Involved

Speed Limit	**Number of Vehicles Involved**			
	Single Vehicle		**Multiple Vehicle**	
km/h	**Number**	**Per Cent**	**Number**	**Per Cent**
60	11	10.5	23	17.6
70	3	2.9	3	2.3
80	10	9.5	24	18.3
90	4	3.8	5	3.8
100	50	47.6	49	37.4
110	27	25.7	27	20.6
Total	**105**	**100.0**	**131**	**100.0**

6.1.3 Horizontal alignment at crash location by number of vehicles involved

Another difference between the two sets of crashes is that single vehicle crashes were more likely to have occurred on right hand curves (35 versus 17%) and less likely to have occurred on straight sections of road (47 versus 67%) than those crashes involving multiple vehicles. This difference was statistically significant ($\chi^2_{(2)}$= 11.78, $p< .01$). The horizontal alignment of the roads where the crashes occurred is shown in Table 6.3.

Table 6.3
Horizontal Alignment at the Crash Location by Number of Vehicles Involved

Horizontal Alignment	**Number of Vehicles Involved**			
	Single Vehicle		**Multiple Vehicle**	
	Number	**Per Cent**	**Number**	**Per Cent**
Straight	50	47.6	88	67.2
Curve Right	37	35.2	22	16.8
Curve Left	18	17.1	21	16.0
Total	**105**	**100.0**	**131**	**100.0**

6.1.4 Driver age by number of vehicles involved

Drivers or riders involved in single vehicle crashes were more likely to have been under the age of 25 (40 versus 23%) and less likely to have been 60 years of age or older (8 versus 16%) than the drivers or riders involved in multiple vehicle collisions. These differences in the distribution of ages of drivers and riders for the two sets of crashes were statistically significant ($\chi^2_{(2)}$= 12.30, $p< .01$). The ages of drivers and riders according to the number of vehicles involved in the crash are shown in Table 6.4 and Figure 6.1.

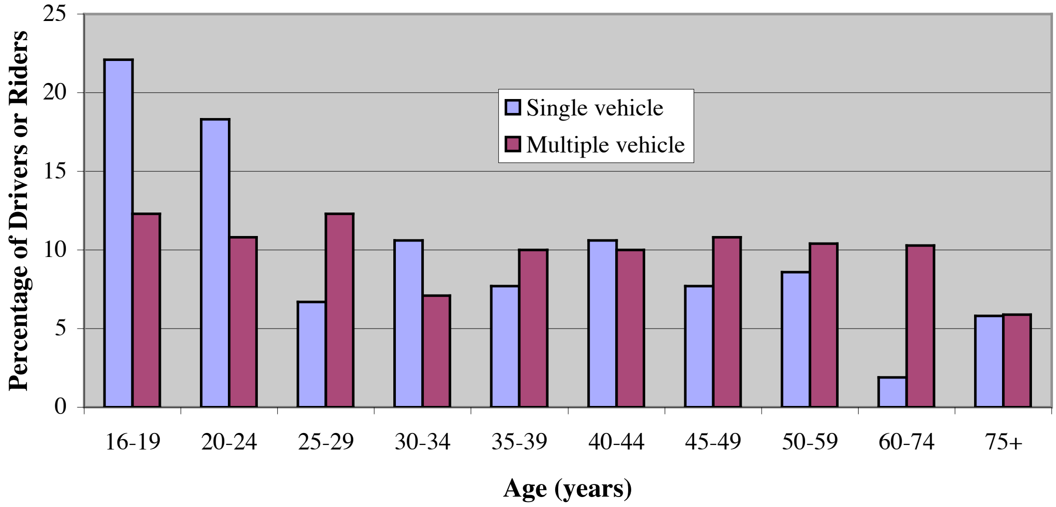

Figure 6.1: Age of Drivers or Riders by Number of Vehicles Involved

Table 6.4
Age of Drivers and Riders Involved in Rural Road Crashes by Number of Vehicles Involved

Age	**Number of Vehicles Involved**			
	Single Vehicle		**Multiple Vehicle**	
Years	**Number**	**Per Cent**	**Number**	**Per Cent**
16-19	23	22.1	33	12.3
20-24	19	18.3	29	10.8
25-29	7	6.7	33	12.3
30-34	11	10.6	19	7.1
35-39	8	7.7	27	10.0
40-44	11	10.6	27	10.0
45-49	8	7.7	29	10.8
50-54	5	4.8	18	6.7
55-59	4	3.8	10	3.7
60-64	2	1.9	9	3.3
65-69	-	-	10	3.7
70-74	-	-	9	3.3
75-79	4	3.8	8	3.0
80-84	1	1.0	6	2.2
85-89	-	-	2	0.7
90+	1	1.0	-	0.0
Unknown	1	-	-	-
Total	**105**	**100.0**	**269**	**100.0**

6.1.5 Driver Licence Status by Number of Vehicles Involved in Crash

The differences in the distribution of ages of drivers and riders according to whether the crash involved a single vehicle or multiple vehicles were reflected in differences in the nature of licences held by these drivers and riders. Those drivers and riders involved in single vehicle crashes were less likely to hold a full licence than those involved in multiple vehicle crashes (72 versus 87%). This difference was statistically significant ($\chi^2_{(1)}$= 13.52, p< .001). A summary of licences held by the drivers and riders for the two sets of crashes is provided in Table 6.5.

Table 6.5
Licence Status of Drivers and Riders Involved in Rural Road Crashes by Number of Vehicles Involved

Licence Status	Number of Vehicles Involved			
	Single Vehicle		Multiple Vehicle	
	Number	Per cent	Number	Per cent
Full	75	71.4	235	87.4
P-Plate	26	24.8	27	10.0
L-Plate	1	1.0	2	0.7
Unlicensed	3	2.9	5	1.9
Total	**105**	**100.0**	**269**	**100.0**

6.1.6 Driver Loss of Control by Number of Vehicles Involved in Crash

These differences between single vehicle crashes and multiple vehicle collisions may be taken as a first approximation of the differences between crashes in which the precipitating factor is a loss of vehicular control (single vehicle) and those in which it is a failure to accommodate to other traffic (multiple vehicle). According to this classification, those crashes precipitated by a loss of vehicular control are more likely than those involving a failure to accommodate to other traffic to occur between midnight and 6am, to occur on roads with a speed limit of 100 or 110 km/h, to occur on a right curve, and to involve young drivers or riders, especially those yet to attain a full licence. Those crashes involving a failure to accommodate to other traffic are more likely than those precipitated by a loss of vehicular control to occur on roads with a speed limit of 60 km/h, to occur on a straight section of road, and to involve drivers or riders who are 60 years of age or older.

It must be pointed out, however, that this classification of single and multiple vehicle crashes in terms of loss of control is not entirely satisfactory. For example, many head on collisions that form a part of the set of multiple vehicle collisions are caused by a driver losing control of his or her vehicle before colliding with another vehicle. Such crashes are often equivalent in their causal factors to single vehicle crashes, except that rather than striking a tree or other roadside object, the vehicle out of control crosses to the incorrect side of the road and collides with an oncoming vehicle. Similarly, some single vehicle crashes result from the driver of one vehicle swerving, successfully, to avoid another vehicle, but then running off the road and striking a tree or other roadside object. Such crashes are equivalent in their causal factors to multiple vehicle collisions.

6.2 Types of Single Vehicle Crash

All of the single vehicle crashes involved the vehicle running off the road, and so it is possible to classify single vehicle crashes according to the direction in which the vehicle left the road. The direction in which a vehicle leaves the road is also influenced by the horizontal alignment of the road, and so a further method of classification of single vehicle crashes is according to whether the road was straight or curving to the left or right. The set of single vehicle crashes, classified according to these variables, is summarised in Table 6.6.

Table 6.6
Manner of Loss of Control
of Single Vehicle Rural Road Crashes

Loss of Control	Number	Per cent
Off road to left, straight road	34	32.4
Off road to right, straight road	16	15.2
Off road to left, left curve	9	8.6
Off road to right, left curve	9	8.6
Off road to left, right curve	32	30.5
Off road to right, right curve	5	4.8
Total	**105**	**100.0**

As can be seen from Table 6.6, most single vehicle crashes occur as a result of a vehicle leaving the road to the left (72%), especially on straight roads (32%) and on right curves (31%). These different ways in which drivers lose control of their vehicles are listed again in Table 6.7, along with a number of road and driver variables associated with the crashes. Each of the six different types of single vehicle crash shown in Tables 6.6 and 6.7 is discussed in the remainder of this chapter, with particular reference made to the road and traffic factors relevant to the loss of vehicular control. The nature of the consequence of the loss of control, including collisions with roadside objects, is discussed in Chapters 12 and 13.

Table 6.7
Manner of Loss of Control of Single Vehicle Rural Road Crashes Investigated And its Relationship to a Number of Road and Driver Variables

Type of Crash (no. of cases)	Speed Limit >90 km/h	Rural Highway %	Unsealed Road %	Down Slope %	Up Slope %	Crest %	No Edge Lining %	Shoulder Sealed %	Male Drivers %	Female Drivers %	Driver Age <25 %	Not Full Licence %	>BAC Limit %
Off road to left, straight road (34)	70.6	70.6	8.8	11.8	-	5.9	35.5	6.7	50.0	50.0	48.5	32.4	28.6
Off road to right, straight road (16)	75.0	56.3	18.8	-	-	-	53.8	23.1	81.2	18.8	50.0	31.3	14.3
Off road to left, left curve (9)	55.6	66.7	-	11.1	22.2	11.1	44.4	25.0	66.7	33.3	11.1	11.1	-
Off road to right, left curve (9)	66.7	88.9	-	22.2	33.3	-	33.3	-	33.3	66.7	22.2	11.1	33.3
Off road to left, right curve (32)	81.3	59.4	9.4	25.0	6.3	-	62.1	3.4	62.5	37.5	40.6	34.4	20.0
Off road to right, right curve (5)	80.0	100.0	-	20.0	-	-	20.0	20.0	80.0	20.0	40.0	20.0	-

Note: the no edge lining variable omits cases where the road was unsealed, the shoulder seal variable refers to cases where the shoulder was fully sealed (to the verge) and omits cases where the road was unsealed or there was no shoulder due to the proximity of an embankment, and the driver age variable omits the case where the driver's age was unknown. The alcohol variable omits cases where the BAC of the driver was not tested.

6.3 Off Road to Left, Straight Road

There were 34 single vehicle crashes in which the vehicle left a straight road on the left side. This represents 32 per cent of the sample of single vehicle crashes and 14 per cent of the sample of rural crashes as a whole. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 56 per cent of cases, compared to 61 per cent for other types of single vehicle crash. A comparison between single vehicle crashes involving the vehicle travelling off a straight road to the left and all other single vehicle crashes is provided in Table 6.8.

Table 6.8
Off Road to the Left, Straight Road Crashes
and Other Single Vehicle Crashes

Variable	Type of Single Vehicle Crash			
	Off road to left, straight road (N=34)		Remainder (N=71)	
	Number	Per Cent	Number	Per Cent
Speed limit >90	24	70.6	53	74.6
Rural highway	24	70.6	48	67.6
Unsealed road	3	8.8	6	8.5
Down Slope	4	11.8	12	16.9
Crest	2	5.9	1	1.4
No edge lining	11	35.5	33	50.8
Shoulder sealed	2	6.7	7	10.9
Male driver	17	50.0	46	64.8
Female driver	17	50.0	25	35.2
Driver age < 25	16	48.5	26	36.6
Not full Licence	11	32.4	19	26.8
>BAC Limit	8	28.6	11	16.9

Note: The percentages calculated for the no edge lining variable omit cases where the road was unsealed, those for the shoulder seal variable refer to cases where the shoulder was fully sealed (to the verge) and omit cases where the road was unsealed or there was no shoulder due to the proximity of an embankment, those for the driver age variable omit cases where the driver's age was unknown, and those for the alcohol variable omit cases in which the driver's BAC was not tested.

As can be seen from Table 6.8, crashes in which a single vehicle went off a straight road to the left, when compared to the remainder of the set of single vehicle crashes, were similar for most of the variables related to the roads on which the crashes occurred. Although there are apparent differences in the lack of edge lining and the incidence of a down slope or a crest, these differences are not statistically significant, with all Chi square analyses yielding results with $p > .05$. Similarly, although Table 6.7 suggests that crashes in which a single vehicle ran off the left side of a straight road appeared to be more likely to involve female drivers, young drivers and those over the legal BAC limit, when compared to the remainder of single vehicle crashes, neither of these apparent differences is statistically significant.

There were a number of crashes that fall into this category for which road and traffic factors were relevant to the loss of vehicular control. These road and traffic factors included unsealed shoulders, the lack of edge lining, unsealed road surfaces, an object on the road, and one case of road layout and signage that did not satisfy the relevant standard

The most common road environment factor associated with the crashes was an unsealed shoulder. An unsealed shoulder was a possible contributing factor to the inability of drivers to regain vehicular control in 23 of these 34 crashes in which the vehicle initially ran off a straight road to the left. This includes cases in which the vehicle passed onto an unsealed section of the shoulder beyond a partial seal. In a majority of the cases involving unsealed shoulders (14 crashes), the driver attempted to steer to the right to get back onto the road but, due to the difference in the coefficient of friction between the shoulder and the bitumen, the driver overcorrected and the vehicle yawed across the road. These vehicles either finished on the right hand side, or yawed back again to finish off the road on the left. Four of these crashes resulted in fatalities, in three cases from striking a tree on the right side of the road and in the other case from striking a utility pole on the left side of the road. In the remainder of these 23 unsealed shoulder crashes, whilst the driver did not overcorrect and cause the vehicle to yaw back across the road, it is likely that the lower coefficient of friction of the unsealed shoulder made it more difficult to redirect the vehicle back onto the road before the vehicle struck a roadside hazard.

There were two cases in which, although the likelihood is that the lack of a shoulder seal was a contributory factor to the crash, it is still likely that the presence of a sealed shoulder would not have enabled the driver to regain control. In one, the vehicle involved drifted off the left side of the road, struck a cutting and rolled onto its right side. As the shoulder before the cutting was narrow, it is likely that the car would have struck the cutting even if the shoulder had been sealed. In another, a prime mover travelled onto the unsealed left shoulder before striking a tree. As the shoulder also included a down slope away from the road to the left, it is likely that even if the shoulder had been sealed, the truck may have drifted off the left with the slope of the shoulder. However, had a sealed shoulder been provided with a similar camber to that of the road, the truck driver might have been able to regain control in time to have avoided the tree.

Although there was no edge lining in over 35 per cent of cases for this type of crash, there are only two cases in which it is probable that the lack of an edge line played a role in the vehicle first drifting off the roadway. In these two cases, the driver was under the influence of alcohol and may have drifted onto the shoulder because the lack of edge lining resulted in the driver being unable to distinguish the edge of the road clearly. The beneficial effect of edge lining on the lateral position of a vehicle driven by an intoxicated driver has been demonstrated in past research (e.g. Johnston, 1981). The provision of edge lining would have been particularly helpful in one of these cases, a fatal crash, in which it was night time and raining. In all other cases in which a vehicle left the road where there was no edge lining, there were sufficient other explanations for the driver losing control.

There were two cases in which it is thought that the road surface may have played a role in the driver losing control of the vehicle. In these cases, the road was unsealed. In one, a car was travelling on a down slope on an unsealed road when it went out of control and struck a tree on the left side of the road. It is likely that a lack of tread depth decreased the grip of the tyres on the unsealed surface of the road. In the other, a car was travelling on a down slope on an unsealed road when it passed across a concrete ford. This caused the car to “bottom out” and the young driver (18 years old), who had a BAC of 0.073 and was travelling in excess of the speed limit, lost control of the vehicle. The car ran off the left side of the road, struck a fence and rolled over.

Another case in which the road infrastructure is likely to have played a contributory role in the crash was one in which a car travelling on a divided road with a speed limit of 90 km/h moved from the centre lane of three into the left lane shortly before the left lane ended. The driver did so to overtake vehicles ahead of him in the centre lane. The car travelled onto the unsealed shoulder at the end of the lane before the driver turned the wheel to the right to avoid striking a light pole on the shoulder. The car yawed across the road, onto the grassed median and struck a fence and a tree, resulting in the death of the two rear seat passengers. This section of road had a number of factors potentially contributing to the causation of the crash. First, the Merge Right sign on the left side of the road was without the Left Lane Ends sign it is required to have above it in such circumstances. This shortcoming was rectified following the crash. Secondly, the relevant Australian Standard (AS 1742.2) specifies that the distance between the Merge Right sign and the beginning of the merging taper be greater than 120 m for a road carrying traffic with an 85^{th} percentile speed of 90 km/h. Also, the merging taper on such a road should be 120 m long. Therefore, the combined length of the section of road preceding the merging taper and the merging taper itself should be 240 m, but at this location it was only 120 m. Had the road been designed in accordance with AS 1742.2, the crash may have been averted, because there would have been a longer section of road available to the driver before the requirement to merge, and the longer merging taper would have decreased the likelihood of the vehicle travelling onto the unsealed surface of the shoulder. It should also be noted that this crash also involved an unlicensed driver who had been using cannabis driving a powerful car at excessive speed.

There were two further cases in which the crash was caused by objects on the road. In one case, a driver of a car encountered an object in the middle of the road at night. Not recognising the object as a plastic play pool, the driver swerved to the left to avoid striking it. The car left the road, travelled along the left unsealed shoulder, struck a tree, mounted an embankment and rolled over. In another case, a car ran over a mudguard that had fallen from a semi trailer, causing its right rear tyre to blowout. The car consequently went out of control, ran onto the left shoulder and struck a tree.

6.4 Off Road to Right, Straight Road

There were 16 single vehicle crashes in which the vehicle ran off a straight road on the right hand side. This represents 15 per cent of the sample of single vehicle crashes and seven per cent of the sample of rural crashes as a whole. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 75 per cent of cases, compared to 56 per cent for the remainder of single vehicle crashes. A comparison between single vehicle crashes involving the vehicle running off a straight road to the right and the remainder of the set of single vehicle crashes is provided in Table 6.9.

Table 6.9
Off Road to the Right, Straight Road Crashes and Other Single Vehicle Crashes

Variable	Type of Single Vehicle Crash			
	Off road to right, straight road (N=16)		Remainder (N=89)	
	Number	Per cent	Number	Per cent
Speed limit >90	12	75.0	65	73.0
Rural highway	9	56.3	63	70.8
Unsealed road	3	18.8	6	6.7
No edge lining	7	53.8	37	44.6
Shoulder sealed	3	23.1	6	7.4
Male drivers	13	81.2	50	56.2
Female drivers	3	18.8	39	43.8
Driver age < 25	8	50.0	34	38.6
Not full licence	5	31.3	25	28.1
>BAC limit	2	14.3	17	21.5

Note: The percentages calculated for the no edge lining variable omit cases where the road was unsealed, those for the shoulder seal variable refer to cases where the shoulder was fully sealed (to the verge) and omit cases where the road was unsealed or there was no shoulder due to the proximity of an embankment, those for the driver age variable omit cases where the driver's age was unknown, and those for the alcohol variable omit cases in which the driver's BAC was not tested.

Although Table 6.9 suggests that single vehicle crashes in which the vehicle ran off a straight road on the right, when compared to the remaining single vehicle crashes, were more likely to involve an unsealed road, less likely to involve an unsealed shoulder, more likely to involve male drivers, more likely to involve young drivers and less likely to involve drivers over the legal BAC limit, none of these apparent differences are statistically significant.

There were a number of crashes that fall into this category for which road and traffic factors were relevant to the crash. These road and traffic factors included an unsealed shoulder, a slippery road surface, a dip, a crest, an on-road hazard, and a traffic calming device.

There were five crashes in which an unsealed shoulder may have contributed to the crash. Unlike the crashes in the previous section, however, in which the driver generally lost control when the vehicle ran onto the unsealed shoulder on the left, any contribution of unsealed shoulders to these crashes occurred after the vehicle had already travelled across the wrong side of the road and was clearly already well out of control of the driver. In four of these five cases, the driver of the vehicle attempted to steer back onto the road from the unsealed shoulder but the car yawed back across the road, resulting in it running off the road on the left.

There were five crashes in which a wet or unsealed road surface may have contributed to the loss of control of the vehicle. In three cases, a car yawed across a sealed road to the right during heavy rain. In one case, a four wheel drive vehicle was travelling on a straight section of a divided national highway in the rain at night, when it began yawing to the right. The vehicle travelled sideways onto the grassed median strip where it narrowly missed a large tree before rolling over. In another, a car travelling in the rain veered to the right side of the road out of control of the driver and rolled down an embankment into a river bed full of rocks. In the final case involving a very wet road, an intoxicated driver (BAC = 0.117) was travelling on a straight road at night in the rain when his utility slid onto the right side of the road. The wheels ran off the road and onto the unsealed shoulder, where the utility rolled over the struck several trees. The driver was killed in the crash.

In the other two cases, the road was unsealed. In both cases, the car, which was being driven at excessive speed by a driver with only a provisional licence, struck a tree on the right side of the road. In one of these crashes, which resulted in a fatality and three hospital admissions, the loss of control occurred after the car had travelled through a dip in the road, whilst in another, the driver was negotiating a crest when he encountered a truck travelling down the centre of the road. The driver braked, locking the wheels, and the car yawed off the road to the right where it collided with a tree. The truck driver had been travelling down the centre of the road in order to avoid overhanging trees.

Another crash in this category was one in which a car went out of control after its right tyres ran over the kerbing of a traffic-calming device in a residential street zoned at 60 km/h in a rural town. The car yawed to the right, mounted the kerb and struck a utility pole. The traffic-calming device consisted of two traffic islands, one on either side of the road, leaving a gap in the centre of the road through which only one vehicle can travel at a time. The driver in this case was travelling at a speed well in excess of the speed limit and had a BAC of 0.243.

6.5 Off Road to Left, Left Curve

There were nine single vehicle crashes in which the vehicle ran off the road on the left side while negotiating a left curve. This represents nine per cent of the sample of single vehicle crashes and four per cent of the sample of rural crashes as a whole. These crashes produced injuries severe enough to require hospital admission for one or more vehicle occupants in 44 per cent of cases, compared to 60 per cent for the remainder of single vehicle crashes. A comparison between single vehicle crashes involving the vehicle travelling off a left curve to the left and the remainder of the set of single vehicle crashes is provided in Table 6.10.

Table 6.10
Off Road to the Left, Left Curve Crashes and Other Single Vehicle Crashes

Variable	Type of Single Vehicle Crash			
	Off road to left, left curve (N=9)		Remainder (N=96)	
	Number	Per Cent	Number	Per Cent
Speed limit >90	5	55.6	72	75.0
Rural highway	6	66.7	66	68.8
Unsealed road	-	-	9	9.4
Up slope	2	22.2	5	5.2
No edge lining	4	44.4	40	46.0
Shoulder seal	2	25.0	7	8.1
Male drivers	6	66.7	57	59.4
Female drivers	3	33.3	39	40.6
Driver age < 25	1	11.1	41	43.2
Not full Licence	1	11.1	29	30.2
>BAC limit	-	-	19	22.1

Note: The percentages calculated for the no edge lining variable omit cases where the road was unsealed, those for the shoulder seal variable refer to cases where the shoulder was fully sealed (to the verge) and omit cases where the road was unsealed or there was no shoulder due to the proximity of an embankment, those for the driver age variable omit cases where the driver's age was unknown, and those for the alcohol variable omit cases in which the driver's BAC was not tested.

In Table 6.10 it appears that, when compared to the remainder of single vehicle crashes, crashes in which a vehicle ran off the road to the left on a left curve involve an under representation of high speed roads, unsealed roads, drivers over the legal BAC limit, and young and unlicensed drivers, and an over representation of up slopes and sealed shoulders. However, due largely to the small numbers, any apparent differences are not statistically significant and, therefore, may have arisen by chance.

Road and traffic factors relevant to this set of crashes include the lack of edge lining and wet or icy roads.

There was one case in which the left wheels of a vehicle travelled onto an unsealed shoulder. In this case, the driver of the four wheel drive vehicle cut the corner on a left bend, the vehicle yawed across to the incorrect side of the road before further overcorrection resulted in the vehicle travelling off the left shoulder again, striking a tree and rolling over. There was no edge lining on the curve. It is possible that better edge lining may have decreased the likelihood of the driver cutting the corner onto the shoulder.

There was one case in which the road was slippery due to ice. The driver of a car was entering a left curve when the tyres slid on a section of road with a layer of ice on it. The car slid off the road to the left, mounted an embankment and rolled over.

Another crash involved a road with a wet surface due to pooled rain. The driver lost control of the vehicle while attempting to steer through a tight left curve, resulting in the car sliding off the road to the left and striking a tree. It is interesting to note that this very tight curve lacked an Advisory Speed sign, but it is unlikely that the addition of such a sign would have averted this crash, given that the driver was a local and so was presumably familiar with the road.

6.6 Off Road to Right, Left Curve

There were nine single vehicle crashes in which the vehicle ran off the right side of the road while negotiating a left curve. This represents nine per cent of the sample of single vehicle crashes and four per cent of the sample of rural crashes as a whole. It also means that when a single vehicle crash occurs on a left curve, the vehicle is equally likely to leave the roadway on the left and right sides (see Section 6.5). These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 67 per cent of cases, compared to 58 per cent for the remainder of single vehicle crashes. A comparison between single vehicle crashes involving the vehicle travelling off the right side of the road on a left curve and the remainder of the set of single vehicle crashes is provided in Table 6.11.

