ADELAIDE IN-DEPTH ACCIDENT STUDY

1975-1979

PART 7: ROAD AND TRAFFIC FACTORS

by

A.J. McLean
W.J. Offler
B.L. Sandow

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ABSTRACT : This report contains a review of those features of the road and traffic environment that were relevant to the causation or consequences of the accidents in a representative sample of accidents to which an ambulance was called in metropolitan Adelaide. The review is presented in the context of descriptions of the accidents in order to demonstrate the interactions between road and traffic factors and those relating to the vehicles and to the road users. Infringement of a traffic rule was the most common factor but this was often more a description of what happened rather than an adequate explanation. Excessive speed was also a prominent factor, even though the actual speed may have been below the legal limit, in collisions at sign-controlled and uncontrolled intersections. Safe approach speeds to uncontrolled intersections were such that a strong case can be made for the provision of some form of control. Fail-to-stand accidents were the most common type of collision at signalised locations, with auxiliary kerb lanes appearing to exacerbate the problem. Characteristics of the road surface were rarely relevant, possibly because the surface was generally dry and of good quality. Roadside objects played a role in determining the consequences of about one-third of the accidents.

*Non IRRD Keywords

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FOREWORD

This study was conducted by the Road Accident Research Unit of the University of Adelaide and was jointly sponsored by the Office of Road Safety, Commonwealth Department of Transport and the Australian Road Research Board.

The general aims were to evaluate the effectiveness of many existing safety measures and to identify other factors related to accident or injury causation in road accidents in metropolitan Adelaide. The areas studied included characteristics of road users, the vehicles and the road and traffic environment.

To achieve these aims a representative sample of all road accidents to which an ambulance was called in the Adelaide metropolitan area was studied in the 12 months from March 1976. Two teams, each comprising a medical officer, an engineer and a psychologist attended 304 randomly selected accidents and collected medical, engineering and sociological data.

The findings are presented in a series of reports, each covering a specific topic. Part 1 provides an overview, and is followed by reports dealing with pedestrians, pedal cyclists, motorcyclists, commercial vehicles, passenger cars and road and traffic factors. The final report in the series provides a summary of the findings and recommendations.

Basic data from the study are held on computer by both the Road Accident Research Unit, University of Adelaide and the Australian Road Research Board. Access to these data can be arranged for bona fide research workers on application to the Australian Road Research Board. Further copies of this report and copies of other reports in the series are available from the Office of Road Safety, Commonwealth Department of Transport.

ACKNOWLEDGEMENTS

The collection of data at the scene of the accident and in the follow-up investigations was performed by:

H.S. Aust and C.T. Hall
(Engineers)

N.D. Brewer and B.L. Sandow
(Psychologists)

J.R. Lipert and P.J. Tamblyn
(Medical Officers)

The completion of this study was due mainly to the willingness of these team members to work exceptionally long hours under difficult and often hazardous conditions.

Much of the road and traffic data was collected by W.J. Offler, who also attended the scenes of the accidents during the final three months.

The recorded information was processed by the above personnel, assisted by J.K. Darwin, G.M. Haymes, O.T. Holubowycz and C.A. Latta.

Mr. R.W. Scriven of the Highways Department of South Australia reviewed much of the material in this report and assisted with many constructive suggestions.

The Steering Committee for the study provided valuable assistance and advice. Its members were: Professor R.E. Luxton (Chairman), Professors: I.D. John, R.B. Potts, J.S. Robertson, A.T. Welford, Drs.: B.L. Cornish (representing the Director-General of Medical Services), I.R. Johnston (D.O.T.), J.B. Metcalf (A.R.R.B.), G. Sved, A.P. Vulcan (D.O.T.), and Messrs.: J.F.M. Bryant (A.R.R.B.), R. Culver, H.E. Roeger (later R.W. Scriven and then M. Knight) (representing the Commissioner for Highways), R. Ungers (D.O.T.) and F.E. Yeend (D.O.T.). The first Chairman was the late Professor N.T. Flentje.

The St. John Ambulance Transport Division played an essential role in the conduct of this study by notifying the Road Accident Research Unit when an ambulance was called to attend a road accident. The South Australian Highways Department, the Road Traffic Board, and the Police Department cooperated in many ways in the execution of this study, as did the Hospitals Department. The proprietors and operators of towing services and crash repair shops facilitated inspections of the damaged vehicles.

The sponsorship and advice of the Office of Road Safety of the Commonwealth Department of Transport and the Australian Road Research Board are gratefully acknowledged.

The final acknowledgement is due to the persons who were involved in the accidents studied and who cooperated freely with the members of the research teams.

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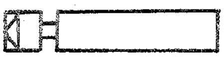
Legend for Scale Plans.

 Semi-trailer

 Bus

 Car

 Small car

Motor cycle/
Pedal cycle

 Motor cycle on side

 Pedal cycle on side

 Subscripts denote
accident sequence

Person

$1_{1}, 2_{3}$ Unit number with
subscript indicating
time sequence

U Uninvolved vehicle

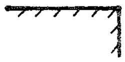
Separation line

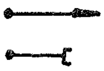
Kerb/Stop line

Unkerbed pavement edge

Lane markings

Boundary/Fence

 Building

 Traffic signals
(Walk sign)

Type of street lamp:
fluorescent

mercury vapour

sodium vapour

incandescent

Utility pole

 Tree

1. INTRODUCTION

A sample of accidents to which an ambulance was called in the Adelaide metropolitan area was investigated at the scene by multi-disciplinary teams from the Road Accident Research Unit of the University of Adelaide. This survey, which ran for twelve months from 23 March, 1976, was sponsored by the Commonwealth Department of Transport and the Australian Road Research Board. Each accident was studied by an engineer, a psychologist and a medical officer. Their observations at the scene started an average of ten minutes after the ambulance was called and were supplemented by further investigations including interviews with the drivers and other active participants (pedestrians and cyclists), detailed examination of the accident site and observation of traffic behaviour at the same time of day as the accident. The injured persons were examined and interviewed in hospital and the vehicles were inspected in towing service depots and elsewhere.

An eight per cent sample, totalling 304 accidents, was obtained of all road accidents as defined above. The sample was representative of this accident population by time of day and day of week.

The purpose of this survey, the sampling technique and the method of investigation are described in detail in another report in this series (Part 1: An Overview) together with a review of the types of accidents investigated and an outline of the general conclusions.

This report contains detailed descriptions of most of these accidents, classified as listed in Section 2.1. A discussion of the relevance of road and traffic factors follows each section. Pedestrian accidents are described in Report No.2 of this series (McLean, Brewer and Sandow, 1979a) and the reader is referred also to the discussion of road and traffic factors in Chapter 6 of that Report. The inclusion of the accident descriptions in the main text, rather than as appendices, has been done to emphasise the many factors that can play a role in accident causation and to try to place road and traffic factors in the correct overall context. The final Chapter represents an attempt to draw together the comments on the relevance of road and traffic factors and to list their relative importance in determining the causation and consequences of the accidents studied. Recommendations based on the findings of the study are included in Chapter 8.

2. TYPES OF ACCIDENTS

2.1 CLASSIFICATION OF TYPE OF ACCIDENT

The 304 accidents in the study have been classified on the basis of the road and traffic characteristics of the accident site. The categories used for this classification are:

- Single vehicle accidents (72),
- Midblock collisions between vehicles (40),
- Uncontrolled intersection accidents (60),
- Sign-controlled intersection accidents (47),
- Accidents at signalised locations (45), and
- Pedestrian accidents (40).

The number of accidents in each category are shown in parentheses. Most (86 per cent) of the single vehicle accidents occurred at midblock locations but they are considered separately from midblock collisions between two or more vehicles because the patterns of causal factors differ considerably for these two types of accident.

2.2 TIME OF DAY, DAY OF WEEK AND ALCOHOL INVOLVEMENT

2.2.1 TIME OF DAY

The time of day at which the accidents occurred in each of the above-listed six categories is shown in Figures 2.1 to 2.6. The distribution of single vehicle accidents by time of day differs markedly from the distributions for other categories of accident, there being a much greater proportion of accidents after midnight (Figure 2.1). There were relatively few single vehicle accidents before 4 p.m.. Midblock collisions between vehicles, while occurring throughout the day, tended to be concentrated between the hours of 2 p.m. to 8 p.m. (Figure 2.2). The distribution of pedestrian accidents shows three peaks: at the hours commencing at 8 a.m., 3 to 4 p.m. and 7 p.m. (Figure 2.6).

Accidents at intersections show some differences in distribution by time of day according to the presence, and type, of traffic control at the intersection. The distribution for accidents at uncontrolled intersections shows a marked peak in the two hours from 4 p.m. (Figure 2.3). It is possible that with a larger sample size the distribution for accidents at sign-controlled intersections would be similar but, as shown in Figure 2.4, it is relatively uniform over the hours from 11 a.m. to 8 p.m. Accidents at signalised locations (mainly intersections, pedestrian crossing accidents being listed in Figure 2.6) are shown in Figure 2.5 where it can be seen that, compared to the distributions in Figures 2.3 and 2.4, there were relatively more accidents at signalised intersections during the morning peak period and after 8 p.m. and comparatively few between 10 a.m. and 2 p.m.

2.2.2 DAY OF WEEK

The percentage of accidents that occurred on a Saturday or a Sunday was between 31 and 33 for accidents at intersections, 25 for midblock collisions and 35 for single vehicle accidents. Only one eighth, 13 per cent, of the pedestrian accidents occurred on a Saturday or a Sunday.

2.2.3 ALCOHOL INVOLVEMENT

Figures 2.1 to 2.6 also show those accidents in which one or more of the active participants (driver, rider or pedestrian) was known to have had a blood alcohol concentration (BAC) above 0.05. There were other accidents in which there was evidence that an active participant was intoxicated but no BAC reading was obtained. Those accidents are noted in the following chapters.

Accidents at intersections had the lowest rate of alcohol involvement, as defined above, with the rate of involvement being 13 per cent for uncontrolled intersection accidents, 15 per cent at sign-controlled intersections and 18 per cent at signalised intersections. One-fifth (20 per cent) of the midblock collisions between vehicles involved one or more driver or rider whose BAC was known to have been above 0.05 as did 18 per cent of the pedestrian accidents (including intoxicated pedestrians).

Single vehicle accidents can be characterised as being the alcohol-related crashes. Forty-nine per cent of the accidents in that category involved alcohol.

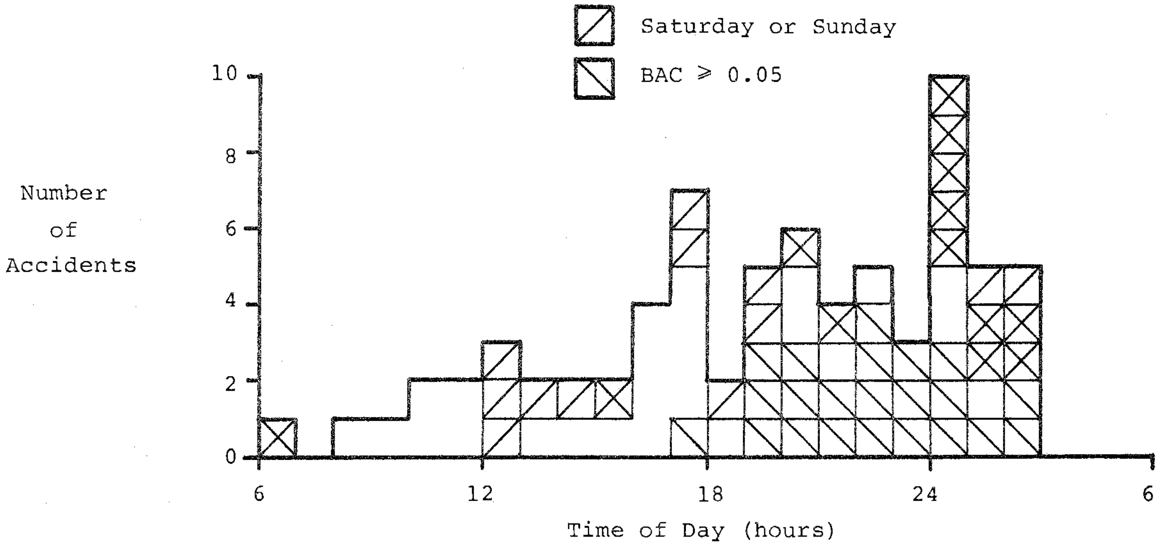
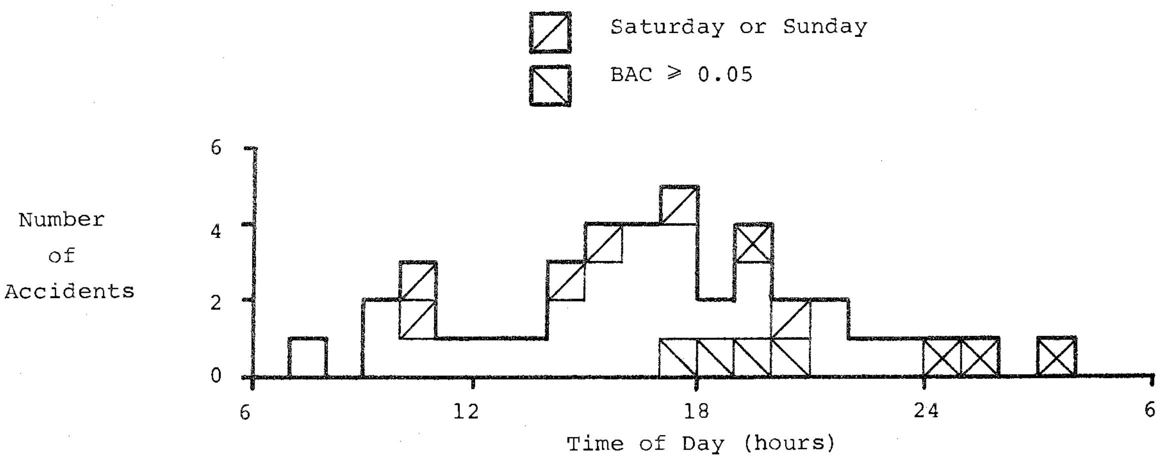


FIGURE 2.1: TIME OF DAY, DAY OF WEEK AND ALCOHOL INVOLVEMENT: SINGLE VEHICLE ACCIDENTS.



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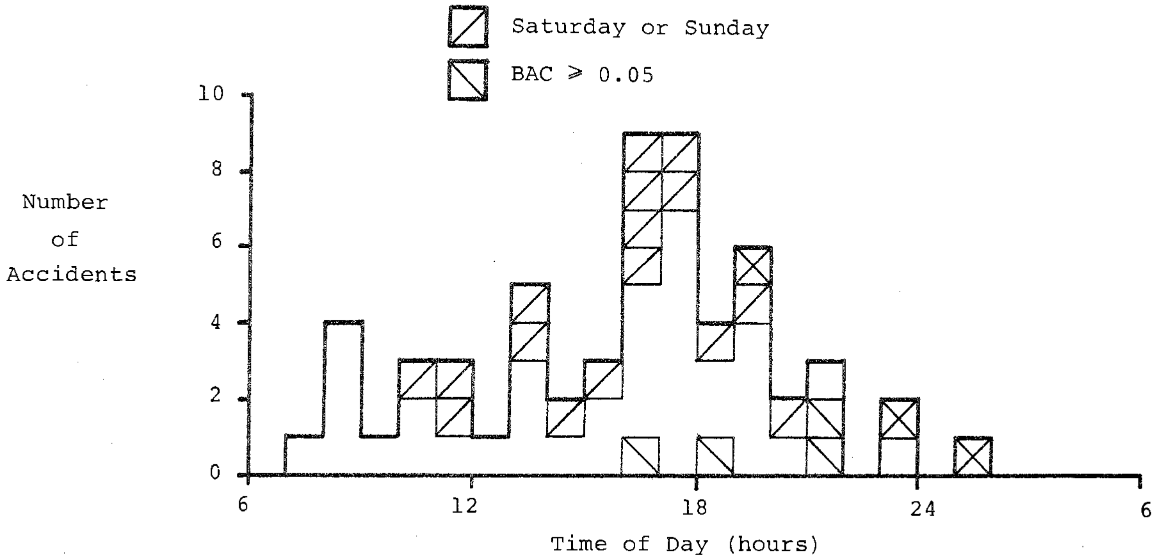


FIGURE 2.3: TIME OF DAY, DAY OF WEEK AND ALCOHOL INVOLVEMENT: UNCONTROLLED INTERSECTION ACCIDENTS.

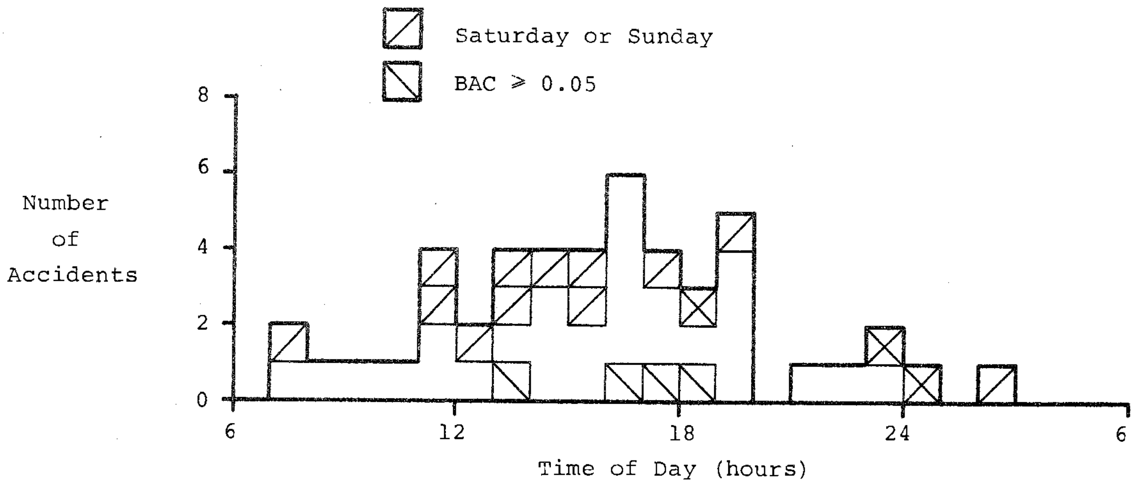
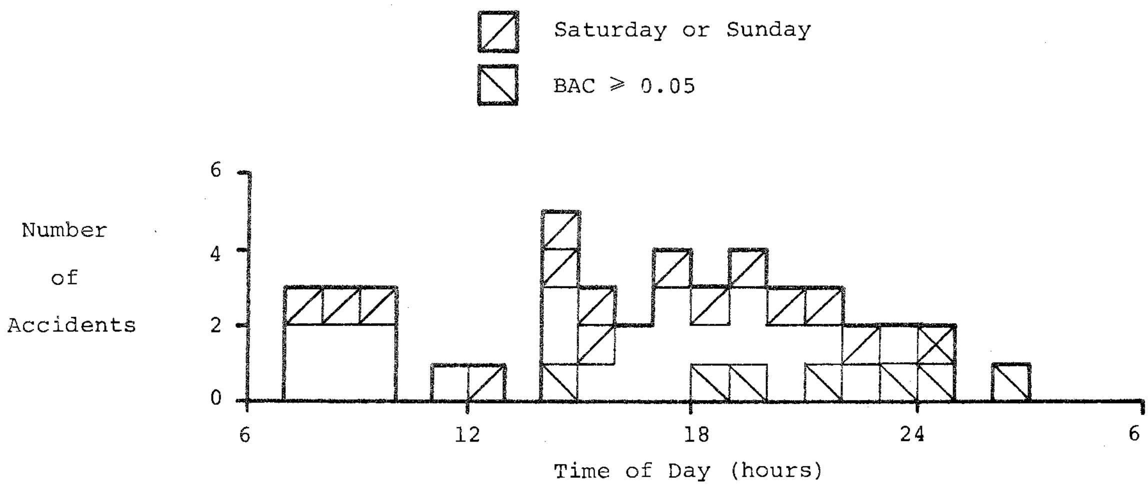


FIGURE 2.4: TIME OF DAY, DAY OF WEEK AND ALCOHOL INVOLVEMENT: SIGN-CONTROLLED INTERSECTION ACCIDENTS.



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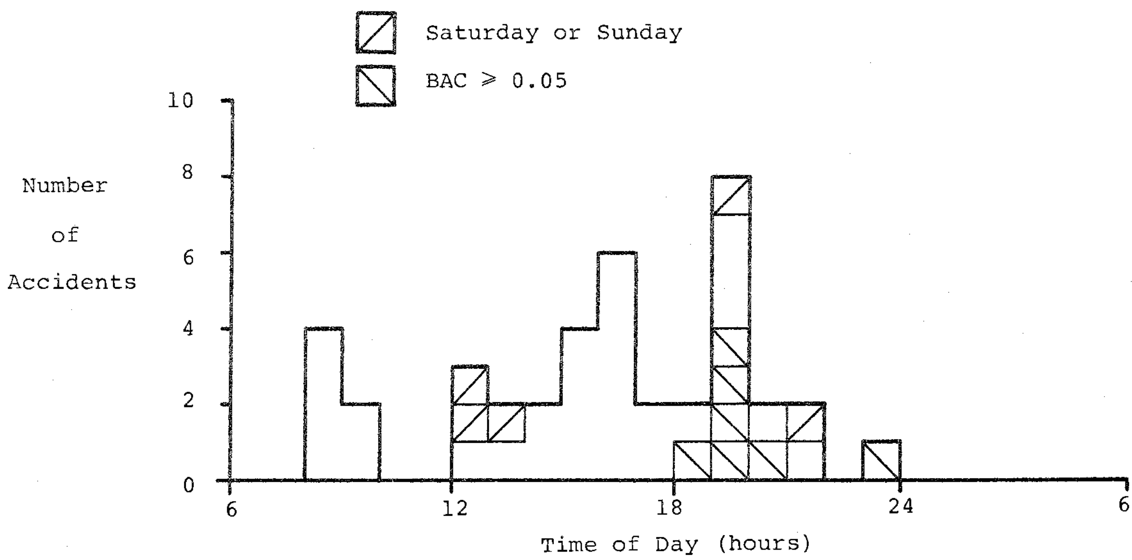


FIGURE 2.6: TIME OF DAY, DAY OF WEEK AND ALCOHOL INVOLVEMENT: PEDESTRIAN ACCIDENTS.

2.3 CHARACTERISTICS OF THE ACTIVE PARTICIPANTS

The term "active participant" is used in the reports on this study to identify those persons who were actively involved in the accident, such as drivers, riders of motorcycles or pedal cycles and pedestrians. Other persons involved in the accident are referred to simply as "participants".

2.3.1 AGE AND SEX

The age and sex groupings for these active participants are shown for the different accident classifications in Tables 2.1 and 2.2 respectively. The relatively large number of children and elderly persons involved as pedestrians is indicated by the high percentages in those age categories. Single vehicle accidents are characterized by a high proportion of drivers and riders in the 16 to 20 year age group. Table 2.2 shows a high rate of involvement of female drivers in accidents at sign-controlled intersections. When compared to the corresponding proportion in accidents at uncontrolled or at signalised intersections this difference is statistically significant at the 10 per cent level in the latter comparison and may therefore warrant further investigation.

2.3.2 DRIVING EXPERIENCE

The period for which those active participants who were operating a motor vehicle at the time of the accident had been licensed is shown in Table 2.3. The relatively high number of inexperienced drivers and riders involved in single vehicle accidents is consistent with the above-noted high percentage in the 16 to 20 age group for that type of accident, which is also characterised by high alcohol involvement (Figure 2.1). The operators of motor vehicles that struck pedestrians included a high proportion (54 per cent) who had been licensed for 10 years or more. This percentage is significantly greater than the 38 per cent for all other operators in Table 2.3 ($p < 0.05$).

2.4 INJURIES

The severity distribution for the injuries sustained by all of the participants involved in these accidents is presented by type of accident in Table 2.4. The high percentage of uninjured persons in pedestrian accidents is due to the fact that the occupants of the striking vehicle are rarely injured. Single vehicle crashes accounted for four of the seven fatalities and had the lowest percentage (16) of uninjured participants. This is reflected in the correspondingly high frequency of extended periods of restricted activity resulting from these injuries (Table 2.5). The severity of the injuries among the pedestrians is apparent even with the "diluting" effect of the uninjured car occupants. The serious nature of the pedestrians' injuries is again reflected in Table 2.5.

TABLE 2.1: AGE OF ACTIVE PARTICIPANT BY TYPE OF ACCIDENT

Age (Years)	Type of Accident													
	Single vehicle		Mid-block collision		Uncontrolled intersection		Sign-controlled intersection		Signalised location		Pedestrian		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0- 5	-	-	-	-	-	-	-	-	-	-	5	6.0	5	0.9
6-10	-	-	2	2.7	2	1.7	-	-	-	-	4	4.8	8	1.5
11-15	2	2.7	3	4.0	1	0.8	1	1.0	-	-	5	6.0	12	2.3
16-20	25[1]	33.8	18	24.0	32	27.1	27	28.1	26	29.9	13	15.7	141	26.5
21-25	17	23.0	19	25.3	24	20.3	17	17.7	20	23.0	11	13.3	108	20.3
26-35	17[1,2]	23.0	14	18.7	27	22.9	24	25.0	18	20.7	17	20.5	117	22.0
36-50	4	5.4	8	10.7	13	11.0	11	11.5	9	10.3	8	9.6	53	9.9
51-65	6	8.1	9	12.0	12	10.2	9	9.4	9	10.3	13	15.7	58	10.9
Over 65	3	4.1	2	2.7	7	5.9	7	7.3	5	5.7	7	8.4	31	5.8
Unknown	1	-	2	-	-	-	1	-	-	-	-	-	4	-
Total	75	100.0	77[3]	100.0	118	100.0	97	100.0	87	100.0	83	100.0	537	100.0

Notes: [1] Includes one driver whose car was involved in a minor collision with the car that crashed.

[2] Includes one driver whose car struck a motorcyclist who had fallen from his machine.

[3] There were three collisions in which one driver was through not to have played a role as an active participant.

TABLE 2.2: SEX OF ACTIVE PARTICIPANT BY TYPE OF ACCIDENT

Sex	Type of Accident													
	Single vehicle		Mid-block collision		Uncontrolled intersection		Sign-controlled intersection		Signalised location		Pedestrian		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Male	61[1,2]	81.3	64	83.1	91	77.1	66	68.0	70	80.5	59	71.1	411	76.5
Female	14[1]	18.7	13	16.9	27	22.9	31	32.0	17	19.5	24	18.9	126	23.5
Total	75	100.0	77[3]	100.0	118	100.0	97	100.0	87	100.0	83	100.0	537	100.0

Notes: [1] Includes one driver whose car was involved in a minor collision with the car that crashed.
[2] Includes one driver whose car struck a motorcyclist who had fallen from his machine.
[3] There were three collisions in which one driver was thought not to have played a role as an active participant.

TABLE 2.3: PERIOD LICENCE HELD BY TYPE OF ACCIDENT

Number of years	Type of Accident													
	Single vehicle		Mid-block collision		Uncontrolled intersection		Sign-controlled intersection		Signalised location		Pedestrian		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Less than one year	12	19.7	3	4.8	15	13.6	8	8.6	10	12.7	3	8.1	51	11.5
One to less than 2	2	3.3	4	6.3	7	6.4	7	7.5	9	11.4	1	2.7	30	6.8
2 to less than 3	5	8.2	4	6.3	4	3.6	12	12.9	7	8.9	1	2.7	33	7.4
3 to less than 4	6	9.8	6	9.5	8	7.3	9	9.7	8	10.1	3	8.1	40	9.0
4 to less than 5	5	8.2	3	4.8	7	6.4	2	2.2	5	6.3	4	10.8	26	5.9
5 to less than 10	10	16.4	15	23.8	20	18.2	17	18.3	9	11.4	5	13.5	76	17.2
10 years or greater	21[1]	34.4	28	44.4	49	44.5	38	40.9	31	39.2	20	54.1	187	42.2
Not applicable	6	-	8	-	3	-	3	-	2	-	43	-	65	-
Unknown	8	-	6	-	5	-	1	-	6	-	3	-	29	-
Total	75	100.0	77[2]	100.0	118	100.0	97	100.0	87	100.0	83	100.0	537	100.0

Notes: [1] Includes two drivers whose vehicles were involved in minor or subsequent collisions.

[2] There were three collisions in which one driver was thought not to have played a role as an active participant.

TABLE 2.4: SEVERITY OF INJURIES BY TYPE OF ACCIDENT

Injury Severity	Type of Accident													
	Single vehicle		Mid-block collision		Uncontrolled intersection		Sign-controlled intersection		Signalised location		Pedestrian		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
None	21	16.2	63	50.0	102	47.0	91	51.1	74	44.6	59	57.3	410	44.6
Minor	63	48.5	35	27.8	69	31.8	63	35.4	56	33.7	13	12.6	299	32.5
Moderate	26	20.0	22	17.5	33	15.2	13	7.3	25	15.1	9	8.7	128	13.9
Severe	9	6.9	5	4.0	5	2.3	8	4.5	6	3.6	13	12.6	46	5.0
Serious	5	3.8	1	0.8	6	2.8	1	0.6	3	1.8	5	4.9	21	2.3
Critical	2	1.5	-	-	2	0.9	2	1.1	1	0.6	2	1.9	9	1.0
Fatal	4	3.1	-	-	-	-	-	-	1	0.6	2	1.9	7	0.8
Unknown	2	-	1	-	-	-	3	-	4	-	1	-	11	-
Total	132	100.0	127	100.0	217	100.0	181	100.0	170	100.0	104	100.0	931	100.0

TABLE 2.5: PERIOD OF RESTRICTED ACTIVITY DUE TO INJURY BY TYPE OF ACCIDENT

Period of Restricted Activity	Type of Accident													
	Single vehicle		Mid-block collision		Uncontrolled intersection		Sign-controlled intersection		Signalised location		Pedestrian		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Nil	51	48.6	80	70.8	141	69.8	121	72.9	101	68.2	65	66.3	559	67.2
Up to one week	24	22.9	14	12.4	28	13.9	20	12.0	27	18.2	10	10.2	123	14.8
Greater than one week up to one month	11	10.5	10	8.8	12	5.9	7	4.2	9	6.1	2	2.0	51	6.1
Greater than one month	19	18.1	9	8.0	21	10.4	18	10.8	11	7.4	21	21.4	99	11.9
Unknown	27	-	14	-	15	-	15	-	22	-	6	-	99	-
Total	132	100.0	127	100.0	217	100.0	181	100.0	170	100.0	104	100.0	931	100.0

3. SINGLE VEHICLE ACCIDENTS

3.1 GENERAL CHARACTERISTICS OF SINGLE VEHICLE ACCIDENTS

Under this heading we review those accidents in which there was only one active participant (Table 3.1). Consequently pedestrian accidents are not presented here, even though they usually involve only one vehicle. There are other cases which could be regarded as "single vehicle" accidents, such as some rear end collisions, but they are discussed elsewhere in this report.

Single vehicle accidents accounted for almost a quarter of the accidents investigated in the study (72 out of 304, or 23.7 per cent). As can be seen in Figure 2.1 this type of accident occurred most frequently from late afternoon onwards with a peak between midnight and 1 a.m. Those occurring on a Saturday or a Sunday were concentrated between midnight and 3 a.m. A total of 35 (48.6 per cent of 72) of the drivers or riders were found to have a BAC greater than 0.05. This percentage is much higher than that obtained for any other category of accident and as in most cases there was no other active participant known to have been involved, it is a direct indication of the extent to which alcohol was thought to have been a significant factor in the causation of these accidents.

3.1.1 TYPE OF ACCIDENT

The types of single vehicle accident are listed in Table 3.1 together with the vehicle manoeuvre that preceded the crash. In listing these manoeuvres a distinction has been made between accidents in which the driver intentionally changed direction (swerved) and those in which he unintentionally deviated (veered) from his intended course.

The type of accident is shown in two general groups: collision and non-collision. This classification is based on the initial event in the accident in most cases, and so some non-collision accidents did in fact involve a subsequent collision, such as with a parked car. In three accidents a second moving vehicle was involved. These cases are nevertheless included among the single vehicle accidents because the collision with the other moving vehicle was a consequence of the accident rather than the main event (Accidents 062, 160 and 265).

3.2 COLLISIONS WITH PARKED VEHICLES

Nineteen of the 304 accidents in this survey were primarily collisions with parked vehicles. There were other accidents in which one or more parked vehicles were hit following an earlier collision, but this Section will concentrate on the 19 accidents which may not have happened, or resulted in an ambulance being called, had the parked vehicle not been present.

Four factors were prominent in the causation of these accidents, in addition to the obvious fact that a parked vehicle was present. Three of these four factors related to the driver: alcohol intoxication, lack of driving experience, and distraction by some secondary activity. The fourth factor was poor visibility, as evidenced by the fact that eleven of these accidents occurred at night at locations which were poorly illuminated. (Three other night-time accidents happened at well-illuminated sites). The following discussion of the roles played by these and other factors will show the commonly-occurring interactions between them, even in an apparently simple accident such as a collision with a parked vehicle.

One accident is unusual in that it was initiated when an unattended semi-trailer rolled away from a parking place (Accident 283). The driver, who was nearby, ran after it and managed to stop it after jumping up into the cab, but not before it had collided with a car parked a short distance further down the road. The driver sustained a minor injury when trying to stop his vehicle. This case will not be considered further in this Section.

In one accident (273) the driver left the scene and has not been identified; consequently we have no information on this person or on the events preceding the accident. This accident occured at night on a road which was poorly illuminated by fluorescent lamps. The case vehicle appeared to have been proceeding straight ahead immediately before the impact.

TABLE 3.1: TYPES OF INITIAL MANOEUVRES IN SINGLE VEHICLE ACCIDENTS

TYPE OF ACCIDENT	INITIAL MANOEUVRE						
	Proceeding straight ahead	Veer to right or left	Swerve to right or left	Run wide at corner or bend	Loss of lateral stability[1]	Moving off from stationary	Total
Collision with:							
Parked vehicle	7	7	1	1	2	1	19
Utility pole	-	9	6	3	1	-	19
Tree	-	5	1	2	2	1	11
Kerb	-	2	1	-	3	-	6
Building	-	-	-	1	1	-	2
Garden wall	-	-	-	1	-	-	1
Roadworks	1	-	-	-	-	-	1
Traffic signal pole	-	-	-	-	1	-	1
Seat at bus stop	-	-	1	-	-	-	1
Power line	1	-	-	-	-	-	1
Non-collision event:							
Pedal cyclist fell off	1	-	-	-	2	-	3
Motorcyclist slid down[2]	-	-	-	-	2	-	2
Rollover, on road	-	-	-	-	2	-	2
Rollover, off road	-	-	-	1	-	1	2
Passenger fell out	1	-	-	-	-	-	1
Total	11	23	10	9	16	3	72

Notes: [1] e.g. Car or truck yaws or rolls over; car with trailer jack-knifes; motorcycle or pedal cycle wobbles or slides down.

[2] Rider hit by moving car after falling from motorcycle in one accident.

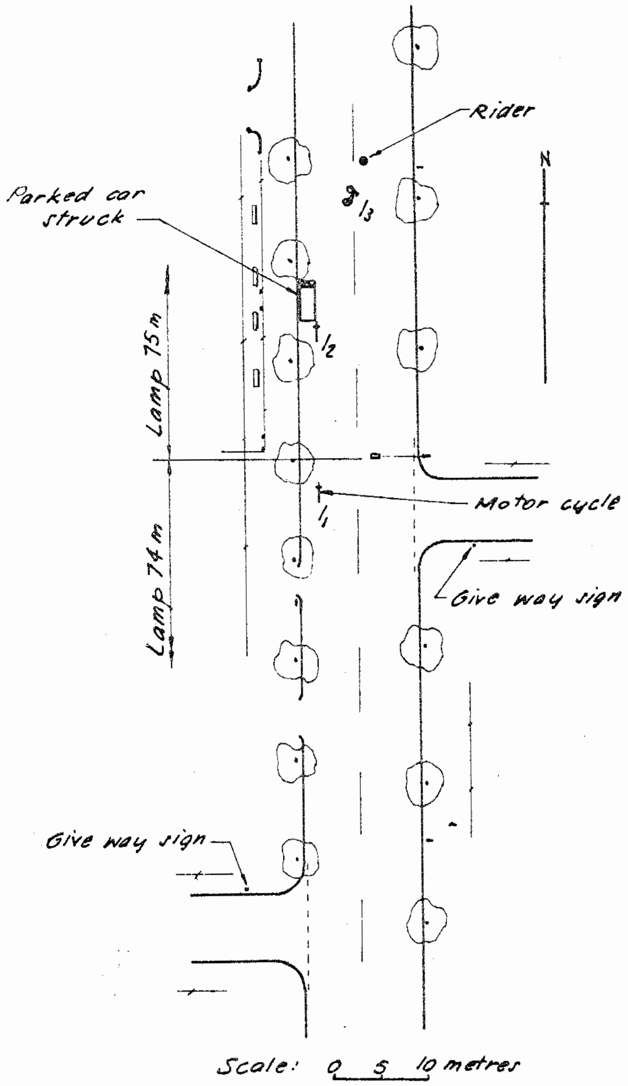


FIGURE 3.1: Accident 217.

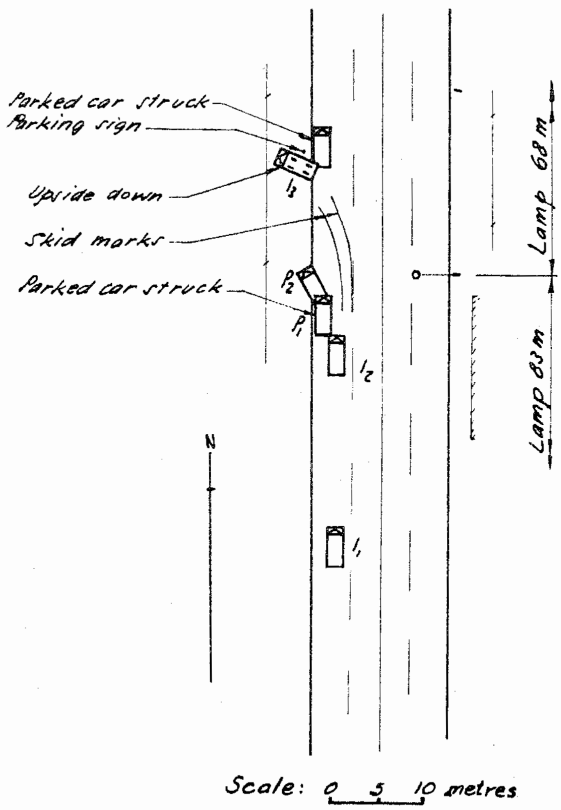


FIGURE 3.2: Accident 071.

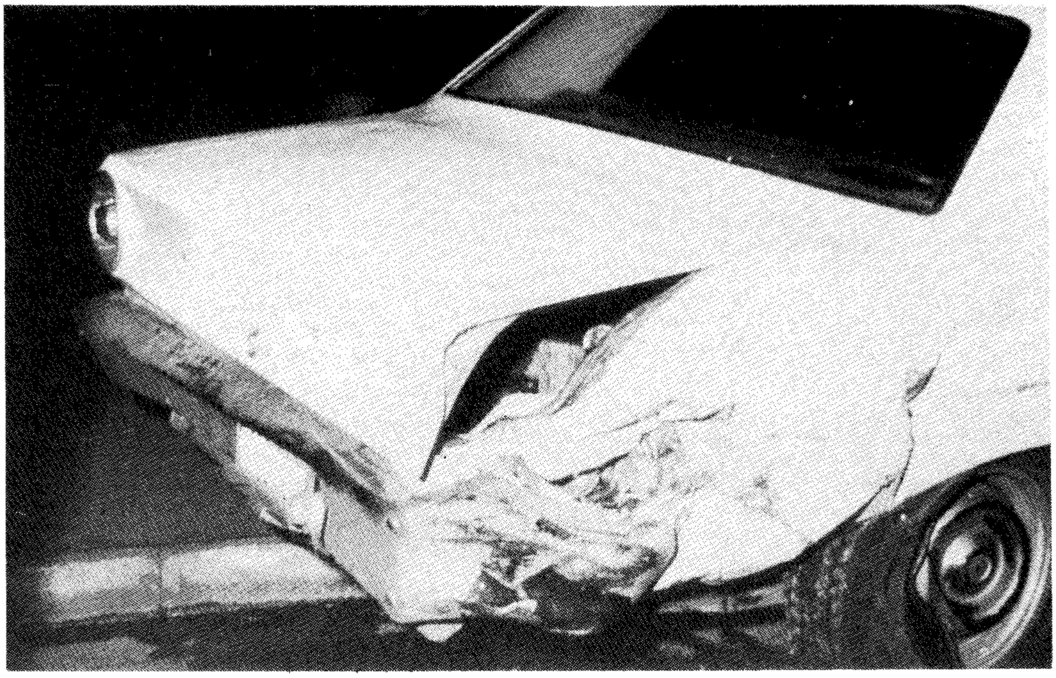


FIGURE 3.3: Damage to parked car : Accident 071.

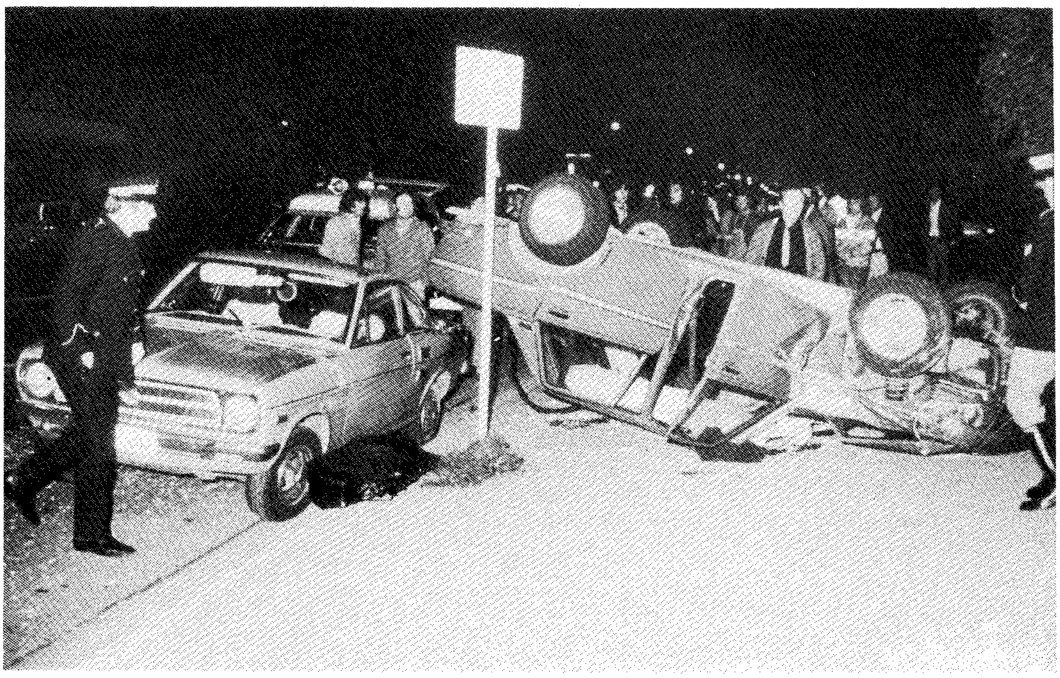


FIGURE 3.4: Final position of car following collision with parked car (not shown in this Figure: see Figure 3.3)

3.2.1 ALCOHOL INTOXICATION

Six drivers had been drinking, and all of them had blood alcohol levels above the legal limit of 0.08. The actual levels ranged from 0.11 to 0.26.

One driver, with a blood alcohol level of 0.14, hit a car parked at the kerb on a well-lit six lane divided road. The accident (074) happened at about 3.00 a.m. Apart from the driver being intoxicated, we know of no other factor which would account for this collision taking place, although the driver would not agree to being interviewed.

The other five accidents in this group all happened on poorly-lit roads. While this would have made it more difficult for these drivers to see the parked vehicles, it is probable that alcohol intoxication was still the main causal factor, with one possible exception. Accident 217 occurred on an arterial road just past a signalised intersection. A motorcyclist, who had a heavy cold, sneezed as he was crossing the intersection. This is a considerable distraction when wearing a crash-helmet with the visor in place, and by the time the rider had recovered from it he realized that he was about to hit a parked car. The two lane exit from the intersection became one lane before the site of the accident. The rider had been in the kerb lane and this meant that he would have had to merge to his right to have avoided the parked car. He had a blood alcohol level of 0.11, which may have reduced his ability to react appropriately. Although sodium vapour lamps are installed on this section of road, as shown in Figure 3.1, the level of illumination is far from uniform due to the distance between the lamps and the blanketting effect of the foliage of the trees at the roadside. The resulting dark patches are accentuated at this location by the uniformly high intensity of the illumination of the adjoining signalised intersection.

One other of these alcohol-involved accidents occurred on an arterial road. In this accident (071, Figure 3.2) the mercury vapour lamps provided a non-uniform level of illumination. The driver of the car had a blood alcohol level of 0.21 and the very poor static visual acuity of 3:36 in both eyes, was not corrected by wearing glasses. His car hit the right rear corner of a parked car (Figure 3.3) and then yawed anti-clockwise and rolled onto the back of a second parked car (Figure 3.4). He reported that he had been talking with his passenger when he hit the first car, which he had not seen, and that he thought that alcohol had only contributed to a small degree, if at all, to his being involved in this crash. This case is listed in Table 3.1 under "Veered to the left" but the car may well have been proceeding straight ahead.

The three remaining accidents in this group of five on poorly-lit roads all happened on streets which were lit by tubular fluorescent lamps. The level of illumination was generally very poor, with long dark sections of road. Despite this, only one of these three drivers was confronted with a car which was difficult to see. This was in Accident 008 in which the driver of a following car, knowing that the driver in front had had too much to drink, saw the parked car and thought to himself that he hoped the other driver had seen it too. The intoxicated driver (BAC 0.16) did not see it and crashed into the back of it.

In Accident 138 the car which was hit was a taxi which was stationary at the kerb with its parking lights on and also the interior light. The driver of the striking car had a blood alcohol level of 0.26 and was talking with his passengers. There was a suggestion that he may have "dozed off" just before he hit the taxi but we could not confirm this. His car did not appear to have veered to the left before the collision but rather had been travelling straight ahead. The resulting damage to the vehicles was severe (Figures 3.5 and 3.6).

The final accident illustrates the apparent difficulty that intoxicated drivers experience when they try to do two things at once. This driver (Accident 246) saw the parked car well before he collided with it but he was trying to get his wallet out from his buttoned-up hip pocket and in the process of doing this his car deviated to the left. After colliding with the parked car his car swerved off the road to the left, crashed through a fence, and rolled over down a rocky embankment. The driver's blood alcohol level was 0.18.

3.2.2 INEXPERIENCED DRIVERS AND RIDERS

Two motorcyclists and one driver had each been licensed for no more than three months at the time of their accident, one rider was operating on a learner's permit and a fourth rider did not hold a licence to ride a motorcycle. The unlicensed rider had ridden a motorcycle only once or twice before he was involved in this accident (Accident 065). He approached a left turn into the stem of a T-junction too fast. When he tried to slow down he found that the brakes on the borrowed motorcycle were badly adjusted and not very effective and so he ran wide on entering the side street, hitting the kerb on the right hand side and then a parked car.

The motorcyclist who had a learner's permit (for only two days) crashed into the back of a parked car (Accident 131). He was riding in the left of two lanes along a road which was unevenly illuminated by sodium vapour lamps (Figure 3.7) and recalled thinking that he could not see very well (partly because he was looking through a tinted visor). Hearing a rattle

FIGURE 3.5: Damage resulting from collision with parked taxi (shown in background and in Figure 3.6) : Accident 138.

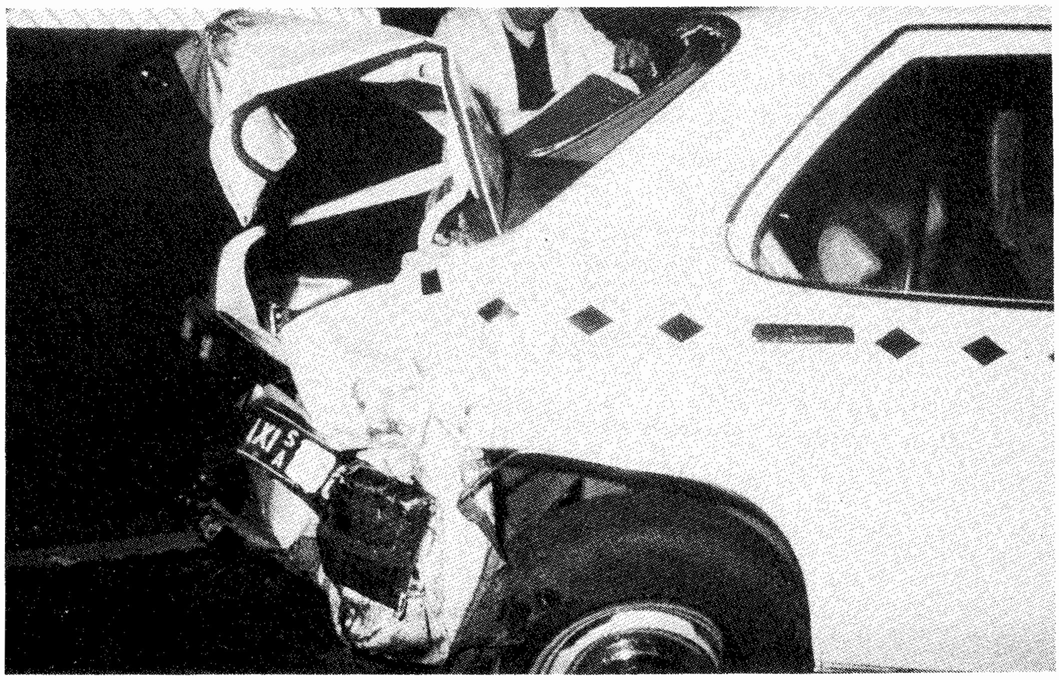


FIGURE 3.6: Damage to parked taxi (see Figure 3.5).

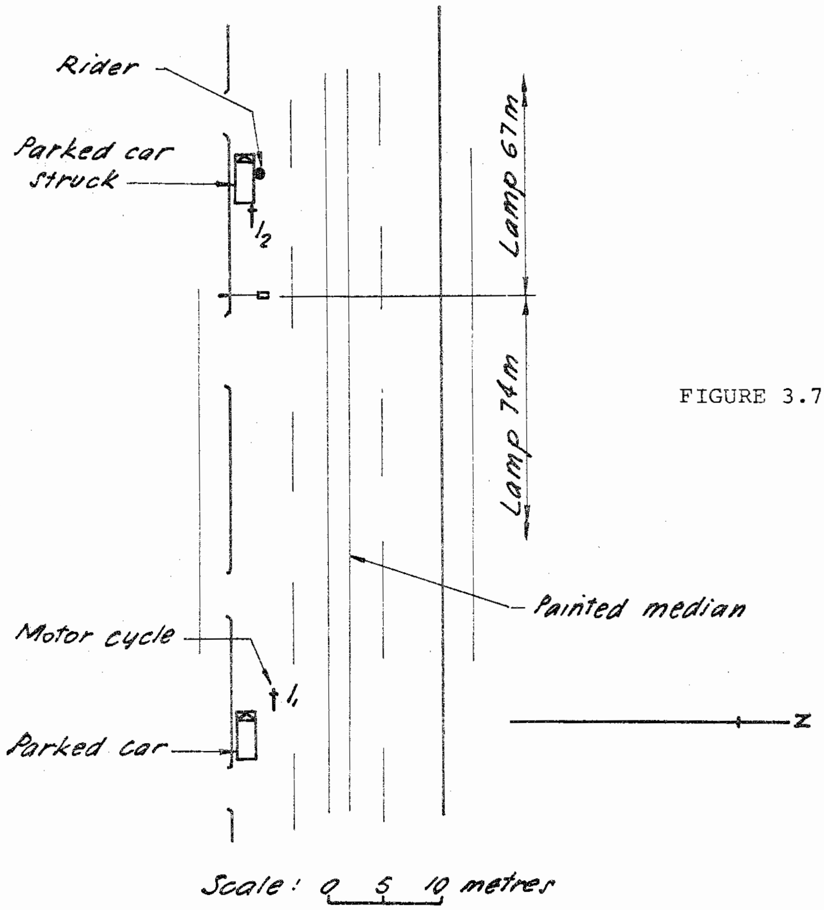


FIGURE 3.7: Accident 131.

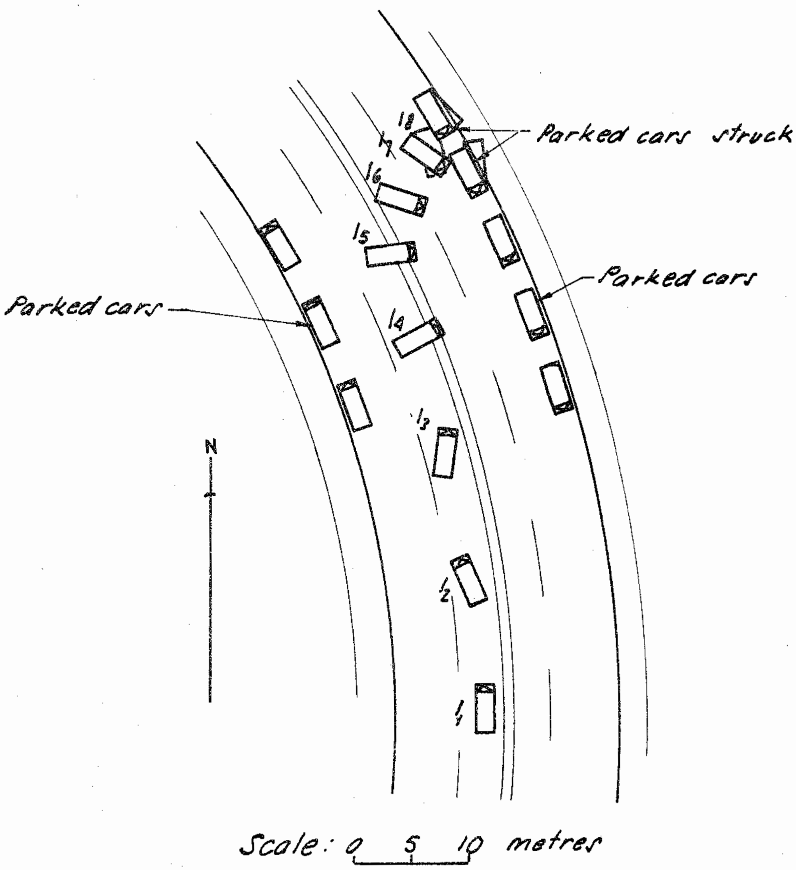


FIGURE 3.8: Accident 132.

coming from his motorcycle he leaned to the left to try to see where it was coming from. As he did so, the motorcycle veered to the left. He did not realize that this had happened until he looked up and saw that he was about to run into the back of a parked car. Although the car was close to a street light he had not seen it earlier.

A motorcyclist who had been licensed for four weeks rode into the back of a truck which was parked in a dark street in a residential area (Accident 093). This truck was very hard to see, having no parking lights on and two small, dirt covered reflectors mounted at the corners of the rear edge of the tray. The rider had good eyesight and had travelled along that street before. It may be that had he been more experienced he might have anticipated the possibility that an unlit vehicle could be parked in a dark area.

The third motorcyclist in this group was riding a small machine up a gradual slope, keeping to the left on a four-lane road (Accident 022). He had his head down and this, together with the peak on his crash helmet, limited his view of the road in front of him. At the last moment he saw a parked car in his path and he tried to swerve to the right but was unable to do so in time. The car had no lights on and was parked in a poorly lit area midway between two sodium vapour street lights which are about 115 metres apart. The rider said that after the accident he realized that he had been riding too close to the kerb but he also thought that he would have seen the car from further back down the road had it been better illuminated.