These crashes in which a single vehicle runs off a left curve to the right, when compared to the remainder of single vehicle crashes (Table 6.11), appear to be more likely to occur on a rural highway, less likely to occur on an unsealed road, less likely to occur where there is no edge lining, less likely to occur where the shoulder is sealed, more likely to involve female drivers, less likely to involve young drivers and more likely to involve drivers with a full licence, and those over the legal BAC limit. However, the number of crashes in this group is small and none of the differences apparent from the table are statistically significant. These apparent differences may therefore have arisen by chance.

Table 6.11
Off Road to the Right, Left Curve Crashes and other Single Vehicle Crashes

Variable	Type of Single Vehicle Crash			
	Off road to right, left curve (N=9)		Remainder (N=96)	
	Number	Per Cent	Number	Per Cent
Speed limit >90	6	66.7	71	74.0
Rural highway	8	88.9	64	66.7
Unsealed road	-	-	9	9.4
Down slope	2	22.2	14	14.6
Up slope	3	33.3	4	4.2
No edge lining	3	33.3	41	47.1
Shoulder seal	-	-	9	10.6
Male drivers	3	33.3	60	62.5
Female drivers	6	66.7	36	37.5
Driver age < 25	2	22.2	40	42.1
Not full Licence	1	11.1	29	30.2
>BAC Limit	3	33.3	16	19.0

Note: The percentages calculated for the no edge lining variable omit cases where the road was unsealed, those for the shoulder seal variable refer to cases where the shoulder was fully sealed (to the verge) and omit cases where the road was unsealed or there was no shoulder due to the proximity of an embankment, those for the driver age variable omit cases where the driver's age was unknown, and those for the alcohol variable omit cases in which the driver's BAC was not tested.

Road and traffic issues relevant to this set of crashes include unsealed shoulders, signage, and sun glare on a wet road.

There were three cases in which an unsealed shoulder may have contributed to the crash when the vehicle was negotiating a left hand curve and went off the road to the right.

One of these three cases occurred on a divided road. The vehicle was travelling in the lane adjacent to the median when it ran wide on a left curve, onto the unsealed shoulder. The driver overcorrected and the vehicle swerved back across the road where it struck a guard rail at an angle of about 40 degrees.

In another of these three cases, the severely intoxicated female driver (BAC = 0.206) allowed the car to run wide onto the unsealed right hand shoulder of a two-way road at night. She swerved to the left and the car yawed anticlockwise back across the road, ran up an embankment, struck a tree and rolled over. The driver was fatally injured.

In the third crash to involve an unsealed shoulder, a four wheel drive vehicle was overtaking on the right side of a two lane road when another vehicle pulled out in front of it to also overtake. This caused the four wheel drive to veer onto the unsealed shoulder on the right hand side. The four wheel drive then went out of control, yawing back onto the road and then off to the right again, before striking a fence and rolling over, fatally injuring the driver who was not wearing a seat belt and was ejected.

Signage was an issue in one crash, in which the driver of a van travelling in a 90 km/h zone failed to negotiate a 90 degree left curve at a junction in the road. The van ran off the right side of the road, struck a tree and rolled over. This crash would have been less likely to occur if there had been extra signs warning of the curve. The occupants of the van were presumably unfamiliar with the road, forming a detour, and were driving at night in the rain. The driver was also intoxicated (BAC = 0.191). This is a scenario in which signage is very important. The junction and the inside of the curve itself were delineated by guide posts, whilst the outside of the entry to the curve, directly in the path of the van, was delineated with a single hazard board and a direction board, both partly obscured. The original alignment of the road is in the background forming a new T-junction, and it is possible that vehicle tail or headlights could be seen on this part of the road prior to the curve, and that headlights could have reduced the conspicuity of the hazard board. For a sharp turn to be safely negotiated by those unfamiliar with the road, especially in the trying conditions involved in this crash, it would be desirable that extra curve warning signs be present, possibly supported by improved delineation.

The only other crash in this set of nine crashes for which road and traffic factors are relevant involved a wet road and a car travelling east at 8 o'clock in the morning. The driver lost control of the car when blinded by the morning sun, which was causing glare off the wet road surface.

6.7 Off Road to Left, Right Curve

There were 32 single vehicle crashes in which the vehicle travelled off the road to the left on a right curve. This represents 31 per cent of the sample of single vehicle crashes and 14 per cent of the sample of rural crashes as a whole. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 59 per cent of cases, which is equivalent to the remainder of the sample of single vehicle crashes (59%). A comparison between single vehicle crashes involving the vehicle travelling off a right curve to the left and the remainder of the set of single vehicle crashes is provided in Table 6.12.

Table 6.12
Off Road to the Left, Right Curve Crashes
and Other Single Vehicle Crashes

Variable	Type of Single Vehicle Crash			
	Off road to left, right curve (N=32)		Remainder (N=73)	
	Number	Per Cent	Number	Per Cent
Speed limit >90	26	81.3	52	69.9
Rural highway	19	59.4	53	72.6
Unsealed road	3	9.4	6	8.2
Down slope	8	25.0	8	11.0
Up slope	2	6.3	5	6.8
No edge lining	18	62.1	26	38.8
Shoulder sealed	1	3.4	8	12.3
Male drivers	20	62.5	43	58.9
Female drivers	12	37.5	30	41.1
Driver age < 25	13	40.6	29	40.3
Not full Licence	11	34.4	19	26.0
>BAC limit	6	20.0	13	20.6

Note: The percentages calculated for the no edge lining variable omit cases where the road was unsealed, those for the shoulder seal variable refer to cases where the shoulder was fully sealed (to the verge) and omit cases where the road was unsealed or there was no shoulder due to the proximity of an embankment, those for the driver age variable omit cases where the driver's age was unknown, and those for the alcohol variable omit cases in which the driver's BAC was not tested.

The comparison between these "run off road to the left on a right hand curve" crashes and other single vehicles crashes (Table 6.12) reveals only one statistically significant difference, and that relates to the absence of edge lining (62% in this set of single vehicle crashes, 39% in the remaining single vehicle crashes, $\chi^2 = 4.41$, $p < .05$).

This means that, given the occurrence of a single vehicle crash, if it involved the vehicle running off to the left on a right curve, then it is more likely to have occurred where there was no edge lining than if it was a different type of single vehicle crash. Other differences in Table 6.12 between these two groups of crashes are either inconsistent (high speed roads and rural highways) or based on very few cases (shoulder seal).

Road and traffic factors that were found to be relevant for individual crashes of this type included unsealed shoulders, a lack of edge lining, debris on the road surface, the nature of the road surface itself, signage, a drainage depression by the side of the road, an unsealed road apron placed on the outside of the right curve, road marking, and a large drop off on the pavement edge.

An unsealed shoulder may have played a role in the crash in 21 cases. In 13 of these 21 crashes, the driver attempted to correct the trajectory of the vehicle when it ran off the road to the left but overcorrected, resulting in the vehicle travelling across to the incorrect side of the road. In the remaining eight crashes, the driver failed to regain control of the vehicle and the vehicle finished on the left roadside.

There were four cases in which the unsealed shoulder was involved in a fatal crash. In one of these, a car ran onto the unsealed surface on the left side of the road and slid into a fence and a tree, fatally injuring the left front seat passenger and the rear seat passenger. This crash may still have occurred had the shoulder been sealed (the young, inexperienced driver had consumed alcohol and other drugs on the night of the crash), but the driver would have had a better chance of regaining control of the car. In another, the car ran onto the unsealed shoulder on the left, yawed back across the road, and struck a utility pole on the right side of the road, resulting in the deaths of the driver and left rear passenger. Again, the vehicle was being driven by a young, inexperienced driver who had been drinking, in this case recording a BAC of 0.196. In another case, the car drifted onto the left shoulder, re-entered the roadway and then yawed off to the left again, before travelling up a small embankment, striking trees and rolling over, fatally injuring the driver. This driver was travelling well in excess of the speed limit and post-mortem investigations revealed senile plaques in the brain indicative of Dementia of the Alzheimer's Type. In the remaining fatal crash in this set of cases, a car ran wide onto the unsealed shoulder on a left hand bend. The car yawed back across to the incorrect side of the road before yawing back off the road to the left and striking two trees. The driver was unconscious but still alive inside the car, according to the Coroner, when the hot exhaust started a grass fire that engulfed the car and incinerated the driver.

The finding above that there was no edge lining present in 62 per cent of these crashes on right hand curves, compared to 39 per cent of other single vehicle crashes, suggests that the lack of edge lining may have been more likely to have played a role in this group of crashes. Indeed, there were six crashes (one third of those where there was no edge lining) in which the lack of edge lining could have contributed to the occurrence of the crash. In each of these six crashes, the vehicle ran onto an unsealed shoulder. Furthermore, all six of these crashes occurred at night, when it is particularly difficult to see the edge of the road. In four of the crashes, the driver only had a provisional licence and, hence, limited driving experience. One of the crashes also occurred in rainy conditions, which would have further compromised visibility of the edge of the road. Two of these six crashes were fatal and another two resulted in the driver being admitted to hospital. In one of the fatal crashes, there was edge lining delineating the left curve for opposing traffic but none for the right curve being negotiated by the crash-involved driver. In both cases involving hospital admission, the drivers were travelling at excessive speed prior to the crash.

There were also seven crashes in which a characteristic of the road surface is likely to have contributed to the crash, and a further three in which a contribution from the road surface to the occurrence of the crash was possible but unable to be substantiated.

In three cases, the crash occurred on an unsealed road, with two of them probably related to the lack of traction afforded by the road surface. In one of these cases, the loss of control occurred on a right hand curve on a down slope of a minor road at the start of an S bend. The vehicle ran off the road, struck a fence post, yawed across the road to the right and rolled over. The driver had been driving at high speed, in pursuit of another vehicle. In another, also on a minor road, the vehicle ran wide on the curve and dropped a wheel into a drainage depression at the edge of the road, leading to the vehicle going out of control and yawing right and then left across the road twice before running up an embankment and rolling over. In the third case, a car with very poor tread depth on its tyres continued straight ahead instead of following the right hand curve and struck trees on the left of the road, fatally injuring the driver. However, this failure to take the curve was not likely to have been related to the road surface, as there were driver-related factors that probably caused the crash.

In two of these 32 cases there was a problem with the surface of a sealed road that may have contributed to the occurrence of the crash. In one of these, the ambient temperature had been very high for some days. This had caused the bitumen to “bleed”, covering the aggregate (Figure 6.7.1). This slippery road surface may have contributed to the vehicle running wide onto the unsealed shoulder, and would have also increased the already substantial difficulty for the driver of regaining control of the car once it re-entered the roadway from the left shoulder.

Figure 6.7.1 Tyre yaw marks in bleeding bitumen

In the other crash that involved a problem with a sealed road surface, bitumen bleeding was also involved. In this crash, a car was faced with another car travelling towards it across the centre line. The driver swerved to the left side of the road onto the unsealed shoulder before overcorrecting, which caused the car to yaw clockwise across the road, strike some trees to the right of the road and run down an embankment. The road surface was bleeding in the same manner as in the other case described above and, furthermore, the surface had deteriorated to such an extent that passing vehicles were spraying bitumen-covered gravel from the road. One local at the scene commented that he had to drive slowly through this patch of road or he would flick tar all over the paint work of his car. This road surface may have contributed to the oncoming car travelling onto the wrong side of the road, and certainly would not have aided the driver of the car that crashed regain control as her vehicle re-entered the roadway from the unsealed shoulder.

Bitumen bleeding through the road surface was not the only problem with the road in this case. Another possible explanation for the oncoming car being on the incorrect side of the road was the position of the centre line. The centre line had been moved to widen the lane in which the car that crashed was travelling. However, the deterioration of the road surface had led to the old centre line being partially re-exposed. This could have resulted in confusion for the driver of the car that failed to keep left. Unfortunately, this driver did not stop, possibly because they were unaware of the crash having happened, and so were unable to be identified and subsequently interviewed.

There were four of these 32 cases in which it is possible, or it was claimed, that debris on the road played a role in the loss of vehicular control that led to the crash. In one, the driver of a four wheel drive vehicle said that recent rain had washed gravel from the unsealed shoulder onto the road. This, according to the driver, combined with very heavy rain, caused him to lose control of the four wheel drive, which yawed across the road to the right, before being overcorrected to the left where it travelled along an embankment, a wheel slipped into a culvert and the vehicle rolled over. In another, the driver said that trucks had dropped small stones on the road, contributing to the loss of control of his car, which struck a utility pole on the left roadside. However, there was no evidence at the scene to substantiate this claim and there were several driver factors (emotional distraction, BAC = 0.200) that were more likely to explain the loss of vehicular control that led to the crash. In the third case, the driver reported that the car slid on wet mulch that had been dropped on the road. As in the first case, the road was very wet at the time. The loss of control precipitated by the wet mulch caused the car to drop a wheel onto the unsealed left shoulder. The young, inexperienced (learner) driver braked, which led to further loss of control, and the car ran off the road and struck a direction sign support.

In the fourth case of debris on the road, there was a junction with an unsealed road on the outside of a right curve and gravel from the apron of the unsealed road had spread onto the sealed road it adjoined. The presence of loose gravel on the road surface on the outside of the right curve contributed to the car sliding out of control, then yawing across the road before returning to the left side, travelling across the left unsealed shoulder, striking some trees and finishing suspended by tree branches above a drain. The small hatchback was also being driven at a speed in excess of the advisory speed for the curve by a young, inexperienced driver.

There were three of these 32 cases in which there was a problem with the signage provided to the drivers. In the first case, the road on which this crash occurred was in a 100 km/h speed limit zone for the direction of travel of the case vehicle. However, a speed limit sign indicated a limit of 60 km/h for travel in the opposite direction. It appeared that either a 60 km/h sign was missing, or had never been installed, for the direction of travel of the case vehicle. Since the crash, a speed limit sign specifying a new limit of 80 km/h was added to the road, as was a new curve warning sign before the curve at which the car crashed.

In the second case, there was no advisory sign to warn of the curve in the road where the car went off onto the shoulder and out of control. An Advisory Speed sign was erected after the crash, along with resurfacing of the road. However, whilst the surface of the road was implicated in the occurrence of the crash, the lack of signage probably did not play any role. This is because the driver, who lived locally, used the road regularly. Nonetheless, the addition of the Advisory Speed sign could benefit other drivers using the road.

In the remaining crash, it is possible that the problem with the signage played a role in the crash. The curve on which the crash occurred had chevron markers delineating the curve and an Advisory Speed sign for one direction only. The inexperienced and intoxicated driver travelling the road at night in this crash was approaching the curve from the other direction. Chevron markers and an Advisory Speed sign, in addition to edge lining (see above), would have helped the driver to negotiate the curve at night.

There was one remaining road factor that contributed to a crash in this set of 32 cases. In this crash, a car driven by a young, inexperienced driver ran onto an unsealed shoulder on the left. The car went out of control, yawed across the road and struck trees on the right side of the road. The additional road factor contributing to this crash was a large drop off on the pavement edge. The difference in height between the top of the road surface and the shoulder was approximately eight centimetres. Such a difference in the level of the road surface and the shoulder contributed to the vehicle slipping onto the shoulder and contributed to difficulties in re-entering the roadway. Inspection of the edge of the roadway revealed marks suggesting that other vehicles had experienced similar difficulties.

6.8 Off Road to Right, Right Curve

There were five single vehicle crashes in which the vehicle left the right side of a road on a right hand curve. This represents five per cent of the sample of single vehicle crashes and two per cent of the sample of rural crashes as a whole. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 40 per cent of cases, compared to 60 per cent for the remainder of single vehicle crashes. A comparison between single vehicle crashes involving the vehicle travelling off the right side of a road on a right curve and the remainder of the set of single vehicle crashes is provided in Table 6.13.

Table 6.13 shows that each of the five crashes in which a single vehicle left a right curve to the right of the road occurred on a rural highway. As the number of crashes in this category is small, no comparisons between this group and the remaining single vehicle collisions yield meaningful or statistically significant results.

The most commonly reported road factor in this group of crashes (4 out of 5 cases) was a very wet road.

Table 6.13
Off Road to the Right, Right Curve Crashes
and Other Single Vehicle Crashes

Variable	Type of Single Vehicle Crash			
	Off road to right, right curve (N=5)		Remainder (N=100)	
	Number	Per Cent	Number	Per Cent
Speed limit >90	4	80.0	73	73.0
Rural highway	5	100.0	67	67.0
Unsealed road	-	-	9	9.0
Down slope	1	20.0	15	15.0
No edge lining	1	20.0	43	47.3
Shoulder seal	1	20.0	8	9.0
Male drivers	4	80.0	59	59.0
Female drivers	1	20.0	41	41.0
Driver age < 25	2	40.0	40	40.0
Not full Licence	1	20.0	29	29.0
>BAC limit	-	-	19	21.6

Note: The percentages calculated for the no edge lining variable omit cases where the road was unsealed, those for the shoulder seal variable refer to cases where the shoulder was fully sealed (to the verge) and omit cases where the road was unsealed or there was no shoulder due to the proximity of an embankment, those for the driver age variable omit cases where the driver's age was unknown, and those for the alcohol variable omit cases in which the driver's BAC was not tested.

In one of the wet road crashes, a van hydroplaned and went out of control in heavy rain on a national highway. It began to yaw in a clockwise direction, ran off the right side of the road and struck a tree, fatally injuring the left front seat passenger. The section of road on which the crash occurred had recently been resurfaced. However, heavy vehicle traffic had forced the aggregate deeper into the seal. This resulted in the road having a smooth rubbery texture. Our team of researchers found that they were able to push a key into the road surface. The tyres on the van had approximately a third of their original tread depth remaining. Since the crash, further resurfacing work has been conducted on the road in an attempt to rectify the problem.

6.9 Summary of Single Vehicle Crashes

Single vehicle crashes are common in rural areas, comprising over 44 per cent of the sample of crashes investigated. They tend to occur on roads having a high speed limit, with the majority occurring on curved sections of road, especially those curving to the right from the perspective of the driver. Young drivers, particularly those on a provisional licence, were over represented in these crashes, as were those with a BAC above the legal limit.

The most commonly identified road factor associated with the loss of vehicular control precipitating these crashes was an unsealed shoulder, which was found to play a role in 52 crashes, or almost half of the single vehicle crashes investigated. An unsealed shoulder was especially prominent in crashes in which the vehicle initially went off a straight road to the left (23 cases or 68%) and those in which it went off to the left of a right hand curve (21 cases or 66%). Therefore, a sensible option for treating this most common of road problems would be to initially embark on a course of sealing the left shoulder on right hand curves. Drivers or riders tended to overcorrect the steering of their vehicles after dropping one or more wheels onto the unsealed shoulder exacerbating the loss of control. Therefore, all drivers may benefit from education with regard to the appropriate response to their vehicle veering onto an unsealed shoulder.

The next most commonly identified road feature implicated in investigations of these crashes was a problem with the road surface, or foreign material on the road (24 cases or 23%). Six cases involved an unsealed road, 12 involved roads that were wet or icy (especially common for cases in which the car travelled off the right side of a right curve), three cases involved debris on the road, and three cases involved the seal covering the aggregate on the road surface (one of these locations was newly resurfaced on a national highway). It is these latter three cases that are of the most concern. Two of these crashes were fatal. Any reports of deteriorating road surfaces should be investigated, and close inspection and monitoring of newly resurfaced roads should also be undertaken.

The most common of the remaining road and traffic factors identified as being involved in the crashes was a lack of edge lining (9 cases). Two thirds of these nine crashes involved a vehicle running off the left side of a right curve. Again, it may be appropriate to initially treat this problem with edge lining on the left side of right hand curves, in addition to shoulder sealing where it is lacking. The other road infrastructure factors identified were: inadequate signage (2 relevant cases), problems with the road layout (2 cases, one of which was an unsealed road apron on the outside of a right hand curve, and the other one involving a merging taper which does not satisfy the relevant Australian Standard), on-road hazards (3 cases), vertical alignment (2 cases), road markings (1 case), a drainage depression by the side of the road (1 case), a large drop off from the pavement edge to the shoulder (one case), and a traffic calming device (1 case, although the device was adequate and only contributed to the loss of control of a vehicle being driven at excessive speed by an intoxicated driver).

7. MIDBLOCK COLLISIONS BETWEEN TWO OR MORE VEHICLES

The sample of 236 rural crashes included 67 crashes (28%) in which two or more vehicles collided without any of the vehicles involved having been attempting to turn into or from another road at the time of the crash. Such crashes are henceforth referred to as "midblock collisions".

7.1 Comparison of Midblock and Other Multiple Vehicle Crashes

7.1.1 Time of day by multiple vehicle crash type

These crashes occurred most commonly during daylight hours, which was also the case with the remaining multiple vehicle crashes. A comparison of time of day for occurrence of midblock and other multiple vehicle crashes is shown in Table 7.1.

Table 7.1
Time of Day of
Midblock Compared to Other Multiple Vehicle Crashes

Time of Day	Type of Crash			
	Midblock		Other Multiple Vehicle	
	Number	Per cent	Number	Per cent
0000 - 0059	-	-	-	-
0100 - 0159	-	-	-	-
0200 - 0259	-	-	-	-
0300 - 0359	-	-	-	-
0400 - 0459	-	-	-	-
0500 - 0559	-	-	-	-
0600 - 0659	1	1.5	-	-
0700 - 0759	1	1.5	2	3.0
0800 - 0859	6	9.0	5	7.8
0900 - 0959	2	3.0	7	10.9
1000 - 1059	9	13.4	5	7.8
1100 - 1159	6	9.0	7	10.9
1200 - 1259	4	6.0	9	14.1
1300 - 1359	2	3.0	7	10.9
1400 - 1459	12	17.9	4	6.3
1500 - 1559	6	9.0	5	7.8
1600 - 1659	6	9.0	3	4.7
1700 - 1759	4	6.0	4	6.3
1800 - 1859	2	3.0	2	3.0
1900 - 1959	3	4.5	1	1.6
2000 - 2059	2	3.0	-	-
2100 - 2159	-	-	3	4.7
2200 - 2259	1	1.5	-	-
2300 - 2359	-	-	-	-
Total	**67**	**100.0**	**64**	**100.0**

7.1.2 Speed limit at crash location by multiple vehicle crash type

A comparison between midblock collisions and other multiple vehicle crashes demonstrates little difference in the distribution of the crashes across roads with different speed limits. In both cases the majority occurred on roads with speed limits of 100 or 110 km/h, yet with significant numbers (approximately one in five crashes in each set of cases) occurring on roads with lower limits of 60 to 70 km/h. The speed limit for the roads on which the two sets of crashes occurred is shown in Table 7.2.

Table 7.2
Speed Limit at the Site of
Midblock Compared to Other Multiple Vehicle Crashes

Speed Limit	**Type of Crash**			
	Midblock		**Other Multiple Vehicle**	
km/h	**Number**	**Per Cent**	**Number**	**Per Cent**
60	14	20.9	9	14.1
70	-	-	3	4.7
80	14	20.9	10	15.6
90	3	4.5	2	3.1
100	31	46.3	19	29.7
110	5	7.5	21	32.8
Total	**67**	**100.0**	**64**	**100.0**

7.1.3 Horizontal alignment at crash location by multiple vehicle crash type

One way in which midblock collisions differ from other multiple vehicle crashes is in the horizontal alignment of the roads on which the crashes occurred. Midblock collisions were more likely to have occurred on curved roads than the remaining multiple vehicle crashes, with crashes on curved roads accounting for over half of the crashes in this category. This difference was statistically significant ($\chi^2_{(2)}$= 20.72, p< .001). The horizontal alignment of the roads where the crashes occurred is shown in Table 7.3.

Table 7.3
Horizontal Alignment at the Site of
Midblock Compared to Other Multiple Vehicle Crashes

Horizontal Alignment	**Type of Crash**			
	Midblock		**Other Multiple Vehicle**	
	Number	**Per cent**	**Number**	**Per cent**
Straight	33	49.3	55	85.9
Curve right	16	23.9	6	9.4
Curve left	18	26.9	3	4.7
Total	**67**	**100.0**	**64**	**100.0**

NB: Whether the road curved to the left or right in a head on collision was determined from the point of view of the vehicle that travelled onto the incorrect side of the road.

7.1.4 Driver age by multiple vehicle crash type

Drivers or riders under the age of 20 are more likely to be involved in midblock collisions than other multiple vehicle crashes (17 versus 7%). Older drivers (60 years of age or older), on the other hand, are less likely to be involved in midblock crashes compared to other multiple vehicle collisions (9 versus 24%). The difference in the distribution of ages for the two sets of crashes was statistically significant ($\chi^2_{(2)}$= 14.36, p< .001), suggesting that any precipitating factors for midblock collisions that differ from those initiating other multiple vehicle crashes are more likely to be involved when a teenager is driving compared to when an elderly person is driving. The ages of drivers and riders in midblock collisions and other multiple vehicle crashes are shown in Table 7.4 and are represented graphically in Figure 7.1.