The fifth accident involving an inexperienced driver or rider occurred on an uphill curve in daylight. The sixteen year old driver entered a curve too fast and when his car started to slide he overcorrected and spun clockwise, sliding across the road and crashing into cars parked at the far kerb (Accident 132, Figure 3.8). He had never been in a skid before and attributed his inability to control his car to a non-existent steering failure. His initial loss of control was prompted largely by mismatched tyres and the subsequent trajectory was affected by the car sliding from a wet surface onto a dry area. This accident is similar to Accident 062 which is reviewed in the next Section on collisions with utility poles.

Three of the accidents in this group suggest that driver and rider training courses should include some night-time training sessions in which the learner driver could be shown the need to exercise particular care in watching for parked vehicles on poorly lit roads.

3.2.3 SECONDARY ACTIVITIES

Some of the accidents described earlier in this Section involved intoxicated drivers who were, unsuccessfully, trying to do something in addition to driving along the road. There were two other accidents in which a secondary activity seems to have been the main factor in causing the crash. One of these happened when a young driver, with eighteen months driving experience, crashed into the back of a row of parked cars while looking to her right (Accident 179). She recalled travelling at just under 60 km/h and keeping to the left lane to allow other traffic to pass her in the right lane but could not remember what it was that had attracted her attention to the right hand side of the road. This accident happened at night under good artificial lighting but during a heavy rain storm.

Another driver turned left at a signalised intersection and soon after remembers trying to swerve to the right to avoid a parked car. In fact this attempt at an avoiding action was too late, and a collision resulted (Accident 129). It was raining lightly at the time and the parked car was not well illuminated by the sodium vapour street lights. The driver was tired, having just finished an unusually long shift at work. A cigarette which was burnt on the filter end was found on the floor of the car below the steering wheel, which suggests that the driver may have been distracted by trying to light a cigarette and, in particular, by lighting it at the wrong end. We were unable to confirm that this had happened, possibly because the driver was concussed and therefore may not have had a clear recollection of an event such as this.

3.2.4 AVOIDING ANOTHER VEHICLE

Accident 035, shown in Figure 3.9, involved a motorcyclist who was forced to swerve to his left when, he claimed, a car ahead indicated a right hand turn and then suddenly swerved to the left possibly intending to enter a side street. An independent witness confirmed that this car was present but was uncertain of its movements immediately before the accident. The driver of the car left the scene of the accident without identifying himself. The rider tried to stop by braking with the back brake only. The wheel locked and the machine started to slide sideways so he released the brake and passed the car on its left, only to find that his way was blocked by a parked car, which he hit. The motorcycle skidded 16 metres when braking and would have slowed down by about 40 km/h by doing so. The collision with the parked car seems to have been at a speed considerably greater than 15 km/h and so it is probable that the initial speed of the motorcycle was greater than the speed limit of 60 km/h.

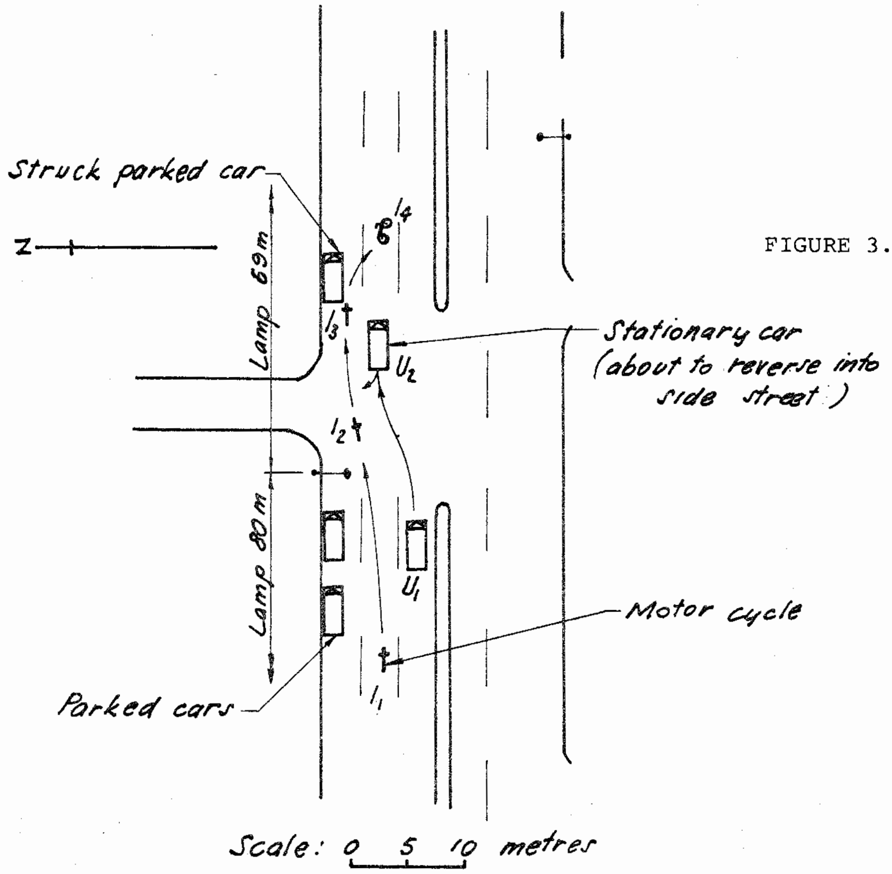


FIGURE 3.9: Accident 035

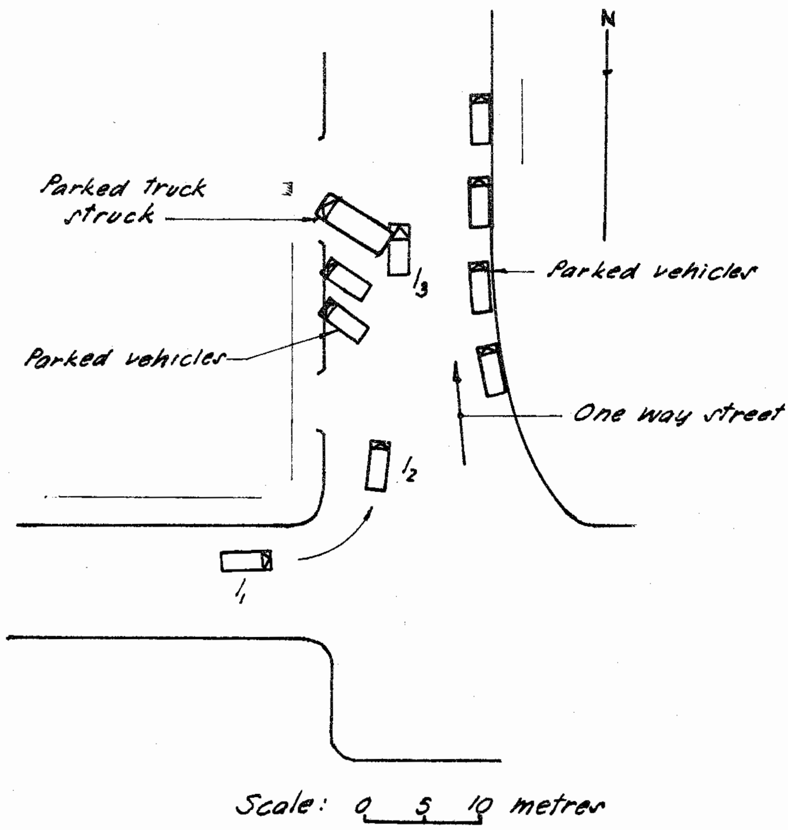


FIGURE 3.10: Accident 202.

3.2.5 ANGLE-PARKED VEHICLE

An elderly driver turned left into a one-way street and noticed the tray of a truck protruding into the roadway from a row of cars parked at an angle on his left (Accident 202, Figure 3.10). Despite the fact that he thought that he had room to pass, the elderly driver's car hit the corner of the tray of the truck. He had relatively poor eyesight (3:18 in both eyes) and there is no other known factor which could explain why this accident happened apart from his misjudging the space between the two vehicles. This accident occurred in daylight.

3.2.6 COLLAPSE OF DRIVER

A driver, who had complained of feeling unwell because of a gastric virus, collapsed over the wheel and his car veered across to the right, striking a parked car and pushing it back into a utility pole (Accident 007, Figure 3.11). After the accident the driver said that he should have asked one of his passengers to drive, rather than having attempted to drive himself.

3.2.7 FAILURE OF VEHICLE MODIFICATION

A small car rolled over on a straight road when a modified rear suspension mounting separated (Accident 291). As it was rolling over it crashed onto the top of a parked car. This accident, and Accident 132 which was reviewed earlier in this Section, are discussed in more detail in Section 4.2 of the companion report on car accidents (McLean, Aust, Brewer and Sandow, 1980).

3.2.8 RELEVANCE OF ROAD AND TRAFFIC FACTORS

Visibility and Conspicuity.

The conspicuity of the parked vehicles did correlate reasonably well with whether or not the driver saw it before the impact, although the number of relevant accidents is small and there were some exceptions.

In Accident 008 the struck car was not directly illuminated by the fluorescent street lighting and was not visible in silhouette. It's presence was indicated mainly by the reflectors mounted in the rear light assemblies, since the dark orange paintwork blended in with the dark background.

The car struck by the motorcycle in Accident 022 was dark red and was parked in a relatively dark area. In Accident 131, however, the car was directly illuminated by a sodium vapour light (Figure 3.7). This car had dark green paintwork and a white vinyl top. The rider did not see it from a distance (before he looked down at his motorcycle to locate the source of a rattle). As noted earlier, he was viewing the roadway through a dark tinted visor.

The rider in Accident 217, who sneezed shortly before his accident, was also looking through a dark tinted visor, in this instance at a gold-coloured car parked under overhanging trees across the road from a sodium vapour light. This motorcyclist very nearly avoided hitting the parked car. Had the car been better illuminated the collision may not have occurred.

The parked cars which were seen well before the impact (before the drivers were distracted) were coloured white, bright orange and bright red. One of these cars (Accident 179) was reasonably well illuminated by the street lighting and the other two less so, although apparently adequately (Accidents 129 and 246).

By comparison with these three accidents there were two white cars which were not seen, even though one of them had its parking lights on (Accidents 071 and 138). However both drivers were severely intoxicated and there is reason to believe that they may have been attending more to their passengers than to the roadway ahead.

The low conspicuity of the parked truck in Accident 093 has been noted earlier in this section. The reflectors at the rear of the truck were ineffective because they were mounted above the level of the top of a correctly-adjusted low beam, as well as being covered with road dirt.

It seems likely that reflectorized number plates would increase the conspicuity of a parked vehicle (eg: Rumar, 1967). Whether such a change would be cost-effective cannot be assessed reliably from these few accidents.

Obstruction of the Carriageway by the Parked Vehicle.

There was only one accident (179) in which the driver commented that the road was too narrow for cars to be parked at the accident site; the kerb lane was 5.0 metres wide, with one adjoining lane 2.8 metres wide for traffic travelling in the same direction. This crash occurred during a heavy rain storm and the painted lane markings were not visible. The struck car was pushed into the car parked in front of it and also into a utility pole located on the kerbed footpath and so we could not be certain of its initial distance out from the kerb but it did appear to have been parked normally before the impact.

The parked car in Accident 246 was more than a metre away from the kerb but this still left at least three metres between the car and the unmarked centre of the roadway. This was an accident in which the driver saw the parked car well before the impact.

The marked kerb lane was blocked by the parked car in Accident 074 but there were two other lanes available. The damage to the two vehicles showed that the striking car was only partly in the kerb lane on impact.

None of the vehicles in the accidents reviewed in this Section were parked illegally, with the exception of the car in Accident 246, but this obviously does not mean that they were therefore parked safely. Shared use of the kerb lane, by parked and through vehicles, inevitably allows for the possibility of accidents of this type. The designation of certain roads as clearways, on which parking or stopping is prohibited, is unlikely to solve this problem unless they are 24 hour clearways, since all of the seven relevant accidents on roads which are, or could reasonably be declared as, clearways occurred at night (Accidents 022, 071, 074, 129, 131, 179 and 217).

Recessed parking bays would greatly reduce, but not entirely eliminate, the frequency of collisions with parked vehicles. Such bays can often readily be formed in streets in residential areas, but on arterial roads they may result in a serious reduction in the traffic flow capacity of the road. Nevertheless, there are reasons for suggesting that an increase in the width of the roadside reserve, such as could accompany the provision of parking bays, would have marked safety benefits. This matter is discussed further in the Section on collisions with utility poles.

3.3 COLLISIONS WITH UTILITY POLES

Nineteen of the accidents were primarily single vehicle collisions with utility poles. For convenience in presentation utility poles are referred to simply as "poles" in this Section. All but three of the 19 poles were of the steel and concrete construction known locally as the "Stobie" pole, after the engineer who developed the basic design. One of the other poles was formed from two lengths of thick-walled steel tubing and the remaining two poles were reinforced concrete lamp standards. Poles were the most commonly-hit fixed roadside objects in the accidents in this survey, a collision with a utility pole having occurred in eleven per cent of the 304 accidents (Table 8.2).

Alcohol intoxication was the outstanding factor in the causation of these accidents. The intoxicated driver was often hampered still further by some secondary activity or by fatigue, as is described below. The few sober drivers crashed into poles for a variety of reasons and so it is not possible, from this small number of cases, to identify a single causal factor which is next in importance to, but no associated with, alcohol intoxication.

There were three accidents (137, 165 and 304) in which there was reason to suspect that the driver may have attempted to commit suicide. This suspicion was strengthened, if not confirmed, in one case because the driver did make a successful attempt, not involving a motor vehicle, on the day after the accident (165). In each of these three cases the car swerved off the road for no apparent reason, even allowing for the fact that two of the drivers had very high blood alcohol levels.

The following review of the 19 accidents is arranged according to the manoeuvre which preceded the collision with the pole.

3.3.1 VEERED OFF THE ROAD

Eight of the nine accidents in this group (see Table 3.1) occurred after 8 p.m. and six took place after midnight. Seven drivers had blood alcohol levels of 0.05 or above, and four of them were above 0.13.

We believe that two of the intoxicated drivers may have fallen asleep. In Accident 051, a witness who was travelling in the other direction said that he saw an oncoming car pull over to the side of the road and then its lights went out. He assumed that it had parked but when he got closer he saw that it had crashed into a pole (Figures 3.12 to 3.15). The pole itself was not badly damaged (Figure 3.14) but this was not true for the car (Figure 3.15). The occupants, neither of whom were restrained, would not have survived had emergency care not been available within minutes of the crash. The driver had a broken neck and chest injuries which made breathing very difficult. The passenger also had severe chest injuries and facial and brain injuries.

Accident 096 (Figure 3.16) was very similar to the one described above. In each accident the car was travelling in the kerb lane, of two available lanes, but in Accident 096 there was also a parking lane defined by a separation line (Figure 3.18). The accident happened at about 2 a.m., when there were no vehicles parked in this lane. The driver was slightly concussed and could not remember the events immediately before the crash. The approach angle shown in Figure 3.18 was established from the marks left by the tyres where they mounted the kerb. It is consistent with the possibility that the driver fell asleep.

The damage to the car was severe (Figure 3.17) but, unlike the car in Accident 051, the windscreen was not

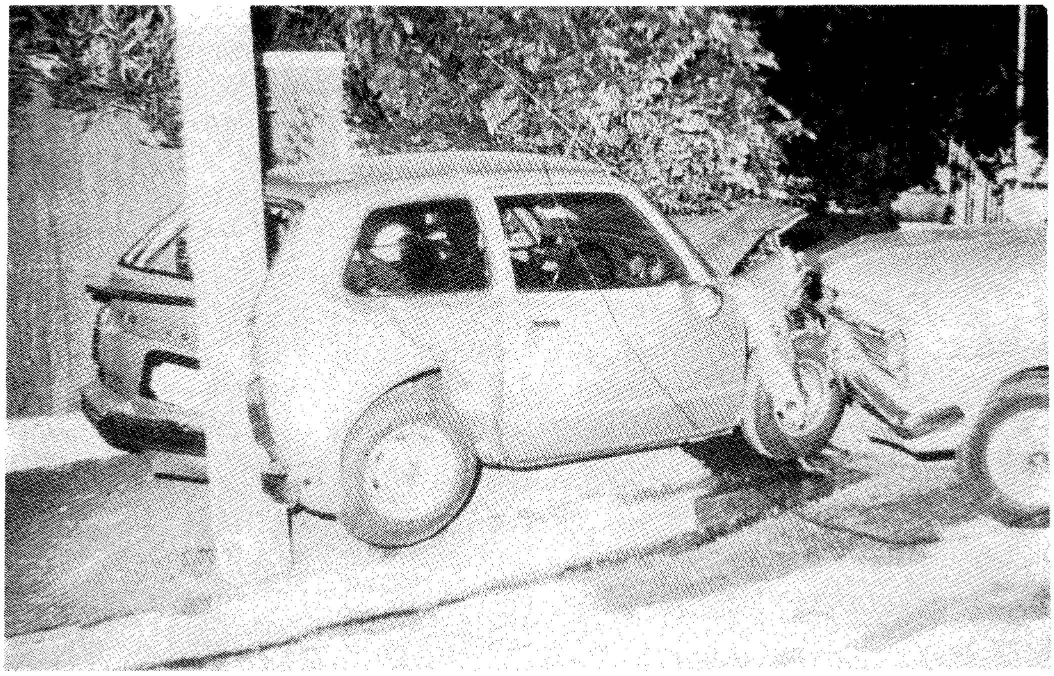


FIGURE 3.11: Parked car crushed between car out of control and a timber utility pole : Accident 007.

FIGURE 3.12: Removal of critically injured driver from car following collision with utility pole : Accident 051.

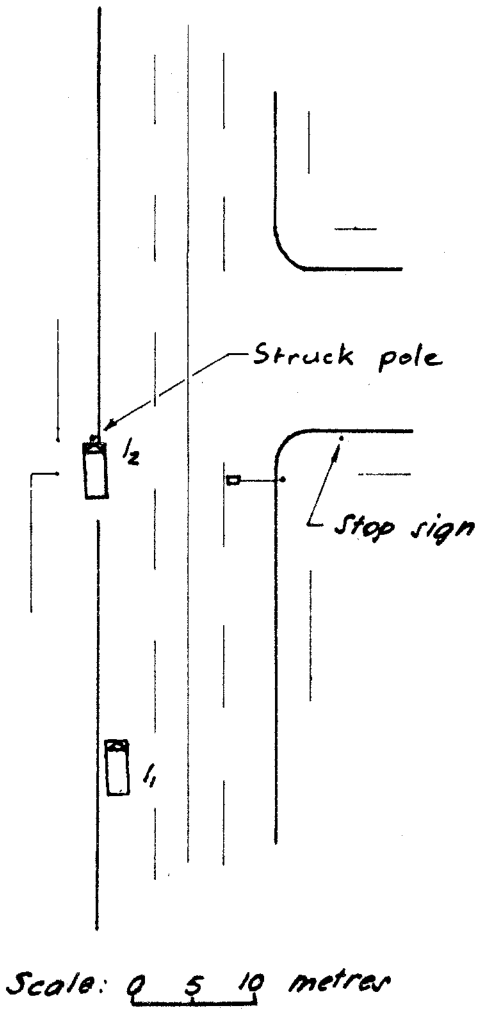


FIGURE 3.13: Accident 051.

FIGURE 3.14: Damage to utility pole : Accident 051.

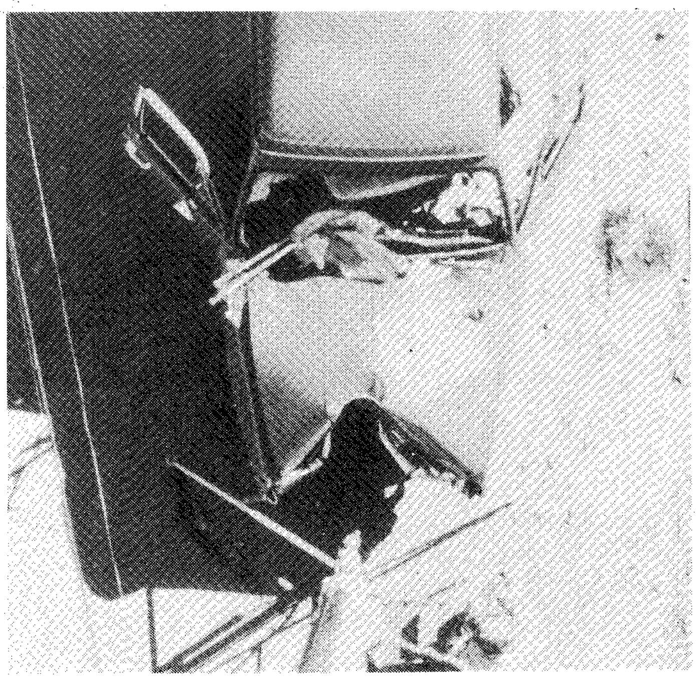


FIGURE 3.15: Damage to car in Accident 051.

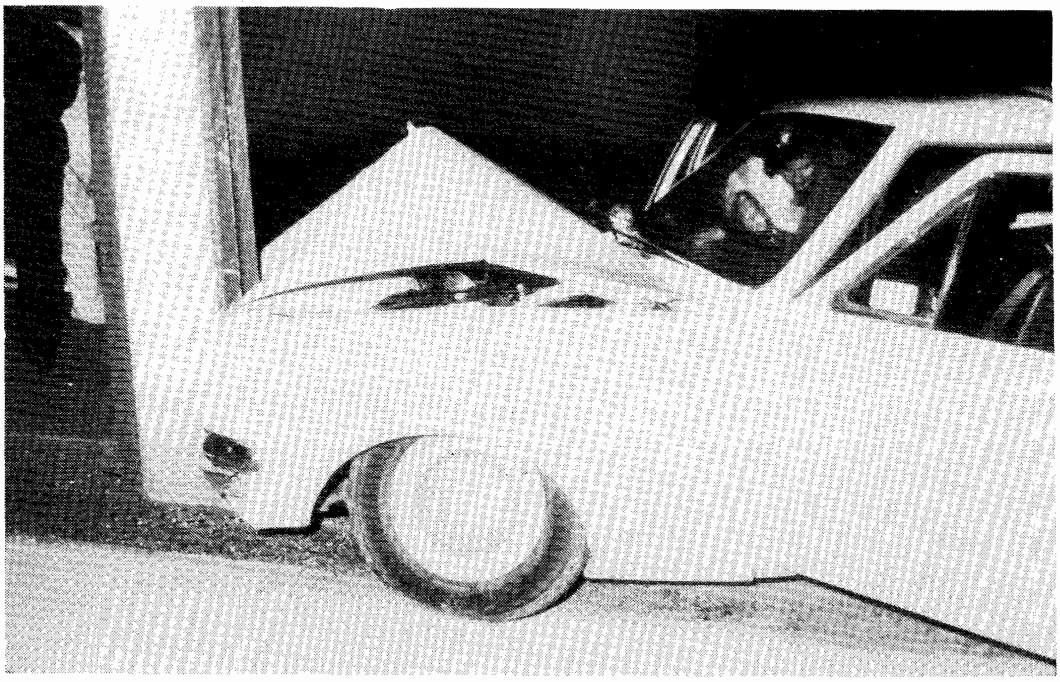


FIGURE 3.16: Damage to car after collision with utility pole : Accident 096.

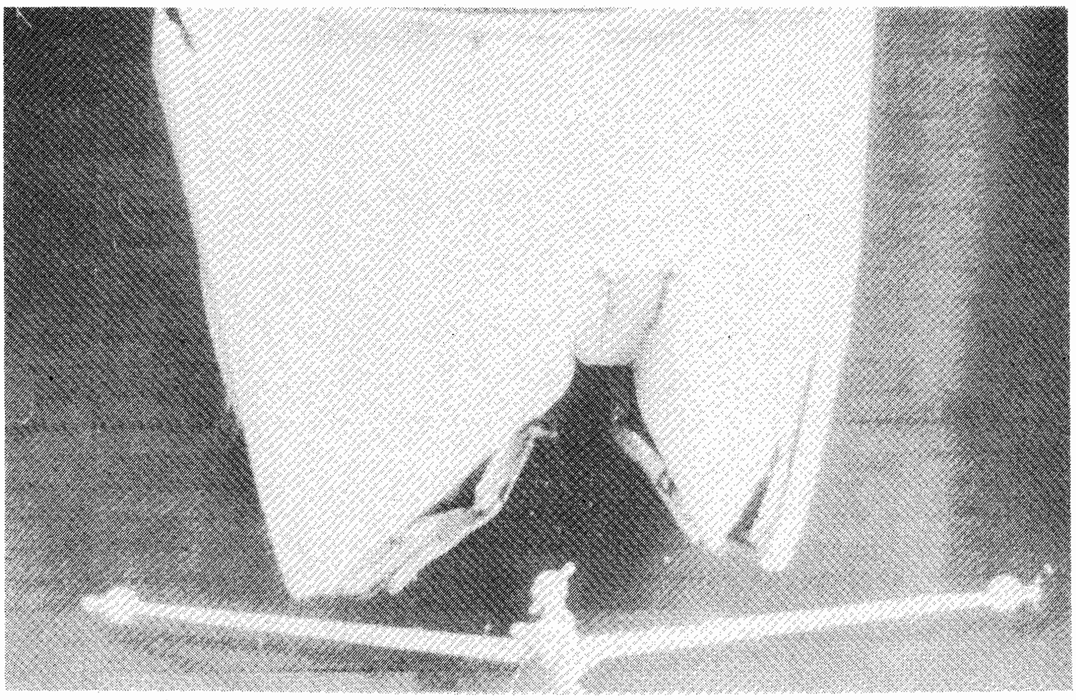


FIGURE 3.17: See Figure 3.16.

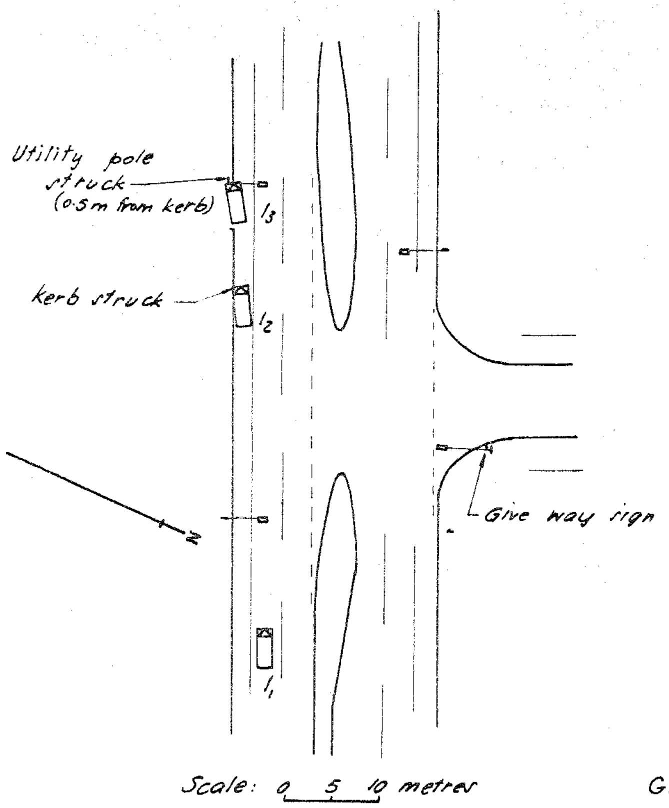


FIGURE 3.18: Accident 096.

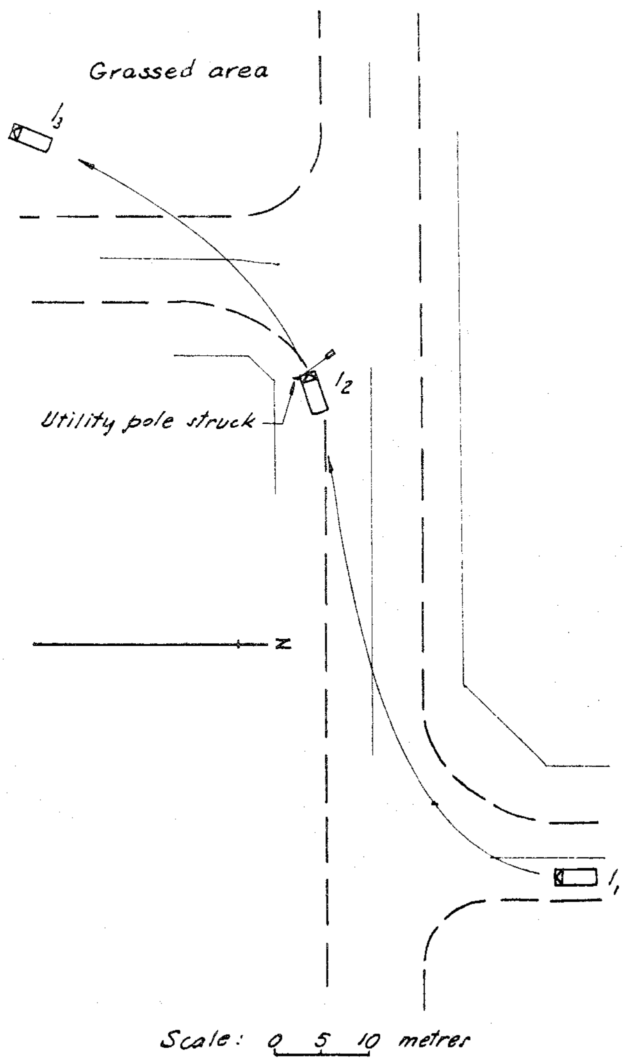


FIGURE 3.19: Accident 235.

broken. This was a trivial consequence of the fact that the occupants were wearing seat belts. The driver sustained fractures of the left wrist and right collar bone in addition to his head injury. He was able to stand alongside the car, unaided, moments after the impact.

In one other accident (263) involving an intoxicated driver we know little about the events leading up to the collision with the pole because the driver refused to talk to us. The remaining four drivers who had been drinking all related some other activity that affected their ability to keep their car on the road.

The driver in Accident 067 was distracted by his child, which was being carried on the mother's lap, vomiting. Another driver was turning left into a major road when his car mounted the kerb and hit a lamp standard. This driver said that he was talking with his passengers and looking to his right to check for oncoming traffic. His blood alcohol level was 0.14 (Accident 301).

One accident (122) was caused by an intoxicated passenger who reached across and pulled the driver towards him until the driver's head was below the level of the dashboard. The car veered off the road and hit a pole, followed by a collision with a wall. The driver's blood alcohol level was 0.05.

The final accident (244) involving a drinking driver whose car veered off the road is a particularly interesting one. It happened at about 7 a.m., but the driver had been at a party and was on his way home, for the second time. About two hours before he had been stopped by the police and required to take a Breathalyzer test. He was found to have a blood alcohol level of 0.085. He was duly charged with exceeding 0.08, the legal limit, and then allowed to drive home from the regional police station. On this journey he got lost. He recalled bending down to pick up something that he had dropped as he was turning an unfamiliar corner. The car did not straighten up but veered across to the right and hit a pole. By the time that a blood sample was taken at the hospital his blood alcohol level was down to 0.05. We found two objects on the floor of the car: an unlit cigarette and the driver's copy of the Breathalyzer certificate.

The remaining two accidents in this group of cars which veered off the road both involved sober drivers but one collapsed at the wheel (Accident 270). This driver was a diabetic and his collapse was a consequence of his blood sugar level falling too low. This accident is similar to Accident 007 in which the driver was affected by a gastric virus. That car, too, would have hit a pole had there not been a parked car in its path (Figure 3.11).

We have not been able to determine why the other sober driver hit the pole (Accident 235). The road layout is shown in Figure 3.19. The pole is located on an earth shoulder which means that the driver would have had little warning that she was off course before the collision if her attention had lapsed for a few moments.

3.3.2 SWERVED OFF THE ROAD

By contrast with the "veered off road" accidents none of the six accidents in which a car swerved off the road occurred after 8.30 p.m. Alcohol intoxication, at very high BACs (0.18 to 0.24) was a factor in four accidents, two of which were possible attempts at suicide. One sober driver was also thought to have possibly hit the pole deliberately. This review covers the three accidents that were not thought to have been suicide attempts.

A car travelling at about 90 km/h in a 60 km/h zone swerved to the left to pass a bus that had pulled out to the second lane of four (Accident 100, Figure 3.20). On finding the kerb lane blocked by a parked car the driver (BAC 0.20) braked but skidded up across the kerb and collided with a Stobie pole (Figure 3.21).

In a similar accident (163) a driver with a BAC of 0.18 swerved sharply to his left to enter the kerb lane because he was following too closely behind a car that had surprised him by slowing to turn right. He was on a railway level crossing at the time and the uneven surface may have contributed to his loss of control. His car hit a pole on the left hand side of the road.

The third accident differed from the other "swerved off road" pole collisions in that the pole was set well back beyond the kerb (1.35 metres) and the car ran along the unpaved footpath for about 25 metres before hitting the pole (Accident 218). The sober driver was concussed and did not have a clear recollection of why he swerved off the minor street but thought that he may have been trying to avoid a dog.

3.3.3 RUN WIDE AT A CORNER OR BEND

One of the three accidents in this category was very similar to the accidents in which a car veered off a straight road. An intoxicated driver (BAC 0.25) was talking with his passenger and failed to notice that he had entered a right hand curve. His car went straight ahead and collided with a reinforced concrete lamp standard. This accident (094) resulted in about the same severity of damage to the car as occurred in Accidents 096 and 051 which were reviewed at the start of this Section on collisions with poles. The driver and passenger were both wearing seat belts. The driver had his belt loosely adjusted and he sustained facial lacerations and contusions from hitting the steering wheel. The load taken by the seat belt was sufficient to fracture his collarbone, as happened with the driver in Accident 096, but this is a very much less severe injury

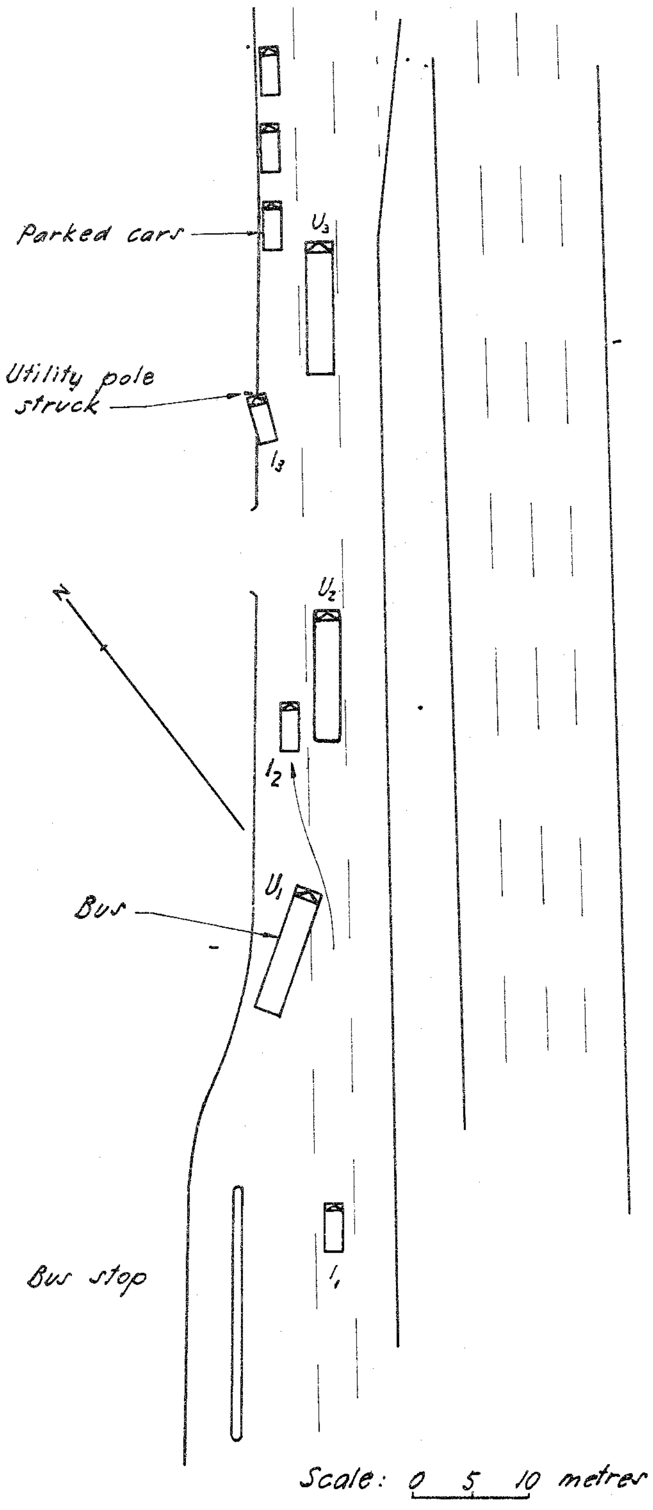


FIGURE 3.20: Accident 100.

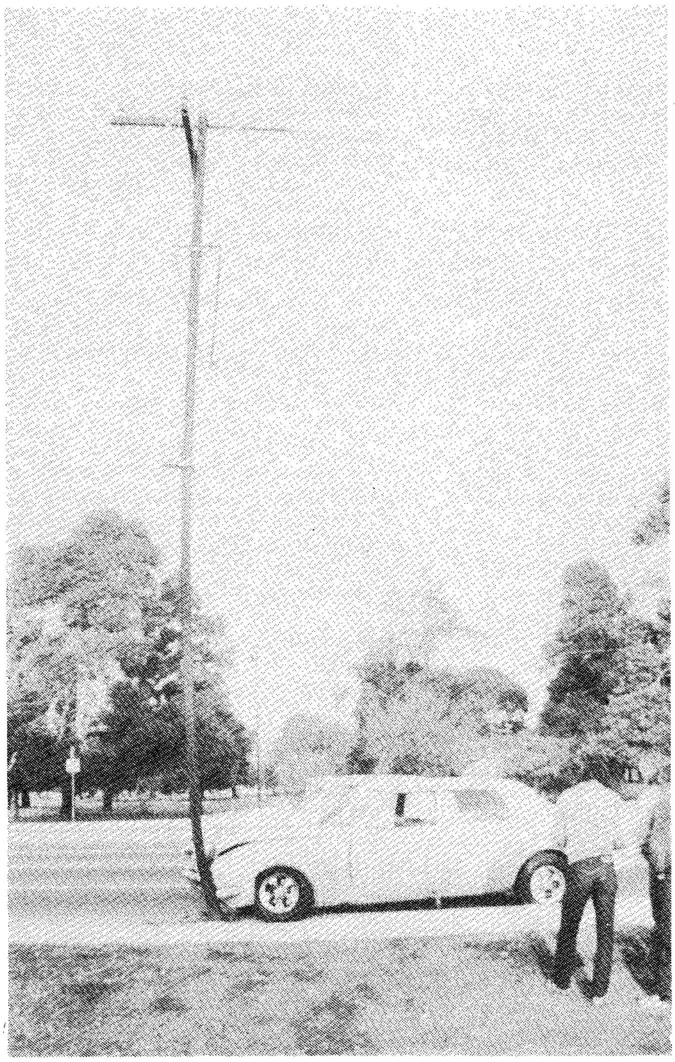


FIGURE 3.21: Damage to pole, Accident 100. (see Figure 3.20)

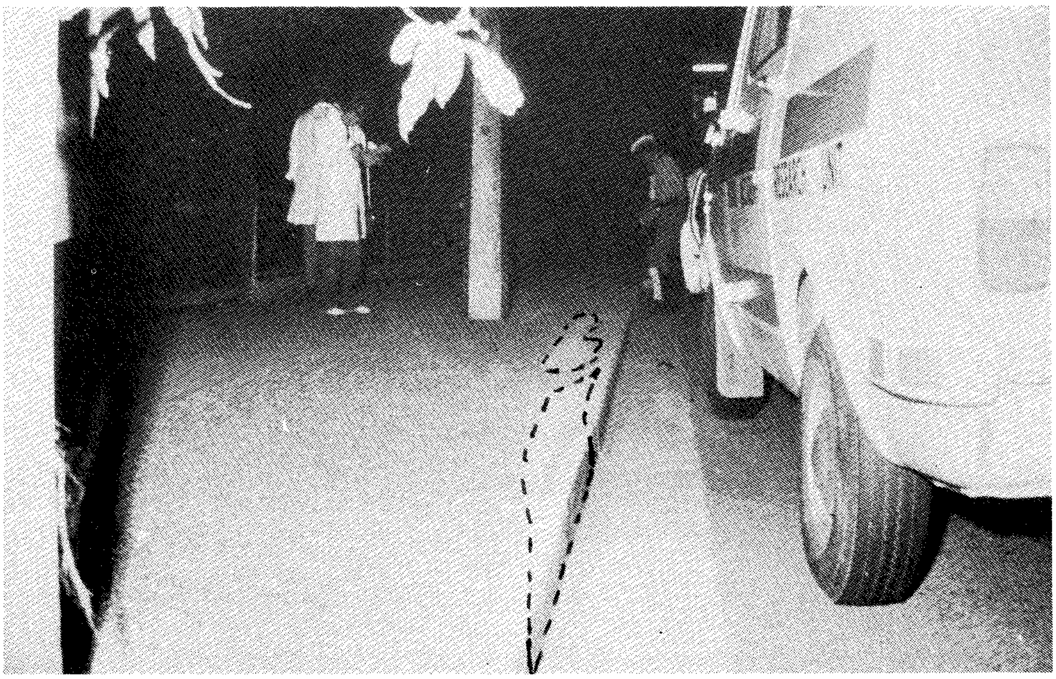


FIGURE 3.22: Tyre marks on kerb and footpath on the approach to pole struck by motorcycle rider and pillion passenger : Accident 289.

than the chest injuries sustained by the driver in Accident 051 who was not wearing a seat belt. The passenger in Accident 094 was wearing a correctly adjusted belt. He received a bruised finger.

A driver following a friend home from a football match turned into a side street by cutting across a painted median because the traffic ahead of him was banked up from a set of traffic signals (Accident 108, Figure 3.23). This driver was not familiar with the area and found that he was travelling too fast to negotiate the turn. His car hit the kerb on the outside of the turn and failed to straighten up, instead continuing on the same curve path back across the side street and crashing into a pole.

The third accident of this type involved a motorcycle which ran up onto the footpath some distance after exiting from a right-hand right angle bend (Accident 289, Figures 3.22 and 3.24). The 16 year old rider and his pillion passenger both hit their heads on a Stobie pole which was narrowly missed by the motorcycle. Despite the fact that they were both wearing crash helmets they were both killed. The rider had a blood alcohol level of 0.14, and had been licensed for six months.

3.3.4 SPIN OUT ON CURVE

This accident (062) was very similar to Accident 132 which resulted in a collision with parked vehicles. A 16 year old driver who had been licensed for two months lost control of his car when it started to slide in a gradual s-bend. It was raining at the time. The car crashed backwards into a pole on the far side of the road and then continued on back across the road. It was involved in a minor collision with another moving car before coming to rest on the footpath up against a fence (Figures 3.25 and 3.26). The condition of the tyres fitted to this car increased the risk of it skidding on a wet road, as was the case in Accident 132.

3.3.5 RELEVANCE OF ROAD AND TRAFFIC FACTORS

Utility poles are placed close to the kerb because that is the most convenient place to put them. The pole does not obstruct the passage of underground services, such as sewage disposal and telephone lines, and the overhead wires are kept as far away as possible from the foliage of trees located on private property. This is also the most dangerous place to put them, other than in the carriageway.

A collision with an unyielding utility pole at 60 km/h, the urban area speed limit, is roughly equivalent to the car rolling over the edge of a sheer drop of about ten metres and crashing head first to the ground below. If streets and roads were built up ten metres above the surrounding land, with no guard rails, then few drivers would choose to travel in the kerb lane. The dangers inherent in locating utility poles close tothe kerb are not as obvious but the accidents reviewed here show that they are very real.

Fox, Good and Joubert (1979) have presented models predicting the costs and benefits associated with a wide range of measures that can reduce the frequency or the severity of collisions with utility poles. Their study was based on a sample of 879 collisions with poles in the Melbourne metropolitan area. The 19 accidents reported here can hardly be regarded as an adequate comparison group but there are some observations that may add a little to the considerable value of the results of the Melbourne study.

For example, information on alcohol involvement was not readily available in Melbourne whereas BAC readings were obtained for all of the 18 drivers and one rider in the accidents described earlier in this Section. Thirteen of them had a BAC above 0.05 (most of them well above) and this was probably a factor, if not the sole factor, in the causation of each of these 13 collisions. Other factors that were identified included some distraction or secondary activity, the driver possibly falling asleep, collapse in a diabetic coma and apparent attempts to commit suicide. From this information we can estimate that eight, or possibly nine, of these 19 collisions may not have occurred had the driver been given adequate warning that his vehicle was off-course. Six of these drivers who could have been alerted were travelling on arterial roads and three on residential streets.

If the pole had been set back from the kerb line it is possible that some of the eight or nine drivers noted above may have been alerted by the impact with the kerb in time to have regained control of their car. A further seven or eight of the 19 collisions may also have been avoided had the pole been set back. However at some locations it may be impractical to move the pole towards the property boundary because of the presence of underground services or for other reasons. An alternative way of achieving the desired separation between the kerb and the pole would be to move the kerb line (thereby reducing the width of the carriageway). This could be done in conjunction with the provision of parking bays on many streets and roads. On arterial roads it may mean that the traffic flow capacity of the road is reduced and this in itself would be a direct cost to the community but, as noted above and by Fox, Good and Joubert, the existing situation is not without its costs.

Other countermeasures are discussed in detail in the report on the Melbourne study (ibid.) and so they are not discussed here apart from brief comments on two suchchanges: slip-base or frangible poles and the consequences of removal of the pole.

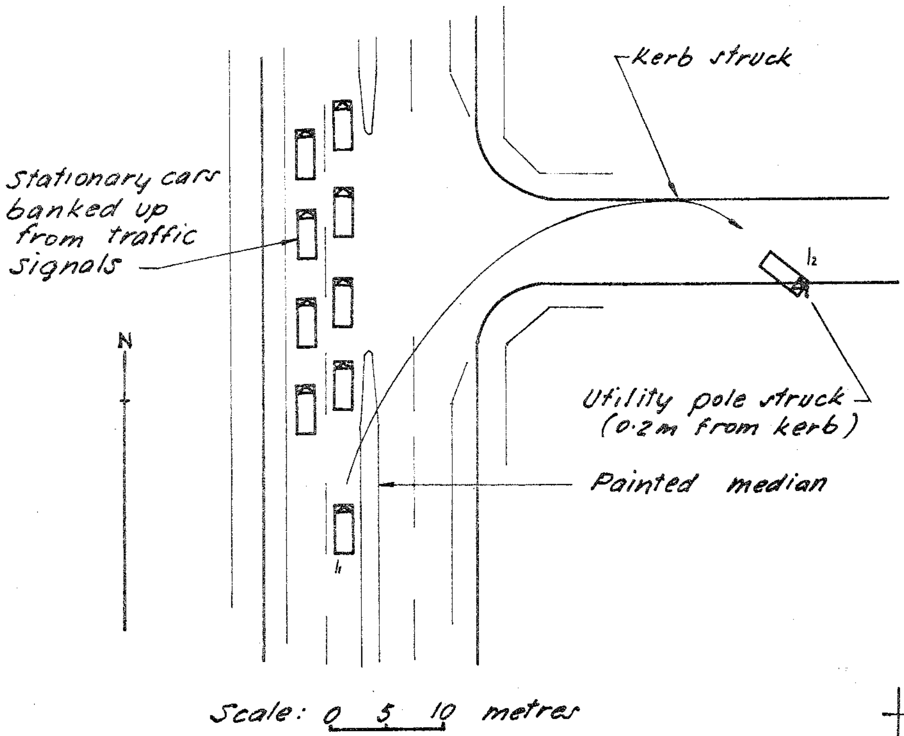


FIGURE 3.23: Accident 108.

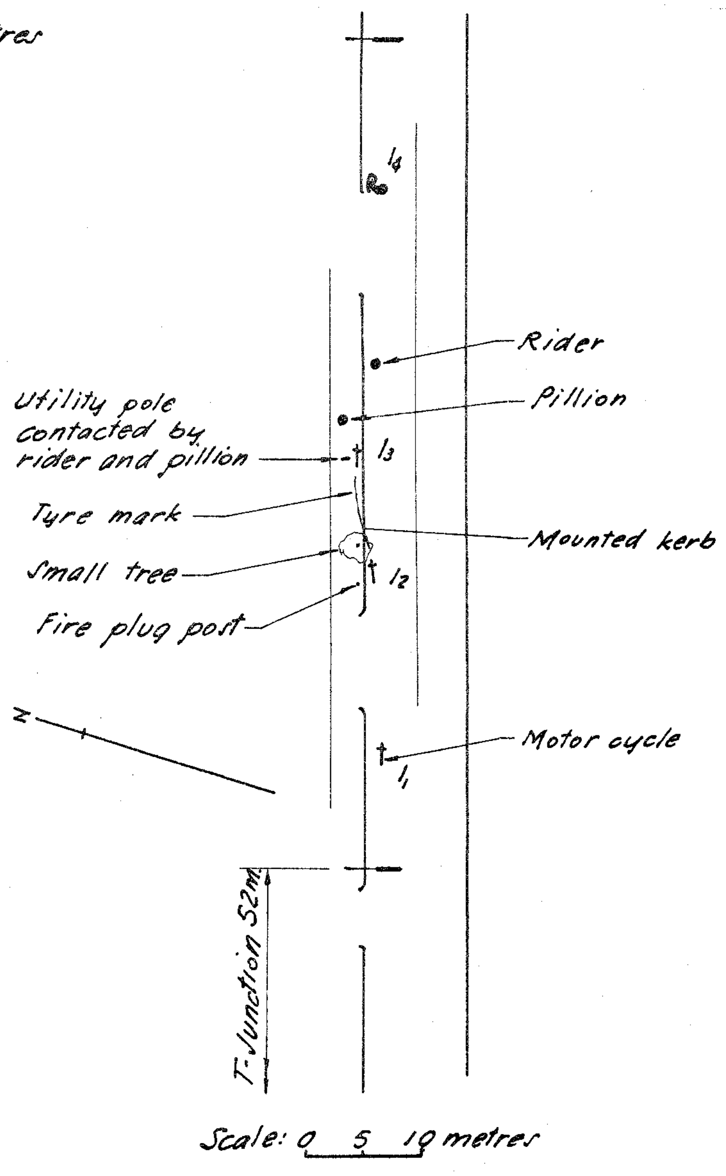


FIGURE 3.24: Accident 289.

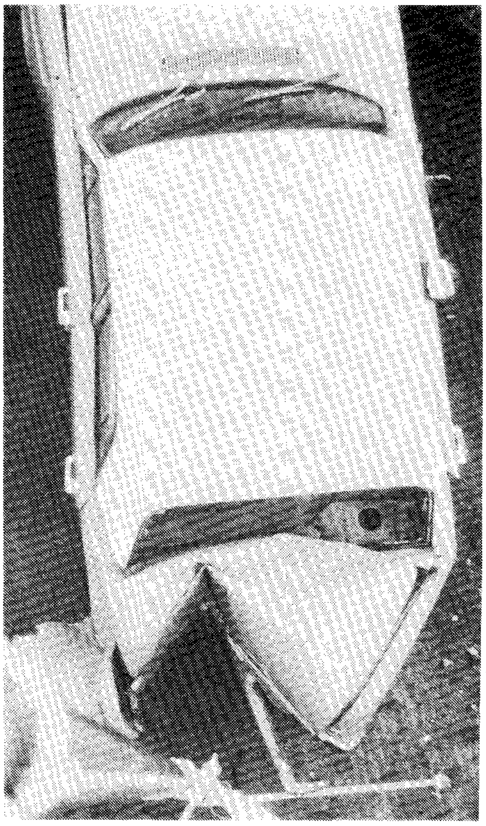


FIGURE 3.25: Damage from collision with pole. (see Figure 3.26)

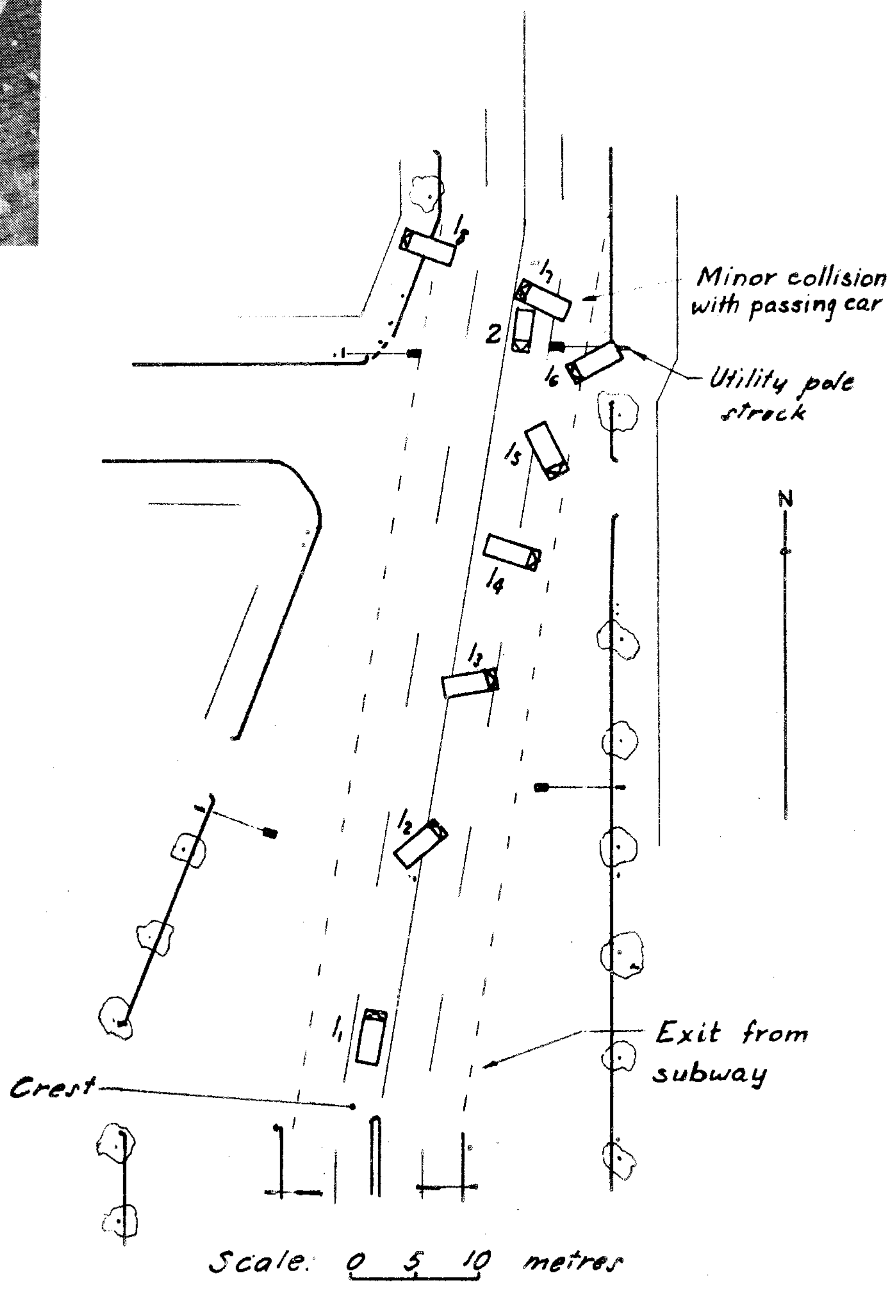


FIGURE 3.26:

Accident 062.