Table 7.4
Age of Drivers and Riders Involved in
Midblock Compared to Other Multiple Vehicle Crashes

Age of Driver or Rider	Type of Crash			
	Midblock		Other Multiple Vehicle	
Years	Number	Per cent	Number	Per cent
16-19	24	17.3	9	6.9
20-24	15	10.8	14	10.8
25-29	21	15.1	12	9.2
30-34	9	6.5	10	7.7
35-39	14	10.1	13	10.0
40-44	13	9.4	14	10.8
45-49	14	10.1	15	11.5
50-54	8	5.8	8	6.2
55-59	8	5.8	4	3.1
60-64	3	2.2	6	4.6
65-69	5	3.6	5	3.8
70-74	3	2.2	6	4.6
75-79	1	0.7	7	5.4
80-84	1	0.7	5	3.8
85-89	-	-	2	1.5
90+	-	-	-	-
Total	**139**	**100.0**	**130**	**100.0**

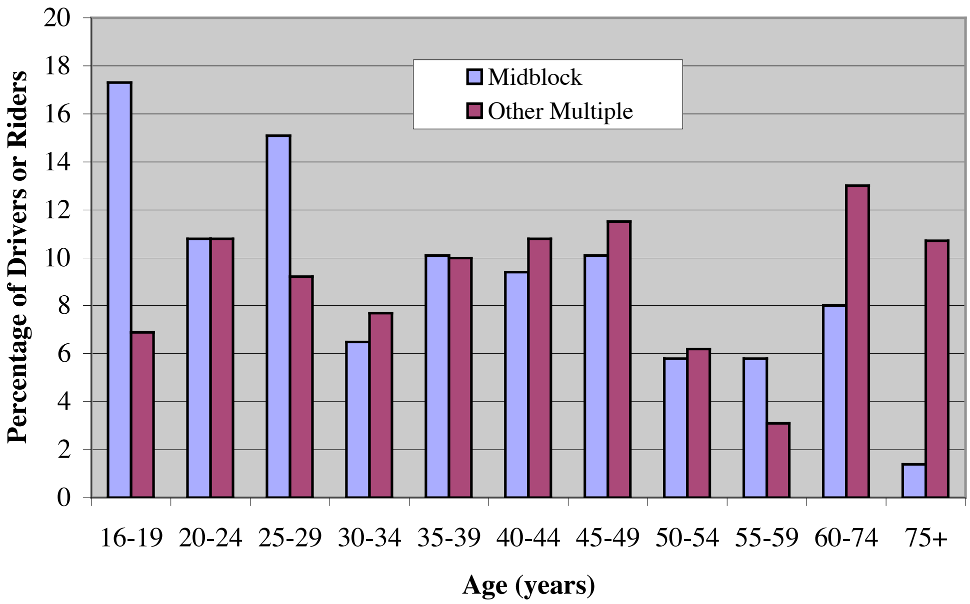

Figure 7.1: Age of Drivers or Riders by Type of Multiple Vehicle Crash

7.1.5 Driver licence status by multiple vehicle crash type

The differences in the distribution of ages of drivers and riders according to whether the crash was a midblock collision or another type of multiple vehicle crash was reflected in differences in the nature of licences held by these drivers and riders. Those drivers and riders involved in midblock collisions were less likely to hold a full licence than those involved in other multiple vehicle crashes (82 versus 93%). This difference was found to be statistically significant ($\chi^2_{(1)}$= 7.45, p< .01). A summary of licences held by the drivers and riders for the two sets of crashes is provided in Table 7.5.

Table 7.5
Licence Status of Drivers and Riders Involved in Midblock Compared to Other Multiple Vehicle Crashes

Licence Status	Type of Crash			
	Midblock		Other Multiple Vehicle	
	Number	Per cent	Number	Per cent
Full	114	82.0	121	93.1
P-Plate	20	14.4	7	5.4
L-Plate	2	1.4	-	-
Unlicensed	3	2.2	2	1.5
Total	**139**	**100.0**	**130**	**100.0**

7.2 Types of Midblock Collision

For the purposes of this report, the 67 midblock collisions have been classified into six types of crash. The different types of crash and the distribution of crashes according to this method of classification is shown in Table 7.6

Table 7.6
Types of Midblock Collisions

Type of Crash	Number	Per cent
Rear end collisions	11	16.4
U turn collisions	6	9.0
Entering or leaving road	8	11.9
Side swipe	3	4.5
Head on, straight road	10	14.9
Head on, curved road	29	43.3
Total	**67**	**100.0**

As can be seen from Table 7.6, a majority of the midblock crashes were head on collisions (58%), which were more likely to occur on curved roads. The next most common type of midblock collision was rear end collisions (16%). These different types of midblock collisions are listed again in Table 7.7, along with a number of road and driver variables associated with the crashes. Each of these six crash types are discussed in the following sections, with particular reference made to the road and traffic factors involved in the crashes.

Table 7.7
Types of Midblock Rural Road Crashes Investigated and Their Relationship to a Number of Road and Driver Variables

Type of Crash (no.)	Speed Limit >90	Rural Highway (%)	Unsealed Road (%)	Down Slope (%)	Up Slope/ Crest (%)	Curve (%)	No Edge Lining (%)	Shoulder Seal (%)	Male Drivers (%)	Female Drivers (%)	Driver Age<25 (%)	Not Full Licence (%)	>BAC Limit (%)
Rear End Collision (11)	54.5	90.9	-	18.2	27.3	9.1	18.2	9.1	45.8	54.2	25.0	8.3	-
U Turn Collision (6)	66.7	100.0	-	-	16.7	33.3	33.3	33.3	50.0	50.0	8.3	8.3	-
Entering or Leaving Road (8)	12.5	62.5	-	-	12.5	25.0	25.0	62.5	68.8	31.3	37.5	31.3	-
Side Swipe (3)	33.3	66.7	-	-	-	-	33.3	100.0	66.7	33.3	33.3	33.3	-
Head On, Straight Road (10)	70.0	60.0	10.0	20.0	10.0	-	33.3	22.2	66.7	33.3	28.6	14.3	-
Head On, Curved Road (29)	58.6	72.4	10.3	24.1	3.4	100.0	38.5	8.3	65.0	35.0	30.0	20.0	9.1

Note: the no edge lining variable omits cases where the road was unsealed, the shoulder seal variable refers to cases where the shoulder was fully sealed (to the verge) and omits cases where the road was unsealed or there was no shoulder due to the proximity of an embankment.

7.3 Rear End Collisions

There were 11 midblock collisions in which a vehicle struck another vehicle in the rear. This represents 16 per cent of the sample of midblock collisions and five per cent of the sample of rural crashes as a whole. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 27 per cent of cases, compared to 57 per cent for the remainder of midblock collisions. A comparison between rear end collisions and the remainder of the set of midblock collisions is provided in Table 7.8.

Table 7.8
Rear End Collisions
and other Midblock Crashes

Variable	Type of Midblock Collision			
	Rear End Collision		Remainder	
	Number	Per cent	Number	Per cent
Speed limit >90	6	54.5	30	53.6
Rural highway	10	90.9	40	71.4
Unsealed road	-	-	4	7.2
Down slope	2	18.2	9	16.1
Crest/up slope	3	27.3	5	8.9
Curve	1	9.1	33	58.9
No edge lining	2	18.2	18	34.6
Shoulder sealed	1	9.1	12	25.0
Male drivers	11	45.8	74	64.3
Female drivers	13	54.2	41	35.7
Driver age < 25	6	25.0	33	28.7
Not Full Licence	2	8.3	23	20.0
>BAC limit	-	-	4	4.9

Note: The percentages calculated for the no edge lining variable omit cases where the road was unsealed, those for the shoulder seal variable refer to cases where the shoulder was fully sealed (to the verge) and omit cases where the road was unsealed or there was no shoulder due to the proximity of an embankment, those for the driver age variable omit cases where the driver's age was unknown, and those for the alcohol variable omit cases in which the driver's BAC was not tested.

It appears from Table 7.8 that rear end collisions, when compared to the remainder of midblock collisions, are more likely to occur on rural highways, more likely to occur on a crest or up slope, less likely to occur on a curve, less likely to occur where there is no edge lining, less likely to occur where the shoulder is sealed, and more likely to involve female drivers. The small number of crashes in this category, however, means that only one of these apparent differences is statistically significant, that being the finding that rear end collisions are less likely to occur on curves ($\chi^2_{(1)}$= 9.14, $p< .01$). Of those 11 drivers who were in control of the striking vehicle in these crashes, seven were female and four were male, and two only held provisional licences. These two drivers with provisional licences were the only drivers without full licences involved in these rear end crashes.

There were a number of crashes that fall into this category for which road and traffic factors were relevant to the crash. These road and traffic factors include restriction of vision caused by a either a crest, a four wheel drive vehicle or a curve in the road, problems with the road layout, and unexpected road works.

Restricted vision caused by a crest contributed to three rear end collisions. In the first, a truck was travelling up to a crest on which a car was in the middle of a U-turn. When the driver of the truck realised that the car was in his way, he braked and veered to the left to avoid a collision. The driver of a car following the truck, who was familiar with the road, saw the truck's brake lights and assumed the truck was braking for an upcoming right curve. The driver did not realise the truck was coming to a stop until it was too late. Despite braking, the car collided with the rear of the truck. Unfortunately, the driver of the car performing the U-turn left the scene and was unable to be interviewed regarding the crash.

The second crash featuring the possible contribution of a crest occurred when a vehicle at the top of a small crest braked to turn into the driveway of a fruit and vegetable market. A vehicle travelling behind came up to the top of the crest and struck the first vehicle in the rear, pushing it across to the right roadside. Observation at the scene of this crash indicated that this particular fruit and vegetable market is very popular, with many vehicles turning into it. However, its location on top of a crest and its limited signage means that vehicles slowing to turn into it may not be seen early enough by following vehicles, and also that drivers looking for a sign may need to stop abruptly, adding to the potential for rear end collisions. Other sets of skid marks unrelated to this crash were noted on the road at this location and whilst at the scene, both on the day of the crash and at a later date, our team of investigators witnessed many near misses involving vehicles whose drivers wished to turn into the fruit and vegetable market.

In the remaining crash, it is possible that the driver of the striking car did not realise that there was a car in front of her turning into a driveway, because of the presence of a small crest separating the two vehicles. The driver of the striking car was distracted just prior to the collision by children in the back seat and this would seem sufficient to account for the collision, but the presence of the crest possibly made her unaware of the presence of the first car, and she chose an inappropriate time to respond to the distraction created by the children in the rear seat.

Restricted vision caused by a four wheel drive vehicle contributed to two rear end collisions. In one of these crashes, a trailer dropped its load onto the road and the driver of a following car slowed to try and manoeuvre around the dropped load (cushions). A four wheel drive vehicle, rather than braking and slowing behind the car, overtook it on the left shoulder. The driver of a car following the four wheel drive, unable to see beyond it, was surprised when confronted with the stationary car after the four wheel drive had veered off the left side of the road. This car struck the stationary car. The dropped load clearly played a role in the causation of the crash and the wet road may have inhibited the ability of the striking car to brake effectively, but the vision restriction caused by the four wheel drive vehicle was necessary for the crash to occur.

In the other crash, the driver of a four wheel drive vehicle braked as a vehicle in front of it turned right to exit the road on which the four wheel drive was travelling. The driver of a car travelling behind the four wheel drive was unable to see past it and so did not expect the need to brake, nor the extent of braking required once the braking of the four wheel drive had been noticed. The driver of this car had to brake heavily to avoid striking the rear of the four wheel drive. The car behind this one subsequently struck it in the rear. The driver of the striking vehicle was inexperienced, and it is alleged that the brake lights of the four wheel drive were obscured by dirt, but it is still likely that the inability of the driver of the car that was struck from behind to see past the four wheel drive contributed to the crash.

There was one crash in which a curve in the road caused a restriction of vision that contributed to the occurrence of a crash. In this crash, a car was coming around a left curve when it encountered a slow moving (approximately 30 km/h on a 110 km/h road) truck towing a trailer. The driver of the car alleged that a vehicle overtaking it in the right lane made it impossible to change lanes and overtake the truck, so he applied the brakes. There was insufficient braking distance, however, and the car struck the rear of the truck. The down slope of the road at this location may also have made it more difficult for the striking car to stop in time.

There was one case in which the road layout contributed to the crash. In this case, a car waiting at the median of a divided road to perform a U-turn was struck in the rear. The particular break in the median at which the driver of the first car chose to perform the U-turn was an inappropriate place for such a manoeuvre. However, this poorly chosen location at which to perform a U-turn is a common place for such manoeuvres, and the reason for this is related to problems with a T-junction just beyond the crash site. The driver attempting the U-turn had previously been travelling on a road adjoining, via a T-junction, the one on which the crash occurred. The driver, rather than attempting a right turn, had decided, as many drivers who regularly use these roads do, to first turn left and then perform a U-turn. The reason so many drivers do this is that there is often a long line of traffic waiting to turn right at this T-junction. Although there is a dedicated lane for right turning traffic on the far side of the road, the high volume of traffic on both roads leads to a substantial delay for vehicles turning right. The first break in the median after a vehicle turns left at the T-junction is chosen by most drivers as the place to perform the U-turn, despite the fact that it was not designed for such manoeuvres.

In the one remaining rear end collision that involved the contribution of a road and traffic factor, a van ran into the rear of a car stopping for a manually operated Stop sign. This Stop sign was in place for road works on a highway on which vehicles normally do not stop. The driver of the van was also distracted at the time of the crash by cargo on the front seat being close to falling off, but the unexpected nature of the Stop sign would have also contributed to the crash, because the usual lack of a need to stop would have provided the context in which the driver felt safe to attend to his cargo whilst driving.

7.4 U-Turn Collisions

There were six midblock collisions in which a vehicle struck another vehicle while it was attempting to complete a U-turn. This represents nine per cent of the sample of midblock collisions and three per cent of the sample of rural crashes as a whole. These crashes produced injuries severe enough to require hospital admission for one or more vehicle occupants in 17 per cent of cases, compared to 56 per cent for the remainder of midblock collisions. A comparison between U-turn collisions and the remainder of the set of midblock collisions is provided in Table 7.9.

Table 7.9 shows that all the U-turn collisions investigated occurred on rural highways, none on unsealed roads and none on down slopes. Few occurred on curves and involved young drivers, when compared to other midblock crashes, whilst according to the same comparison, there appears to be an over representation in U-turn crashes of high speed roads, up slopes, sealed shoulders and female drivers. However, as there were only six U-turn collisions investigated, none of these apparent differences are statistically significant.

Road and traffic factors relevant to the causation of this set of crashes include road design and restriction of vision caused by a curve or a four wheel drive vehicle.

Table 7.9
U-Turn Collisions and other Midblock Crashes

Variable	Type of Midblock Collision			
	U-turn Collision (N=6)		Remainder (N=61)	
	Number	Per cent	Number	Per cent
Speed limit >90	4	66.7	32	52.5
Rural highway	6	100.0	44	72.1
Unsealed road	-	-	4	6.6
Down slope	-	-	11	18.0
Up slope	1	16.7	3	4.9
Curve	2	33.3	32	52.5
No edge lining	2	33.3	18	31.6
Shoulder sealed	2	33.3	11	20.8
Male drivers	6	50.0	79	62.2
Female drivers	6	50.0	48	37.8
Driver age < 25	1	8.3	38	29.9
Not Full Licence	1	8.3	24	18.9
>BAC limit	-	-	4	4.3

Note: The percentages calculated for the no edge lining variable omit cases where the road was unsealed, those for the shoulder seal variable refer to cases where the shoulder was fully sealed (to the verge) and omit cases where the road was unsealed or there was no shoulder due to the proximity of an embankment, those for the driver age variable omit cases where the driver's age was unknown, and those for the alcohol variable omit cases in which the driver's BAC was not tested.

There were three crashes in which the view for one of the drivers of other traffic was restricted, contributing to the collision. In two cases, the crash occurred on a curve which made it difficult for the driver of the turning vehicle to judge when it was safe to turn, and which resulted in the driver of the striking vehicle having little time to react to finding a car blocking the roadway. In one of these two cases, the striking vehicle was also travelling at a speed in excess of the limit.

In another crash, a four wheel drive was in the middle of a U-turn when it collided with an oncoming car. Another four wheel drive had moved off from the roadside in front of the turning vehicle just before the commencement of the turn, and this four wheel drive may have blocked the driver of the turning vehicle's view of the approaching car. There was no centre line on this road as it had just been resurfaced, but there were tags on the road indicating the location for a broken centre line, which would permit turns.

In one crash, vision, although not restricted, may have been degraded by the tinted windows of the turning vehicle. In this crash, a car was in the middle of a U-turn when it was struck by a motorcycle coming from behind it on its original side of the road. The tinted windows of the car probably contributed to the failure of the driver to see the motorcycle. The low conspicuity of the motorcycle may also have been an issue, especially given that the crash occurred in the day time when headlights would not have indicated the presence of the motorcycle as clearly as during the night time.

There was one other crash in which a road factor was alleged by one of the drivers to have contributed to the causation of the collision. The driver of a utility pulled over to the side of the road before attempting a U-turn in front of a car travelling in the original direction to the utility. The car struck the front right side of the utility, rolled over and slid along the road on its roof. The driver of the utility alleges that its wheels slipped on the wet, unsealed shoulder, causing the vehicle to slide onto the road. However, there is some reason to believe that this may not have occurred, or at least not been the main cause of the collision.

7.5 Entering or Leaving Road, Collided with Another Vehicle

There were eight midblock collisions in which a vehicle that was either exiting the road into a driveway (3 cases) or entering the road from a driveway (5 cases) was struck by another vehicle. This represents 12 per cent of the sample of midblock collisions and three per cent of the sample of rural crashes as a whole. All of the vehicles entering the road from the driveway were attempting to turn right, whilst one of the three exiting the road into a driveway was turning left. These crashes produced injuries severe enough to require hospital admission for one or more vehicle occupants in 38 per cent of cases, compared to 54 per cent for the remainder of midblock collisions. A comparison between rear end collisions and the remainder of the set of midblock collisions is provided in Table 7.10.

Table 7.10
Entering or Leaving the Road Collisions
and other Midblock Crashes

Variable	Type of Midblock Collision			
	Entering or Leaving the Roadway		Remainder	
	Number	Per cent	Number	Per cent
Speed limit >90	1	12.5	35	59.3
Rural highway	5	62.5	45	76.3
Unsealed road	-	-	4	6.8
Down slope	-	-	11	18.6
Up slope	1	12.5	3	5.1
Curve	2	25.0	32	54.2
No edge lining	2	25.0	18	32.7
Shoulder sealed	5	62.5	8	15.7
Male drivers	11	68.8	74	60.2
Female drivers	5	31.3	49	39.8
Driver age < 25	6	37.5	33	26.8
Not Full Licence	5	31.3	20	16.3
>BAC limit	-	-	4	4.8

Note: The percentages calculated for the no edge lining variable omits cases where the road was unsealed, those for the shoulder seal variable refer to cases where the shoulder was fully sealed (to the verge) and omit cases where the road was unsealed or there was no shoulder due to the proximity of an embankment, those for the driver age variable omit cases where the driver's age was unknown, and those for the alcohol variable omit cases in which the driver's BAC was not tested.

Judging from Table 7.10, crashes involving vehicles entering or leaving the road, when compared to the remaining midblock collisions, are rare on high speed roads, on rural highways, on unsealed roads, on down slopes, on curves, and where there is edge lining, but occur more commonly on up slopes, where the shoulder is sealed, and with young drivers yet to attain full licences. However, due to the small number of crashes in this category, none of these apparent differences is statistically significant.

Although there was one crash in which a driver ignored road markings, and one in which the nature of the driveway contributed to the crash, the main road and traffic factor playing a role in the causation of these collisions was a problem with vision, whether it was a restriction of vision or low conspicuity of the vehicle that had right of way.

In two cases, the crash involved a vehicle turning right from a driveway situated on a curve, where the driver of the turning vehicle had only a restricted view of oncoming traffic. In one of these two cases, the owner of the property serviced by the driveway in question, who was not the driver in this crash, claims never to attempt a right turn from the driveway. Instead, a left turn is executed to enter the roadway, followed by a U-turn at the first safe opportunity. In the other case, it is possible that the eyesight of the 78 year old driver exiting the driveway also contributed to the crash, although she was wearing glasses as specified by her licence. Both of these crashes occurred on roads marked with a double centre line, where it would be illegal to overtake, yet where the drivers involved thought it appropriate to turn across the centre line from the driveway.

A major factor contributing to one crash was a restricted view of oncoming traffic because of the inappropriate location chosen by the driver to turn right from a car park. The driveway from which the 66 year old female driver attempted to exit was marked with an arrow pointing into the service station. The exit from the car park was further along the road. If the driver had exited the car park where it was appropriate to do so, the signs and fence the driver claimed blocked her view of the traffic, and made it necessary to move the vehicle slightly into the roadway, would have ceased to be an obstruction to vision.

In three other cases, the vehicle with right of way was a motorcycle, raising the issue of the conspicuity of the motorcycle as a contributing factor. In each of these cases, the view of the motorcycle for the driver of the turning vehicle was obscured by other traffic. In one, a car turned right into a car park across the path of an oncoming motorcycle that was obscured by cars travelling in the same direction as the original direction of the turning car. The driver of the car had a disqualified licence. In the second case, a car driver attempted a right turn out of a service station after waiting to ensure that approaching cars were turning left into the service station. The driver failed to see the motorcycle behind the left turning cars and so failed to give way to it. When the young, inexperienced driver of the car saw the motorcycle approaching, she panicked and stalled the car in the motorcycle's path, resulting in a collision. In the third case, a motorcycle was negotiating a roundabout when the driver who was entering the road looked to see if the road was clear. Although in all three cases involving the failure to detect a motorcycle there were road or traffic circumstances making this task more difficult, it is likely in each case that a car in a similar position to the motorcycle would have been detected.

The remaining crash of this sort that featured the possible contribution of the compromise of vision involved a four wheel drive vehicle turning left from a driveway onto the roadway and then attempting a right turn into another driveway. This vehicle was then struck by a car coming from behind it, a car to which the driver of the four wheel drive was required to give way before the initial left turn. In this case, the possible compromise of vision was caused by the patches of shadows of trees on the road that would have made if more difficult to detect the car. The young, inexperienced driver of the car was also travelling at a speed above the limit.

The final crash in this category involved a car turning left into a driveway being struck by a car travelling behind it. The main road factor contributing to this crash was the sharp angle the driveway made with the road, meaning that a very tight left turn was required to get into the driveway. The driver of the first car indicated to turn left and then veered over to the right in order to be able to turn at enough of an angle to manoeuvre the car into the driveway. The 66 year old female driver of the following car, after seeing the first car veer towards the right, assumed that the left turn signal was incorrect and that the first car was actually going to turn right. When the first car turned left, it was struck on the left side by the following car.

7.6 Side Swipe Collisions

There were three collisions in which the side of one vehicle struck the side of another vehicle travelling in the same direction. These will be referred to as "side swipe collisions". They comprise five per cent of the sample of midblock collisions and one per cent of the total sample of rural car crashes. None of the three crashes resulted in injuries severe enough to require hospital admission. Each of the side swipe collisions occurred on straight, level, sealed roads. Two had no shoulder and the remaining road was bounded by a kerb.

Road and traffic factors did not seem to make a major contribution to these crashes. In the first crash, a young driver who had attained her provisional licence only eight days previously attempted to overtake a garbage truck on a two lane, two way road. When this inexperienced driver saw another vehicle heading towards her, she pulled the car back sharply to the left, causing it to clip the truck and travel out of control off the left side of the road.

Of the remaining two crashes in this category, one was the result of an inexperienced driver not checking adequately for traffic before moving off from the kerb, and the other occurred when the brakes on a prime mover failed and the driver attempted an emergency left turn at a signalised intersection, before side swiping another prime mover which had just turned right at the same T-junction.

7.7 Head On Collisions, Straight Road

There were 10 midblock collisions in which a vehicle struck another vehicle travelling in the opposite direction on the same straight road, without either of the vehicles first attempting a turning manoeuvre. These collisions are referred to here as "head on collisions on a straight road". This group of crashes represents 15 per cent of the sample of midblock collisions and four per cent of the sample of rural crashes as a whole. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 70 per cent of cases, compared to 49 per cent for the remainder of midblock collisions. A comparison of head on collisions on straight roads and the remainder of the set of midblock collisions is provided in Table 7.11.

It appears from Table 7.11 that head on collisions on straight roads, when compared to the remaining midblock crashes, are more likely to occur on high speed roads and less likely to occur on rural highways. However, none of these apparent differences are statistically significant, due to the small number of crashes in this category. On all other variables, it appears from Table 7.11 that head on collisions on straight roads are similar to other midblock crashes.

The road and traffic factors that typically played an important role in the crashes in this category were unsealed shoulders and the restriction of vision caused by a crest.

Table 7.11
Head On Collisions on Straight Roads and other Midblock Crashes

Variable	Type of Midblock Collision			
	Head On Collision, Straight Road (N=10)		Remainder (N=57)	
	Number	Per cent	Number	Per cent
Speed limit >90	7	70.0	29	50.9
Rural highway	6	60.0	44	77.2
Unsealed road	1	10.0	3	5.3
Down slope	2	20.0	9	15.8
Crest	1	10.0	3	5.3
No edge lining	3	33.3	17	32.7
Shoulder sealed	2	22.2	11	22.0
Male drivers	14	66.7	71	60.2
Female drivers	7	33.3	47	39.8
Driver age < 25	6	28.6	33	28.0
Not Full Licence	3	14.3	22	18.6
>BAC limit	-	-	4	5.2

Note: The percentages calculated for the no edge lining variable omits cases where the road was unsealed, those for the shoulder seal variable refer to cases where the shoulder was fully sealed (to the verge) and omit cases where the road was unsealed or there was no shoulder due to the proximity of an embankment, those for the driver age variable omit cases where the driver's age was unknown, and those for the alcohol variable omit cases in which the driver's BAC was not tested. Where the road sloped up or down was determined from the point of view of the vehicle which veered onto the wrong side of the road.