Slip-base and frangible poles can greatly reduce the severity of the injuries sustained by the occupants of a striking car and the total cost of the accident (ibid.). However such poles are likely still to be hazardous objects for motorcyclists or even for cyclists.

If the Pole Had Not Been There.

The removal of the pole altogether, by the provision of underground cables or other means, can be criticized using the argument that the pole protects the area beyond it from being invaded by the striking vehicle. In eight of the 19 accidents reviewed here it is probable that the driver would have regained control of his vehicle, assuming that he was alerted by the impact with the kerb that he was off the road. In four more cases he would either have regained control or his car would have run into a garden fence or wall. There were two accidents (062 and 270) in which there was no prospect of the driver being able to regain control of his car. Both vehicles would have hit a garden fence or low wall. The motorcyclists were falling from their machine when they hit the pole but this may have been a consequence of the rider swerving to try to avoid the pole. Therefore it is possible that they would not have hit another object and may have stayed on the motorcycle. There is little point in speculating on what other objects may have been hit by the three cars whose drivers appeared to have chosen to hit the pole deliberately. In none of these 19 accidents would a pedestrian or other road user have been hit if the pole had not been there.

None of these accidents was likely to have been as severe, in terms of either damage or injuries, had the pole not been there. In some accidents other property would have been damaged but even then the overall losses associated with the accident would almost certainly have been less than those which actually resulted.

Finally, it is noted again that this Section has not considered those accidents in which a utility pole was struck following an earlier collision (see Table 8.2).

3.4 COLLISIONS WITH TREES

There were eleven single vehicle accidents which were primarily collisions with trees. The manoeuvres which initiated these crashes are listed in Table 3.1 where it can be seen that veering away from an initially straight course was the most frequent initial event.

Seven of these accidents occurred at night and nine after 5 p.m. Alcohol intoxication, inexperience in driving, and attempting to engage in some secondary activity while driving were all relatively common factors in these crashes.

3.4.1 ALCOHOL INTOXICATION

Alcohol intoxication was again an important factor in the causation of these accidents, as it was in collisions with utility poles and with parked vehicles. Five of the eleven drivers had blood alcohol levels which were above 0.08 and four of these five were above 0.18.

The driver in Accident 204 had, according to an independent witness, been driving at 70 to 80 km/h and "wandering all over the road" for some distance before he hit a tree after turning right from a STOP sign (Figure 3.27). He sustained only minor injuries and so was not taken to hospital where a blood sample would routinely have been taken and analysed to determine his blood alcohol level. The police officers present did not ask him to submit to a breath alcohol screening test, possibly because he had a bruised lip, but he willingly blew into our Alcolmeter, which registered a blood alcohol level of 0.23.

One of the two accidents involving the loss of lateral stability (Table 3.1) seems to have happened largely because the driver was intoxicated (BAC 0.19). He passed one car on its left, then swervedacross into the right lane to pass another car (Accident 237, Figure 3.28). On swerving back to the left lane his car yawed anti-clockwise and rolled over. It left the road, knocking down a hydrant marker post, a small tree and a chain wire fence before crashing into a large tree located on private property. The driver had no idea why the accident happened.

The three remaining intoxicated drivers all allowed their cars to veer gradually off the road to the left without realizing what was happening. One driver (Accident 018) dropped a cigarette while trying to light it, this mishap in itself possibly being a consequence of his degree of intoxication (BAC 0.22). The two other drivers were both talking to their passengers. Their blood alcohol levels were 0.22 (Accident 121) and 0.09 (Accident 019). The latter driver had held a licence for less than a year and may have been aided in veering to the left by a change in the camber on the road. As shown in Figure 3.29 (Accident 019), the collision occurred just beyond a T-junction. At this junction there is little cross-fall from the centre of the through road in the direction travelled by this vehicle but immediately after there is a cross-fall of nine per cent. The unusually large gap in the row of trees shown in Figure 3.29 is a consequence of a tree being uprooted when hit by a car only a few days after Accident 019 occurred.

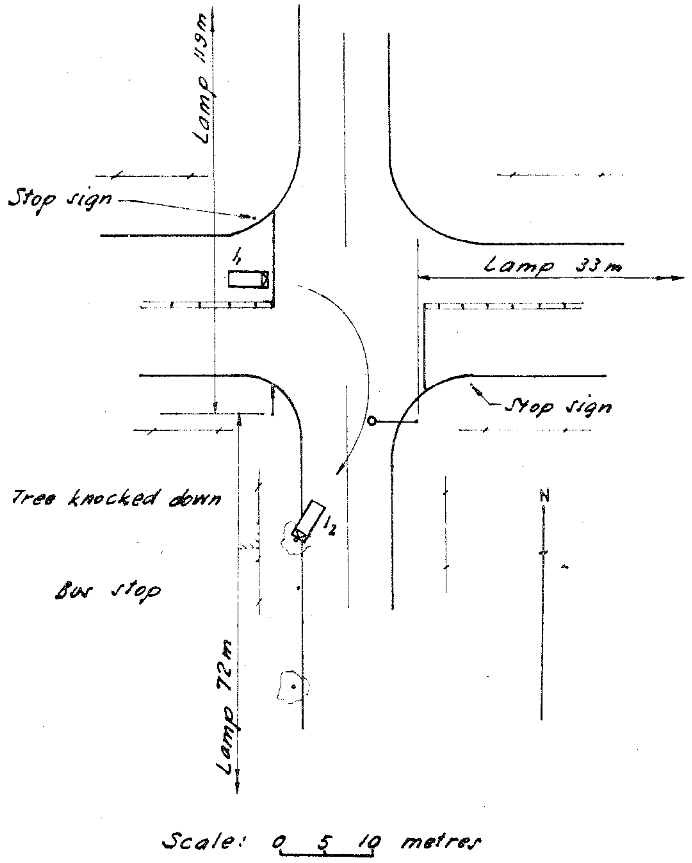


FIGURE 3.27: Accident 204.

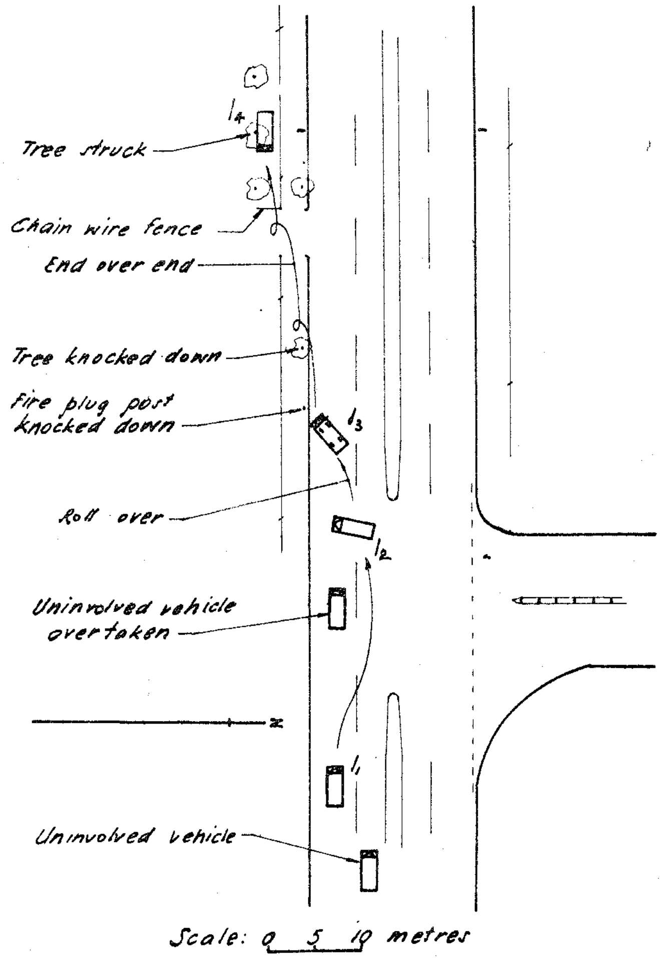


FIGURE 3.28: Accident 237.

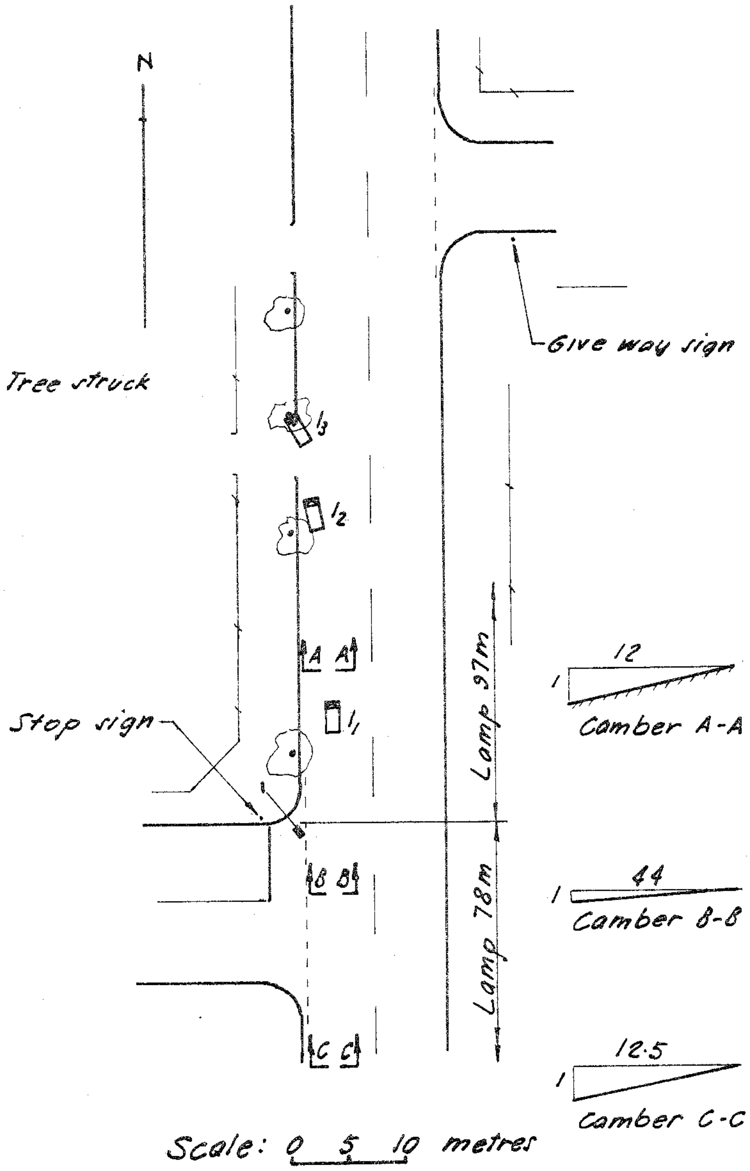


FIGURE 3.29: Accident 019.

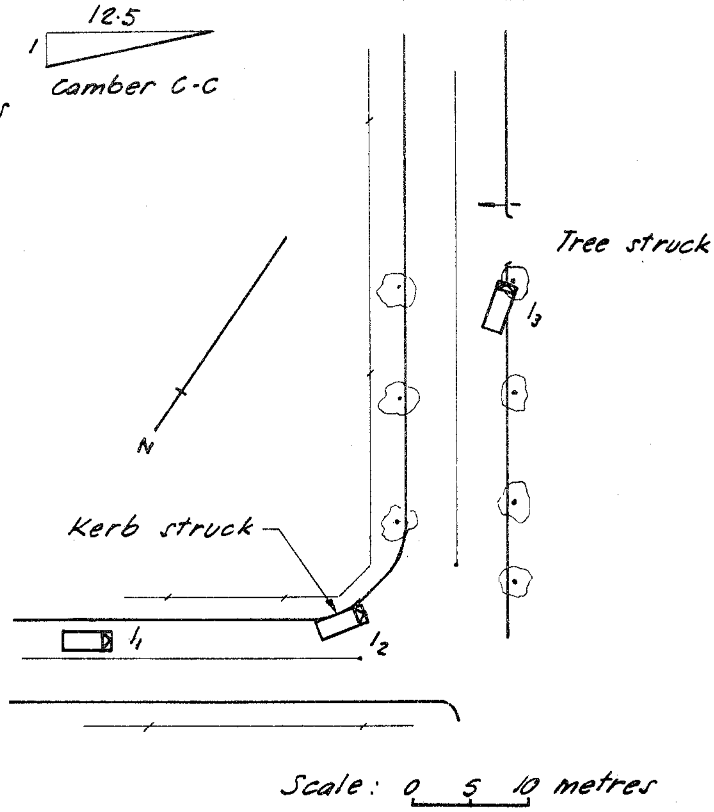


FIGURE 3.30: Accident 057.

3.4.2 INEXPERIENCE IN DRIVING

Three of the eleven drivers who hit trees had never held a drivers licence. Two were under age, with one being only 13 (the youngest driver in this survey).

The 13 year old driver had never driven on the road before being invited to drive a friend's car late at night. The car ran wide on negotiating a left-hand turn at a T-junction and hit the far kerb. It continued in the turn, travelling back across the road and crashed into a tree (Accident 236).

The other under-age driver (15 years) had stolen a car from an off-street garage where it was parked with the keys in the ignition lock (Accident 057). Some hours later he clipped the kerb on the inside of a ninety-degree left-hand bend, deflating the rear tyre on that side, and then ran wide on the exit from the bend. The car mounted the kerb and struck a tree (Figures 3.30 to 3.32).

The third unlicensed driver was 22 years old (Accident 241) and was driving the car slowly along a street so that the owner of the car could check from the roadside whether the turn indicators were operating correctly. As the automatic transmission jerked into second gear the driver, who had never driven a car on the road before, looked down at the gear change indicator. The car veered to the left and bumped up over the kerb. The driver looked up but too late to avoid hitting a tree.

A fourth driver had held a licence for only three months but this is unlikely to have been relevant to the causation of the accident in which it seems likely that she fell asleep while driving home after working a night shift. She had not had any sleep during the previous 30 hours. The car veered across to the right and crashed into a tree (Accident 231, Figure 3.33). It then rolled over and slid along the footpath on its roof, coming to rest between a utility pole and a fence.

3.4.3 AVOIDING OTHER VEHICLE

A cyclist who turned right from the left side of the carriageway without first checking for following traffic, although he did indicate a right turn, caused a car driver to brake and swerve to the left (Accident 290, Figure 3.34). The car ran onto the earth shoulder and hit a tree which was two metres from the edge of the pavement. The driver, who had been talking with his passengers, had not noticed the cyclist before the cyclist indicated a right turn and started to turn at the same moment. This accident happened in daylight.

3.4.4 TRAILER JACK-KNIFED

The final accident to be reviewed in this Section happened when a car-trailer combination began to oscillate on a steep downgrade. The driver was unable to control this oscillation and the combination jack-knifed, fracturing the towing connection and running off the road onto private property where it crashed into a tree. The hired two-axled trailer appeared to have been grossly overloaded.

3.4.5 RELEVANCE OF ROAD AND TRAFFIC FACTORS

Unlike the utility pole, a tree is planted at the roadside because it is pleasing to look at and provides welcome shade. In rural areas the removal of trees from the roadside or the realignment of the road to provide a safe shoulder may be both acceptable and practicable. The removal of trees in a metropolitan area is less likely to be acceptable and major realignment of the roadway is rarely practicable but many streets in residential areas could be reduced in width, without hindering the flow of traffic, thereby ensuring that the kerb line is well out from the existing trees. As noted in the corresponding discussion on utility poles, such a re-alignment of the kerb line would allow for the provision of parking bays.

On arterial roads many trees have been removed as a consequence of road widening programs. The hazards presented by those that remain could be diminished by reverting to a narrower carriageway, as discussed in relation to utility poles.

There are roads in the Adelaide metropolitan area where rows of substantial trees have recently been planted close to the kerb when there has been space available to have located them some metres further away from the edge of the carriageway. On two such roads the overhead lighting is provided by lanterns mounted on slip-based standards which are located in line with the trees. Within a few years the protection afforded by the break-away poles will be negated by the presence of the adjacent trees.

If the Tree Had Not Been There.

In this assessment of what might have happened had the struck tree not been there we have assumed that no trees were present at all, because at three locations it is likely that the next object in line was the next tree. In none of these cases, or in any of the collisions with utility poles, was there a report of a pedestrian or other road user being present in the probable path of the car.

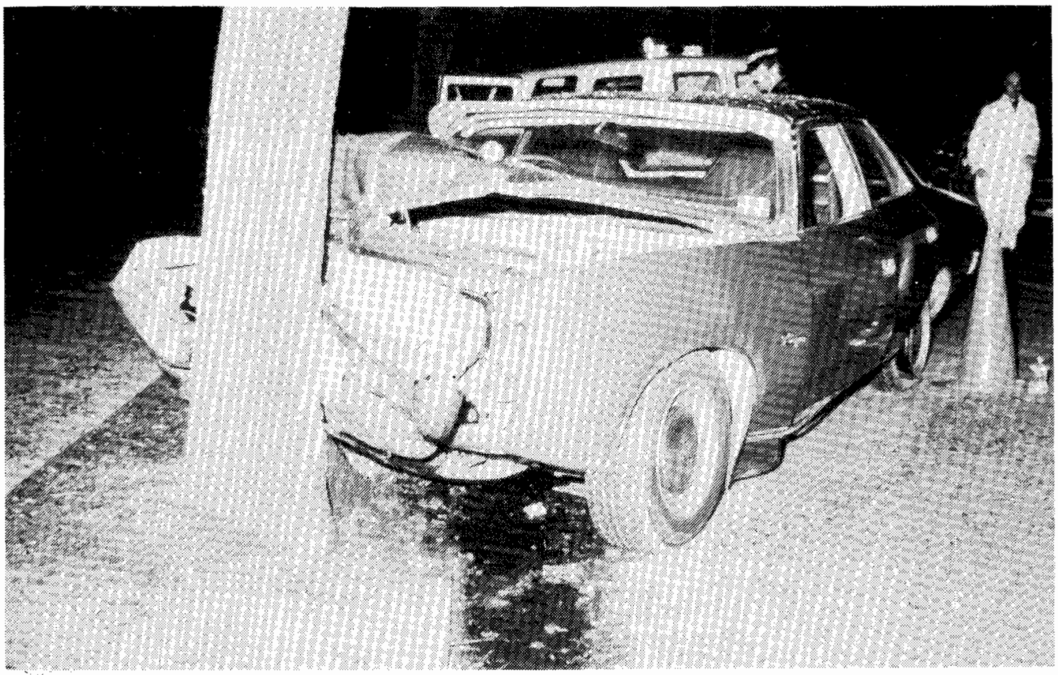


FIGURE 3.31: Damage resulting from collision with tree : Accident 057 (See also Figures 3.30 and 3.32).

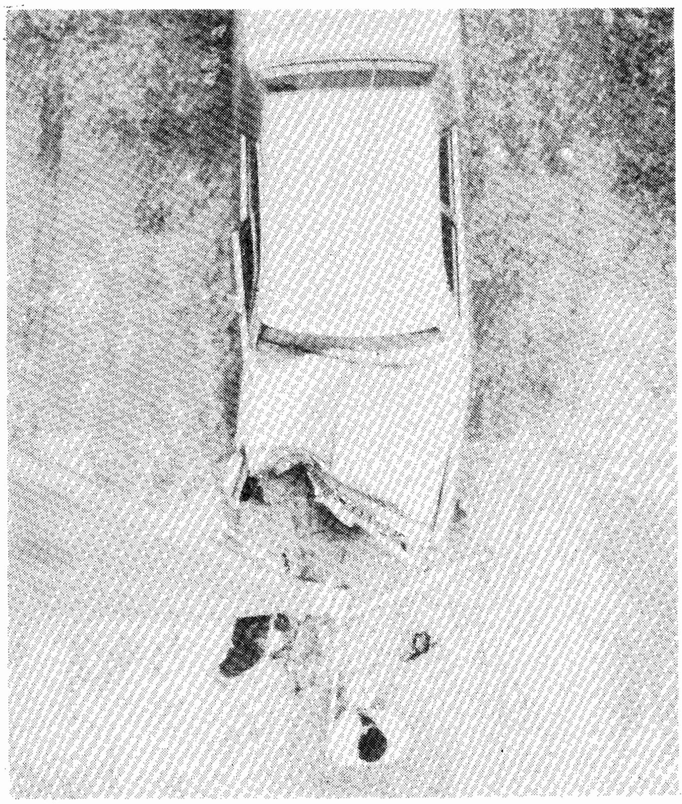


FIGURE 3.32: See Figures 3.30 and 3.31.

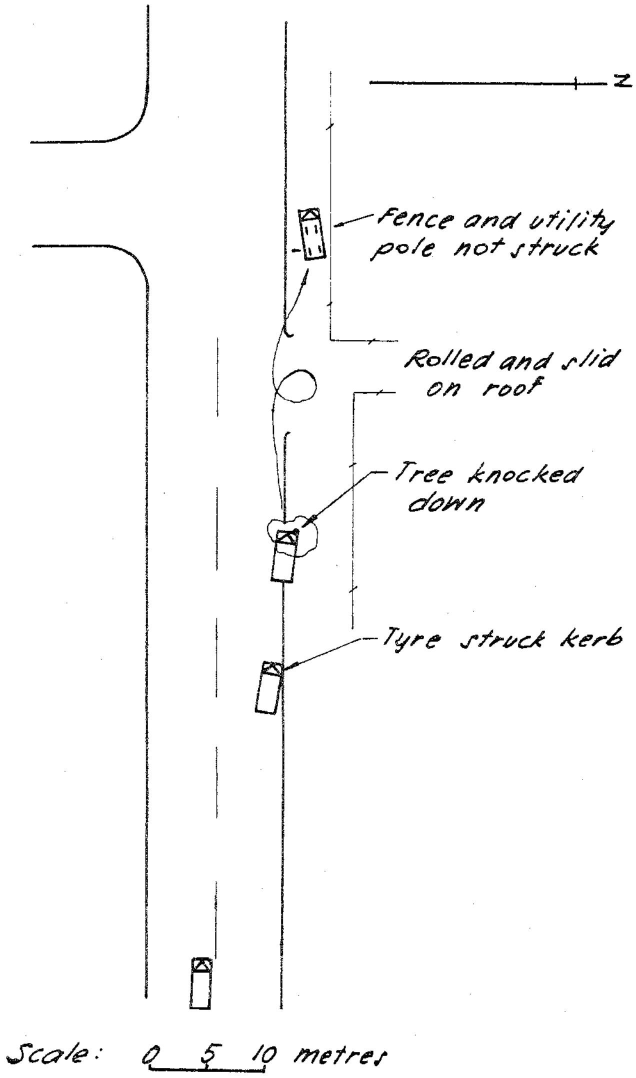


FIGURE 3.33: Accident 231.

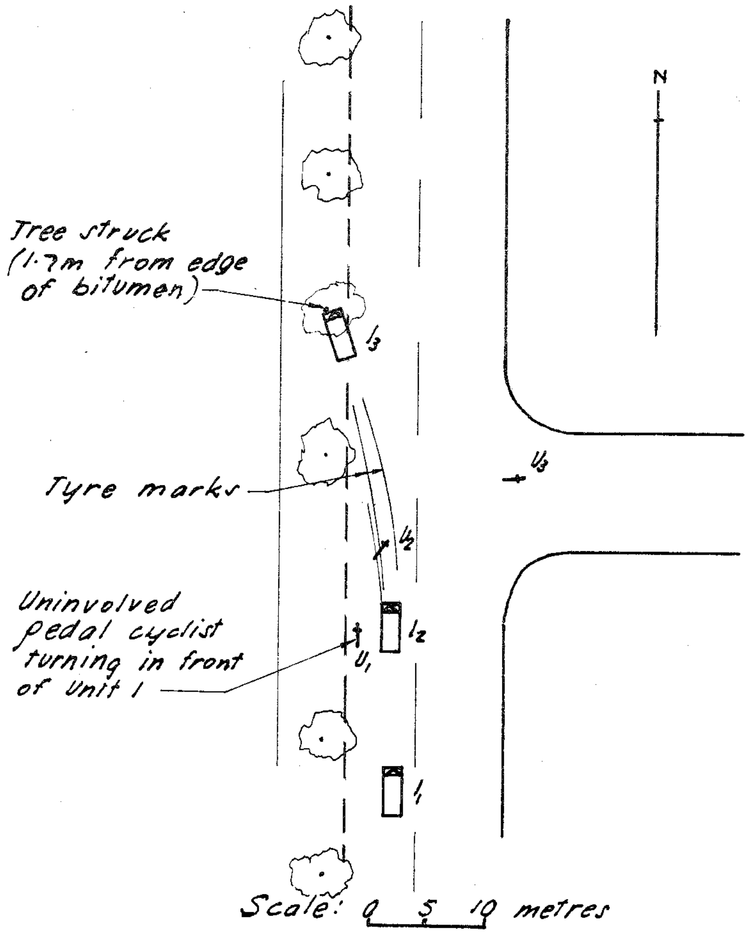


FIGURE 3.34: Accident 290.

Six of the eleven drivers might have regained control of their cars without being involved in a collision (apart from hitting the kerb in most cases) had the tree not been there. Two of these six could equally as probably have hit a fence before they had time to stop or redirect their vehicles. One car would have run up onto a steeply-sloping grassed roadside verge and another would have come to rest in a front garden or possibly have struck the brick front wall of a house.

Two accidents would not have been greatly affected had the tree not been there: Accident 046, in which the trailer jack-knifed and 237, in which the car had rolled several times before hitting the more substantial of two trees.

In Accident 057 the car would probably have hit a Stobie pole, in which case the resulting damage would have been about the same apart from the cost of repairing any damage to the pole. It is possible that it may have missed the pole and hit a garden fence instead.

As with the collisions involving utility poles, there were no cases in which the accident would have been likely to have been more severe had the tree not been there. In almost all cases it would either have not required reporting or would have resulted in less severe damage and injuries.

3.5 COLLISIONS WITH KERBING

In the previous Sections dealing with collisions with poles and trees most of the vehicles struck a kerb before hitting the pole or tree. The six accidents which warrant grouping under the present heading involved five motorcycles and one pedal cycle. For these single-track vehicles a collision with a kerb is far more likely to have serious direct consequences than it is for a car.

Four of the five motorcycle riders were illegally intoxicated (BAC above 0.08), another lost control for no apparent reason and the pedal cyclist swerved to avoid a car which had turned across his path at a signalised intersection. The last-mentioned accident (030) is reviewed in the Chapter on accidents at signalised locations and will not be considered further in this Section.

3.5.1 ALCOHOL INTOXICATION

Two of the four intoxicated riders appeared to have allowed their machines to veer from a straight-ahead course and run into the kerb. In Accident 034 the semi-mountable kerb of a median strip was contacted at a shallow angle. The motorcycle crossed the median and continued on for some distance with the rider falling off and tumbling along the median before coming to rest back on the left side of the carriageway (Figure 3.35). The rider had a blood alcohol level of 0.20.

In a similar accident the motorcycle contacted a non-mountable kerb on the left-hand side of the carriageway, narrowly missing a utility pole (Accident 045). Ten metres further on the rider fell to the left and then tumbled along the footpath for a further 22 metres where he struck a wooden gate and then the corner of the supporting post. His crash helmet had come off by this time and the impact with the post resulted in fatal head injuries. This accident occurred at about 3.00 a.m. and so it is possible that the rider (BAC 0.22) may have fallen asleep.