There were three cases in which an unsealed shoulder contributed to a vehicle losing control before travelling onto the wrong side of the road and striking another vehicle. These crashes, therefore, were similar to single vehicle crashes (off road to left, straight road), except that subsequent to the vehicle going out of control, it struck another vehicle rather than a roadside object. It is likely in these cases, that had there been no vehicle on the other side of the road, the out of control vehicle would have been involved in a crash anyway.

In two of these crashes involving unsealed shoulders, a crest also contributed to the crash. In one, a young, inexperienced driver was travelling up to a crest at night when startled by a set of headlights coming over the crest from the other direction. Each driver alleges the other was over the centre line. As both drivers were young (under the age of 20), it is possible that neither was over the centre line but that inexperience led each to suspect this, the drivers not used to encountering headlights appearing from over a crest on an unlit road. The driver of one of the cars was so startled that she veered off to the left and travelled onto the left shoulder. She lost control of the vehicle on this shoulder, causing it to yaw across to the incorrect side of the road where a third car was travelling in the opposite direction. This third car was then struck by the car out of control, and its driver (also a teenager) was killed. It is likely that, had the crest not been there, the drivers of the two cars would have been prepared for each other and so the driver of the crashed car would not have felt the instinctive need to suddenly veer off to the left. Following this crash, the section of road where the collision occurred was temporarily closed. A council meeting determined that the road should be reopened, despite some misgivings about the safety of a road featuring the substantial crests and dips that characterise it.

In the other case involving a crest, a car overtook a line of other vehicles whilst travelling over the crest, crossing an unbroken centre line in the process. The driver of a car travelling in the opposite direction, when faced with this overtaking car on the wrong side of the road, attempted to avoid a collision by steering sharply to the left. This car, as a result of this manoeuvre, ran off the road onto the left unsealed shoulder. The car then went out of control, yawing across to the incorrect side of the road, where it struck a utility that had been overtaken on the crest. The driver of the first car should not have attempted to overtake in such a place, as the crest restricted vision of traffic coming in the opposite direction.

There was another crash in this category that involved a crest. This crash occurred at the site of a small (20 metres), arched bridge, which preceded a significant down slope on an unsealed road. On the day of the crash, a number of motorcycle riders had been performing jumps off the end of the bridge, landing on the downward sloping road on the other side. A local property owner had been waiting for a considerable time for the riders to stop doing this, so that he could drive out onto the road and up across the bridge in the opposite direction in order to run an errand. When satisfied that the riders had stopped, the local property owner proceeded to drive up to the bridge in his utility. Just prior to reaching the bridge, one of the motorcycles came flying off the end of the bridge and landed on the bonnet of his utility. The rider of the motorcycle was thrown over the rear of the utility and onto the roadway. He required hospital admission for his injuries. Although this crash resulted from a sight restriction, it also would not have occurred if the motorcyclist had not been riding in a dangerous manner.

There was one other crash in this category in which a sight restriction played a role in the crash causation but it was not due to a crest. Rather, it was caused by smoke emanating from a fire lit by a property owner by the side of the road. This smoke billowed out across the road, creating conditions of near nil visibility for passing motorists. It was in these conditions that two vehicles, one a utility and one a prime mover, both of which were travelling near the centre line, clipped each other's right front corners. The driver of the prime mover alleges that the property owner who failed to monitor his fire was later fined by the police, and it is clear that the restricted vision resulting from the fire was the chief cause of the collision.

7.8 Head On Collisions, Curved Road

There were 29 midblock collisions in which a vehicle travelling on a curved section of road struck another vehicle travelling in the opposite direction on the same road, without either of the vehicles first attempting a turning manoeuvre. The most common form of midblock collision, this category represents 43 per cent of the sample of midblock collisions and 12 per cent of the sample of rural crashes as a whole. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 72 per cent of cases, compared to 37 per cent for the remainder of midblock collisions. Furthermore, this set of crashes accounted for 60 per cent of all midblock collisions in which one or more occupants were killed or admitted to hospital. A comparison between head on collisions on curved roads and the remainder of the set of midblock collisions is provided in Table 7.12.

Table 7.12
Head On Collisions on Curved Roads and Other Midblock Crashes

Variable	Type of Midblock Collision			
	Head On Collision, Curved Road (N=29)		Remainder (N=38)	
	Number	Per cent	Number	Per cent
Speed limit >90	17	58.6	19	50.0
Rural highway	21	72.4	29	76.3
Unsealed road	3	10.3	1	2.6
Down slope	7	24.1	4	10.5
Up slope	1	3.4	3	7.9
No edge lining	10	38.5	10	30.3
Shoulder sealed	2	8.3	11	31.4
Male drivers	39	65.0	46	58.2
Female drivers	21	35.0	33	41.8
Driver age < 25	18	30.0	21	26.6
Not Full Licence	12	20.0	13	16.5
>BAC limit	4	9.1	-	-

Note: The percentages calculated for the no edge lining variable omits cases where the road was unsealed, those for the shoulder seal variable refer to cases where the shoulder was fully sealed (to the verge) and omit cases where the road was unsealed or there was no shoulder due to the proximity of an embankment, those for the driver age variable omit cases where the driver's age was unknown, and those for the alcohol variable omit cases in which the driver's BAC was not tested. Where the road sloped up or down was determined from the point of view of the vehicle which veered onto the wrong side of the road.

Table 7.12 suggests that head on collisions on curved roads, when compared to the remaining midblock collisions, are more likely to involve a vehicle losing control on a down slope and are less likely to occur where shoulders are sealed. However, the only difference between this set of crashes and the remaining midblock crashes that was statistically significant was that concerning unsealed shoulders ($\chi^2_{(1)}$= 4.42, p< .05), which means that, given the occurrence of a midblock collision, if it was a head on collision on a curved road, it is more likely that the shoulders of the road were unsealed.

There were several road and traffic factors relevant to this set of crashes. These include the road surface, an unsealed shoulder, signage, restricted vision, a narrow road, and road markings.

There were eight cases in this category in which the road surface is likely to have played a role in the crash. Of these eight, three involved an unsealed road, two involved a very wet road, one involved a road which was both wet and slippery with oil, one involved a road which was both wet and slippery due to gravel, and the remaining crash involved debris from road works.

In two of the crashes on unsealed roads, the unsealed surface was not as important in contributing to the crash as the narrowness of the roads. In one, the road was approximately 6.1 metres wide where the two vehicles collided but was 3.4 metres wide on a bridge a few metres prior to that, whilst in the other, the road width was approximately 4.2 metres. In the first case, two cars negotiating a bend in the road and travelling in opposite directions collided head on. The road, as well as being too narrow for two cars to pass each other easily, was characterised by pot holes and loose gravel. Local residents had allegedly petitioned for improvements to the road after previous crashes. In the second, two four wheel drive vehicles collided on a bend, on a narrow road bordered by an embankment on one side and a sheer drop on the other. In the remaining crash on an unsealed road, the surface of the road is such that the centre is hard and clear of debris, whilst the sides of the road are covered with gravel. Although this results in drivers choosing to drive more towards the centre of the road, it is likely that this collision was more directly related to driver error than to the road surface (driving on the wrong side of the road after having been in Europe).

Four crashes involved a road that was slippery due to rain. In two of these, young, inexperienced drivers lost control of their vehicles while negotiating curved roads in the rain. In each case, the car travelled onto the incorrect side of the road where it collided with an oncoming vehicle. In one of these two cases, the driver, who held a provisional licence, had never driven in wet conditions before. In the other, the young driver was travelling in excess of the speed limit, despite the conditions and had a BAC of 0.177. He died in the crash. In the two remaining wet road crashes, the wet road was made more slippery by gravel from the unsealed shoulder in one of them, whilst, in the other, the wet road was made more slippery by the presence of oil on the road. In the former, the vehicle slid not only on the wet road and the gravel from the shoulder, but also on the unsealed shoulder itself. The difficulty of driving on the wet roads and the curves in the roads in two of the four crashes may also have been compounded by the vehicles travelling on down slopes at the time.

In the remaining crash in which the road surface played a role, the driver of a car lost control while negotiating a right curve. The car yawed across to the incorrect side of the road where it was struck by a truck travelling in the opposite direction and pushed against a strainer post on the left roadside. The driver of the car was killed. The day previous to the crash, road works had been conducted, patching up a small section of the road surface on the curve on the side of the road travelled by the truck. This repair work had been conducted using emolium spray pressed with small stone chippings. Traffic on this side of the road subsequent to the road works had apparently caused some of the surplus stone chippings to spray onto the side of the road on which the car was travelling, resulting in a slippery road surface. It is on these loose stone chippings that the driver of the car lost control. Witness reports from drivers who passed through this bend near the time of the crash suggest that a number of drivers lost traction on this section of the road, and, furthermore, that there were no signs erected to warn motorists travelling on this side of the road of the loose stones and slippery surface. Without such signs, all the witness drivers drove through the bend at their normal speed, not realising that there was cause to drive more slowly. It is apparent that, not only should signs have been erected, but also that the loose stone chippings should have been thoroughly swept before completing work at the site. Also, an argument can be made that the method of repairing the road surface was not appropriate for a curve. Loose stone chippings would not have been left on the other side of the road if hot mix bitumen had been used instead. This method requires stabilisation of the base material first, and is more expensive, but on curved sections of road may be a more appropriate method than one that may result in a slippery road surface. Warning signs were erected immediately after the crash, and grading of the shoulder was conducted. Since then, a hazard board previously located on the side of the road travelled by the car has been replaced by chevron markers to better delineate the curve. However, the Advisory speed sign for traffic on that side of the road has curiously been changed from 65 to 70 km/h.

Problems with signage not only played a role in this crash (the lack of warning signs for the road works) but also possibly played a role in two other crashes. In these two crashes, vehicles collided on a curved section of road where one of the vehicles was faced with an Advisory speed sign, whilst the vehicle that went out of control and onto the incorrect side of the road had no advisory sign to guide them. In one, the vehicle that went out of control and that was travelling in the lane for which no advisory sign had been posted was a motorcycle, the rider of which was fatally injured in the collision. There is reason to suspect that some motorcycle riders do not regard advisory signs as applying to them, but nonetheless, it is possible that they use them as a guide for the tightness of curves and therefore, indirectly as a guide for speed, even if the speed they decide upon, based on the Advisory Speed sign, is greatly in excess of the speed actually suggested. It is also interesting to note that this crash occurred at the same location as the head on collision involving an overseas tourist discussed below, which had occurred five months earlier. At that time, there was paint on the road specifying that an Advisory Speed sign was soon to be installed at this location, and which would have applied to the lane in which the motorcyclist was travelling. This, however, had not been done when the motorcycle crash occurred. In the other case involving the lack of an Advisory speed sign, the driver who lost control was a 69 year old who had been travelling in excess of the speed limit.

Restricted vision, caused by the curve in the road and the nature of the roadside environment, played a role in six crashes. Three of these were the crashes occurring on unsealed roads, discussed above. In one of the three other crashes, the driver of a car alleges that as she approached a left bend, a truck travelling in the opposite direction appeared from around the bend, partially on the incorrect side of the road. This caused the young, inexperienced driver of the car to veer to the left onto the left unsealed shoulder before she lost control, causing the car to yaw across the road and strike the truck. It is alleged that the truck had veered into the centre of the road to avoid a prime mover parked by the side of the road. If the curve had not restricted the vision of the two drivers, it is unlikely, even if the truck had veered onto the incorrect side of the road, that the driver of the car would have had to react so drastically and lose control of her vehicle. In another case, two cars collided head on, due to one of the cars being driven on the wrong side of the road by a tourist from overseas. If vision had not been blocked by the curve and embankment, the driver of the car on the incorrect side of the road may have realised his error in time and moved back onto the left side of the road. In the remaining crash involving a restriction of vision, a utility and a car were involved in a head on collision that probably would have been avoided if the driver of the utility had been aware that a vehicle was approaching from the other direction prior to the collision. The driver of the utility, who was 'cutting the corner' on a right curve, was unable to see the car approaching the curve from the opposite direction, due to high grass on the side of the road and a small dip in the section of the road that the car was travelling on. The driver of the car, for the same reasons, was unable to tell that the utility was encroaching onto her side of the road. Consequently, neither driver had enough time to take effective evasive action.

There was another factor contributing to this crash. This factor was the road markings at the site. As vehicles travel through the curve where the collision occurred, the unbroken centre line disappears. This is because another section of road joins the road that the two vehicles were travelling on in a T-junction governed by a Give Way sign. The break in the centre line occurs at this junction. It creates, however, a problem for drivers wishing to travel in the directions travelled by the two vehicles involved in the collision. The guide for where to position a vehicle whilst negotiating the curve that would be provided by the continuation of the centre line is absent. This can result in vehicles "cutting the corner", as the utility in this crash did, and therefore in the increased likelihood of head on collisions, which is compounded by the restriction of vision at this location.

The final road and traffic factor contributing to head on collisions on curved roads was an unsealed shoulder. Unsealed shoulders contributed to six crashes, three of which have already been discussed above. The remaining three included one in which a car had already veered over to the incorrect side of the road before veering back to the left and onto the left shoulder. The unsealed shoulder caused further loss of control, before the car yawed across to the incorrect side of the road again, where it was struck by a four wheel drive travelling in the opposite direction. The driver in this case was disqualified from driving at the time. He was also travelling too fast for the bend and was intoxicated (BAC = 0.122). In another crash, the young, inexperienced driver who lost control of his car was both speeding recklessly (120 km/h in a 60 km/h zone) and attempting to overtake a slower moving vehicle on the left unsealed shoulder on a right curve. In the remaining crash involving an unsealed shoulder, there was no edge lining on the outside of the right curve, which may have increased the likelihood that the young, unlicensed and intoxicated (BAC = 0.123) driver allowed his car to run partly onto the unsealed shoulder prior to further loss of vehicular control.

7.9 Summary of Midblock Collisions

Midblock collisions between two or more vehicles, as defined in this report, are very common in rural areas, accounting for over 28 per cent of the crashes investigated in this study. Only single vehicle crashes were more common. Over half of the midblock collisions occurred on curves, nearly equating to the level of involvement of curved roads witnessed in single vehicle crashes. Young drivers and those without full licences were over represented, whilst drivers over the age of 60 were less common than in other multiple vehicle rural crashes. Over half of the crashes were head on collisions, and these produced the highest likelihood of severe injuries.

The most commonly involved road and traffic factor in midblock collisions was some form of restriction of vision, which was implicated in 22 crashes (33%). The involvement of restricted vision occurred in at least half of rear end collisions, U turn collisions and collisions in which one of the vehicles was turning into or out of a driveway. The restriction of vision in eleven cases was due to a curve in the road, indicating the importance of ensuring, wherever practicable, adequate sight distance around curves. In six cases, the restriction of vision was due to the vertical alignment of the road, in three cases to the presence of a four wheel drive in the driver's visual field, in one case to smoke on the road, and in one case possibly to the shadows cast onto the road by roadside trees.

The next most commonly involved road and traffic factor was the presence of an unsealed shoulder (nine crashes). Notably, all of these were involved in head on collisions, in which the occurrence of the crash was precipitated by one driver's loss of vehicular control. Six of these occurred on curved sections of road, with four of these six involving a vehicle going out of control on a right curve. This supports the recommendation made in Section 6.9 that sealing of shoulders on curves may prevent many crashes.

Problems with the road surface were involved in five crashes, but most notable was the fact that these six crashes were all head on collisions occurring on curved sections of road. The most common problem with the road surface (four cases) was the road being wet from heavy rain, although this problem also occurred in conjunction with oil on the road and debris from the unsealed shoulder. In one instance, a female driver of a car lost her life due to loose material on a sealed surface associated with road works, with no warning of the hazardous conditions.

Signage was also a factor in three crashes, and again this problem affected only head on collisions on curved roads. It appears there can be inconsistencies in the application of Advisory Speed signs and the delineation of curves.

Problems with vision are not solely caused by the alignment of roads and the presence of vegetation and embankments on the roadsides, but may also arise due to the low conspicuity of vehicles. In particular, there were four cases in which the driver of a vehicle attempting either a U turn or a turn to leave the roadway failed to see a motorcycle. Although more care should have been taken by the turning drivers, the low conspicuity of motorcycles probably contributed to the occurrence of these crashes, despite the likely daytime headlight use by the motorcyclists in all four cases.

The remaining road and traffic factors that probably contributed to the crashes were the narrowness of roads (two cases), problems with the road layout (one case), road design (one case), road marking (one case), the presence of road works (one case), and the sharp angle with which a driveway meets the road (one case).

8. COLLISIONS AT INTERSECTIONS NOT CONTROLLED BY A PRIORITY SIGN

The sample of 236 rural crashes included 14 crashes (6%) that for the purposes of this report are being defined as "collisions at unsigned intersections". These crashes are those in which vehicles collided at intersections or T-junctions that had no signs to control their use. Excluded, however, are crashes at locations that would remain unaffected by any possible addition of signage, such as crashes in which one vehicle turns right in front of another vehicle travelling in the opposite direction on the same road (see Section 11: "other intersection crashes").

8.1 Comparison of Unsigned Intersection Crashes and the Remaining Intersection Crashes

8.1.1 Time of day by intersection crash type

These 14 crashes occurred almost exclusively during the daytime. There was only one crash, which occurred at dusk in winter, that was outside the period of the day between 8am and 5pm. Particularly common was the period in the morning between 9am and noon, in which half of the crashes occurred. This tendency for these crashes to occur during daylight hours is replicated by the distribution of time of day for the remaining crashes at intersections, for which only seven out of 50 occurred outside of the 8am to 5pm period. A comparison of time of day of occurrence of unsigned intersection crashes and the remaining intersection crashes is shown in Table 8.1.

Table 8.1
Time of Day of
Unsigned Intersection Crashes and
Remaining Intersection Crashes

Time of Day	Type of Crash			
	Unsigned Intersection		Remaining Intersection	
	Number	Per cent	Number	Per cent
0000 - 0559	-	-	-	-
0600 - 0659	-	-	-	-
0700 - 0759	-	-	2	4.0
0800 - 0859	1	7.1	4	8.0
0900 - 0959	2	14.3	5	10.0
1000 - 1059	3	21.4	2	4.0
1100 - 1159	2	14.3	5	10.0
1200 - 1259	1	7.1	8	16.0
1300 - 1359	1	7.1	6	12.0
1400 - 1459	1	7.1	3	6.0
1500 - 1559	-	-	5	10.0
1600 - 1659	1	7.1	2	4.0
1700 - 1759	1	7.1	3	6.0
1800 - 1859	1	7.7	1	2.0
1900 - 1959	-	-	1	2.0
2000 - 2059	-	-	-	-
2100 - 2159	-	-	3	6.0
2200 - 2259	-	-	-	-
2300 - 2359	-	-	-	-
Total	**14**	**100.0**	**50**	**100.0**

8.1.2 Speed limit at crash location by intersection crash type

Unsigned intersection crashes, when compared to the remainder of intersection crashes, appear to be less likely to occur on roads with a speed limit of 60 to 70 km/h (7 versus 22%) but more likely on roads with a speed limit of 80 to 90 km/h (29 versus 16%). Due, however, to the small number of unsigned intersection crashes, any apparent differences are not statistically significant. The proportions of crashes in the two sets of cases occurring on high speed roads (100-110 km/h speed limits) are similar. The speed limits for the roads on which the two sets of crashes occurred is shown in Table 8.2.

Table 8.2
Speed Limit at the Site of Unsigned Intersection Crashes and Remaining Intersection Crashes

Speed Limit	**Type of Crash**			
	Unsigned Intersection		**Remaining Intersection**	
km/h	**Number**	**Per cent**	**Number**	**Per cent**
60	1	7.1	8	16.0
70	-	-	3	6.0
80	4	28.6	6	12.0
90	-	-	2	4.0
100	4	28.6	15	30.0
110	5	35.7	16	32.0
Total	**14**	**100.0**	**50**	**100.0**

8.1.3 Driver age by intersection crash type

The distribution of ages of the drivers and riders involved in unsigned intersection crashes appears roughly equivalent to that for the remaining intersection crashes. Although the percentage of teenage drivers involved in unsigned intersection crashes is double that for the remaining intersection crashes, the numbers are too low to be of statistical significance. The ages of drivers and riders in unsigned intersection crashes and the remaining intersection crashes are shown in Table 8.3.

8.1.4 Driver licence status by intersection crash type

The distribution of licence status of drivers and riders involved in unsigned intersection crashes demonstrates that the majority of those drivers or riders had attained full licences, with only four of the 28 drivers holding provisional licences. Of the 102 drivers involved in the remaining intersection crashes, 97 were in possession of a full driver’s licence. This converts to a percentage that appears substantially higher than that for the drivers in unsigned intersection crashes, but the small numbers of drivers without full licences means that the difference is not statistically significant. A summary of licences held by the drivers and riders for the two sets of crashes is provided in Table 8.4.

Table 8.3
Age of Drivers and Riders Involved in Unsigned Intersection and Remaining Intersection Crashes

Age	Type of Crash			
	Unsigned Intersection		Remaining Intersection	
Years	Number	Per cent	Number	Per cent
16-19	3	10.7	6	5.9
20-24	2	7.1	12	11.8
25-29	3	10.7	9	8.8
30-34	3	10.7	7	6.9
35-39	1	3.6	12	11.8
40-44	2	7.1	12	11.8
45-49	2	7.1	13	12.7
50-54	3	10.7	5	4.9
55-59	1	3.6	3	2.9
60-64	3	10.7	3	2.9
65-69	2	7.1	3	2.9
70-74	1	3.6	5	4.9
75-79	-	-	7	6.9
80-84	2	7.1	3	2.9
85-89	-	-	2	2.0
90+	-	-	-	-
Total	**28**	**100.0**	**102**	**100.0**

Table 8.4
Licence Status of Drivers and Riders Involved in Unsigned Intersection Crashes and Remaining Intersection Crashes

Licence Status	Type of Crash			
	Unsigned Intersection		Remaining Intersection	
	Number	Per cent	Number	Per cent
Full	24	85.7	97	95.1
P-Plate	4	14.3	3	2.9
L-Plate	-	-	-	-
Unlicensed	-	-	2	2.0
Total	**28**	**100.0**	**102**	**100.0**

Of the 14 unsigned intersection crashes, 12 occurred at T-junctions and the other two at four way intersections. These two different types of crashes and the road and traffic factors relevant to them are discussed in the following sections. Statistics for these crashes are compared to the "remainder of intersection crashes", which for the purposes of this report includes all other crashes except for single vehicle crashes and "midblock collisions".

8.2 Collisions between two vehicles at unsigned T-junctions

There were 12 crashes in which a vehicle attempting to turn out from the stem of an unsigned T-junction was involved in a collision with a second vehicle. This represents 86 per cent of the sample of unsigned intersection crashes and five per cent of the sample of rural crashes a whole. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 27 per cent of cases, compared to 57 per cent for the remainder of intersection crashes. A comparison between collisions at unsigned T-junctions and the remainder of intersection crashes is provided in Table 8.5.

Table 8.5
A Comparison of Collisions at Unsigned T-junctions and Other Intersection Crashes

Variable	Type of Crash			
	Unsigned T-junction (N=12)		Remaining Intersection (N=52)	
	Number	Per cent	Number	Per cent
Speed Limit >90	7	58.3	33	63.5
Rural Highway	10	83.3	39	75.0
Unsealed Road	-	-	3	5.8
Down Slope	1	8.3	4	7.7
Crest	1	8.3	2	3.8
>2 Lanes	3	25.0	8	15.4
Male Drivers	15	62.5	74	69.8
Female Drivers	9	37.5	32	30.2
Driver age < 25	4	16.7	19	17.9
Driver age > 59	7	29.2	24	22.6
Not Full Licence	3	12.5	6	5.7
>BAC Limit	-	-	1	0.9

Note: The percentages calculated for the driver age variable omit cases where the driver's age was unknown, and those for the alcohol variable omit cases in which the driver's BAC was not tested.

As can be seen from Table 8.5, crashes at unsigned T-junctions, when compared to the remainder of intersection crashes, were similar for most of the variables related to the roads on which the crashes occurred. There are few apparent differences between the drivers involved in this set of crashes and those in the remaining intersection crashes, with approximately a quarter of drivers being aged at 60 years or more and less than a fifth being under the age of 25. The apparent over representation of drivers without full licences in this set of crashes is not statistically significant.

Road and traffic factors relevant to the crashes at unsigned T-junctions included signage, the road layout, and restriction of vision either by a crest, a parked vehicle, a house by the side of the road, or a curve in the road.

Five of these twelve crashes involved vision restrictions. In one case, the restriction of vision was caused by a truck parked by the side of the road. The presence of this truck meant that the elderly driver (84 years old) of a car wishing to turn right from the stem of a T-junction was unable to see traffic approaching from the right. In order to see the traffic, the driver moved out into the roadway and then reversed back again when he saw cars approaching. When he tried this a second time, there was no time to reverse back before his car was struck by another car at right angles on the driver's side doors.

In another case, the restricted vision was caused by the presence of a house and surrounding vegetation by the left corner of the stem of a T-junction. This vision restriction resulted in the driver of a truck on the stem of the T-junction not seeing a car approaching from the left on a 110 km/h speed limit road before attempting a right turn. It could be argued that the driver of the truck did not make a sufficient attempt to give way but it could also be argued that the restriction of vision at the junction is sufficient to require the installation of a Stop Sign.

Two cases involved restricted vision resulting from a crest, in addition to problems, in one case, with the road layout and, in the other, with signage. In the first case, a car attempted to turn right from the stem of an unsigned intersection and was struck by a car travelling towards a crest from the right side. The crest in this case makes it very difficult for drivers of vehicles attempting to turn from the stem of the T-junction to detect the presence of vehicles approaching from the right. This is especially the case during daylight hours when no headlights provide an early warning of a vehicle travelling towards the crest. In this case, the headlights of the approaching car were on, but it is difficult to tell how much difference this would have made at the time of the crash (dusk). The proximity of the junction to the crest constitutes a hazardous road layout.

The manner in which the presence of a crest contributed to the crash was different in the other case. In this crash, the driver of a panel van was unable to stop or turn and travelled straight ahead at the stem of a T-junction, resulting in the panel van being struck by a four wheel drive vehicle approaching from the left. The driver of the panel van was unfamiliar with this road but he did notice the T-junction warning sign as he approached the crest. He did not expect, however, the junction to occur immediately beyond the top of the crest. He had planned to turn left at the junction but had no time to do that upon arriving at it. Unable to stop, he skidded straight ahead under braking and was struck by the four wheel drive. The role of the crest, therefore, was to obscure the termination of the road in the junction. Aside from redesigning the road, the other solution to this problem would be the provision of hazard boards opposite the junction to alert approaching drivers of the impending termination of the road they are travelling on. There was a hazard board in precisely this location before the crash, but it was not high enough to be seen above the crest. Since the crash, another hazard board has been added to the top of the original one, so that it can be seen by drivers in vehicles approaching the crest.

In the final crash in which restricted vision played a part, the driver of a car was attempting to turn right from the stem of an unsigned T-junction when it was struck by a car approaching from the right. In this case, the driver's vision of traffic approaching from the left was limited by a curve in that section of road. This restricted vision would have resulted in the driver of the turning vehicle having to pay extra attention to the left and having to be very cautious in giving way to traffic approaching from that direction. This may help explain why the driver failed to give way to a car approaching from the right. Other factors involved in this crash include the possibly low conspicuity of the silver vehicle approaching from the right when viewed against the background of the bitumen road, combined with tinted front side windows on the turning vehicle.

There was another case in which the possibly low conspicuity of a vehicle combined with a difficult turning situation may have contributed to the crash. In this one, the driver of a car was attempting to turn right from the stem of a T-junction onto a four lane divided road. As the side of the road onto which she wanted to turn did not have a merging lane for right turning vehicles, this driver was required to give way in both directions. The car on the through road was dark blue and, on an overcast day on a bitumen road, may have been difficult to see. The demanding nature of the turning task may have combined with the low conspicuity of the car to result in the failure of the turning driver to detect the presence of the car on the right.

In another case, there were problems with the road layout. Subsequent to this crash, Give Way signs were added to the T-junction at which it occurred, but another crash in this study later occurred at the junction. This junction is described in more detail in Section 9.2.

8.3 Collisions between two vehicles at uncontrolled four way intersections

There were two collisions in which two vehicles, each travelling straight ahead, collided at right angles at an uncontrolled, four way intersection. This represents 14 per cent of uncontrolled intersection crashes and one per cent of the sample of rural crashes as a whole. Both of these crashes resulted in one or more of the occupants being admitted to hospital.

These two crashes occurred on unsealed rural roads with a speed limit of 100 km/h. In both cases, the roads were straight and flat. In one crash, the drivers were an 18 year old male with only a provisional licence and a 61 year old male. In the other crash, the drivers were both female, aged 33 and 48 respectively.

With regard to road and traffic factors, in each crash the restriction of vision of the other road by roadside vegetation was an issue, in addition to a lack of priority signs.

In one crash, two cars collided at right angles in the middle of a four way intersection of two unsealed roads. There was a sign on only one of the approaching roads warning of the intersection, and no sign to tell either of the drivers to give way or stop. The lack of an intersection warning sign on one of the roads was especially relevant to this crash, given that the driver travelling on that road was young and inexperienced. He stated that he thought the intersection, once he noticed it, was a T-junction, and that any vehicles on the other road would therefore have to stop. The site would also benefit from a Stop sign governing the intersection as the roadsides at the location were lined with vegetation that restricted vision of the other road for both drivers. Neither driver would have been aware of the other vehicle until immediately before the collision occurred in the middle of the intersection.

The other case also involved two cars colliding in the middle of a four way intersection of two unsealed roads. Once again, there was vegetation on the roadsides restricting vision of the other roads for both drivers. Despite this, there were no Stop or Give Way signs. The driver of the car who failed to give way to the right was travelling on a 5.6 metre wide unsealed road whilst the other car was on a 4.2 metre wide road that was little more than a dirt track. According to the driver of the car required to give way to the right, the other road used to be controlled by a Give Way sign but this sign had been knocked down a few months previously and had not been replaced. The driver on the dirt track claimed that prior to the crash, she had been startled when passing through another intersection lacking a Give Way sign. Signs should be placed, or replaced, on the smaller road to assign right of way to traffic on the larger road. Also, given that vision is severely restricted by vegetation on the roadside, there may be a benefit to a Stop sign rather than a Give Way sign.

8.4 Summary of collisions at intersections not controlled by a priority sign

Crashes at unsigned intersections, as defined in this report, accounted for six per cent of the sample of rural crashes. The majority of these occurred at T-junctions, where the priority is implied by the junction layout, with only two occurring at four way intersections, which require signs or signals to determine priority. These crashes tended to occur during daylight hours, suggesting that the failure to detect other vehicles, more likely in the absence of the headlights used at night, may be a contributing factor in these crashes, although the effects on the sample of the limited on-call hours of the investigation team must also be kept in mind. Also over-represented in these crashes were elderly drivers, with more than a quarter of the drivers being over 60 years of age. However this also may be partly a consequence of the bias towards daytime crashes in the sample.

The most common road and traffic factor contributing to the collisions at unsigned intersections was a restriction of vision, which played a part in half of the crashes in this group. In three cases, vision for one of the drivers was restricted by roadside vegetation, in two cases by a crest, in one case by a curve, and in another case by a truck parked by the kerb.

Often, however, the difficulty presented by the restriction of vision was compounded by some other road and traffic factor. In both of the crashes at uncontrolled intersections, sight distance was inadequate, yet there was no Stop sign for either vehicle. A similar situation existed for one of the T-junction crashes, in which a driver, whose view of the road he was turning into was restricted on the approach to the junction, should have been faced with a Stop sign. In another case, restriction of vision by a crest on the approach to the through road meant that hazard boards should have been placed well above the roadway opposite the T-junction.

The road layout, in combination with a restriction of vision, contributed to another crash. In this case, a T-junction exists in which one road terminates on a section of another road offering limited vision of approaching traffic, due to a crest. Ideally, when two roads are joined in a T-junction, the drivers on the terminating road who wish to turn onto the other road should not be required to do so near a crest (or other road alignments that restrict vision, such as curves) on the other road.

9. COLLISIONS AT SIGN CONTROLLED INTERSECTIONS

The sample of 236 rural crashes included 24 multiple vehicle crashes at intersections (10%), in which one vehicle involved in the collision was engaged in a manoeuvre governed by a priority sign. These crashes, for the purposes of this report, are called "collisions at sign controlled intersections".

9.1 Comparison of Sign Controlled Intersection Crashes and the Remaining Intersection Crashes

9.1.1 Time of day by intersection crash type

Collisions at sign controlled intersections typically occurred during daylight hours, with only two occurring after sunset. The majority that did occur during daylight hours appeared to be spread more evenly over the day compared to the remaining intersection crashes, of which 50 per cent occurred between 10am and 2pm. However, any apparent differences by time of day were not statistically significant. A comparison of time of day for occurrence of sign controlled intersection crashes and the remaining intersection crashes is shown in Table 9.1.

Table 9.1
Time of Day of Sign Controlled Intersection Crashes and Remaining Intersection Crashes

Time of Day	Type of Crash			
	Sign Controlled Intersection		Remaining Intersection	
	Number	Per cent	Number	Per cent
0000 - 0059	-	-	-	-
0100 - 0159	-	-	-	-
0200 - 0259	-	-	-	-
0300 - 0359	-	-	-	-
0400 - 0459	-	-	-	-
0500 - 0559	-	-	-	-
0600 - 0659	-	-	-	-
0700 - 0759	1	4.2	1	2.5
0800 - 0859	3	12.5	2	5.0
0900 - 0959	4	16.7	3	7.5
1000 - 1059	1	4.2	4	10.0
1100 - 1159	1	4.2	6	15.0
1200 - 1259	4	16.7	5	12.5
1300 - 1359	2	8.3	5	12.5
1400 - 1459	2	8.3	2	5.0
1500 - 1559	2	8.3	3	7.5
1600 - 1659	1	4.2	2	5.0
1700 - 1759	1	4.2	3	7.5
1800 - 1859	1	4.2	1	2.5
1900 - 1959	-	-	1	2.5
2000 - 2059	-	-	-	-
2100 - 2159	1	4.2	2	5.0
2200 - 2259	-	-	-	-
2300 - 2359	-	-	-	-
Total	**24**	**100.0**	**40**	**100.0**

9.1.2 Speed limit at crash location by intersection crash type

The speed limit for the roads on which sign controlled and the remaining intersection crashes occurred is shown in Table 9.2. The majority of sign controlled intersection crashes occurred on roads with a speed limit of 100 or 110 km/h but this was typical of all intersection crashes. A higher proportion of sign controlled intersection crashes appeared to occur on 60 km/h roads compared to remaining intersection crashes, but the number of crashes was too small for this apparent difference to be statistically significant.

Table 9.2
Speed Limit at the Site of Sign Controlled Intersection Crashes and Remaining Intersection Crashes

Speed Limit	**Type of Crash**			
	Sign Controlled Intersection		**Remaining Intersection**	
km/h	**Number**	**Per cent**	**Number**	**Per cent**
60	5	20.8	4	10.0
70	1	4.2	2	5.0
80	2	8.3	8	20.0
90	-	-	2	5.0
100	10	41.7	9	22.5
110	6	25.0	15	37.5
Total	**24**	**100.0**	**40**	**100.0**

9.1.3 Driver age by intersection crash type

Fourteen per cent of the drivers and riders involved in sign controlled intersection crashes were under the age of 25, compared to 20 per cent for the drivers in the remaining intersection crashes, whilst 24 per cent were at least 60 years old, compared to 23 per cent for the remaining intersection crashes. These small differences were not of statistical significance. The ages of drivers and riders in the two sets of crashes are shown in Table 9.3.

9.1.4 Driver licence status by intersection crash type

The distribution of licence status of drivers and riders involved in sign controlled intersection crashes demonstrates that almost all of the drivers or riders had full licences, with only two of the 49 drivers holding provisional licences, and only one driver lacking a licence altogether. Of the 81 drivers involved in the remaining intersection crashes, 75 were in possession of a full driver's licence. A summary of licences held by the drivers and riders for the two sets of crashes is provided in Table 9.4.

Table 9.3
Age of Drivers and Riders Involved in Sign Controlled Intersection Crashes and Remaining Intersection Crashes

Age	Type of Crash			
	Sign Controlled Intersection		Remaining Intersection	
Years	Number	Per cent	Number	Per cent
16-19	2	4.1	7	8.6
20-24	5	10.2	9	11.1
25-29	4	8.2	8	9.9
30-34	2	4.1	8	9.9
35-39	6	12.2	7	8.6
40-44	8	16.3	6	7.4
45-49	7	14.3	8	9.9
50-54	2	4.1	6	7.4
55-59	1	2.0	3	3.7
60-64	2	4.1	4	4.9
65-69	1	2.0	4	4.9
70-74	3	6.1	3	3.7
75-79	4	8.2	3	3.7
80-84	1	2.0	4	4.9
85-89	1	2.0	1	1.2
90+	-	-	-	-
Total	**49**	**100.0**	**81**	**100.0**

Table 9.4
Licence Status of Drivers and Riders Involved in Sign Controlled Intersection Crashes and Remaining Intersection Crashes

Licence Status	Type of Crash			
	Sign Controlled Intersection		Remaining Intersection	
	Number	Per cent	Number	Per cent
Full	46	93.9	75	92.6
P-Plate	2	4.1	5	6.2
L-Plate	-	-	-	-
Unlicensed	1	2.0	1	1.2
Total	**49**	**100.0**	**81**	**100.0**

Of the 24 sign controlled intersection crashes, 5 occurred at T-junctions and the other 19 at four way intersections. Of the 19 crashes at four way intersections, 15 involved the vehicle faced with the sign travelling straight ahead, with the remaining four involving the vehicle turning from the road governed by the sign. These three different types of crash and the road and traffic factors relevant to their causation are discussed in the following sections. Statistics for these crashes are compared to the "remainder of intersection crashes", which for the purposes of this report includes all other crashes except for single vehicle crashes and "midblock collisions".

9.2 Turn from sign at T-junction, collided with other vehicle

There were five crashes in which a vehicle attempting to turn out from the stem of a sign controlled T-junction was involved in a collision with another vehicle. This represents 21 per cent of the sample of sign controlled intersection crashes and two per cent of the sample of rural crashes a whole. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 40 per cent of cases, compared to 53 per cent for the remainder of intersection crashes. Three of the intersections were controlled by Give Way signs and two by Stop signs. A comparison between collisions at sign controlled T-junctions and the remainder of intersection crashes is provided in Table 9.5.

Table 9.5
A Comparison of Collisions at Sign Controlled T-junctions And the Remainder of Intersection Rural Road Crashes Investigated

Variable	Type of Crash			
	Sign Controlled T-junction (N=5)		Remaining Intersection (N=59)	
	Number	Per cent	Number	Per cent
Speed limit >90	4	80.0	36	61.0
Rural highway	5	100.0	44	74.6
Unsealed road	-	-	3	5.1
Non-level	-	-	15	25.4
>2 lanes	2	40.0	9	15.3
Male drivers	7	70.0	82	68.3
Female drivers	3	30.0	38	31.7
Driver age < 25	2	20.0	21	17.5
Driver age > 59	2	20.0	29	24.2
Not Full Licence	-	-	9	7.5
>BAC limit	-	-	1	0.8

Note: The percentages calculated for the driver age variable omit cases where the driver's age was unknown, and those for the alcohol variable omit cases in which the driver's BAC was not tested.

As can be seen from Table 9.5, collisions at sign controlled T-junctions, when compared to the remainder of intersection crashes, appear to be more likely to occur on high speed roads, to occur on rural highways, to occur on level roads, and to occur on roads with more than one lane each way. However, given the small number of collisions at sign controlled T-junctions, none of these apparent differences are statistically significant.

The main road and traffic factor that appears to have played a role in these crashes is the road layout. This was particularly the case for one of the crashes, which involved a car turning right from the stem of a Give Way sign controlled T-junction and being struck by a B-double road train approaching from the right. The driver of the car turning right was killed in the collision.

The junction at which this crash occurred was also the site of a previous crash in the study, in which a car was turning right at the T-junction and was struck by another car approaching from the right. When the first crash occurred, there was no Give Way sign controlling the intersection and so this crash is included in the "collisions between two vehicles at unsigned T-junctions" section (Section 8.2). The main problems with the layout of the junction, however, are discussed here.

A new T-junction had been created to take traffic from a former Y-junction with priority reassigned. A five fold increase in the reported crash rate, and an increase in the severity of the crashes, followed the design change. The junction was subsequently the subject of a special investigation by the Road Accident Research Unit at the request of Transport SA. From that investigation, and the investigation of this crash, several issues became apparent.

The first feature of the junction is that the terminating road joins the through road on the outside of a curve. Traffic travelling north on the through road, a National Highway, is required to negotiate a right curve as it nears the junction. This results in the drivers of vehicles attempting to turn right onto the through road (to travel south) experiencing difficulties in, first, detecting the presence of the northbound traffic (which approaches from the right), and secondly, determining the approximate travel speed of this northbound traffic. Detection of the northbound traffic can be difficult because the curve can result in it being obscured by southbound traffic or the A pillar of the vehicle as it approaches the through road on the stem of the T-junction. Adding to the difficulty in detecting the presence of the northbound traffic is the problem that in the background of the turning driver's view, there is a road carrying vehicles that have split from northbound traffic in a Y junction a few hundred metres prior to the T-junction. Particularly at night, it is difficult for drivers at this T-junction to determine if northbound traffic is continuing on the through road or travelling off onto the other leg of the Y junction. Often, drivers are not aware that a vehicle is approaching on the through road until it is well into the curve.

Another problem is that drivers are often confused about to whom they must give way. The dedication of a separate lane for vehicles travelling south after they have turned right at the junction means that those drivers, when turning, only have to give way to northbound traffic and traffic turning right into the stem of the T-junction, a manoeuvre which occurs rarely. However, many drivers also give way to southbound through traffic before turning, unnecessarily delaying traffic waiting behind them, and also distracting their attention from the main task of giving way to the right. Adding to this is the fact that the stem of the T-junction is a left curving road that tightens as it gets closer to the through road. This means that drivers must concentrate on negotiating the curve in the road they are travelling on as well as devoting attention to whether traffic on the through road requires them to give way. The difficulty of these competing demands is illustrated by tyre marks on the right kerb on the approach to the junction.

The cars turning right at this junction are required to enter a southbound acceleration lane divided by relatively narrow concrete medians from the through traffic approaching from both the right and the left. When this lane ends, they must merge with the traffic on their left. The acceleration lane at this location is problematic for a number of reasons. First, many drivers do not like turning into the acceleration lane at the same time as heavy vehicles are travelling on their left in the southbound lane. Secondly, the superelevation of the through road means that vehicles on the stem of the T-junction cannot see the layout of the junction as they approach it. A clear view of the entrance to the acceleration lane is not possible until a driver has steered his vehicle away from the holding line and half way into the turn. Thirdly, the adverse camber of the entrance to the acceleration lane causes problems for articulated heavy vehicles turning into it. Due to the low lateral stability of such vehicles, drivers feel the need to turn especially slowly into the acceleration lane, increasing the time that the vehicle spends blocking the northbound lane. Fourthly, the requirement for vehicles to merge with traffic on their left at the end of the left curving acceleration lane causes difficulties for many drivers. Visibility can be restricted, particularly in the case of towing vehicles, due to the road curving to the left at this point. Some drivers feel compelled, in times of heavy traffic, to stop at the end of the acceleration lane. Although some of these problems were not directly related to the crash, they are components of the road layout that characterises this junction, many aspects of which appear to have compromised safety and even been contrary to guidelines for the design of intersections (National Association of Australian State Road Authorities, 1988).

Since the time when this crash occurred, there has been another fatal crash at this junction. Again it involved a vehicle attempting to turn right from the stem of the T-junction being struck on the driver's door by a vehicle approaching from the right on the through road. The elderly male driver of the car turning right was killed in the collision and the elderly female front seat passenger spent approximately ten weeks in hospital. This crash occurred despite some work having been conducted at the junction. Specifically, the approach of the stem of the T-junction had been straightened and the level of the terminating road was raised by approximately a metre in an attempt to improve visibility of the intersection for the drivers of vehicles turning onto the through road.

Some of the problems with this junction also apply to the junction at which two other crashes in this sample occurred. The T-junction at which both of these crashes occurred sits at the base of a down slope on the through road for traffic approaching from the right. The stem of the T-junction is straight, and the through road is straight. It is governed by a Stop rather than a Give Way sign, and the acceleration lane is divided from the through road, not by a concrete median, but by a rumble strip. Traffic on the through road to the right of the junction travel on a downward slope as it approaches the junction. In both of these crashes, a car was turning right from the stem of the T-junction when it was struck on the right by a car travelling on the through road. Again, as has already been discussed in relation to the other crash site, there is likely to be confusion at this junction regarding where the driver must look to give way before turning.

9.3 Straight across from sign at four way intersection, collided with other vehicle

There were 15 crashes in which a vehicle faced with either a Stop or Give Way sign attempted to travel straight through a four way intersection when it was struck by a vehicle travelling on the intersecting road. These crashes, for the purposes of this report, are referred to as "straight ahead at sign controlled intersection" crashes. These 15 crashes comprise 63 per cent of sign controlled intersection crashes and six per cent of the sample of rural crashes as a whole. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 67 per cent of cases, compared to 47 per cent for the remainder of intersection crashes. Eleven of the intersections were controlled by Give Way signs and four by Stop signs. A comparison between straight ahead at sign controlled intersection crashes and the remainder of intersection crashes is provided in Table 9.6.

Table 9.6
A Comparison of Straight Ahead at
Sign Controlled Intersections Crashes and Other Intersection Crashes

Variable	Type of Crash			
	Straight Ahead at Sign Controlled Intersection (N=15)		Remaining Intersection (N=49)	
	Number	Per cent	Number	Per cent
Speed limit >90	9	60.0	31	63.6
Rural highway	8	53.3	41	83.7
Unsealed road	-	-	3	6.1
Non-level	1	6.7	14	28.6
Male drivers	19	61.3	70	70.7
Female drivers	12	38.7	29	29.3
Driver age < 25	2	6.5	21	21.2
Driver age > 59	8	25.8	23	23.2
Not Full Licence	1	3.2	8	8.1
>BAC limit	-	-	1	1.5

Note: The percentages calculated for the driver age variable omit the case where the driver's age was unknown, and those for the alcohol variable omit cases in which the driver's BAC was not tested.

In Table 9.6 it appears that straight ahead at sign controlled intersection crashes, when compared to the remainder of intersection crashes, were less likely to occur on a rural highway, less likely to involve roads with a non-level vertical alignment and less likely to involve young drivers. None of these apparent differences were statistically significant, although the comparative rarity of young drivers in straight ahead at sign controlled intersections was approaching significance ($\chi^2_{(1)}$= 3.53, p= .06). The table also shows that none of these crashes occurred on unsealed roads, that almost all of the drivers involved were in possession of a full licence at the time of the crash, and that over a quarter of the drivers were 60 years of age or older.

The road and traffic factors relevant to this set of crashes included the road layout, road markings, and restrictions of vision that in one case had implications for signage at the intersection involved.

Restriction of vision played a role in four crashes. In two of these crashes, a driver's vision was restricted by vegetation. In one of these cases, the driver of a car attempting to travel straight through a Give Way sign controlled intersection when the car was struck on the right side by a four wheel drive vehicle to which the driver should have given way. The driver of the car died instantly. The view of the driver of the car to the right was blocked by a fence and vegetation. Such a restriction of vision should either be eliminated or taken into consideration when deciding on the signage to use at the intersection. It is more likely that the driver would have stopped at the intersection if there had been a Stop sign rather than a Give Way sign.

In the other case involving restricted sight distance due to vegetation, two cars collided in the middle of a four way intersection after one of them failed to yield at a Give Way sign. The driver of the car faced with the Give Way sign did not have a clear view of vehicles approaching on the intersecting road because of bushes along the property boundary, and therefore should possibly have been faced with a Stop sign instead. An additional problem at this location is that traffic on the less used, unsealed road has priority over that on the more heavily trafficked, sealed road. Given the nature of the two roads, and particularly their juxtaposition, drivers on the road with the Give Way sign are not going to expect to encounter a vehicle on the intersecting road when passing through the Give Way sign. Drivers on an unsealed road, however, when approaching a junction with a sealed road would be far more likely to comply with a sign requiring them to give way. The failure on the part of the driver faced with the sign to give way may also have been partly due to the faded road markings at this location. In particular, the Give Way line facing the driver in this crash was very faded, and that may have contributed to the driver not feeling that it was necessary to slow down sufficiently to be able to give way if required.

In another crash, a four wheel drive vehicle parked by the kerb blocked vision of the intersecting road to the right of the driver of a car wishing to drive across the road from a Give Way sign. In similar circumstances to a crash described in Section 8.2, the elderly male driver of the car (80 years old) moved out into the roadway to see if any traffic was approaching from the right. When no traffic was coming from the right, the driver proceeded across the road. His car was then struck by a vehicle approaching from the left.

In the other crash involving restricted vision, the elderly female driver of a car (87 years old) stopped at the Stop sign on a four way intersection before attempting to drive straight across the intersecting road. Despite the driver having stopped to give way to other traffic, when she did attempt to cross, the car was struck on the side by a car approaching from the left. The restriction of vision in this case resulted from the intersection being located near a crest on the intersecting road. The car that struck the car travelling through the Stop sign was not seen by the elderly driver because it was concealed by the crest when she looked in that direction. It was also being driven at a speed in excess of the speed limit.

There was one intersection that was the site of two crashes in this study. In both cases, a vehicle travelled straight ahead through a Give Way sign and collided with another vehicle in the middle of the intersection, resulting in one of the vehicle occupants being killed. Prior to these crashes, this intersection had been the site of 15 crashes in the previous four years. This had prompted local newspaper articles and a petition from local residents calling for improvements. Following the second of these two crashes, approval was given for the replacement of Give Way signs with Stop signs. Although Stop signs would likely have had no effect in the first crash, in which medical conditions suffered by the driver were thought to have contributed to the occurrence of the crash, it is possible that they may have saved the life lost in the other case. Local police embarked on a period of enforcement of compliance with the Stop signs beginning with a period of cautions only, followed by a period of reporting drivers who disobeyed the signs. Subsequent to these crash reduction strategies, Federal "Black Spot" funds were used to alter the layout of the intersection. Now, instead of a four way intersection, there are two T-junctions. This was done to ensure that drivers were forced to slow down, because the majority of the crashes at this intersection involved vehicles failing to give way before proceeding through the intersection.

9.4 Turning from sign at four way intersection, collided with other vehicle

There were four crashes in which a vehicle faced with either a Stop or Give Way sign attempted to turn into the intersecting road at a four way intersection when it collided with a vehicle travelling on the intersecting road. These crashes, for the purposes of this report, are referred to as "turning at sign controlled intersection" crashes. These four crashes comprise 17 per cent of sign controlled intersection crashes and two per cent of the sample of rural crashes as a whole. One of the crashes resulted in a fatality and another resulted in hospital admission. In all four cases, the intersection was controlled by a Give Way sign. In two cases, the driver of the turning vehicle was 77 years of age and in another, the two cars that collided were both driven by teenage drivers on Provisional licences.