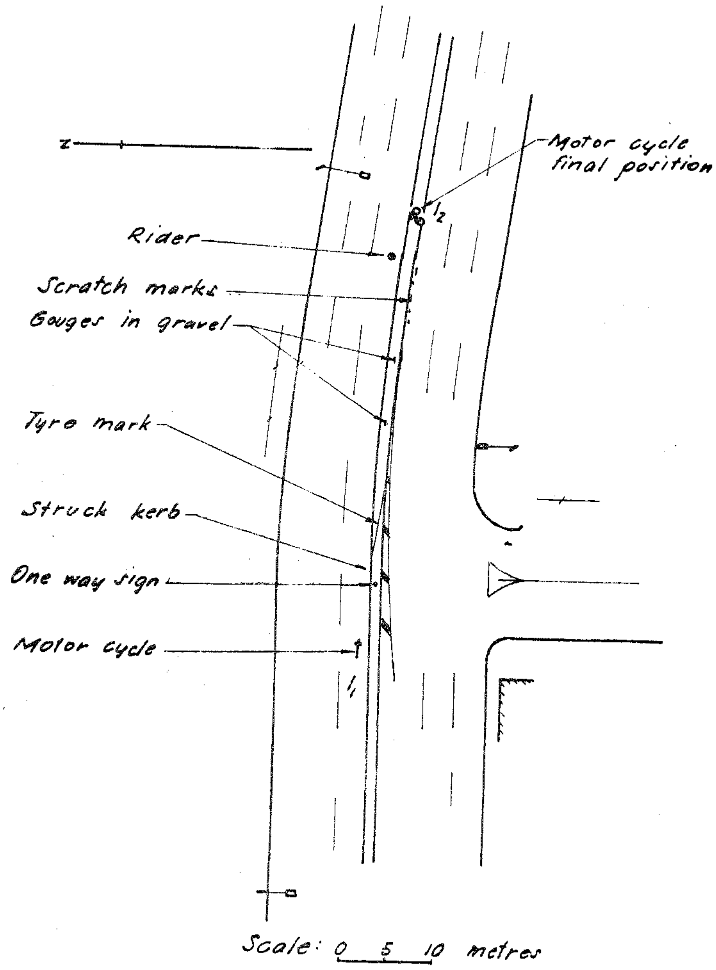
Unlike the two preceding cases, the other intoxicated riders fell from their motorcycles well before hitting the kerb. A rider who was operating on a Learner's permit applied his back brake and changed to a lower gear to slow down before negotiating a roundabout. The back wheel skidded sideways on the wet road and the rider fell from the motorcycle, which slid along until it hit the semi-mountable kerb of the roundabout. It then mounted the roundabout where it broke off a KEEP LEFT sign, and eventually came to rest 66 metres from the point where the back wheel had started to slide (Accident 085, Figure 3.36). The rider (BAC 0.17) travelled 49 metres from this initial point and was found on the roundabout alongside another KEEP LEFT sign which he had hit after first striking the kerb.

The fourth rider, accompanied by a pillion passenger, was racing two other motorcycles late at night (Accident 113). As he entered a left-hand curve the centre stand began to scrape on the road as the machine keeled over to the left. Soon after the stand contacted the road the motorcycle crossed a slightly raised patch on the road surface around a man-hole cover. The stand appeared to catch on the edge of this patch, throwing the rider off balance, and the machine slid down. The rider, who had a blood alcohol level of 0.10, told us that he had been travelling at about 110 to 120 km/h, which seems plausible because he came to rest alongside his motorcycle 100 metres further on, after sliding into the kerbing of a median strip, breaking off a timber support of a KEEP LEFT sign and then tumbling along to the far side of the carriageway. The pillion passenger was found on the grass verge on the same side of the road 60 metres from the man-hole cover. Neither the rider nor the pillion passenger was hurt, apart from minor bruises and abrasions.

3.5.2 LOSS OF STABILITY

The remaining collision with a kerb resulted from the experienced female rider appearing to lose control of her motorcycle as she turned right from a side street into a four lane priority road. The motorcycle began to wobble and travelled relatively

FIGURE 3.35: Accident 034.



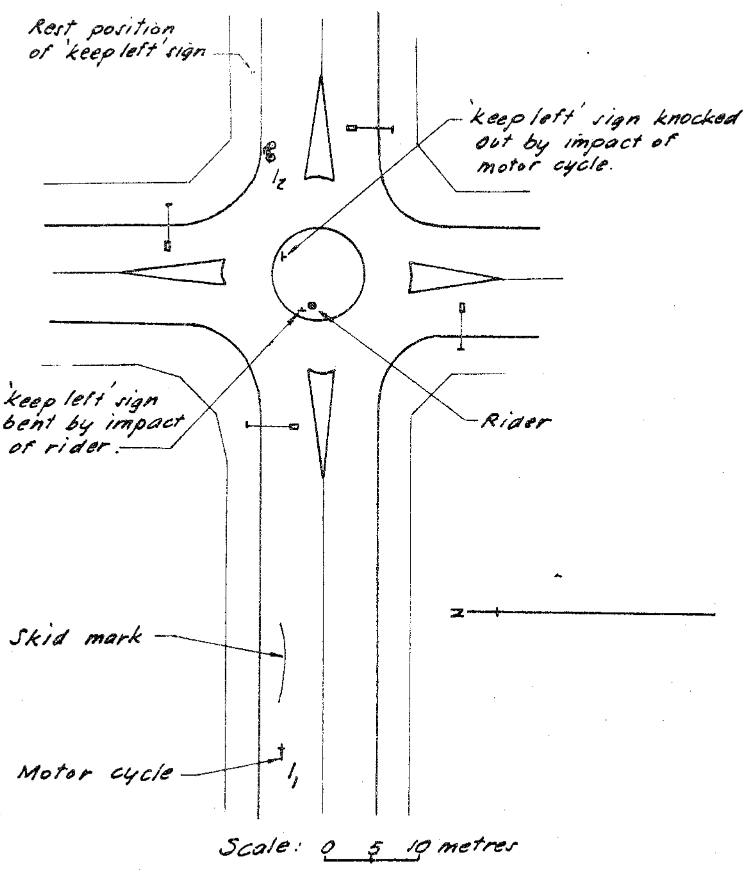


FIGURE 3.36: Accident 085.

slowly across to the left until it hit the kerb and the rider fell off (Accident 251). The reason for the loss of control is not known. The rider, who was sober, denied having entered the priority road from the side street, despite reports from two independent witnesses that she had done so.

3.5.3 RELEVANCE OF ROAD AND TRAFFIC FACTORS

Whereas a kerb impact can reasonably be expected to alert a car driver to the fact that he is straying off the carriageway and yet give him the opportunity to regain control of his vehicle, the same is obviously not true for the motorcyclist. It may be that on roads such as the one in Accident 045, where there is a wide kerb lane, coarser aggregate could be laid in a strip about 300 mm wide, parallel to and about a metre from the kerb. This might then function as a rumble strip, as used on the shoulders of some freeways, and serve to warn a driver or rider that he is no longer on course while retaining smoother pavement adjacent to the kerb for the convenience of pedal cyclists.

The use of semi-mountable kerbing does not appear to be an adequate solution, if the events of Accident 034 can be taken as a reliable indication. Admittedly, the rider involved in that accident was intoxicated and therefore presumably less able to control his motorcycle when it hit the kerb but intoxicated riders appear to be at high risk, compared to sober riders, of running off the road and thereby colliding with a kerb. Intoxication, therefore, should be recognized as being a common condition among motorcyclists involved in single vehicle accidents of this type.

In addition to upsetting the stability of a motorcycle, a kerb may be a hazardous object to a motorcyclist who has fallen from his machine and is sliding along the road. The rider in Accident 085 sustained only minor abrasions from the fall from his motorcycle and from sliding along the road. He then hit the semi-mountable kerbing of the roundabout and also a KEEP LEFT sign. In these impacts he sustained an injury to his neck and is unlikely ever to regain more than minimal use of his left arm.

3.6 MISCELLANEOUS SINGLE VEHICLE COLLISIONS

The remaining seven single vehicle collisions arose from four types of initial manoeuvre and resulted in collisions with an even greater variety of objects. Consequently most of these accidents are reviewed individually, although there are some common features, as noted below.

3.6.1 RUN WIDE AT CORNER OR BEND

Two accidents resulted from the driver's failing to negotiate a bend. The circumstances of one of these crashes were unusual (Accident 119). A car ran off the road on the exit from a shallow S-bend (Figure 3.37). It mounted the kerb, knocked down a low fence and then crashed into a brick-veneer house. The damage to the house was severe, with one exterior wall being pushed along about 150 mm on its foundations. The car was being used to chase another car containing a group of people who had fled from a fight. The driver of the car had a blood alcohol level of 0.11. He claimed that he chose to run off the road through the fence because had he attempted to get back onto the road by running along the footpath he would have hit a utility pole. He was not familiar with the area and may have been misled by the street lighting (tubular fluorescent) which did not provide an accurate indication of the road alignment.

The other accident of this type occurred under similar lighting. A young male who had been licensed to drive for only two months swerved hard to his left at a Y-junction when he suddenly realized that the alignment indicated by the street lighting (again tubular fluorescent) led him into a No Through Road (Accident 293, Figure 3.38). His car ran up over the kerb onto the footpath, knocked down a street signpost and a small tree and then crashed into a low brick wall. He had not been drinking.

3.6.2 LOSS OF CONTROL ON CURVE

An intoxicated (BAC 0.11) 16-year-old male lost control of a car on an S-bend on a one way section of road which has a 25 km/h speed limit (Accident 168). The car yawed anti-clockwise as it ran wide on the left hand exit from the bend and headed back across the road, where it crashed into a concrete wall of a building. The driver was not familiar with the car, having met up earlier the same night with the girl who had been driving it. His licence to ride a motorcycle was under suspension at the time of the accident as a consequence of four prior serious motoring offences, including driving without a licence. He had never held a licence to drive a car. As a consequence of being involved in this accident his period of licence suspension was extended by three weeks.

3.6.3 MOTORCYCLIST SLID DOWN

In an accident which appears to have been similar in many respects to Accident 085 (reviewed in the Section dealing with collisions with kerbs) a motorcyclist fell from his machine on the approach to a signalised Y-junction (Accident 010, Figure 3.39). The motorcycle began to

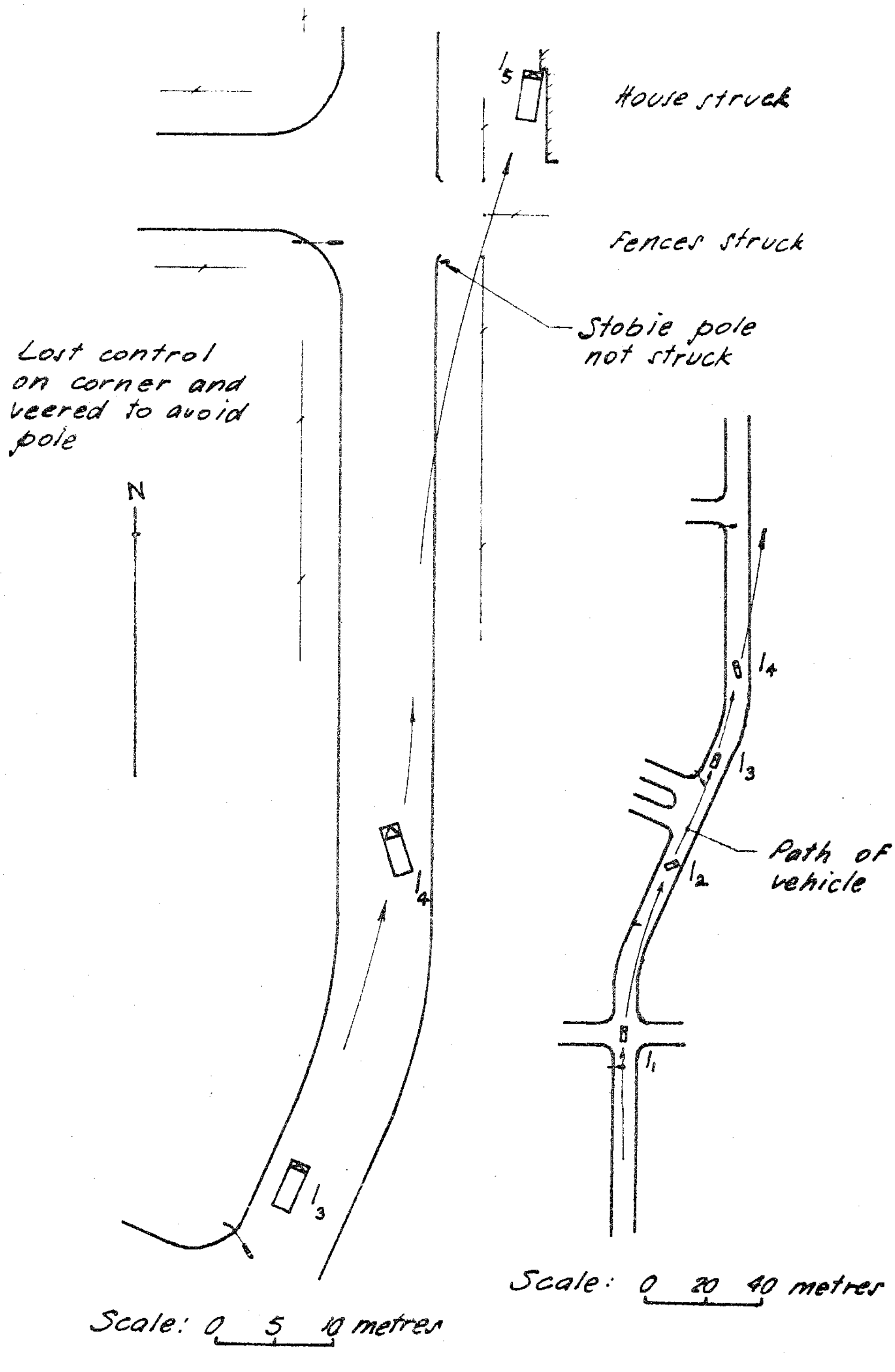


FIGURE 3.37: Accident 119.

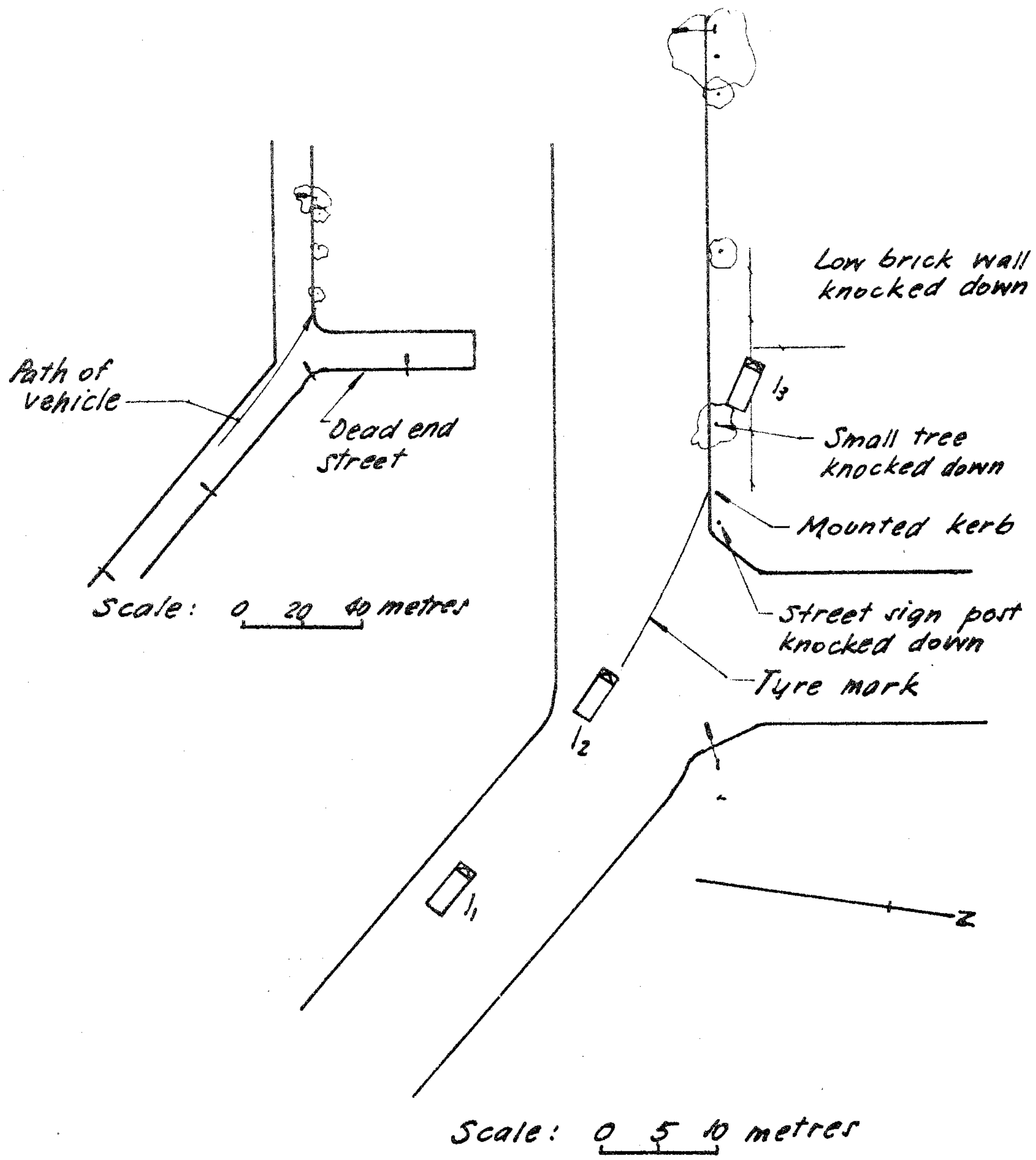


FIGURE 3.38: Accident 293.

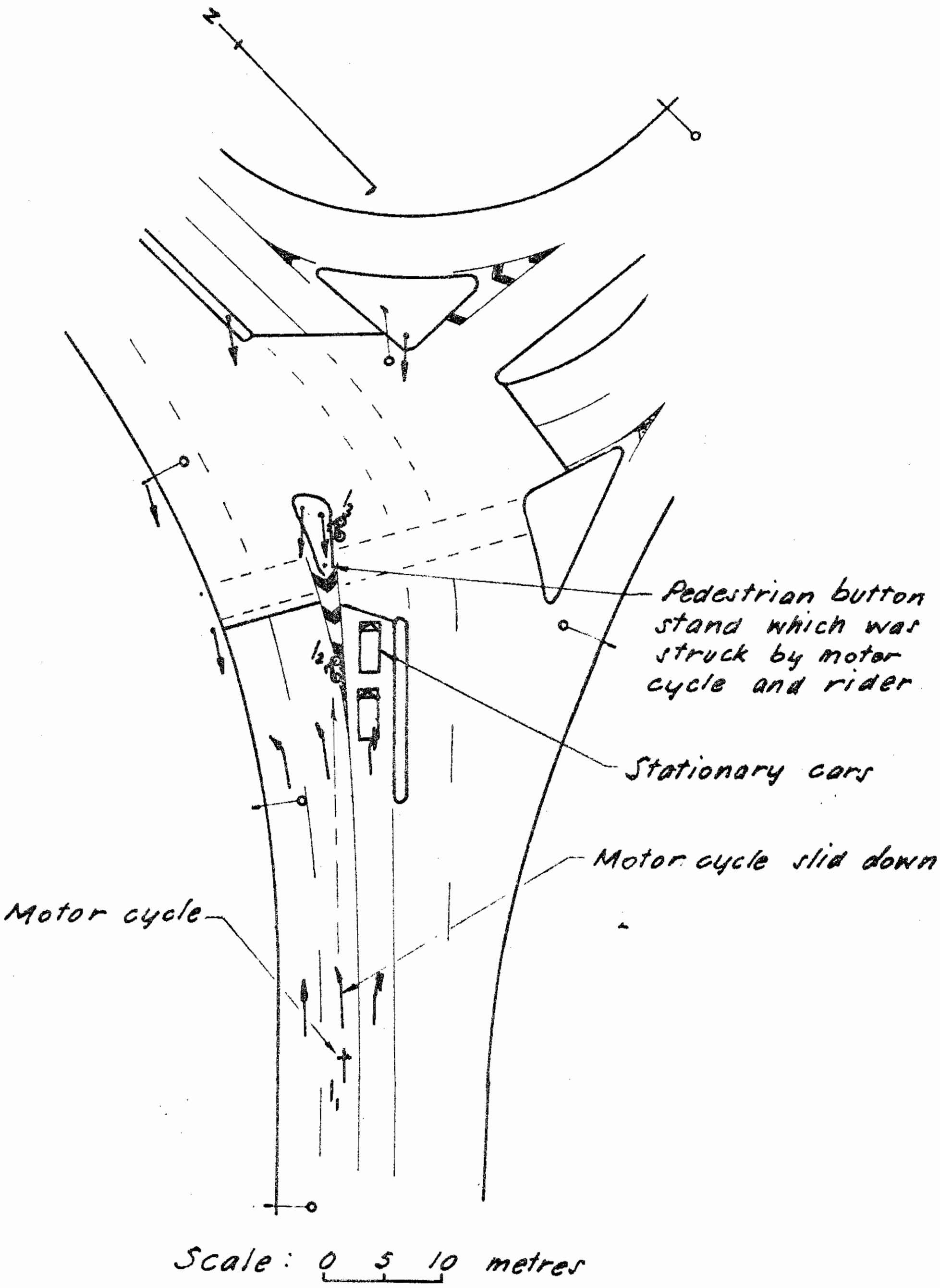


FIGURE 3.39: Accident 010.

slide down when on a painted arrow. It continued on, sliding on its side together with the rider, until they hit a pole carrying an actuating button for the pedestrian crossing at the intersection. The rider was seriously injured in this impact, sustaining concussion and multiple fractures. Because of his head injury he was not able to remember the events leading up to the accident, beyond knowing that he was returning from a trip to a take-away food shop. He said that he would have been intending to follow the road around to the left and not turning right. He was intoxicated (BAC 0.15) and this may have caused him to brake unduly sharply. The surface of painted road markings is known to be slippery, compared to the pavement surface, even when dry, as it was at the time of this accident, but we cannot say that this was the cause of the rider losing control or even a contributing factor. It is possible that the motorcycle may have hit, or been hit by, another vehicle although there was no clear evidence of such an event on the damaged machine. A driver of one of the cars which was stationary in the right turn lane heard a bang immediately before the motorcycle and rider slid past and hit the pole but this could have been the sound of the motorcycle hitting the road.

3.6.4 SWERVE TO AVOID A COLLISION

The collision with a seat at a bus stop at the roadside (Accident 118, see Table 3.1) resulted from an intoxicated (BAC 0.16) and somewhat inexperienced motorcyclist being forced to swerve to the left to avoid colliding with a car which cut him off as it moved abruptly from the right lane to the left, or kerb, lane. This initial event was observed by an independent witness. The motorcycle mounted the kerb at the entrance to a side road and continued on along the footpath, passing behind a concrete seat at a bus stop. The rider hit his right leg on the back of the seat. When he stopped his motorcycle a short distance further on he was unable to maintain his balance and fell to the ground.

3.6.5 PROCEEDING STRAIGHT AHEAD

The final two accidents in this miscellaneous grouping also involved motorcycles. In one, the rider was plucked from his motorcycle by a power line which was hanging across an eleven-lane divided road (Accident 285, Figure 3.40). The line had fallen from a support on a pole on the median strip and the arrangement of the other two poles was such that it was hanging just over a metre above the road surface in the path of the motorcyclist. He hit it with either his upper arms or the face-guard part of his "full face" crash helmet (that part of the helmet was severely abraded). The line then slid across the rider's neck pulled him away from his motorcycle and deposited him on the road. He sustained extensive abrasions and contusions across his neck. Unlike the other four motorcyclists in this group he had not been drinking. The sequence of events was confirmed by another motorcyclist who was travelling just behind him and to his left and by the presence of the power line, which was broken by the impact. None of the three poles showed any sign of having been hit by a vehicle.

The remaining accident was similar in that the rider was pulled from his motorcycle by a wire, in this case the wires of a post and wire fence. This event was a sequel to the rider failing, until the last moment, to notice a warning barrier, which had been erected to indicate that the road was closed (Accident 155, Figure 3.41). The rider had entered the road about 200 metres from the barrier, which consisted of a string of orange flags hung between stands carrying flashing yellow traffic hazard warning lamps (Figure 3.42). The stands each comprised a single tubular steel upright, painted white with a black band, with four shorter tubular sections set at 90 degrees as a base. The barrier was mid-way between two tubular fluorescent street lights and the orange flags were not directly illuminated. An advance warning sign was located 200 metres away at the left side of the entrance to this road, which was at a Y-junction.

The rider had a blood alcohol level of 0.22 and was riding a borrowed motorcycle. He braked shortly before running through the barrier, leaving a rear wheel skid mark seven metres long. The right handlebar hit one of the steel uprights, knocking it over and breaking off the motorcycle rear vision mirror and the mounting clamp for the front brake lever. The rider sustained a minor injury to his right hand from this impact. The motorcycle then continued on, with unabated speed, according to an eye witness, into an area where the road pavement had been excavated and partially replaced with low mounds of loose earth. From there it ran into a post and wire fence. The two strands of wire caught the rider with the top strand ending up across his neck. This fractured his cervical spine and he was dead when the ambulance arrived. We learnt later that he did not hold a licence to ride a motorcycle and his licence to drive a car had been suspended for 12 months.

3.6.6 RELEVANCE OF ROAD AND TRAFFIC FACTORS

Alignment of Street Lighting

In two of the seven "miscellaneous" accidents in Section 3.6 the tubular fluorescent street lighting did not indicate the alignment of the roadway accurately. Both of these accidents occurred in residential areas where the

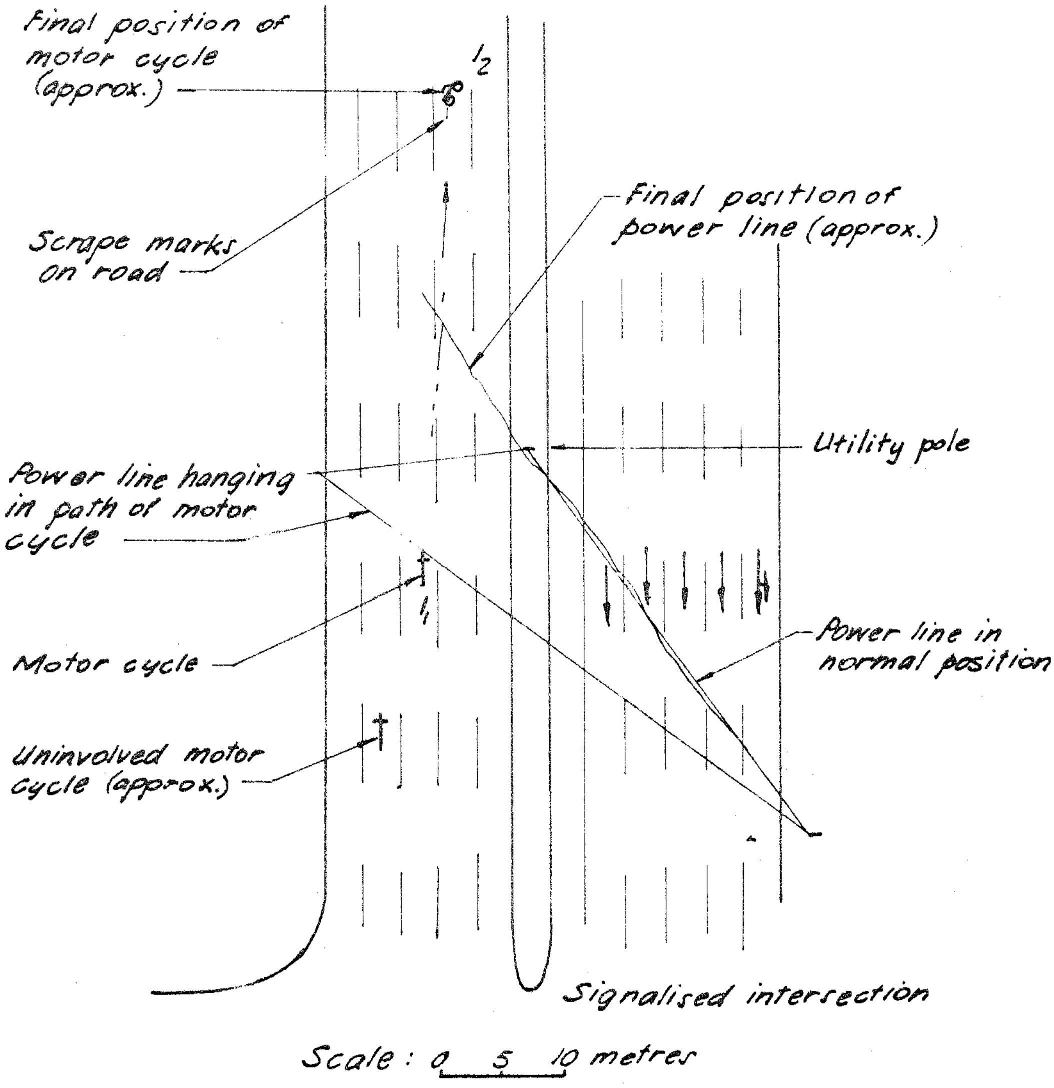


FIGURE 3.40: Accident 285.