With regard to road and traffic factors, the most notable aspect of this category of crashes is that two of them occurred at the same intersection. In the first, a young, inexperienced driver faced with a Give Way sign attempted to turn left onto the intersecting road to travel west, but failed to give way to a car approaching from the right. The driver of the second car, who was also young and inexperienced, and who was travelling in excess of the speed limit, attempted to avoid a rear end collision by veering to the left onto the sealed shoulder. The driver of the car that had turned, however, also veered onto the shoulder. As a result, the second car struck the left rear of the first car before rolling down an embankment on the left side of the road. In the second crash, the elderly driver of a car (77 years old) faced with a Give Way sign attempted a right turn onto the intersecting road to travel west. This driver steered his car onto the shoulder on the far side of the intersecting road before attempting to merge with westbound traffic. However, a car in the westbound lane, which was travelling in excess of the speed limit, had veered onto the same shoulder in an attempt to avoid a collision with the turning car. The second car then struck the rear of the first car, before rolling down the same embankment as the car in the first crash.

The driver of the turning car in the second crash, who was a local and regularly uses these roads, stated that he and almost everyone else who executes the same right turn he did in the crash, deliberately turn firstly onto the sealed shoulder before merging with westbound traffic. Our team of investigators noticed that many vehicles, particularly heavy vehicles such as trucks, do precisely this whenever they turn at this intersection. This is done so that they can use the length of the shoulder up to 100 km/h on the upward sloping road. Without performing this manoeuvre, it would be extremely difficult, especially for heavy vehicles to turn right at this intersection to travel west, without holding up westbound traffic while they attempt to accelerate to the speed limit. Therefore, the intersection causes problems for motorists because it lacks an acceleration and merging lane dedicated for those vehicles turning right, and because vehicles turning right to travel west are required to accelerate up to 100 km/h on an up slope. In the second crash, the motorist on the intersecting road did not realise that the right turning car was going to turn onto the shoulder before merging. This caused this driver to veer to the left in an attempt to miss the car, which he perceived to be turning into his path without giving way.

9.5 Summary of collisions at sign controlled intersections

The crashes defined in this report as being collisions at sign controlled intersections represented 10 per cent of the total sample of rural crashes. These crashes almost all occurred during daylight hours, suggesting that the failure to detect other vehicles may be a contributing factor in these crashes, given that at night, the presence of another vehicle's headlights increases the likelihood of it being detected, although the limited on call times for the investigating team must also be remembered. Elderly drivers were also over represented (as in crashes at uncontrolled intersections, see Section 8), accounting for nearly a quarter of all the drivers involved. Of the crashes at four way intersections, the majority involved the driver of the vehicle faced with a sign attempting to travel straight through the intersection (79 per cent) rather than turning into the intersecting road.

The most prevalent road and traffic factor in crashes at sign controlled intersections appears to be the layout of the road (6 cases, or 25%). In particular, it is evident that it is unsafe for a junction of two roads to be located at, or adjacent to, a curve or a crest on the priority road. When this occurs, problems eventuate both in the detection of oncoming traffic on the priority road and the judgment of its speed, both necessary for effective compliance with Give Way or Stop signs. Also, attention needs to be paid to intersections at which the drivers of right turning vehicles feel compelled to turn first onto the shoulder on the far side of the road before merging with traffic on the through road. Such a manoeuvre can cause confusion in drivers on the road into which the turn is being made, resulting in a crash avoidance measure actually causing a collision.

Anther issue arising from the investigation of crashes at sign controlled intersections is the restriction of vision resulting from vegetation. In particular, it is necessary, unless vegetation is regularly controlled or eliminated near intersections, that the signage at the intersections is appropriate for the available sight distance. If a driver's view approaching an intersection at which priority must be given to traffic on the other road is compromised by vegetation, then the appropriate sign may be a Stop sign rather than a Give Way sign. Similarly, Stop signs might be used where a large number of crashes occur as a result of drivers failing to give way, even if the other requirements for such a sign are not satisfied by the location.

It is also important that the assignment of priority at an intersection is appropriate for the comparative levels of usage of the roads, while also taking into account the comparative quality of the road surfaces. Maintenance of the road markings associated with Give Way signs would also appear to be an important safety matter.

10. OTHER COLLISIONS AT INTERSECTIONS

Of the 236 rural crashes investigated, 21 (9%) have been classified for the purposes of this report as "other collisions at intersections". These crashes involved the collision of two vehicles at an intersection, in which the presence or lack of signage was irrelevant for its causation. That is, if the intersection was or had been controlled by a sign, the manoeuvres being performed by the two crash involved vehicles were not or would not have been governed by the sign. There were two types of crashes in the sample satisfying these requirements. They were collisions in which one vehicle collided with another travelling on the same road when it was turning into the stem of a T-junction or when it was turning right at a four way intersection.

10.1 Comparison of Other Intersection Crashes and the Remaining Intersection Crashes

10.1.1 Time of day by intersection crash type

The vast majority of these "other intersection crashes" occurred during daylight hours, consistent with the remainder of intersection crashes. Only one of the 21 "other intersection crashes" occurred during hours of darkness. "Other intersection crashes" were also concentrated in the middle of the day, between the hours of 11am and 4pm. During this time, 76 per cent (16 cases) of the crashes occurred, compared to 37 per cent of the remaining intersection crashes. This difference in the two distributions of time of day was statistically significant ($\chi^2_{(1)}$= 8.58, p< .01). A comparison of time of day of occurrence of "other intersection crashes" and the remaining intersection crashes is shown in Table 10.1.

Table 10.1
Time of Day of Other Intersection and Remaining Intersection Crashes

Time of Day	Type of Crash			
	Other Intersection		Remaining Intersection	
	Number	Per cent	Number	Per cent
0000 - 0659	-	-	-	-
0700 - 0759	-	-	2	4.7
0800 - 0859	1	4.8	4	9.3
0900 - 0959	-	-	7	16.3
1000 - 1059	1	4.8	4	9.3
1100 - 1159	4	19.0	3	7.0
1200 - 1259	4	19.0	5	11.6
1300 - 1359	4	19.0	3	7.0
1400 - 1459	1	4.8	3	7.0
1500 - 1559	3	14.3	2	4.7
1600 - 1659	1	4.8	2	4.7
1700 - 1759	1	4.8	3	7.0
1800 - 1859	-	-	2	4.7
1900 - 1959	1	4.8	-	-
2000 - 2059	-	-	-	-
2100 - 2159	-	-	3	7.0
2200 - 2259	-	-	-	-
2300 - 2359	-	-	-	-
Total	**21**	**100.0**	**43**	**100.0**

10.1.2 Speed limit at crash location by intersection crash type

The majority of "other intersection crashes" occurred on roads with a speed limit of 100 or 110 km/h, which was typical of all intersection crashes. In fact, there is very little difference between the distributions of speed zones in which the two sets of crashes occurred, as shown in Table 10.2.

Table 10.2
Speed Limit at the Site of Other Intersection and Remaining Intersection Crashes

Speed Limit	Type of Crash			
	Other Intersection		Remaining Intersection	
km/h	Number	Per cent	Number	Per cent
60	3	14.3	6	14.0
70	1	4.8	2	4.7
80	4	19.0	6	14.0
90	-	-	2	4.7
100	5	23.8	14	32.6
110	8	38.1	13	30.2
Total	**21**	**100.0**	**43**	**100.0**

10.1.3 Driver age by intersection crash type

The distribution of ages of the drivers and riders involved in "other intersection crashes" is very similar to that for the remaining intersection crashes, with just under 18 per cent of drivers in both sets of cases being under the age of 25, and at least 22 per cent of drivers being over the age of 60. Therefore, the distribution of ages of drivers and riders in this group of crashes is a fair representation of that for intersection crashes in general (Table 10.3).

Table 10.3
Age of Drivers and Riders Involved in Other Intersection and Remaining Intersection Crashes

Age	Type of Crash			
	Other Intersection		Remaining Intersection	
Years	Number	Per cent	Number	Per cent
16-19	3	6.7	6	7.1
20-24	5	11.1	9	10.6
25-29	5	11.1	7	8.2
30-34	4	8.9	6	7.1
35-39	6	13.3	7	8.2
40-44	2	4.4	12	14.1
45-49	6	13.3	9	10.6
50-54	3	6.7	5	5.9
55-59	1	2.2	3	3.5
60-64	1	2.2	5	5.9
65-69	2	4.4	3	3.5
70-74	2	4.4	4	4.7
75-79	2	4.4	5	5.9
80-84	2	4.4	3	3.5
85-89	1	2.2	1	1.2
90+	-	-	-	-
Total	**45**	**100.0**	**85**	**100.0**

10.1.4 Driver licence status by intersection crash type

The distribution of licence status of drivers and riders involved in "other intersection crashes" demonstrates that the majority of drivers or riders had attained full licences, with only one of the 45 drivers only holding a provisional licence, and one driver lacking a licence altogether. Of the 85 drivers involved in the remaining intersection crashes, 78 were in possession of a full driver's licence (Table 10.4).

Table 10.4
Licence Status of Drivers and Riders Involved in
Other Intersection and the Remaining Intersection Crashes

Licence Status	Type of Crash			
	Other Intersection		Remaining Intersection	
	Number	Per cent	Number	Per cent
Full	43	95.6	78	91.8
P-Plate	1	2.2	6	7.1
L-Plate	-	-	-	-
Unlicensed	1	2.2	1	1.2
Total	**45**	**100.0**	**85**	**100.0**

Of the 21 "other intersection crashes", 11 involved a vehicle turning right into the stem of a T-junction, while the remaining 10 involved a vehicle turning right at a four way intersection. In the group of crashes at T-junctions, eight involved the turning vehicle being struck by a vehicle travelling in the opposite direction, with the remaining three involving the turning vehicle being struck from behind. In the group of crashes at four way intersections, the pattern of crashes was similar, with seven involving the second vehicle travelling in the opposite direction and three involving it coming from behind. These two different types of crashes and the road and traffic factors relevant to their causation are discussed in the following sections. Statistics for these crashes are compared to the "remainder of intersection crashes", which for the purposes of this report includes all other crashes except for single vehicle crashes and "midblock collisions".

10.2 Turning right into the stem of T-junction, collided with other vehicle

There were 11 crashes in which a vehicle turning right into the stem of a T-junction was struck by another vehicle travelling on the same road. This represents 52 per cent of the sample of "other intersection crashes" and five per cent of the sample of rural crashes a whole. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 45 per cent of cases, compared to 53 per cent for the remainder of intersection crashes. A comparison between "turning right into the stem of a T-junction collisions" and the remainder of intersection crashes is provided in Table 10.5.

Table 10.5
Turn Right into the Stem of a T-junction Collisions And Remainder of Intersection Crashes

Variable	Type of Crash			
	Turn Right into the Stem of a T-junction Collisions (N=11)		Remaining Intersection Crashes (N=53)	
	Number	Per Cent	Number	Per Cent
Speed limit >90	7	63.6	33	62.2
Rural highway	9	81.8	40	75.5
Unsealed road	-	-	3	5.7
Non-level	5	45.5	10	20.4
Curve	3	27.3	6	11.3
>2 lanes	4	36.4	7	13.2
Male drivers	18	75.0	71	67.0
Female drivers	6	25.0	35	33.0
Driver age < 25	2	8.3	21	19.8
Driver age > 59	6	25.0	25	23.6
Not Full Licence	-	-	9	8.5
>BAC limit	-	-	1	1.3

Note: The percentages calculated for the driver age variable omit cases where the driver's age was unknown, and those for the alcohol variable omit cases in which the driver's BAC was not tested.

As can be seen from Table 10.5, "turn right into the stem of a T-junction" collisions, when compared to the remainder of intersection crashes, appear to be less likely to occur on level roads, more likely to occur on curved roads, more likely to occur on roads with more than one lane each way, and less likely to involve drivers under the age of 25. However, given the small number of collisions involving a vehicle turning into the stem of a T-junction, none of these apparent differences are statistically significant. Drivers over the age of 60 were involved more often than those under the age of 25, in this set of crashes accounting for a quarter of the drivers.

The road and traffic factors relevant to this set of crashes include restricted vision, conspicuity of vehicles, road layout, signage and an unsealed shoulder.

Restriction of vision potentially played a role in three crashes. In the first, a car was following a prime mover and approaching a left bend. The driver of the car attempted to turn right into the stem of a T-junction (which was actually more like a Y-junction) located at the centre of the curve when it struck another car travelling in the opposite direction. The driver of the turning car had not seen the other car because it was hidden from view on the curve by the prime mover. The driver had also been unable to see the car earlier, on the approach to the curve, because of trees and bushes. Although it is arguable that the driver of the car failed to exercise sufficient care before turning, it is also the case that the crash was not likely to have occurred had the vision of the driver not been blocked by the prime mover and the vegetation. Also, the layout of the road played a role in the crash because the curve restricted sight lines and the T (or Y)-junction possibly tempted the driver to veer off mistakenly. There is an advantage to right turn lanes in such situations as, in addition to removing turning vehicles from the traffic stream, they allow the drivers of right turning vehicles to move over and get a better view of oncoming traffic.

In another crash, a small truck was negotiating a left curve when it ran into the rear of a stationary car that was about to turn right into the stem of a T-junction. In this case, the restriction of vision was caused by the combination of the curve in the road and vegetation by the roadside. Both drivers were familiar with the road, but, once again, T-junctions near curves in the through road pose extra difficulties for drivers, requiring special attention from road authorities, such as clear prior warning and safe escape paths as a minimum.

In the third case in which a restriction of vision was possible, a car was turning right into the stem of a T-junction when it was struck by a car travelling in the opposite direction on the through road. The car that was struck rotated after the collision and struck a third car waiting at the T-junction to turn onto the through road. It is possible that the vision of the driver of the turning car, when looking for oncoming traffic, was restricted by high grass on the median dividing the road and by a sign on the median that was of sufficient size that at its distance it subtended a visual angle sufficient to momentarily hide a car behind it. Although the grass on the median was long and due to be mowed, it is unlikely that it contributed significantly to the crash. The sign that restricted the driver's view of the junction was on the off ramp from the nearby freeway. It displayed information regarding the prohibition of horses, pedestrians and bicycles on the freeway. The sign's value in its current location is questionable, given its ability to block drivers' views of oncoming cars.

There are other problems, however, with this location that are of greater concern than the sign and the grass on the median. This location was the site of 15 reported crashes between the start of 1997 and the end of 1999. The main problem with the junction is the road layout, with the two sides of the divided through road, one being the freeway off ramp and the other being the freeway on ramp, being at different elevations. Vehicles turning right into the T-junction, as one car was attempting to do in this case, must travel on a down slope and into a dip as they make the turn. Conversely, vehicles turning right onto the freeway on ramp from the T-junction, governed by a Give Way sign, must travel on an up slope. This change in elevation causes a number of problems for turning vehicles. First, when the dip is encountered by heavy or articulated vehicles as they turn right, the drivers feel the need to turn slowly to avoid scraping the road surface with the bottom of their vehicles. In fact, the proprietor of a nearby crash repairs business explained to our team of investigators that when he is carrying cars on his truck, he avoids turning right onto the freeway on ramp at this junction, preferring to turn left first and then execute a U turn. Otherwise, he risks scraping the road with the bottom of his truck. This tendency for heavy vehicle drivers to turn slowly through the intersection to avoid scraping the road results in their vehicles blocking the roadway for through traffic for longer periods of time, thus increasing their chances of being involved in a collision. Secondly, when the up slope is encountered by heavy vehicles executing the right turn from the stem of the T-junction to enter the freeway on ramp, those vehicles and others with limited acceleration move slowly, and hence spend increased time blocking the roadway.

Another problem at the intersection at which this crash occurred is the lack of adequate provision for vehicles turning right from the stem of the T-junction. Faded road markings and damaged raised reflective pavement markers meant that there was no clearly defined turn right lane for vehicles about to enter the freeway on ramp. Furthermore, the merging taper once on the on ramp is too short. This results in drivers performing manoeuvres similar to that of the drivers at the intersection described in Section 9.4 where two crashes occurred. These manoeuvres involve the right turning vehicle crossing over into the sealed shoulder on the far side of the road where the vehicle then accelerates before merging back to the right. The second crash at the other intersection graphically illustrates the dangers of such manoeuvres, and the danger at this location is considerable given that many drivers, according to a local resident, use the sealed shoulder to overtake slower vehicles on this section of road.

Other problems at the intersection at which this crash occurred include the fact that the large radius of the curve of the freeway off ramp results in the left turn indicators of many vehicles exiting the freeway not cancelling automatically before reaching the intersection. This may result in drivers who are waiting to turn right from the T-junction thinking that vehicles are going to turn left prior to the junction when in fact they are going to continue straight through the intersection, thus requiring that the waiting driver must give way. Also, there is a driveway opposite the T-junction that can only be accessed from the freeway off ramp by a driver turning right in front of following drivers who would not be expecting such a manoeuvre. Any right turns into or out of this driveway require that the painted island marked on the road be driven over. The turn right out of the driveway also can only be made safely if there are no vehicles waiting to turn right at the T-junction, and the driver turning from the driveway gives way to traffic on the off ramp. However, that traffic is obscured from view until the turning vehicle is in the centre of the road.

There were three cases in this set of crashes in which the low conspicuity of vehicles contributed to the causation of the crash. In two of them, the crash resulted from an elderly male driver (88 years of age in one case and 80 in the other) failing to detect the presence of a maroon coloured car against a background of trees on an overcast day before attempting a right turn into the stem of a T-junction. Coincidentally, the car not detected was the same make and model in each case and the two crashes occurred at the same location.

The third crash involving the possible role of low conspicuity of vehicles occurred when the driver of a car turned into the stem of a T-junction. While turning, the car struck a tandem bicycle continuing straight ahead on the through road in the opposite direction. The bicycle riders, who were wearing dark clothing, were difficult to see when viewed against a background of shadows cast by large roadside trees.

There was one other crash involving the contribution of a road factor. This crash occurred when a car was overtaking a line of traffic and clipped the front right side of another car that was turning right into the stem of a T-junction. The car then slid onto the unsealed shoulder on the right side of the road. The driver of the car failed to regain control on the unsealed surface of the shoulder, with the car yawing back across the road, mounting an embankment and rolling over in a field. The occurrence of the crash was chiefly caused by the irrational actions of the driver, whose attempt to overtake a long line of vehicles was potentially related to mental health issues, but the unsealed shoulder contributed to the failure of the driver to regain control of his vehicle.

10.3 Turn right at 4-way intersection, collided with other vehicle

There were 10 crashes in which a vehicle attempting to turn right at a four way intersection collided with another vehicle travelling on the same road. This represents 48 per cent of the sample of "other intersection crashes" and four per cent of the sample of rural crashes a whole. Half of these crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants, compared to 52 per cent for the remainder of intersection crashes. A comparison between "turning right at four way intersection collisions" and the remainder of intersection crashes is provided in Table 10.6.

Table 10.6
A Comparison of Turn Right at a Four Way Intersection Collisions and the Remainder of Intersection Crashes

Variable	Type of Crash			
	Turn Right at a Four Way Intersection Collisions (N=10)		Remaining Intersection (N=54)	
	Number	Per cent	Number	Per cent
Speed limit >90	6	60.0	34	63.0
Rural highway	10	100.0	39	72.2
Unsealed road	-	-	3	5.6
Non-level	4	40.0	11	20.4
Curve	-	-	9	16.7
>2 lanes	-	-	11	20.4
Male drivers	17	81.0	72	66.1
Female drivers	4	19.0	37	33.9
Driver age < 25	6	28.6	17	15.6
Driver age > 59	4	19.0	27	24.8
Not Full Licence	2	9.5	7	6.4
>BAC limit	-	-	1	1.3

Note: The percentages calculated for the driver age variable omit cases where the driver's age was unknown, and those for the alcohol variable omit cases in which the driver's BAC was not tested.

As can be seen from Table 10.6, turn right at four way intersection collisions, when compared to the remainder of intersection crashes, appear to be more likely to occur on rural highways, less likely to occur on flat roads, less likely to occur on curved roads, less likely to occur on roads with more than one lane each way, and more likely to involve drivers under the age of 25. Unlike the remainder of intersection crashes, drivers under the age of 25 appear to be involved more often than drivers over the age of 60 (29 versus 19%). However, given the small number of collisions in this study involving a vehicle turning right at a four way intersection and colliding with a vehicle travelling on the same road, none of these apparent differences are statistically significant.

The road and traffic factors that were most prevalent in this set of crashes were those related to the ability to detect the presence of the other vehicle. Specifically the restriction of vision resulting from crests, and the conspicuity of other vehicles were the most common explanatory factors for this set of cases.

A crest was present from the point of view of one of the drivers involved in these crashes on three occasions. In one such case, a young driver was approaching a crest at high speed, unaware that a truck was turning right into a side street at the bottom of the down slope beyond the crest, which had resulted in a line of traffic waiting behind the truck. The driver, upon coming over the crest, attempted to overtake the line of traffic behind the truck, but struck the side of the truck as it attempted to turn. The truck was tipped onto its side, whilst the two occupants of the car were fatally injured in the collision. Although excessive speed and driver inexperience were the major factors in the causation of this crash, the restriction of vision due to the crest and the location of an intersection beyond the crest on a down slope were also factors in the collision.

In another fatal crash featuring a crest in the road, a car towing a horse float turned right at a four way intersection and was struck by a motorcycle that had just travelled over a small crest at a speed in excess of the speed limit. The presence of the crest would have prevented the driver of the car from seeing the oncoming motorcycle, and vice versa.

In the remaining crash involving a crest, the young, inexperienced driver of a utility attempted to turn right at a four way intersection located before a crest. The utility was struck by a four wheel drive vehicle travelling in the opposite direction. The driver of the utility claimed that, after a van he had been following turned left, he looked toward the top of the crest before turning and so did not notice the four wheel drive that had already passed the crest and was near the intersection. Although the presence of the crest causes problems at this intersection, it is also possible that the light brown four wheel drive was inconspicuous against the soil of the vineyards in the background.

There were two other crashes in which the turning drivers said that their failure to detect the presence of the oncoming vehicle was responsible for the crash. In one of these, it was suggested that a silver van was difficult to see in the shadows of roadside trees, whilst in the other, it was suggested that a dark blue car was difficult to see against the background of the straight bitumen road on which it was travelling. This car was also travelling at a speed in excess of the speed limit.

Another crash occurred at the same site as the last one referred to in the previous paragraph. In this crash, the driver of a car was attempting to make the same right turn when the driver of a following car attempted to overtake on the incorrect side of the road. The second car struck the first car on its right side, just to the rear of the driver's door.

10.4 Summary of other intersection crashes

The crashes defined in this report as being "other intersection collisions" represented nine per cent of the total sample of rural crashes. These crashes almost all occurred during daylight hours, especially between 11am and 4pm. The tendency to occur during daylight hours is typical of all intersection crashes (see Sections 8 and 9) and suggests that the failure to detect other vehicles may be a contributing factor in these crashes, given that at night, the presence of another vehicle's headlights increases the likelihood of it being detected, although the limited on-call times of the investigating teams must also be remembered. Elderly drivers were over represented (as in the remainder of intersection crashes, see Sections 8 and 9), accounting for over a fifth of all the drivers involved. Unlike collisions at unsigned intersections and collisions at sign controlled intersections, however, "other intersection crashes" were evenly distributed between T-junctions and four way intersections. In the majority of cases (71%), the turning vehicle was struck by a vehicle approaching it from the opposite direction.

The most common factor contributing to "other intersection crashes" was one driver failing to detect the presence of the other vehicle. This probably occurred in 11 cases (52%). In five of these 11 cases, one driver's vision of a section of the road was restricted, either by a crest (two cases), a curve in the road (two cases) or tall grass and a sign on a median (one case). Often, however, as with unsigned intersection crashes (see Section 8.3), restriction of vision occurred in the presence of other road and traffic factors. For example, the road layout was also involved in all three cases in which vision was possibly restricted for one of the drivers in a crash at a T-junction. In two cases, the T-junction was located on the outside of a curve, whilst in the other case, there were a number of problems with the layout of the road. The restriction of vision at two of the crashes at four way intersections resulted from a crest in the road.

Low conspicuity of the vehicle travelling straight ahead through the intersection was a possible factor in the causation of six crashes. In four of these cases, the low conspicuity resulted in part from the presence of roadside trees. In two of these cases, the shadows cast by the trees onto the road made it hard to see the approaching vehicles, whilst in the other two, the approaching vehicle may have been difficult to see against the background of the trees themselves. In the remaining two cases, it is possible that the approaching vehicle was inconspicuous against the background of the road surface, and the vineyards in the background, respectively.

In addition to these various problems with drivers seeing other vehicles, there was one case in which signage was relevant to the crash, and another in which an unsealed shoulder contributed to the crash. In the signage case, there was no sign to warn motorists of a T-junction following a curve in the road. In the unsealed shoulder case, a car veered onto an unsealed shoulder after clipping the side of a turning vehicle. Once on the unsealed surface of the shoulder, the driver was unable to regain control of the vehicle. It yawed back across the road, mounted an embankment and rolled over in a field.

11. COLLISIONS AT SIGNALISED LOCATIONS

Of the 236 rural crashes investigated, five (2%) occurred at signalised locations. Three of these five were crashes in which one vehicle was turning right at a set of traffic lights when it collided with another vehicle and two were crashes in which a vehicle collided with a train at a railway level crossing. Of these five crashes, two occurred during daylight hours (7:40am and 9:40am) and the remaining three occurred at night. This contrasts with the remaining intersection crashes in which the vast majority occurred during daylight hours (see sections 8, 9 and 10). Two of the crashes occurred on a road with a speed limit of 110 km/h, two with a limit of 90 km/h and one with a limit of 70 km/h. Of the eight drivers involved in crashes at signalised locations (the two train drivers were not counted), three were under the age of 25, while only one was over the age of 60. All of the drivers had full driver's licences.

11.1 Turn right at traffic signals, collision with other vehicle

There were three crashes in which a vehicle attempting to turn right at a set of traffic signals collided with another vehicle. This represents one per cent of the sample of rural crashes as a whole. This small proportion of the total sample of crashes reflects the comparatively small number of intersections controlled by traffic signals in rural areas. One of these three crashes resulted in a fatality and another in a hospital admission. Two crashes occurred at the same location, which was a T-junction on a divided rural highway with four lanes and a speed limit of 90 km/h. The other location was also a divided rural highway but with a speed limit of 70 km/h. Three of the drivers were aged under 25 but all had a full driver's licence, whilst none was aged over 60. There were even numbers of male and female drivers. Of interest, given that most of the intersection crashes in this study occurred in the daytime, is that all three of these crashes occurred at night.

In one case, the crash occurred at a T-junction when the driver of a utility on the through road, a National Highway approaching a metropolitan area, drove through a red traffic signal and struck the left side of an oncoming car turning right in front of it. The driver of the utility claimed that he saw the flashing lights warning of the upcoming traffic signals but that "they are pretty meaningless because the lights are likely to change anyway", so that he does not "usually take too much notice of them." The driver also claimed that, once he was near the intersection, the mixture of the headlights of oncoming vehicles, the brake lights of vehicles on his side of the road, and overhead street lights decreased his ability to distinguish the presence of the red traffic signal.

One of the other crashes in this group occurred at the same location. In this case, however, the turning vehicle was a car turning right onto the through road from the stem of the T-junction. The main factor relevant to this crash was a blackout at the time that resulted in the traffic signals not operating. This meant that the driver of the car had to turn right onto the busy through road without the benefit of traffic signals and street lighting. The darkness at the time would possibly have hindered her ability to judge accurately the speed and distance of oncoming vehicles, contributing to her error in driving out in front of a semi trailer approaching from the right. The driver of the car in this case was fatally injured in the collision.

In the remaining crash that occurred at a signalised intersection, the driver of a car turned right in front of an oncoming car at a four way intersection. The car travelling straight ahead was doing so with a green traffic signal, whilst the turning car also had a green signal but had to give way to oncoming vehicles. An occupant of the car travelling straight ahead suggested that the driver of the turning car may have first seen a red arrow prohibiting turning and then, upon the disappearance of this arrow, had assumed that it was then appropriate to turn. Unfortunately, due to the lack of an opportunity to interview the driver of the turning car and also discrepancies in the descriptions of the actions of the turning driver prior to turning that were given by the two occupants of the car going straight ahead, it is impossible to tell if this suggested confusion regarding the traffic signals was the reason for the error of judgement of the driver of the turning car. As such signal sequences are very common at signalised intersections, and the young driver was under the influence of alcohol at the time (BAC = 0.073) as well as possibly distracted by a full car of young friends, it is likely that these other factors may provide a sufficient explanation for this collision.

11.2 Railway level crossing

There were two crashes in which a vehicle collided with a train at a railway level crossing. This represents one per cent of the sample of rural crashes a whole. One of these two crashes resulted in the driver being admitted to hospital, whilst in the other, no injuries were sustained. Both of the roads intersecting with the railways had speed limits of 110 km/h. One of them intersected the railway immediately following a right bend, whilst the other one, although straight, was unsealed except for a small section just prior to the railway. Both crashes occurred in the morning in daylight, although it was not long after dawn in one of the cases.

In the first case, the 76 year old male driver of a van was negotiating a right curve when he encountered a stationary car at a railway crossing. The driver of the van veered to the left to avoid colliding with the car but his van side swiped a guard rail and then proceeded into the railway crossing where it struck the right side of a moving train. The main reason for this crash occurring appears to have been sun glare compromising the vision of the driver as he steered around the right hand bend, although the proximity of the crossing to the bend in the road also gave the driver little opportunity to avoid the collision. There were signs warning drivers of the right curve (a 45 km/h Advisory Speed sign) and of the railway crossing, and signals at the crossing were operational at the time.

In the remaining crash, a train struck the front of a garbage truck that was fully blocking the railway at a crossing before its driver realised this and attempted to reverse off the tracks. The road at this point crosses the railway at an angle rather than perpendicularly, and there is no Stop line on the road, meaning that drivers of vehicles would have difficulty in judging the best position to stop as they approach the crossing. Such a situation is made worse when, as in this case, the crossing is “unprotected”, which means that there is no boom gate to block the railway from road traffic when a train crosses.

11.3 Summary of collisions at signalised locations

Crashes at signalised locations accounted for two per cent of the sample of rural road crashes investigated. This small percentage is due to the majority of intersections in rural areas being controlled either by signs only or not at all, relying on drivers to follow give way rules. Three of the signalised location crashes occurred when vehicles attempted right turns at intersections controlled by traffic signals. Each of these three crashes occurred during hours of darkness, unlike the vast majority of the remainder of intersection crashes in the study. The remaining two crashes in this category occurred at railway crossings.

Of the three crashes at traffic signals, the only relevant road and traffic factor was the loss of functioning of the traffic signals and streetlights due to a power blackout. Of the two that occurred at railway crossings, both featured the contribution of the crossing layout. In one case, the railway crossing is placed just past a right curve in the road. In the presence of glare from the sun just after dawn, the driver of a van was not prepared to stop as soon as was required following the curve. In the other crash, the unprotected crossing lacked a Stop line, which was especially problematic given that the railway lines crossed the road at an angle. This resulted in difficulty for the driver of a garbage truck in positioning his vehicle to give way to the approaching train.

12. CONSEQUENCES OF LOSS OF CONTROL

The previous six chapters have been concerned with the road and traffic factors relevant to rural crashes. These next two chapters are concerned with the role of road and traffic factors in the causation of injuries in the event of a rural crash. First, the types of potentially injurious events that follow from the loss of vehicular control will be considered and, specifically, whether there is any pattern in such events according to the manner of loss of control. The next chapter will concentrate on roadside hazards and the role they played in the relative severity of the rural road crashes investigated. The crashes included for discussion in these two chapters are those in which some failure on the part of the driver to control their vehicle precipitated the crash. These crashes therefore include all of the single vehicle crashes and a number of the midblock collisions.

Table 12.1 provides a summary of the main types of potentially injurious events (striking a roadside hazard or rolling over in the case of single vehicle crashes, or striking another vehicle) that occurred following a driver or rider's loss of vehicular control. The 105 single vehicle crashes included five cases in which the vehicle rolled over without striking a roadside hazard. Three of these cases involved prime movers that have a lower level of lateral stability compared to smaller vehicles. Also included in the table is the manner in which control was lost, specifically the direction in which the vehicle first veered when control was lost and the horizontal alignment of the road.

Table 12.1
Types of Potentially Injurious Events
Following Loss of Control

Loss of Control	Roadside Hazard or Rollover		Other Vehicle Collision
	On left	On right	
Off to left, straight road	22	12	4
Off to right, straight road	5	11	2
Off to left, left curve	9	-	1
Off to right, left curve	3	6	13
Off to left, right curve	23	9	5
Off to right, right curve	-	5	6
Total	**62**	**43**	**31**

As can be seen from Table 12.1, there were 136 non-intersection crashes that were precipitated by one driver or rider losing control of their vehicle. The most common potentially injurious events were impacts with roadside hazards or rollovers on the left side of the road (62 cases or 46%), particularly when the vehicle losing control veered off to the left on a straight road (22 cases or 16%) or a right curve (23 cases or 17%). Also of note, for single vehicle crashes, is that in the majority of cases (76 cases, or 72%), vehicles struck roadside hazards or rolled over on the same side of the road to which they veered during the initial loss of control. For cases in which the out of control vehicle struck another vehicle, a majority (21 cases, or 67.7%) occurred when the vehicle that lost control did so off to the right, with the most common loss of control sequence being the vehicle losing control off to the right on a left curve (13 cases, or 41.9%). That multiple vehicle collisions occurred most commonly when the out of control vehicle veered to the right is to be expected, given that all but one of these collisions occurred with a vehicle travelling in the opposite direction and, therefore, required the out of control vehicle to veer to the right to enter the lane(s) for oncoming traffic. In cases in which the out of control vehicle struck a vehicle travelling in the opposite direction after having lost control to the left, the driver in most cases attempted to correct the trajectory of the vehicle but overcorrected, causing the vehicle to yaw across from the left to the right.

To enable a comparison of the severity of these various crashes, Table 12.2 sets out the percentages of the crashes in Table 12.1 that resulted in one or more vehicle occupants either being fatally injured or injured severely enough to require hospital admission. The overall percentage of loss of vehicular control crashes resulting in such severe injuries was 63 per cent, compared to 46 per cent for the remaining rural road crashes investigated.

Table 12.2
Percentage of Hospital Admission or Fatal Crashes According to the Types of Potentially Injurious Events Following Loss of Control

Loss of Control	Roadside Hazard or Rollover		Other Vehicle Collision
	On left	On right	
Off to left, straight road	45.5	75.0	50.0
Off to right, straight road	60.0	81.8	100.0
Off to left, left curve	44.4	-	0.0
Off to right, left curve	66.7	66.7	84.6
Off to left, right curve	65.2	44.4	100.0
Off to right, right curve	-	40.0	50.0
Total	**54.8**	**65.1**	**74.2**

Table 12.2 shows that in this sample of crashes, the higher likelihood of a fatality or serious injury after the loss of vehicular control occurred in crashes involving collisions with another vehicle rather than those involving only impacts with roadside hazards or rollovers. However, it is important to remember that most of the crashes precipitated by loss of vehicular control were single vehicle crashes, and that even if multiple vehicle collisions in this sample were more likely to be severe, the highest number of severe injuries resulted from single vehicle crashes. This is demonstrated by Table 12.3, which sets out the same data as Table 12.2, except that it includes the raw numbers rather than percentages.

Table 12.3
Number of Hospital Admission or Fatal Crashes According to the Types of Potentially Injurious Events Following Loss of Control

Loss of Control	Roadside Hazard or Rollover		Other Vehicle Collision
	On left	On right	
Off to left, straight road	10	9	2
Off to right, straight road	3	9	2
Off to left, left curve	4	-	-
Off to right, left curve	2	4	11
Off to left, right curve	15	4	5
Off to right, right curve	-	2	3
Total	**34**	**28**	**23**

As can be seen from Table 12.3, although in this sample of crashes multiple vehicle collisions following loss of control were more likely to produce severe injuries, the majority of severe injuries (73%) resulted from single vehicle crashes.

Having established that most crashes precipitated by the loss of vehicular control result in a single vehicle striking a roadside hazard or rolling over, and keeping in mind that multiple vehicle collisions could also involve roadside hazards, the next section deals specifically with the risks associated with vehicles running onto the roadside in rural areas.

13 COLLISIONS WITH ROADSIDE HAZARDS

Table 13.1 lists the different roadside hazards and their frequency of involvement in rural crashes according to whether the crash involved one or multiple vehicles. Rollovers are included in Table 13.1 and each crash may have involved multiple roadside hazards.

Table 13.1
The Involvement of Roadside Hazards In Loss of Control Crashes By Number of Vehicles Involved

Roadside Hazard	Number of Vehicles Involved			
	Single Vehicle		Multiple Vehicle	
	Number	Per Cent	Number	Per Cent
Tree	59	36.9	2	11.1
Fence	16	10.0	4	22.2
Raised Embankment	13	8.1	2	11.1
Utility Pole	12	7.5	-	-
Guard Rail	6	3.8	2	11.1
Steep Drop	5	3.1	2	11.1
Drain/Culvert	4	2.5	-	-
Other	6	3.8	3	16.7
Rollover	39	24.4	3	16.7
Total	**160**	**100.0**	**18**	**100.0**

Note: individual crashes may involve more than one roadside hazard, and a crash cushion is classified as a guard rail for the purpose of this analysis.

As can be seen from Table 13.1, the most commonly struck fixed roadside object was a tree, comprising 37 per cent of single vehicle impacts with roadside hazards. The next most commonly struck roadside hazard was a fence, comprising 10 per cent of impacts. Rollovers accounted for 24 per cent of single vehicle impacts. However, of these 39 crashes involving rollovers, there were only six crashes in which no fixed roadside object was involved.

With regard to multiple vehicle collisions, Table 13.1 shows that, in the 31 midblock crashes precipitated by a loss of vehicular control by one driver or rider, 18 roadside hazards or rollovers were involved in addition to the impact with the other vehicle or vehicles. The most common type of roadside hazard involved in these crashes was a fence, as occurred in 22 per cent of hazard impacts.

The following sections detail the role of each of the roadside hazard types separately.

13.1 Trees

As noted in Table 13.1, there were 59 single vehicle crashes in which the vehicle struck a tree. This represents 56 per cent of the sample of single vehicle crashes. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 66 per cent of cases, compared to 50 per cent for the remainder of single vehicle crashes. A summary of single vehicle collisions with trees is provided in Table 13.2.

Table 13.2
Single Vehicle Rural Road Crashes Investigated Involving Collisions With Trees

Variable	Number	Per cent
Straight Road	33	55.9
Right Curve	16	27.1
Left Curve	10	16.9
Tree on Left	35	59.3
Tree on Right	24	40.7
Speed Limit > 90	48	81.4
Divided Road	4	6.8
Total	**59**	**100.0**

As with the rest of the sample of single vehicle collisions, the majority of collisions with trees occurred on straight roads. When the road was not straight, right curves were more prevalent than left curves. The two multiple vehicle collisions involving collisions with trees were both on right curves for the vehicle that went out of control, precipitating the crash.

As with roadside hazards generally (see Table 12.1), collisions with trees occurred more often on the left side of the road than the right. Both of the multiple vehicle collisions in this group involved collisions with trees on the right side of the road. This is not surprising given that the vehicle that was out of control had to be on the right side of the road for the collision with the second vehicle to occur.

The speed limit at the site of most of the single vehicle tree crashes was 100 or 110 km/h (81%) more often than for the remainder of single vehicle crashes (63%) and the remainder of rural crashes as a whole (59%). The comparison with the remainder of single vehicle crashes was significant ($\chi^2_{(1)}= 4.43, p< .05$), as was that with the remainder of rural crashes as a whole ($\chi^2_{(1)}= 9.42, p< .01$). Both of the multiple vehicle collisions occurred on roads with speed limits of 100 km/h.

Four of the roads (7%) were divided and two crashes involved collisions with trees that had reportedly been planted on the median strip and subsequently grown to a hazardous size. These two crashes resulted in three fatalities and two hospital admissions.

13.2 Fences

As noted in Table 13.1, there were 16 single vehicle crashes in which the vehicle struck a fence. This represents 15 per cent of the sample of single vehicle crashes. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 38 per cent of cases, compared to 63 per cent for the remainder of single vehicle crashes. A summary of single vehicle collisions with fences is provided in Table 13.3.

Table 13.3
Single Vehicle Rural Road Crashes
Involving Collisions With Fences

Variable	Number	Per cent
Straight Road	8	50.0
Right Curve	7	43.8
Left Curve	1	6.3
Fence on Left	5	31.3
Fence on Right	11	68.8
Speed Limit > 90	11	68.8
Divided Road	2	12.5
Total	**16**	**100.0**

Half of the single vehicle crashes involving collisions with fences occurred on curved roads, with right curves predominant again. Of the four midblock collisions, three were on right curves and one was on a straight road.

In contrast to the remainder of single vehicle crashes, the impacts with fences tended to occur on the right side of the road (69%). In the remainder of single vehicle crashes, the roadside hazard was encountered on the right side of the road in only 40 per cent of cases. This difference was statistically significant ($\chi^2_{(1)}$= 6.03, $p< .05$). In the four multiple vehicle crashes, the fence that was struck was on the right side of the road in three cases.

There were two cases in which a vehicle struck a fence on the median of a divided road. In one of these cases, the major impact of the crash was with a tree (see section 13.1). In the other case, the sole occupant of the vehicle only sustained minor injuries.

It is also necessary to point out that in cases involving impacts with fences and fatal or serious injuries to vehicle occupants, it was usually not the impact with the fence that was responsible for the severe injuries. In two cases, the vehicle also collided with a tree, and it was this impact with the tree that was largely responsible for the occupants' fatal injuries. In the remaining fatal single vehicle crash, the vehicle rolled after striking a fence. The driver was ejected and was trapped under the vehicle, which came to rest on its side.

In the midblock crashes involving collisions with fences, there were five occupants in the three vehicles that struck a fence. Two of these occupants were fatally injured and one was admitted to hospital. In one case, the vehicle out of control was struck by a large truck and pushed against a strainer fence post. The collision with the truck was the major cause of the fatal injuries. In another, the car out of control struck a guard rail on the left side of the road before veering over to the right side where it was struck by a second car. The first car then went through railings on the side of the bridge and fell 12 metres to the riverbank below. In this case, the impact with the riverbank would have caused the fatal injuries rather than that with the fence. In the third case, the vehicle out of control struck a second car and a tree in addition to the fence. The injuries sustained by the driver could have resulted from either or both of the other impacts.

13.3 Raised embankments

As shown in Table 13.1, there were 13 single vehicle crashes in which the vehicle struck a raised embankment. This represents 12 per cent of the sample of single vehicle crashes. These crashes produced injuries severe enough to require hospital admission for one or more vehicle occupants in 23 per cent of cases, compared to 64 per cent for the remainder of single vehicle crashes. A summary of single vehicle collisions with raised embankments is provided in Table 13.4.

Table 13.4
Single Vehicle Rural Road Crashes
Involving Collisions With Raised Embankments

Variable	Number	Per cent
Straight Road	6	46.2
Right Curve	4	30.8
Left Curve	3	23.1
Embankment on Left	9	69.2
Embankment on Right	4	30.8
Speed Limit > 90	12	92.3
Divided Road	2	15.4
Total	**13**	**100.0**

Collisions with raised embankments occurred most often on the left rather than the right side of the road, and almost all were on roads with a speed limit of 100 or 110 km/h.

The most noteworthy aspect of single vehicle collisions with raised embankments, however, was that all of them resulted in the vehicle rolling over. Rollovers are discussed below in a separate section (13.9).

13.4 Utility poles

As noted in Table 13.1, there were 12 single vehicle crashes in which the vehicle struck a utility pole. This represents 11 per cent of the sample of single vehicle crashes. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 75 per cent of cases, compared to 57 per cent for the remainder of single vehicle crashes. A summary of single vehicle collisions with utility poles is provided in Table 13.5.

Table 13.5
Single Vehicle Rural Road Crashes
Involving Collisions With Utility Poles

Variable	Number	Per cent
Straight Road	6	50.0
Right Curve	6	50.0
Left Curve	-	-
Pole on Left	8	66.7
Pole on Right	4	33.3
Speed Limit > 90	3	25.0
Divided Road	1	8.3
Total	**12**	**100.0**

Half of the roads on which crashes with poles occurred were straight and the other half were curved to the right. The lack of pole collisions on left curves contrasts with the remainder of single vehicle crashes, of which 19 per cent occurred on roads curving to the left.

The majority of collisions with poles being on the left side of the road rather than the right was consistent with roadside hazard crashes in general.

The most noteworthy aspect of Table 13.5 is that there were comparatively few roads involved with speed limits above 90 km/h. The percentage of such roads for pole collisions (25%) was substantially less than that for the remainder of single vehicle crashes investigated (80%). This would be due to the higher density of utility poles in rural towns where speed limits are lower. Of the twelve crashes, seven (58%) were on roads with 60 km/h speed limits, compared to four per cent for the remainder of single vehicle crashes. The fact that these crashes tended to occur on roads with lower speed limits means that the average pole impact occurred at lower speeds than the average impact with other roadside hazards. However, as noted above, pole collisions were more likely to have produced severe injuries than the remainder of rural crashes, despite the lower average impact speeds involved. Pole impacts were also more likely to result in fatal or severe injuries (75%) than were impacts with trees (66%) even though the latter mostly occurred on roads having a speed limit of 100 or 110 km/h. Many of the trees were large, such that the collision was similar to an impact with a rigid barrier rather than a pole. All of these poles were formed from two rolled steel joists separated by concrete (commonly referred to as “Stobie poles” after the name of the South Australian design engineer). Made in various sizes, they present a comparatively narrow rigid object to a colliding car, often resulting in severe intrusion into the passenger compartment even in comparatively low speed collisions. In the event of high impact speeds, the resulting injuries are very severe. Of the five crashes on roads with speed limits above 60 km/h, two produced hospital admissions, and another two produced three fatalities between them.

In the only case in which the crash occurred on a divided road, the vehicle struck the pole on the left side of the road.

13.5 Guard rails or crash barriers

As shown in Table 13.1, there were six single vehicle crashes in which a guard rail or crash barrier was struck by the vehicle. This represents six per cent of the sample of single vehicle crashes. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 50 per cent of cases, compared to 60 per cent for the remainder of single vehicle crashes. These six collisions involved seven different impacts with a guard rail or crash barrier, because there was one crash in which a truck struck a guard rail on the left side of the road before rolling and striking a crash barrier on the right side of the road. The summary of single vehicle collisions with guard rails or crash barriers provided in Table 13.6 omits this secondary impact.

Table 13.6
Single Vehicle Rural Road Crashes Involving Collisions With Guard Rails or Crash Barriers

Variable	Number	Per cent
Straight Road	-	-
Right Curve	2	33.3
Left Curve	4	66.7
Guard Rail on Left	6	100.0
Guard Rail on Right	-	-
Speed Limit > 90	3	50.0
Divided Road	2	33.3
Total	**6**	**100.0**

Note: A crash cushion is classified as a guard rail or crash barrier for the purpose of this analysis.

One aspect of guard rail crashes emerging from Table 13.6 that is likely to be indicative of the nature of such collisions was the over representation of curved roads. All of these 6 cases involving a collision with a guard rail occurred on a curved road. This is, of course, likely to be due to guard rails being placed more often on curved rather than straight sections of road.

Another point of interest in Table 13.6 is the fact that almost all the impacts with guard rails occurred on the left side of the road. There were two cases out of the eight (including the multiple vehicle crashes) in which the vehicle striking the guard rail veered back across the roadway after the collision. In one case, after the impact with the guard rail on the outside of a left curve, the driver steered the car back across the roadway and onto the other side of the road. It could it not be argued that there was any failure of the guard rail or crash barrier implicated in the vehicle moving across the roadway to the right following the impact. In the other case, the vehicle involved was a small truck. The truck first struck a guard rail on the left side of a left curve before rolling onto its side and striking the concrete crash barrier on the right side of the road. Given the likelihood of load shift contributing to the rollover, it would seem that the guard rail's performance in the first impact was acceptable. The concrete barrier struck in the second impact prevented the truck from falling down a sheer drop to the other side of the divided road. Therefore, the second barrier operated successfully to prevent injuries, not only to the driver of the truck, but also to occupants of vehicles travelling in the opposite direction on the other side of the road.

That severe injuries occurred in 50 per cent of crashes including impacts with guard rails, which are designed to prevent injuries, is in need of clarification. Two of the crashes involved motorcycles colliding with a guard rail on the left side of a right curving road. One of the motorcycle riders was fatally injured and the other was admitted to hospital. In another crash, in which the driver of a car was admitted to hospital and the left front seat passenger was fatally injured, the event responsible for the severe injuries to the occupants was not the secondary impact with the guard rail but that with a tree.

In the fatal multiple vehicle crash including an impact with a guard rail, the impact with the guard rail was comparatively minor. All of the injuries would have resulted from the impact of the vehicle with a riverbank after it fell off the side of a bridge.

It also needs to be pointed out that this sample provides a misrepresentation of impacts with guard rails. Most impacts with guard rails would prevent the occurrence of severe injuries to vehicle occupants and would therefore prevent the collision from resulting in the need for an ambulance to be called. This would, in turn, result in the collision not being included in this study. Thus, there were likely to have been many impacts with guard rails and possibly also crash barriers that did not result in injurious crashes. To properly assess impacts with protection devices such as guard rails and crash barriers, a separate study would be required that did not have the selection criterion of an ambulance being called to the crash.

13.6 Steep drops

As noted in Table 13.1, there were five single vehicle crashes in which the vehicle went down a steep drop. These steep drops were either steep embankments sloping down from the road or sheer drops. These five crashes represent five per cent of the sample of single vehicle crashes. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 60 per cent of cases, compared to 59 per cent for the remainder of single vehicle crashes. A summary of single vehicle crashes involving steep drops is provided in Table 13.7.

Table 13.7
Single Vehicle Rural Road Crashes
Involving Steep Drops

Variable	Number	Per cent
Straight Road	2	40.0
Right Curve	2	40.0
Left Curve	1	20.0
Steep Drop on Left	1	20.0
Steep Drop on Right	4	80.0
Speed Limit > 90	4	80.0
Divided Road	-	-
Total	**5**	**100.0**

The most noteworthy aspect of the sample of crashes in which steep drops played a part was that the fatalities resulting from them could have been prevented. In the multiple vehicle crash that produced a fatality, the vehicle broke through a fence on the side of a bridge before falling 12 metres to a riverbank. The fence on the side of a bridge that supports a roadway 12 metres above a river should be able to prevent a vehicle from crashing through it if the vehicle is travelling at a speed within the normal range of vehicles using that road. The car that crashed in this case was not travelling above the 60 km/h speed limit, yet the fence it struck was inadequate for containing it.