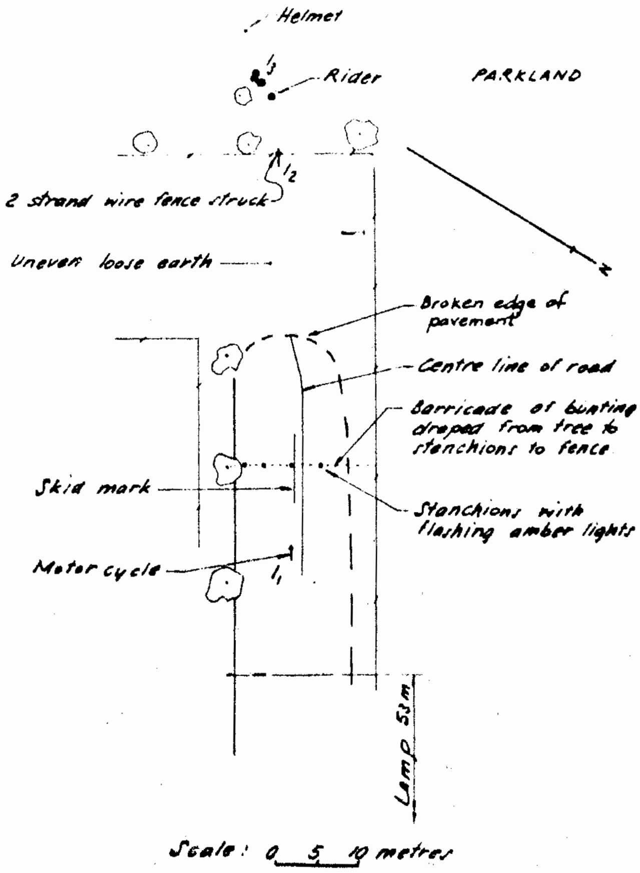


FIGURE 3.41: Accident 155 (see Figure 3.42)

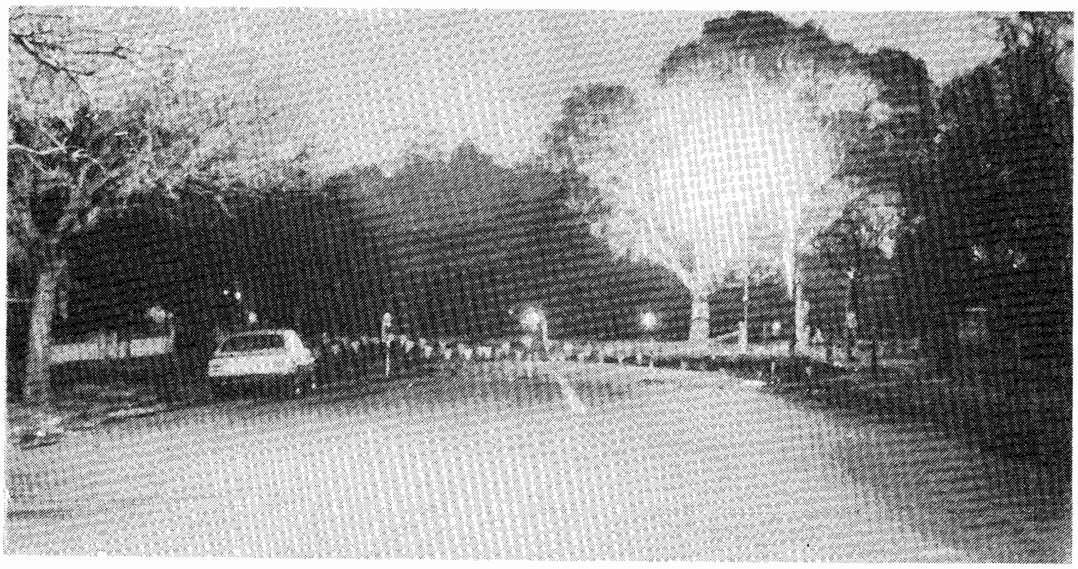


FIGURE 3.42: Roadworks warning barrier (see Figure 3.41).

street lamps were the most obvious features of the road layout at night.

Skid Resistance of Pavement Markings.

Our inability to determine the cause of Accident 010 and the absence of any other accidents involving skidding on road markings in this survey, should not be taken as evidence that painted road markings do not present a hazard to motorcyclists (and, to a lesser extent, to other road users). The most critical situation in this respect is likely to be at night when it is raining, because then the painted markings are extremely slippery and often virtually invisible. Only 13 of the 304 accidents in this survey occurred under such circumstances and only 21 in which the road surface was wet, regardless of the natural lighting conditions.

Road marking materials which are not slippery are available but they are not widely used in Australia, partly because they become coated with rubber and lose contrast with the road surface. Despite this, and the associated expense involved in frequent replacement of the markings, their use would appear to be justifiable in critical areas such as the approaches to traffic signals where heavy braking may be required, since the costs associated with a simple skidding accident can be very high.

Delineation of Roadworks.

Accident 155 suggests that there may be a need to design warning systems to attract the attention of the impaired driver, both for his own protection and also to protect anyone who may be working behind the warning barrier. In this accident it is possible that the only truly effective barrier may have been a physical one, which would have stopped the motorcycle, but that would be difficult to arrange without it also resulting in injury to the rider. It does seem that flashing yellow lights are an inadequate warning on a dark road at night. The orange flags were probably of little value, since they rely on being illuminated by the vehicle's headlight. In this accident the headlight of the motorcycle was splattered with mud but, even so, the flags may not have been seen in time when the headlight was on low beam.

When working at accident sites at night we found that placing internally illuminated plastic cones in such a way as to guide drivers around the crashed vehicles was the most effective way to ensure that they did not pass dangerously close to those vehicles. The flashing yellow light mounted on the roof of each of our vehicles appeared not to have a marked effect on driver behaviour, apart from appearing to distract them from looking where they were going, without reducing speed.

3.7 SINGLE VEHICLE NON-COLLISION ACCIDENTS

3.7.1 PEDAL CYCLIST FELL OFF

Two of the three accidents in this category involved 16-year-old school girls. In one (Accident 154) a girl was riding on the elongated seat of a "dragster" style bicycle, which was too small for a rider of this age, and in the other (Accident 214) there was a heavy load of books on the carrier. Both riders lost control ("got the wobbles" as one girl put it) when riding down a steep slope and fell from their bicycles. The passenger in Accident 154 jumped off when she realized that the rider had lost control. The rider was thrown to the road and sustained concussion, a fractured jaw and facial lacerations. The rider in Accident 214 was on a loaned bicycle which she had not ridden before (the owner was walking along the pedestrian path while her companion cycled through a subway). She contacted the side wall of the subway after she lost control and then fell to the road. This rider was also concussed, and received multiple minor lacerations and abrasions.

This latter case suggests that it may be of value to investigate the effect of the location of a load on the stability of a bicycle, the alternative location to a carrier behind the rider being one mounted above the front wheel.

The third accident (271) was a consequence of a 69-year-old man having a stroke when cycling along a footpath. He fell from his bicycle and tumbled over a post and wire fence. This event was not regarded as a road accident at the hospital and no blood sample was taken for the purpose of blood alcohol analysis, but a police accident report is on file.

3.7.2 MOTOR CYCLIST SLID DOWN

There were several accidents in which a motorcyclist slid down but in all but two the rider then hit some fixed object which, in most cases, was the main cause of the injuries which he sustained. The two exceptions are reviewed here but only one of these did not result in a subsequent collision for the rider, if not for the motorcycle.

A group of motorcyclists were travelling along an arterial road late at night when, for a reason which we have not been able to determine, one rider fell from his machine (Accident 160). As he slid along the road he crossed the centreline and was hit by a car which was travelling in the opposite direction. This car, which was not hit by the motorcycle, dragged the motorcyclist underneath it for some distance before the driver was able to react and brake it to a standstill. The rider, who had a blood alcohol level of 0.07, was severely injured.

The other motorcyclist had held a drivers licence for six years but had only held a learner's permit for a motorcycle for two months (Accident 203). He was testing a Lambretta motor scooter when it jammed in first gear. As he declutched the scooter hit a small pot-hole (approximately 20 cm in diameter and 4 cm deep) and dislodged the rider, who fell to the road. The small wheels of the scooter would have increased the disturbance caused by striking the pot hole. The accident occurred on a residential street.

3.7.3 ROLLOVER, ON ROAD

The characteristics of the topography and road layout in the Adelaide metropolitan area (flat coastal plain, with a grid-iron pattern of streets and roads) are reflected in the very low incidence of vehicles rolling over on the road or, for that matter, after leaving the road.

One of the two rollovers on the road resulted from an intoxicated driver (BAC 0.20) losing control of his early model Holden when he entered an unlit, poorly marked bend (Accident 189, Figure 3.43). The car yawed anti-clockwise in the left hand bend and rolled to its right through one full turn, coming to rest on its wheels. We were unable to obtain an interview with the driver and so we do not know whether or not he was familiar with that stretch of road. There is no advance warning sign and no buildings adjoining the roadway to indicate that there is a bend in the road. There are guide posts and a hazard marker board located on the outside of the bend.

The second accident was caused by the load (ten tonnes of paper bags) shifting on a semitrailer (Accident 013) as it accelerated after having slowed for a signalized intersection. The load had been taken on less than 20 km from the accident site. A car driver who was on the left of the semitrailer at the point where the lane marking ends (Figure 3.44) saw the load tilting towards him and so he braked, allowing the semitrailer to get ahead. As it did so it slowly capsized onto its left side (Figure 3.45). From the statement by the car driver, it seems that the load was shifting as the semitrailer entered the curve (shown, from the opposite direction, in Fugure 3.46). The owner of the semitrailer refused to allow us to interview the driver, who had not been injured, but an acquaintance of the driver assured us that it was well known that paper bags were a "trick" load because they were particularly likely to slip out of position.

3.7.4 ROLLOVER, OFF ROAD

As noted above, the Adelaide metropolitan area is set on a coastal plain. The locations of the two accidents in this category are uncharacteristic of this area, one being at the base of the foothills and the other adjacent to a small river or stream. In Accident 058 the driver told us that he had swerved to avoid a dog when driving down a steep winding road. We have no way of knowing whether this really was the cause of the car running off the road. The same result could have arisen from attempting to travel too fast around the preceding left-hand bend. Whatever the cause (the driver was sober, and the accident occurred in daylight on a dry road) the car ran off the road on the right hand side, knocked over three wooden guide posts and then ran down a steep embankment until it hit a clump of saplings and rolled onto its roof. This section of road could possibly be made safer by the erection of a guard rail but, apart from reducing the extent of the damage to the vehicle, it is unlikely that the provision of such a rail would have been of particular value in reducing the severity of this accident. (The driver, who was wearing a seat belt, sustained concussion and minor lacerations).

In the other accident (265) the rollover was the last event (albeit the most spectacular and damaging) in a rapidly occurring sequence of mishaps. An intoxicated (BAC 0.13) elderly male driver drove quickly out of a hotel car park across the centre of a Y-junction. His car followed a steady curve to the right and mounted the kerb on the far side of the junction. As it came back onto the road it clipped a passing car and then re-entered the car park. From there it ran over the edge of a steep bank. After rolling over several times it came to rest partially submerged in a stream at the foot of the bank. The driver was probably not wearing a seat belt. He sustained concussion and minor abrasions and lacerations. He did not have a clear recollection of the events which resulted in the accident and could not offer any explanation for why it had happened.

3.7.5 PASSENGER FELL OUT

The final case (267) in this review of single vehicle accidents involves an intoxicated passenger (BAC 0.16) who fell from the back of a panel van as it ran across a spoon drain. (The driver of the van was sober). We were told that the tailgate of the van had been closed but it came open when the vehicle hit the spoon drain. The van was still accelerating away from a standstill at that time. It may be that the tailgate had not been fully closed but simply on the safety catch. We could not find any defect in the operation of the latch.

3.7.6 RELEVANCE OF ROAD AND TRAFFIC FACTORS

There were only three of the ten single

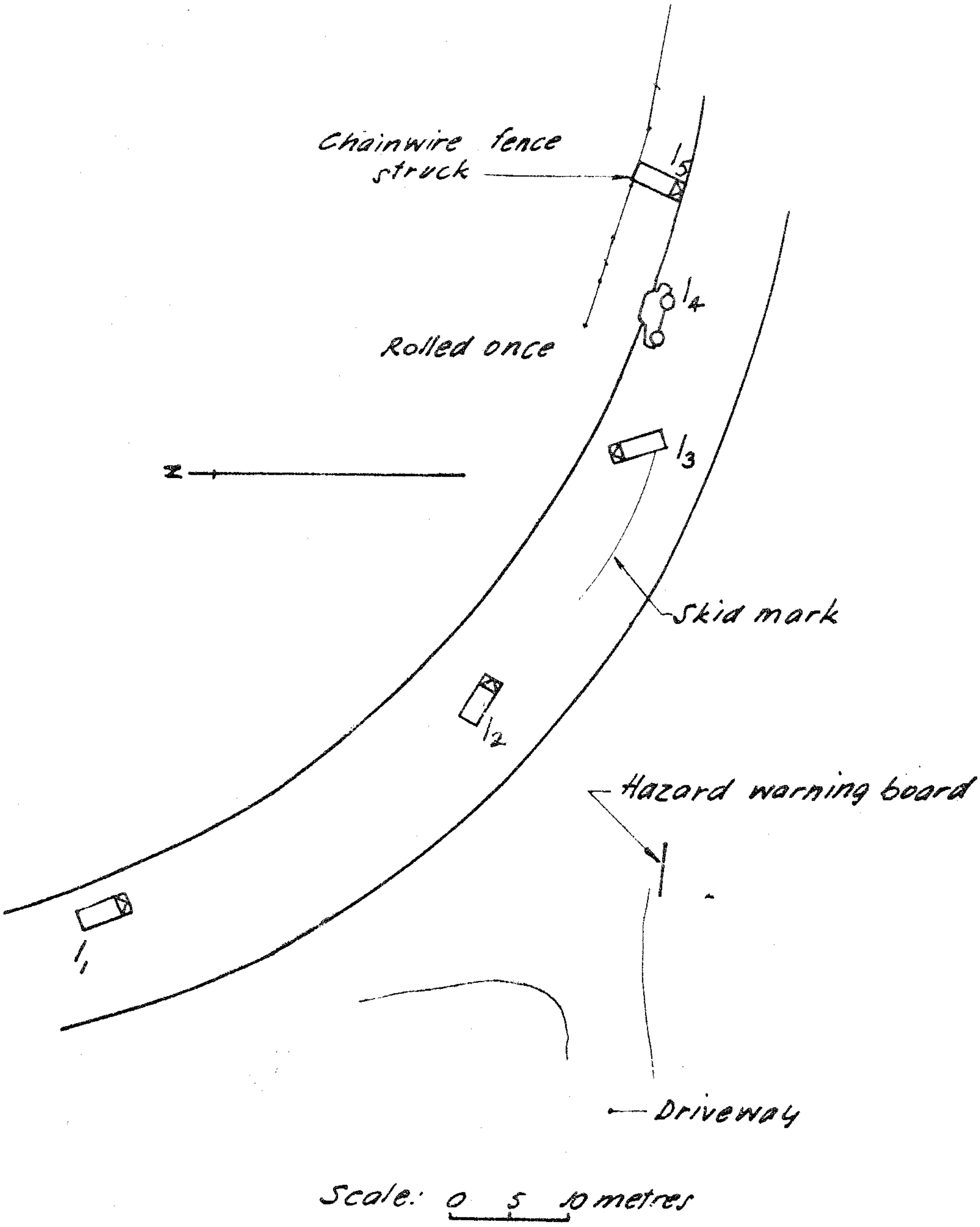


FIGURE 3.43: Accident 189.

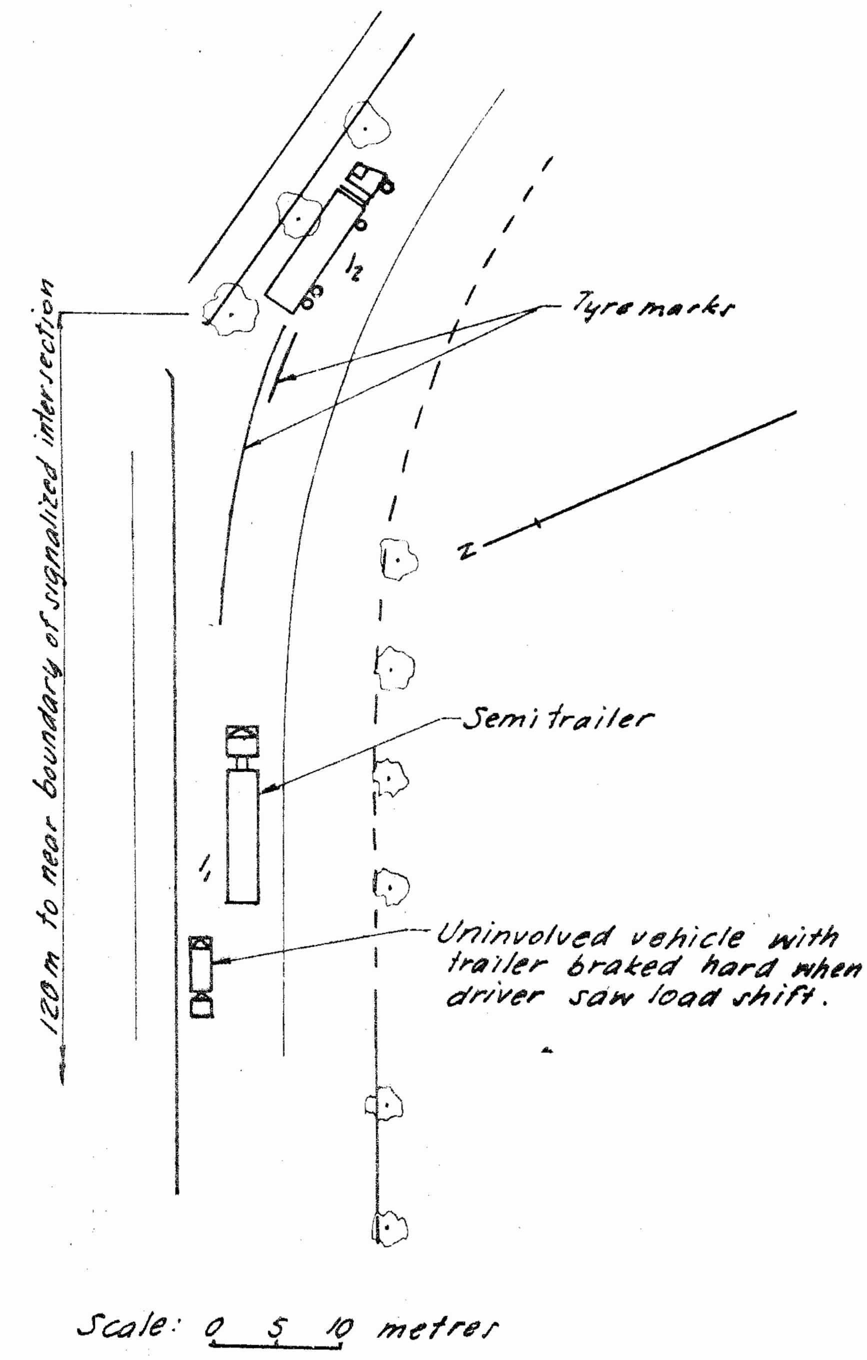


FIGURE 3.44: Accident 013.

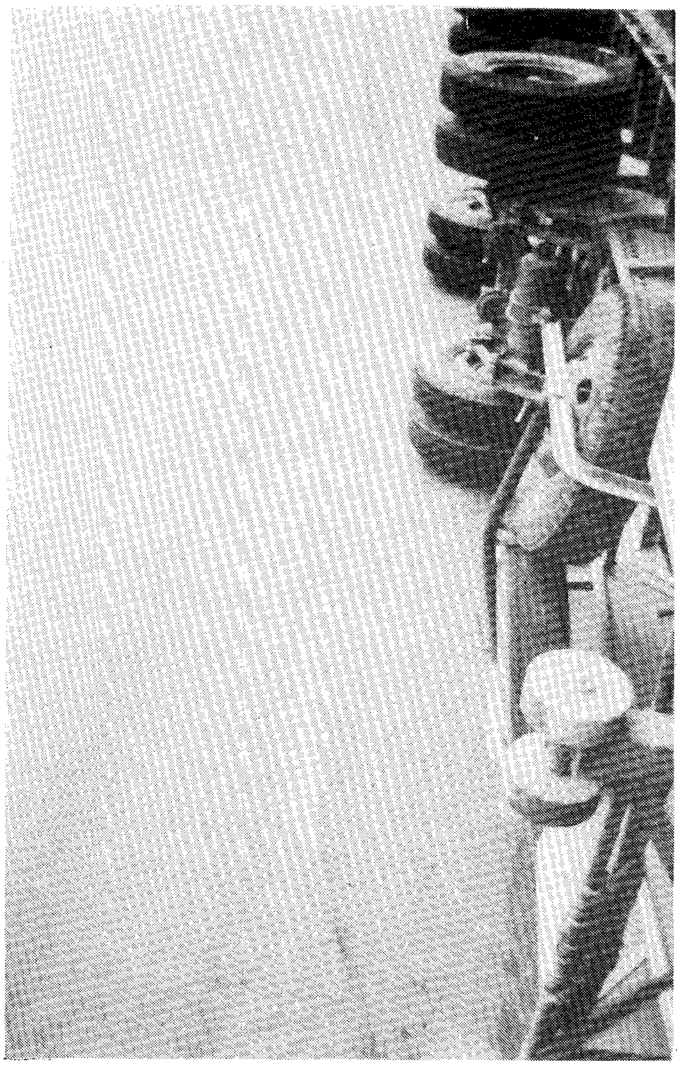


FIGURE 3.45: Capsized semi-trailer, showing scuff marks on road surface : Accident 013.

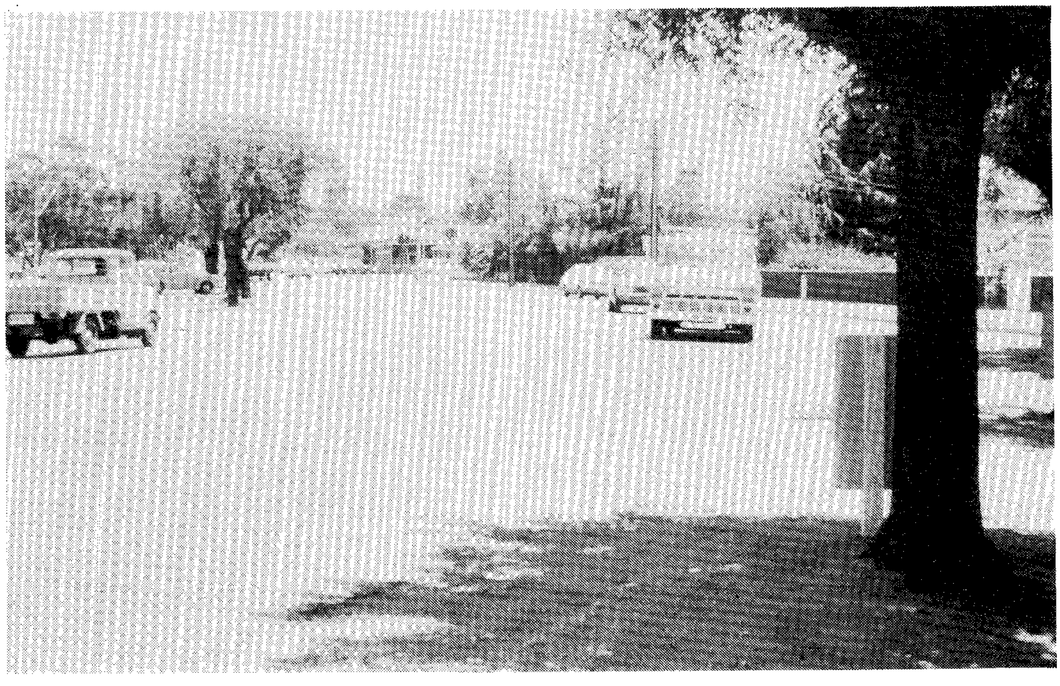


FIGURE 3.46: View back along the approach path for the semi-trailer in Accident 013 (see Figures 3.44 and 3.45)

non-collision accidents in which a road or traffic factor played a role. In Accident 203 the novice rider of the motor-scooter probably would not have fallen off had the scooter not hit a pothole in the road. The dimensions of the pothole were such that the hole would not have affected the course of a car or, possibly, a motor-cycle having larger wheels.

Accident 189 involved an intoxicated driver in a car that was not fully road-worthy (see Section 4.2 of the companion report on car accidents; McLean, Brewer, Aust and Sandow, 1980). Even so, clearer delineation of the roadway may have alerted the driver in time for him to have reduced speed before entering the curve.

The tailgate of the panel van in Accident 267 came open when the van hit a spoon drain. As we were unable to determine the reason for the tailgate opening we cannot conclude that it was due to the presence of the drain across the road but that possibility remains.

4. MIDBLOCK COLLISIONS BETWEEN VEHICLES

4.1 GENERAL CHARACTERISTICS OF MIDBLOCK COLLISIONS BETWEEN VEHICLES

This Chapter concentrates on collisions between two or more vehicles at uncontrolled midblock locations. Other types of accidents at these locations are reviewed in the preceding Chapter (Single Vehicle Accidents, such as collisions with parked cars) and in the companion report on pedestrian accidents (McLean, Brewer and Sandow, 1979a).

There were 40 accidents (13 per cent of the total of 304) in this category of midblock collisions between vehicles. They were distributed throughout the day (Figure 2.3) but occurred most frequently between 2 p.m. and 8 p.m. As shown in Figure 2.2, eight accidents (20 per cent of 40) had one or more of the drivers or riders with a BAC above 0.05. There were four accidents in which at least one driver appeared to have been drinking but no BAC reading could be obtained. Therefore alcohol intoxication may have been a factor in up to 30 per cent of these 40 accidents.

4.1.1 TYPES OF VEHICLES AND COLLISIONS

The types of vehicles involved in these collisions are listed in Table 4.1. The type of vehicle that should have yielded to, or kept clear of, the other vehicle is indicated also, as is the type of collision. The characteristics of each of these collision types are discussed in Section 4.2 in the order in which they are listed in Table 4.1.

4.1.2 ROAD LAYOUT

Almost half (19 of 40) of the midblock collisions occurred on two-lane roads (Table 4.2) with the most common type of collision on those roads resulting from one vehicle turning right to leave the roadway. Four of the eight collisions of this type on two lane roads involved pedal cycles turning across the path of a car or a motorcycle. Rear end collisions were more likely to have occurred on arterial roads, as indicated by the fact that nine of the 14 accidents of this type took place on four or six lane roads. The one U-turn collision on a road with a raised median resulted from a car attempting a U-turn through a tap in the median.

4.2 CHARACTERISTICS OF SPECIFIC TYPES OF MIDBLOCK COLLISIONS

4.2.1 REAR-END COLLISIONS

The 14 rear-end collisions were similar in some respects to collisions with parked vehicles, as might be expected from the nature of the collision. Half of the 14 accidents occurred at night, compared to 58 per cent of the 19 collisions with parked vehicles. Six of the 14 (or 43 per cent) of the striking drivers either had a BAC above 0.05 or appeared to have been drinking. The corresponding percentage for drivers who collided with parked vehicles was thirty-two.