In the fatal single vehicle crash involving a steep drop, there was a 10 metre gap in a sequence of temporary crash barriers. A four wheel drive veered off the right side of the road on a right bend and travelled through this gap, before falling down a sheer drop. Other temporary barriers were available on site that were not being used at the time and could have been placed at this location to prevent vehicles running or being driven onto the roadside and over the edge of the precipice.

13.7 Drains and culverts

As noted in Table 13.1, there were four single vehicle crashes in which the vehicle collided with a drain. This represents four per cent of the sample of single vehicle crashes. These four crashes resulted in no fatalities but one of the six vehicle occupants was admitted to hospital.

Of the four crashes, three occurred on roads with speed limits of 100 or 110 km/h, two occurred on right curves, and all four impacts occurred on the left side of the road.

The one crash in which a hospital admission resulted involved a car that veered off the left side of the road, struck a tree and fell into a large drain. In this case, it is likely that the injuries sustained by the driver were caused chiefly by the initial impact with the tree. The drain was not the only roadside hazard involved in two of the other crashes. In one, the vehicle also ran up a slight embankment before a wheel dropped into a culvert and the vehicle rolled onto its side, whilst in the other, the vehicle also struck trees on the side of the road before falling into the drain. The remaining case was a minor impact with a drainage channel that caused the tyre of the vehicle colliding with it to blow out.

13.8 Other roadside hazards

As noted in Table 13.1, there were six single vehicle crashes in which the vehicle collided with roadside objects not fitting into any of the other categories. This represents six per cent of the sample of single vehicle crashes. These collisions produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in one third of the six cases, compared to 61 per cent for the remainder of single vehicle crashes. The objects struck included rocks (three cases), a water meter, a kerb, and a directional sign. In the multiple vehicle crashes, the objects involved were a large log, a bird bath and a ditch. A summary of single vehicle crashes involving impacts with miscellaneous roadside objects is provided in Table 13.8.

Table 13.8
Single Vehicle Rural Road Crashes
Involving Miscellaneous Roadside Objects

Variable	Number	Per cent
Straight Road	2	33.3
Right Curve	2	33.3
Left Curve	2	33.3
Object on Left	3	50.0
Object on Right	3	50.0
Speed Limit > 90	5	83.3
Divided Road	-	-
Total	**6**	**100.0**

Analysis of this group of crashes is complicated by the fact that it is not homogenous with regard to the objects struck. Each different type of roadside hazard needs to be treated separately.

The three single vehicle crashes involving collisions with rocks produced injuries of sufficient severity to require hospital admission for the driver in one case. In this crash, the driver said that the car veered over to the incorrect side of the road in heavy rain, before going down an embankment into a dry riverbed strewn with large rocks. Due to the inability to conduct a detailed interview with the elderly driver and access her medical records, it was not possible to determine what was primarily responsible for causing whatever injuries she sustained. Nonetheless, it is likely that impacts with the rocks would have contributed to the driver's injuries.

In the other two cases involving rocks, the driver was also the only occupant of the vehicle and any injuries sustained were relatively minor. In the first, the car involved hydroplaned across a wet road onto the right shoulder, before striking some large rocks, rolling down the side of a hill and colliding with a fence. In the second, the driver veered across to the right shoulder, crashed through a fence, side swiped a tree and mounted a large pile of dirt and rocks by the side of a vineyard. The vehicle became airborne before landing on top of the rocks and dirt. Neither of these drivers sustained any significant injuries.

In two cases, the vehicle occupants did not suffer severe injuries despite colliding with roadside hazards. In one case, the car struck guide posts and a large sign indicating the direction of nearby towns. In the other, the car struck a small tree and a water meter. None of the objects struck in these two collisions were sufficiently large and rigid to pose a threat to the occupants of vehicles striking them.

In the remaining single vehicle crash, the vehicle involved struck kerbing on the left side of the road, which tore the left rear wheel from the car. The vehicle then ran up an embankment and rolled over.

In two of the three multiple vehicle collisions, the collision with the other vehicle produced the injuries that resulted in the vehicle occupants being admitted to hospital, rather than the impact with the bird bath in one case or the vehicle veering into a large ditch in the other. In the remaining case, both the impact with the second vehicle and that with a large log on the side of the road were substantial and could have played a role in causing the severe injuries sustained by the driver of the car. The front seat passenger of the car was ejected through the windshield but is believed not to have suffered serious injuries.

13.9 Rollovers

As shown in Table 13.1, there were 39 single vehicle crashes in which the vehicle rolled over. This represents 37 per cent of the sample of single vehicle crashes. These crashes produced injuries severe enough to cause death or require hospital admission for one or more vehicle occupants in 49 per cent of cases, compared to 65 per cent for the remainder of single vehicle crashes. A summary of single vehicle collisions involving rollovers is provided in Table 13.9.

Table 13.9
Single Vehicle Rural Road Crashes
Involving Rollovers

Variable	Number	Per cent
Straight Road	18	46.2
Right Curve	13	33.3
Left Curve	8	20.5
Rollover on Left	22	56.4
Rollover on Right	17	43.6
Speed Limit > 90	31	79.5
Divided Road	6	15.4
Total	**39**	**100.0**

Note: In cases in which the vehicle rolled over on the road, the rollover was classified as being on the left side of the road if it was precipitated on the left side of the road, and vice versa for rollovers precipitated on the right side of the road.

The analysis of the relative severity of rural road crashes involving rollovers is complicated by the common involvement of additional impacts with roadside hazards. Table 13.10 provides a summary of the other roadside hazards struck by vehicles that rolled over.

Table 13.10
Other Roadside Hazards Involved in
Single Vehicle Rollovers

Hazard	Number	Per cent
Tree	16	37.2
Embankment	13	30.2
Fence	8	18.6
Guard Rail	2	4.7
Steep Drop	1	2.3
Drain/Culvert	1	2.3
Utility Pole	-	-
Other	2	4.7
Total	**43**	**100.0**

Note: individual crashes may involve more than one roadside hazard, and a crash cushion is classified as a guard rail or crash barrier for the purpose of this analysis.

As can be seen in Table 13.10, the roadside hazards most commonly involved in rollover crashes were trees, followed by embankments. None of the 12 impacts with utility poles, however, were associated with rollovers, possibly because of the comparatively low speeds at which these crashes occurred. There were six single vehicle rollovers in which no roadside hazard was involved. In the three multiple vehicle crashes involving rollovers, one included an impact with a guard rail, one an impact with a fence, and the remainder did not involve a roadside hazard.

Table 13.11 provides a summary of the severity of injuries sustained by vehicle occupants in the rollover crashes, according to the other roadside hazards struck in the crash. For each type of roadside hazard, the table lists the number of vehicle occupants sustaining injuries that proved fatal or that required hospital admission.

Table 13.11
Vehicle Occupants Fatally Injured or Requiring
Admission to Hospital Following a Single
Vehicle Rollover and Impact with Another
Roadside Hazard

Hazard	Number	Per cent
Tree	15	50.0
Embankment	5	27.7
Fence	2	22.2
Guard Rail	-	-
Steep Drop	-	-
Drain/Culvert	-	-
Utility Pole	-	-
Other	1	50.0
Total	**23**	**46.4**

Note: individual crashes may involve more than one roadside hazard, and a crash cushion is classified as a guard rail or crash barrier for the purpose of this analysis. There were four vehicle occupants admitted to hospital after rollovers in which no roadside hazards were struck.

As can be seen from Table 13.11, single vehicle rollovers including collisions with trees were more likely to have produced severe injuries than rollovers involving other roadside hazards. Although embankments were involved in 13 rollover crashes, only five vehicle occupants sustained severe injuries.

When considering the role of roadside hazards in rollover crashes, it is also necessary to determine how often the rollover was caused by, or was a consequence of, the impact with the roadside hazard. Table 13.12 provides a summary of the number of rollovers precipitated by collisions with each type of roadside hazard.

Table 13.12
The Number of Single Vehicle Rollovers Precipitated by an Impact with Another Roadside Hazard

Hazard	Number	Per cent
Embankment	13	100.0
Tree	8	50.0
Fence	6	75.0
Steep Drop	1	100.0
Drain/Culvert	1	100.0
Guard Rail	-	-
Utility Pole	-	-
Other	2	100.0
Total	**28**	**84.8**

Note: The percentages in the table refer to the percentage of crashes for each hazard in which the collision with the hazard precipitated a rollover. The total refers to the total number of rollover crashes involving an impact with a roadside hazard in which the rollover was precipitated by the roadside hazard collision. The total is not the sum of numbers in the column above it because in some crashes, the rollover was precipitated by more than one hazard. A crash cushion is classified as a guard rail or crash barrier for the purpose of this analysis.

Table 13.12 shows that in approximately 85 per cent of single vehicle rollovers in which an impact with a roadside hazard occurred, the rollover was actually precipitated by the roadside hazard collision. When rollovers without roadside hazard collisions are included, the proportion of rollovers precipitated by impacts with roadside hazards remains substantial (72%). Also revealed by Table 13.12 is that in every single vehicle rollover including an impact with an embankment, it was the impact with the embankment which caused the rollover to occur. Fences were also likely to be associated with rollovers (75%), whilst when trees were involved, the rollover resulted from the tree impact in half of the crashes. This tendency for rollovers to result from impacts with roadside hazards suggests that if hazards were removed from the roadside environment, not only would there be less injuries resulting directly from vehicular impacts with them, but there would also be a reduction in injuries resulting from rollovers.

In the three multiple vehicle collisions involving rollovers, one case resulted in a car rolling onto a guard rail and another included a minor impact with a fence.

13.10 Distance of hazards from the road

The further from the edge of the road a hazard is located, the less likely it is to be struck and the lower the impact speed in the event of a collision. Conversely, when a fixed roadside object is close to the edge of the road, it is more likely to be struck and more likely to be struck at a higher impact speed. This section details the relationship between collisions with hazards and their distance from the roadway for the rural road crashes investigated in this study.

The following three tables detail the distances from the roadway of trees (Table 13.13), utility poles (13.14) and fences (13.15). These three hazards were chosen because they had sample sizes over 10 and because the locations of the hazards could be determined precisely.

Table 13.13
The Distance From the Edge of the Road of Trees Struck in Single Vehicle Rural Road Crashes

Distance (m)	Number	Per cent
< 3.1	18	30.5
3.1 – 6.0	25	42.4
6.1 – 9.0	13	22.0
Over 9.0	3	5.1
Total	**59**	**100.0**

As shown in Table 13.13, over 30 per cent of the collisions with trees on the side of the road occurred within three metres of the road edge and 95 per cent occurred within nine metres. The average distance of the trees from the roadway was 4.5 metres. In the two multiple vehicle collisions with trees, the trees were 4.8 and 2.7 metres from the roadway, respectively.

Table 13.14
The Distance From the Edge of the Road of Fences Struck in Single Vehicle Rural Road Crashes

Distance (m)	Number	Per cent
< 3.1	6	40.0
3.1 – 6.0	4	26.7
6.1 – 9.0	4	26.7
Over 9.0	1	6.7
Total	**15**	**100.0**

Note: The total is 15 for fence crashes because in one case, the distance of the fence from the roadway was unable to be measured.

As can be seen in Table 13.14, 40 per cent of the collisions with fences were within three metres of the roadway, and over 93 per cent were within nine metres. The average lateral displacement of the fences from the roadway was 4.6 metres. In the four multiple vehicle crashes involving collisions with fences, the distances of the fences from the roadway were 2.8, 5.9, 0.4 and 4.0 metres.

Table 13.15
The Distance From the Edge of the Road of Utility Poles Struck in Single Vehicle Rural Road Crashes Investigated

Distance (m)	Number	Per cent
< 3.1	4	33.3
3.1 – 6.0	7	58.3
6.1 – 9.0	-	-
Over 9.0	1	8.3
Total	**12**	**100.0**

According to Table 13.15, a third of the impacts with utility poles occurred within three metres of the roadway, and over 91 per cent occurred within nine metres. The average distance from the roadway of the poles struck in these crashes was 4.0 metres.

Therefore, it appears that a substantial proportion (approximately a third) of collisions with fixed roadside objects in rural areas occur within three metres of the edge of the road, while over 90 per cent occur within nine metres. The distances involved were similar for trees, poles and fences.

The question of whether greater injury severity results from collisions with objects closer to the roadway may be addressed by looking at the lateral displacement of objects struck in fatal crashes compared to those in which all vehicle occupants survived. This was done for trees only, because of the limited sample sizes available for fatal pole and fence collisions. Table 13.16 provides a summary of the distances of trees from the roadway in fatal tree collisions.

Table 13.16
The Distance From the Edge of the Road of Trees Struck in Fatal Single Vehicle Rural Road Crashes Investigated

Distance (m)	Number	Per cent
< 3.1	9	47.4
3.1 – 6.0	7	36.8
6.1 – 9.0	1	5.3
Over 9.0	2	10.5
Total	**19**	**100.0**

Table 13.16 shows that just under half of the fatal collisions with trees occurred within three metres of the edge of the road, compared with less than a quarter for crashes in which all vehicle occupants survived. When the distribution of distances in Table 13.16 was compared with that of the remainder of tree collisions in which all vehicle occupants survived, the difference was approaching statistical significance ($\chi^2_{(1)}$= 3.76, p=.053). In other words, fatal tree collisions tend to involve impacts with trees closer to the roadway than tree collisions in which all occupants survive. In the one fatal multiple vehicle collision involving an impact with a tree, the tree was 2.7 metres from the edge of the road.

These results are consistent with previous work on roadside hazards in South Australia. In particular, a study by Kloeden, McLean, Baldock and Cockington (1999) looked at fatal crashes in South Australia between 1985 and 1996 and found that when roadside hazards were involved, 55 per cent of them were reported to be three metres or less from the roadway. In that study, due to the methodology of examining coroner's reports rather than at-scene investigation, distances were rounded off to the nearest metre, so that a distance of 3.4 metres would be classified as 3 metres. Therefore, the 55 per cent quoted refers to the number of crashes closer than 3.5 metres from the roadway.

13.11 Summary of collisions with roadside hazards

One of the major threats to the safety of a vehicle occupant in the event of loss of vehicular control is the presence of hazards on the roadside. Injury can result from impacts with fixed objects or from rollovers precipitated by such impacts or by steep roadside gradients. These hazards not only cause injury in single vehicle crashes but they can also be involved in multiple vehicle collisions. In 31 midblock collisions resulting from one driver or rider's loss of vehicular control, there were 12 cases in which one or more of the vehicles struck roadside hazards as well as another vehicle.

In the sample of rural road crashes investigated for this study, the roadside hazards most commonly struck were trees, followed by fences, embankments, and utility poles. Rollovers were also very common, with tree impacts the only roadside hazard more numerous, although rollovers typically involved impacts with roadside objects as well. In fact, three quarters of rollovers were directly caused by collisions with roadside objects. The crashes most likely to involve fatalities or severe injury were those in which vehicles collided with trees or utility poles or in which the vehicle ran down a steep drop adjacent to the roadside.

One of the suggestions of past research on roadside hazards (see, for example, Kloeden et al, 1999) was that a clear zone of nine metres be provided on the sides of rural roads having a speed limit of 80km/h or higher. In this study, over 90 per cent of trees, poles and fences struck by vehicles that had run off the road were within nine metres of the edge of the roadway. Therefore, the clear zone suggested by Kloeden et al. would be expected to be very effective in reducing road trauma in rural areas. Even given that some vehicles striking hazards within this zone would have struck hazards beyond nine metres from the roadway if such a clear zone had been in place, the finding that fatal tree impacts tended to occur closer to the roadway more than less injurious ones suggests that, in addition to the clear zone reducing the number of crashes, it would also reduce the average severity of crashes.

Where roadside hazards cannot be removed or relocated from a nine metre clear zone, consideration could be given to the installation of some form of barrier to protect road users from striking hazards in the event of loss of vehicular control. If the installation of some physical barrier is considered not to be practicable, then a lower speed limit may be a suitable alternative method for reducing the risks posed by roadside hazards, by reducing the likelihood of a vehicle leaving the roadway.

Clear zones should not only include the roadside but also any central reservations on divided roads. Trees planted on the medians contributed to the deaths of three people in two crashes investigated as part of this study. Although trees can block the headlights of oncoming vehicles, thus preventing glare, and can also prevent out of control vehicles from reaching oncoming traffic, these desirable features of the central reservation can be achieved in other ways. Headlights producing glare can be blocked with smaller shrubs that lack a substantial rigid trunk and vehicles can be prevented from crossing the median by guard rails or other forms of barrier.

Care also needs to be taken in ensuring that steep slopes adjacent to the roadside are adequately protected. There were two crashes investigated as part of this study in which vehicles fell down large sheer drops, resulting in three fatalities.

14. OVERALL SUMMARY OF RURAL ROAD CRASHES

Rural road crashes tend to be severe. In the study sample of 236 rural road crashes to which an ambulance was called, over 55 per cent resulted in injuries severe enough to be fatal or require hospital admission for one or more of the vehicle occupants involved. One in every 10 vehicle occupants died as a result of injuries sustained in the crashes and one in every four was admitted to hospital. Even accounting for a degree of sampling bias in the study procedure, these figures represent a high level of severe injury and death on South Australian rural roads.

With regard to the types of roads involved, approximately two thirds were classified as rural highways (main rural roads under the control of Transport SA), with an additional 13 percent being national highways. Curved sections of road were common (over 40%) whilst sealed shoulders were not. Nearly 80 per cent of shoulders at the sites of rural crashes were unsealed. With regard to the drivers, the majority were male, and over 17 per cent were not in possession of a full driver's licence at the time of the crash.

The most common type of crash involved a single vehicle, accounting for nearly 45 per cent of the sample. The analysis of single vehicle crashes revealed an over representation of right curved sections of road, young, inexperienced drivers and drunk drivers. With regard to contributing factors, an unsealed shoulder contributed to half of this group of crashes, particularly when the vehicle ran off to the left on a straight road or on right curves. In many cases, the driver attempted to steer the vehicle back onto the road but overcorrected and lost control. Other common factors involved in the single vehicle crashes included problems with the road surface (either a deterioration of the surface or the presence of foreign material), a lack of edge lining, and problems with the layout (including unsealed road aprons located on the outside of right curves on sealed roads).

The second most common type of crash was a midblock collision. Curved roads and young, inexperienced drivers were again over represented. Head on collisions were the most severe crashes in this group and also the most common, comprising over half of the sample. In these head on collisions, the contributing factors tended to resemble those in single vehicle crashes, as would be expected given that head on collisions were mostly precipitated by one driver or rider losing control of their vehicle. Again, crashes were related to unsealed shoulders, particularly on curved sections of road, and problems with the road surface. In rear end collisions, U turn collisions and crashes involving vehicles entering or leaving driveways, a sight restrictions for one of the drivers involved was the most common factor to have contributed to the collision.

Crashes at intersections not controlled by signs or traffic signals occurred mostly during daylight hours, suggesting that a contributing factor was likely to be the failure of one driver or rider to see another vehicle, given that at night, headlights on vehicles improve their chances of being detected by other motorists. Unlike single vehicle and midblock collisions, which tended to involve young, inexperienced drivers and riders, crashes at uncontrolled intersections were more likely to involve elderly drivers. The most common factor contributing to this type of crash was a sight restriction at the intersection, often caused by vegetation or crests. These sight restrictions were in some cases related to the road layout (eg the location of T-junctions next to curves or crests).

Crashes at sign controlled intersections shared many of the characteristics of those at uncontrolled intersections. One difference was that the sample of sign controlled intersections crashes included intersections featuring higher density traffic, thus necessitating the sign control. These junctions between heavily trafficked roads require considerable thought when being designed to reconcile the competing demands of different sets of traffic. In some cases, the junctions investigated were found to have insufficient provisions for turning vehicles. The perceived need on the part of some motorists to steer their vehicles onto the sealed shoulder on the far side of the road into which they were turning represents a dangerous situation. Often the use of Stop Signs rather than Give Way Signs could be justified by sight restrictions at the intersections.

Other intersection crashes, in which a vehicle turning was struck by another vehicle travelling on the same road (and in the majority of cases, in the opposite direction), also shared many of the characteristics of crashes at uncontrolled or sign controlled intersections. However, these crashes also revealed the importance of conspicuity of vehicles on rural roads, and also how conspicuity of vehicles is affected by the road environment. In particular, roadside trees not only pose a hazard when struck by vehicles that have run off the road but they can also effectively camouflage vehicles on the road (particularly those that are less conspicuous) both with the shadows they cast and the dark backdrop they create.

Crashes at locations controlled by traffic signals were uncommon due to the rarity with which traffic signals are used to control rural intersections. There were two crashes occurring at railway crossings. In one case, the crossing was very close to a curve and the driver was affected by sun glare, while, in the other, the railway crossed the road at an angle and lacked proper road markings.

When only those crashes precipitated by one driver or rider's loss of vehicular control were considered, it was found that the consequence of loss of control on rural roads was most commonly a collision with a tree. The next most common result was a vehicle rollover, followed in order of frequency by a collision with another vehicle, a collision with a fence, a collision with an embankment and a collision with a utility pole. Rollovers also tended to involve impacts with other roadside hazards. The most severe crashes, in terms of injuries, were those with trees, followed by utility poles, and those involving the vehicle falling down a steep drop, although there were relatively few crashes in the latter category.

15. RECOMMENDATIONS

Based on the summary contained in Section 14, a number of recommendations can be made concerning the road infrastructure which could aid in reducing the toll of fatalities and serious injuries sustained by vehicle occupants in rural road crashes.

(1) In light of the frequency with which unsealed shoulders contributed to single vehicle crashes, and multiple vehicle head on collisions, it is recommended that the shoulders of all highways and major rural roads be sealed to a width of at least half a metre, with priority given to sealing shoulders on the outside of curves.

(2) Additionally, given that drivers or riders overcorrected the steering of their vehicles in many cases involving loss of control and unsealed shoulders, it is recommended that the feasibility of a public education campaign concerned with control of a vehicle in the event of dropping a wheel onto an unsealed shoulder be investigated.

(3) Given the occurrence of a number of crashes related to the road surface, in some cases after road works had been conducted, it is recommended that a policy be introduced to formalise a procedure for the investigation of reports of hazardous road surfaces and the monitoring and inspection of sites at which road works have recently been undertaken.

(4) In light of the contribution of a lack of edge lining to single vehicle crashes, it is recommended that all highways and major rural roads have edge lining, with priority given to marking the outsides of curves. This edge lining could be introduced in conjunction with the shoulder sealing described in recommendation (1).

(5) In addition to the sealing of shoulders, it is also recommended that the aprons of unsealed roads adjoining sealed roads be sealed, with priority given to unsealed road aprons forming T-junctions with sealed roads on the outside of curves.

(6) Due to a number of collisions at intersections occurring where the view of the other road was obscured by vegetation for one of the drivers or riders, it is recommended that signage at all intersections of major rural roads and highways be reviewed. In particular, if the intersecting road does not have a Stop Sign, the degree of visibility available to drivers and riders should be sufficient to be able to give way without first having to stop.

(7) Due to the prevalence of multiple vehicle collisions at intersections resulting from sight restrictions imposed by curves or crests, it is recommended that all new roads be designed, where practicable, so that no intersections occur within 100 metres of a curve or crest that restricts vision of an intersecting road.

(8) In addition to recommendation (7), the review of signage at intersections undertaken with regard to roadside vegetation, described in recommendation (6), should also take into account the sight restrictions, and consequences for signage, of crests and curves in the intersecting roads.

(9) A number of intersections were identified at which inadequate provisions were made for drivers turning right. In particular, it was noticed at two intersections that drivers turning right would turn onto the sealed shoulder on the far side of the road before merging to the right. It is recommended that the feasibility of engineering treatments for such intersections be investigated, and that other major intersections of multi-lane roads be

reviewed to determine the ease with which motorists are able to turn right and merge with traffic on the intersecting road.

(10) Given the high frequency of impacts with fixed roadside objects adjacent to the roadside, it is recommended that a clear zone of nine metres be established, where practicable, on new rural roads with a speed limit above 80 km/h. A program should also be introduced to clear the roadside of rigid fixed objects to a distance of nine metres, where practicable, on the outside of curves. Where roadside objects cannot be removed, safety barriers should be installed along the side of the road and/or consideration be given to reducing the speed limit to reduce the likelihood of a vehicle running off the road.

(11) Due to the incidence of collisions with trees on the central reservations of divided roads, it is recommended that the recommendations in item (8) be implemented as a matter of urgency and that tree planting policies on medians be reviewed. Safety barriers can provide the advantages of having trees on medians without the high likelihood of high injury severity crashes.

(12) In view of the high injury severity resulting from impacts with Stobie poles, despite their occurrence typically in 60 km/h zones, it is recommended that a review be conducted of the best methods available for treating the hazards posed by roadside utility poles.

(13) As severe injuries resulted from vehicles falling down steep slopes and sheer drops, it is recommended that all such features adjacent to the roadside be protected by a safety barrier that is sufficient to prevent vehicles travelling within the normal range of vehicle speeds seen on the road from crashing through it.

(14) In addition to recommendation (13), fences along bridges should be reviewed to ensure that they are adequate and in an acceptable state of repair.

(15) Also, as a thorough understanding of the nature of road crashes and the contribution of the road infrastructure to their occurrence is essential for determining the facets of the road environment that need attention, it is recommended that the in-depth investigation of rural road crashes become a routine component of the operation of road transport system.

16. REFERENCES

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