The 14 accidents in this category are discussed below under four headings: alcohol intoxication (six accidents), inattentive driver (five accidents), excessive speed (one accident) and vehicle factors (two accidents). As will be seen in the following descriptions, these categories are not mutually exclusive.

Alcohol Intoxication

Accident 097 was a rear-end collision with a car that was stationary, broken down, on a slight crest and midway between two sodium vapour lamps that were 75 metres apart. This car was close to the broken white centreline of the two-way road. The person who had been driving the car was talking with the driver of a taxi that had stopped at the far side of the road when he saw another car approaching. He ran down the road waving his arms to warn the oncoming driver of the presence of his stationary, and unlit, vehicle. The approaching driver, who had a BAC of 0.05, saw this person waving but did not see the stationary car until the last moment and was unable to avoid a collision. The stationary car was a dull red colour and was difficult to see in the relatively dark area between the street lamps. This fact alone may not have been sufficient reason for the collision to have occurred but it almost certainly played a role together with the distraction caused by the person waving and the driver's (relatively low) blood alcohol level. (This accident, which involved only one manned vehicle, is discussed here rather than in the Chapter on single vehicle accidents because it is similar to some of the rear-end collisions described below.)

TABLE 4.1: TYPES OF MIDBLOCK COLLISIONS BETWEEN VEHICLES BY TYPES OF VEHICLES INVOLVED

Type of Collision	Types of Vehicles Involved										
	Car Car[1]	Car M/c	M/c[2] Car	Car P/c	P/c[3] Car	Car Truck	Truck Car	M/c P/c	Truck[4] M/c	M/c M/c	Total
Rear end	10	2	-	-	1	-	-	-	-	1	14
U-turn	3	-	3	-	-	-	1	-	-	-	7
Turn right to leave road:											
Overtaking vehicle	1	-	1	2	-	-	-	2	1	-	7
Oncoming vehicle	1	-	1	-	2	-	-	-	-	-	4
Turn left to leave road:											
Overtaking vehicle	-	-	1	-	-	-	-	-	-	-	1
Turn right on entering road:											
Vehicle on right	1	-	1	-	-	-	-	-	-	-	2
Reverse onto road	1	-	-	-	-	-	-	-	-	-	1
Sideswipe, same direction:	-	-	1	-	-	1	-	-	-	-	2
Head on	1	-	-	-	-	-	-	-	-	-	1
Opening car door:											
Overtaking cyclist	-	-	-	-	1	-	-	-	-	-	1
Total	18	2	8	2	4	1	1	2	1	1	40

Notes: [1] Vehicle that should have yielded, or kept clear, is listed in the second row.

[2] M/c = motorcycle

[3] P/c = pedal cycle

[4] Truck = light utility (not a derivative of a passenger car).

TABLE 4.2 ROAD LAYOUT BY TYPE OF MIDBLOCK COLLISION

Type of Collision	Road Layout							
	2 lane		4 lane			6 lane		Total
				median		median		
	unmarked	marked	undivided	painted	raised	painted	raised	
Rear end	2	3	1	5	2	-	1	14
U-turn	1	2	3	-	-	-	1	7
Turn right to leave road:								
Overtaking vehicle	4	3	-	-	-	-	-	7
Oncoming vehicle	-	1	2	-	-	1	-	4
Turn left to leave road:								
Overtaking vehicle	-	-	-	-	-	-	1	1
Turn right on entering road:								
Vehicle on right	-	-	1	1	-	-	-	2
Sideswipe, same direction	1	-	1	-	-	-	-	2
Head on	1	-	-	-	-	-	-	1
Reverse onto road	-	1	-	-	-	-	-	1
Cyclist into car door	-	-	-	1	-	-	-	1
Total	9	10	8	7	2	1	3	40

Two other drivers of striking vehicles were known to have BACs that were below the legal limit of 0.08 but which may have been a factor in the causation of the accident. In Accident 176 a car slowed to allow another car to complete reversing out onto the road from private property. As it slowed down it was rammed from the rear by a third car. The driver of this third car admitted that he had been following too closely behind the car in front. When he realized that it was slowing down he braked, locking the wheels, but his car still crashed into the back of the other car. This driver's BAC was 0.07. The illumination provided by the sodium vapour street lighting was non-uniform but this was unlikely to have been a significant factor.

The third driver who had been drinking but who was known not to have been illegally intoxicated had a BAC of 0.05. He crashed into the back of a car which was travelling at about 50 to 60 km/h, according to its driver, along a well-lit arterial road at 3 a.m. The striking car then yawed clockwise and skidded across the right-hand side of the carriageway, where it hit a car that was parked at the kerb (Accident 275, Figure 4.1). These post-impact motions of the striking car suggest that it was travelling at a speed far in excess of the 60 km/h limit.

The fourth accident in which alcohol was a factor in this group of 14 rear-end collisions occurred at about eight o'clock at night. Two drivers who appeared to have been drinking but who both refused to blow into our breath alcohol meter were travelling one behind the other along the centre lane of a four-lane road (Accident 233). The versions of the accident that were given by the two drivers differed; the one in the striking car, which sustained only minor damage, said that he was travelling at 60 to 65 km/h when an oncoming car crossed the centreline (Figure 4.2). When swerving to avoid this car he lost control and clipped the back of the car in front, sending it out of control. The other driver said that he, too, was travelling at just above the 60 km/h speed limit when he heard a screech of tyres and then his car was hit in the rear, causing it to spin around. The striking car skidded under braking for 35 metres on a dry road, and would have been travelling at, at least, 90 km/h at the start of the skid. The struck car yawed in an anti-clockwise direction and slid for more than 80 metres before crashing into a car parked on the left-hand side of the road and pushing it into a second parked car. As in the accident described in the previous paragraph, the post-impact motions were consistent with initial speeds that were much greater than the legal speed limit.

A 20 year old motorcyclist who had a BAC of 0.12 swerved across to the left lane of three available lanes, to pass a car which he thought was slow to move off when the traffic signals changed to green (Accident 243, Figure 4.3). The left lane became a parking lane soon after the intersection, and the rider swerved to his right to pass the first parked car. As he did so he realized that there was a car moving slowly just ahead of him in the lane adjacent to the parked cars. He tried to stop, but was unable to do so in time and crashed into the back of that car. The accident occurred in daylight.

The final accident (252) in this group of six involved a car driven by a 20 year old male. The struck car was travelling at about 40 km/h along a 14 metre wide two-way road having a broken white centreline. The street lighting was similar to that at the location of Accident 097; widely spaced sodium vapour lamps that resulted in alternating bright and dark lengths of roadway. Little is known about the driver of the striking car other than that he attempted to leave the scene of the crash, despite having shattered the windscreen with his head. He was persuaded to wait for the ambulance to arrive but later got out when the ambulance stopped at a red signal en route to the hospital. Hence no blood sample was taken and so his BAC is not known even though he was reported to have appeared to have been intoxicated.

Inattentive Driver

Inattention is often an unsatisfactory category in any listing of causal factors since it can conceal other more basic characteristics of the accident sequence. There were five of these 14 rear-end collisions, however, in which there was reason to believe that the driver of the striking car was not looking where he or she was going, or was in some other respect not paying attention to his or her driving. This resulted in a collision when the car in front stopped.

In Accident 021 a driver slowed down in the left hand lane of a four-lane divided road and then drove into a gap between two parked cars, intending to park at the kerb. The gap was smaller than she thought and so she stopped with her car at an angle, with the back still out in the traffic lane. She then saw a car coming up behind her in that lane and immediately thought that she was going to be hit, even though the other car was some distance away. The other driver had just turned around after missing a left turn at a nearby intersection. He said that he saw the car ahead of him slow down, the brake lights came on, and he then checked his rear vision mirror to see if the right hand lane was clear. When he looked back the car in front had stopped. He braked hard, but skidded into the back of it, pushing it into the row of parked cars (Figure 4.4).

In a similar accident a taxi crashed into the back of a car which was stationary behind a car reversing into a parking place (Accident 258). The passenger in the taxi said that the driver was not watching the road ahead and did not realize that a collision was imminent until he, the passenger, shouted a warning.

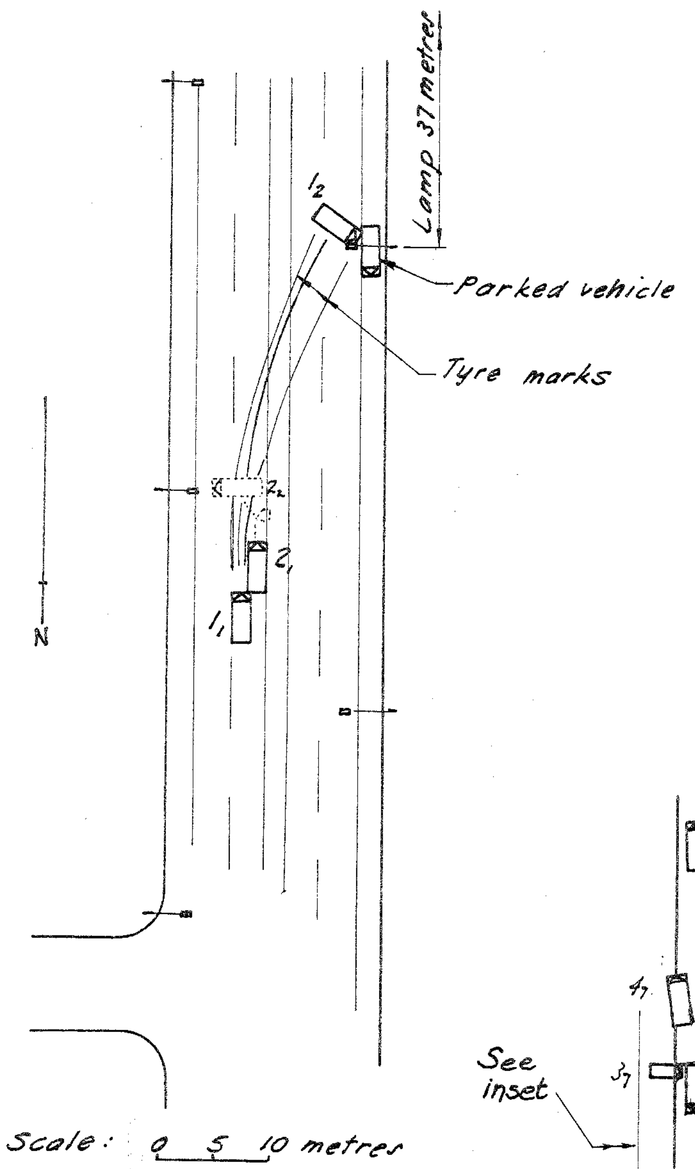


FIGURE 4.1: Accident 275.

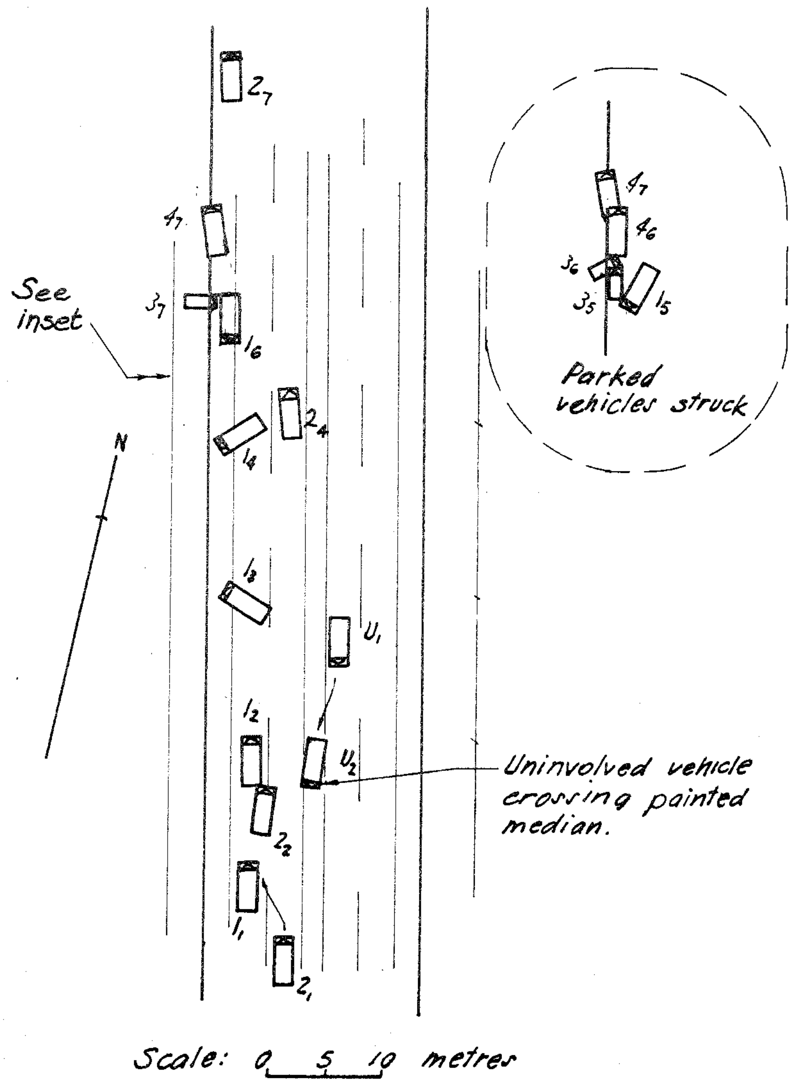


FIGURE 4.2: Accident 233.

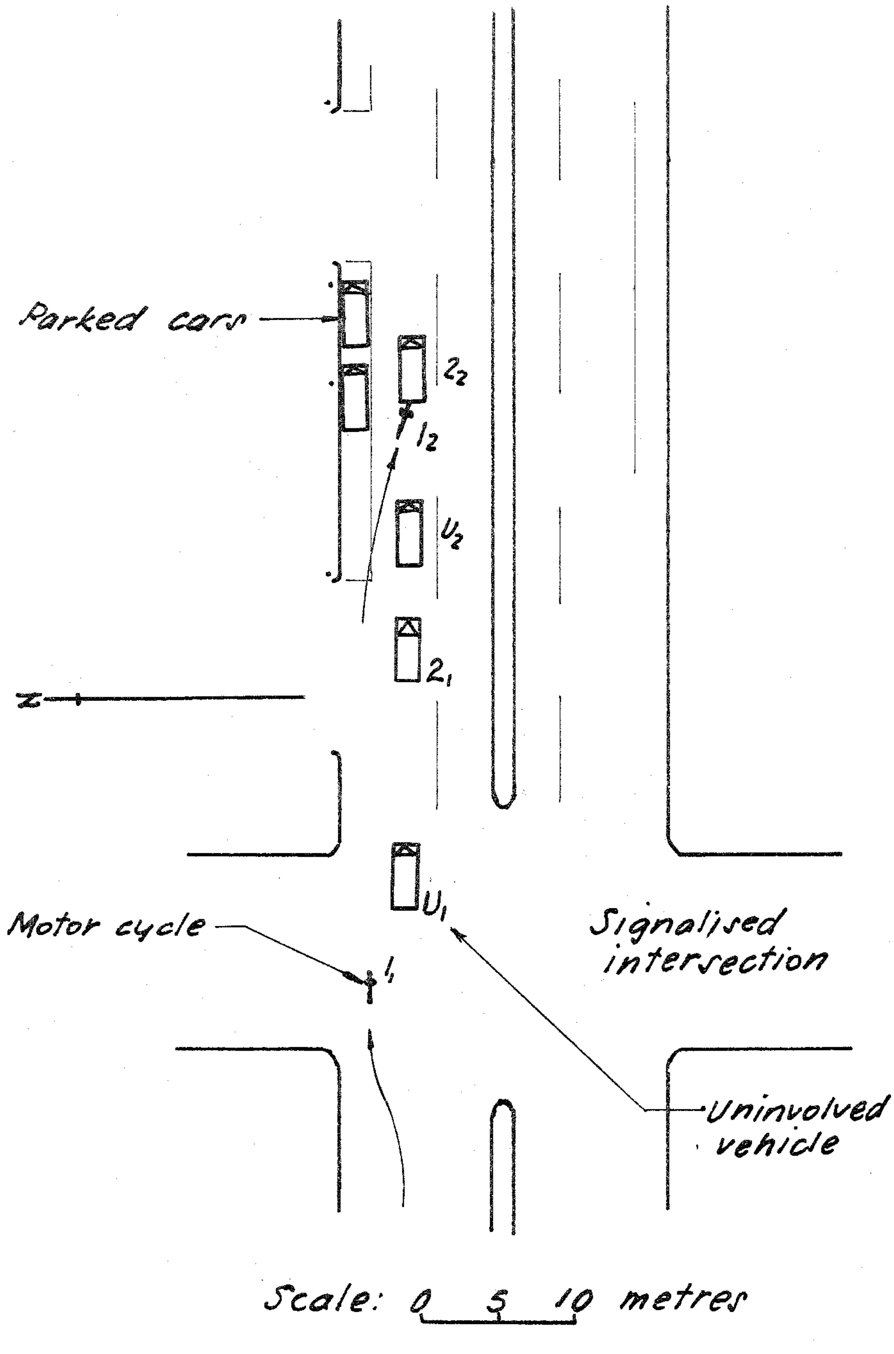


FIGURE 4.3: Accident 243.

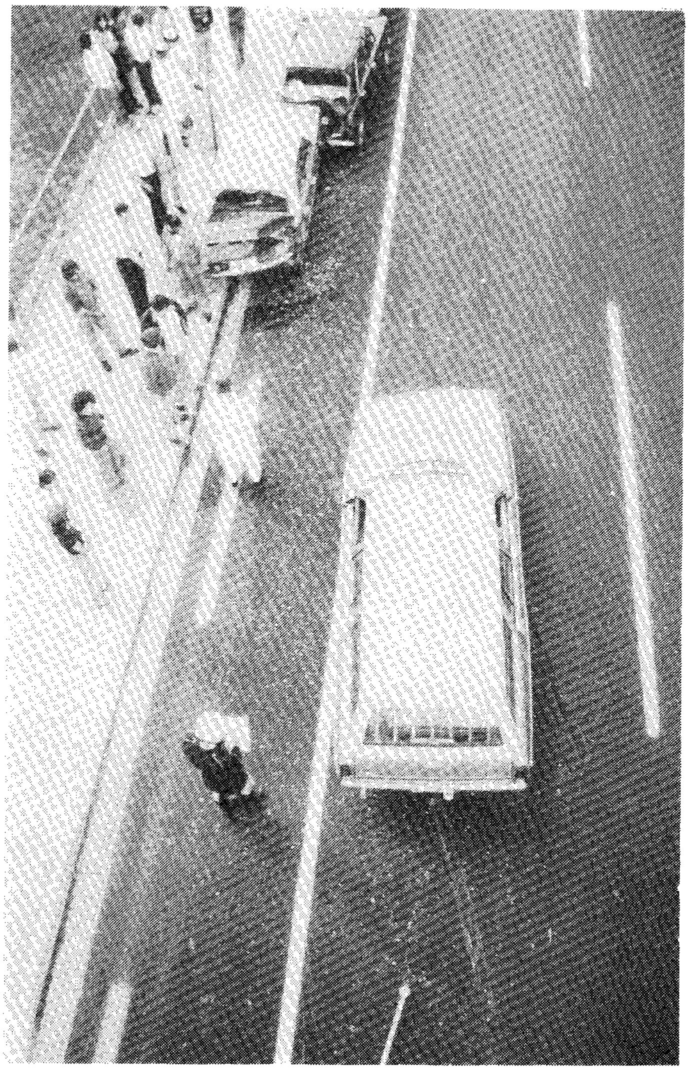


FIGURE 4.4: Rest positions of cars after rear-end collision : Accident 021.

Two of the three remaining accidents in this group both involved a driver who was following close behind another car and who was unable to avoid running into the back of that car when it braked unexpectedly.

In Accident 277 the lead car slowed because a third driver had stopped just past a traffic island, apparently because he had been confused by the recently-installed island and had missed the right turn that he had intended to make. The following car, the last of the three, then crashed into the back of the car which had been forced to slow down. The driver of the striking car refused to discuss the accident with any member of the research team.

The other accident in which the driver was following too closely occurred when, according to the driver of the struck car, she had to brake suddenly to avoid hitting a car which slowed down in front of her. As she braked, she checked her rear vision mirror and saw the driver of the following car looking to her left (Accident 184). The driver of this striking car claimed that no third vehicle was present, and so she was not expecting the car in front to brake; although she did say that she was "probably travelling a little too close".

The fifth accident in this group involved a 61-year-old female who was travelling in the kerb lane (of two lanes in that direction). The traffic ahead of her was slowing, so she said she looked in her rear vision mirror to see whether it was safe to move across to the right lane. When she looked back she saw that the queue of cars ahead of hers had slowed down even more, and she was unable to stop before crashing into the last car in the queue (Accident 079).

Excessive Speed

One accident (023) was primarily a consequence of a car driver travelling along an arterial road at a speed of about 90 km/h in a 60 km/h speed limit area at about 4 p.m. An adult male cyclist was merging across to the centre of the arterial road with the intention of turning right at the next intersection. He was on his way home from work, and followed this route every day. On this occasion he misjudged the approach speed of the overtaking car and was struck from the rear.

Accident 023 has been described under the heading of "excessive speed" because, as noted, that was the major causal factor in that collision. This does not mean that this was the only one of these 14 rear-end collisions in which the striking car was speeding. There was some evidence that excessive speed was a factor in six other collisions: Accidents 021, 097, 233, 243, 252 and 275.

Vehicle Factors

Vehicle factors played an important role in the two remaining rear-end collisions, both of which involved motorcycles.

A 21-year-old female motorcyclist bumped into the back of a car that braked unexpectedly when another car pulled away from the kerb at a sharp angle after the driver had bought a newspaper from a paper boy (Accident 227, Figure 4.5). The car that left the kerb had moved out to avoid an oncoming motorcycle that had swerved across in front of it, on the wrong side of the road, to get to the paper boy. The motorcyclist tried to brake as soon as she realized that the car ahead of her was stopping, but she used the wrong foot. Her confusion arose from the fact that she had recently been riding another motorcycle which had the footbrake pedal on the left hand side, whereas her machine had it on the right. By the time that she managed to apply the brake she had hit the back of the car and then fell to the roadway.

The remaining rear-end collision was attributed to a modification of one of the vehicles (Accident 015). Two motorcyclists were riding along a poorly lit residential street at night when the lead motorcycle suddenly slowed down, possibly intending to turn left into a narrow lane. The owner-rider of this motorcycle had disconnected the actuating mechanism for the stop light and so no immediate warning that the brakes had been applied was given to the following rider, whose machine then crashed into the rear left side of the other, almost stationary, motorcycle. Neither of these riders had been drinking.

The following motorcycle had also had its stop-light actuating mechanism disconnected. The two riders declined to discuss why they had modified their motorcycles in this way, but one possible reason may have been a desire not to be called "chicken" if they should feel obliged to brake to slow down before negotiating a curve.

Relevance of Road and Traffic Factors

Street lighting

The characteristics of the street lighting may have contributed to the causation of three of the seven rear-end collisions that occurred at night. In two accidents (097 and 252) the sodium vapour lamps provided non-uniform illumination along the road, the spacing between the lamps being greater than recommended in the relevant Australian Standard for the lighting of urban traffic routes (AS1158 Part 1 - 1973). As noted in the descriptions of these two accidents there were other possibly more important factors involved, including alcohol intoxication and excessive speed.

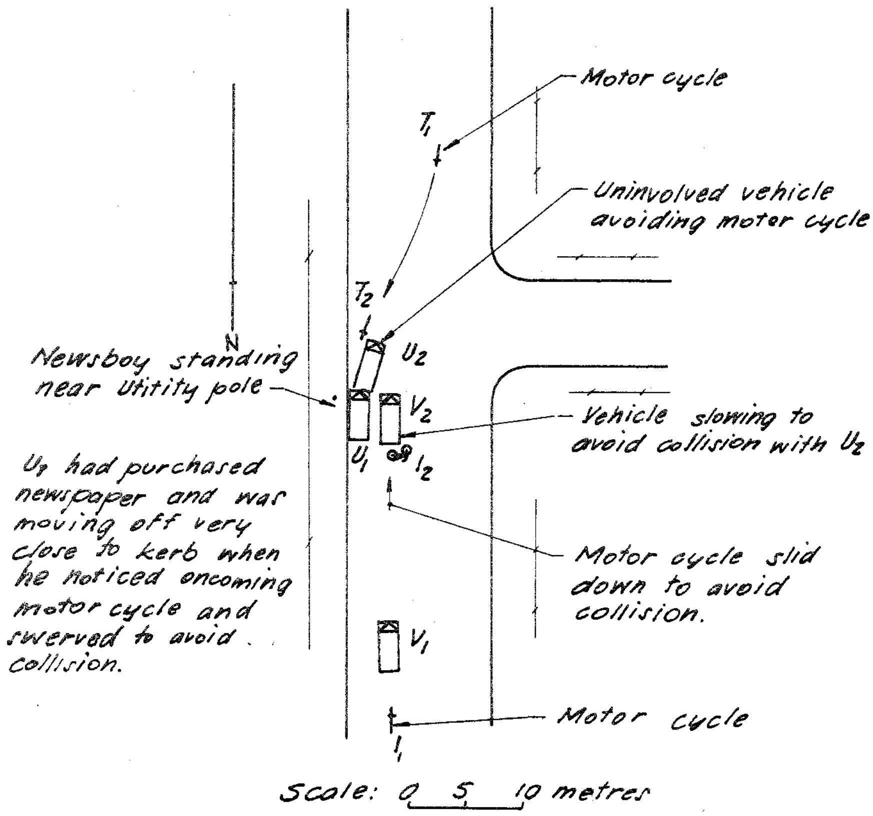


FIGURE 4.5: Accident 227.

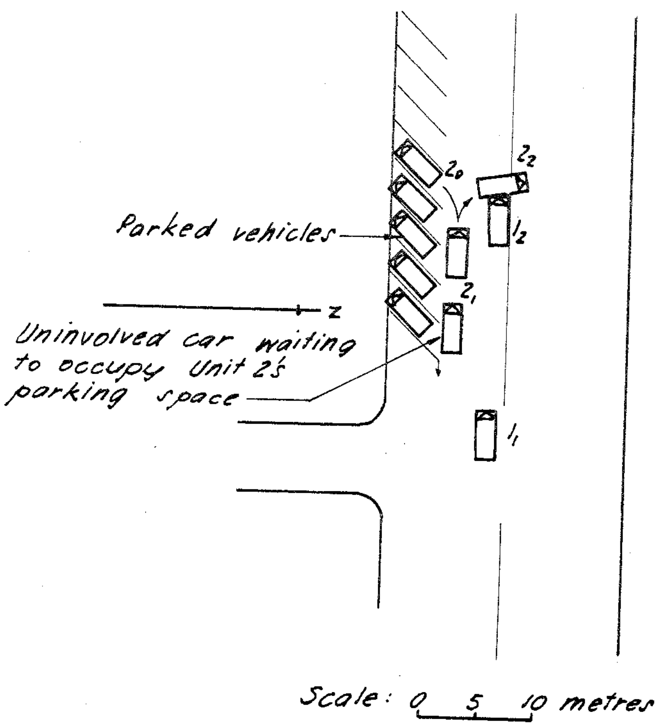


FIGURE 4.6: Accident 195.

Accident 015 occurred in a residential street lit by tubular fluorescent lamps. Although long stretches of the road were virtually dark between lamps this collision was located almost directly under one lamp. Had the sequence of events leading up to this collision, as described above, occurred in daylight the following rider may have had sufficient warning that the motorcycle in front was braking to have avoided the collision. It is possible that artificial illumination of a much higher standard than that installed along this road may have prevented this accident.

Excessive speed

The role of excessive speed, as confirmed or suspected, in seven of these 14 collisions has been noted above. Measures that can be shown to be effective in reducing the frequency of speeding (particularly speeds that are 20 to 30 km/h above the legal limit of 60 km/h) can therefore be expected to contribute to a reduction in the frequency of rear-end collisions.

Additional traffic lane at a signalised intersection

This comment relates to intersection design but it is noted here because an additional lane at a signalised intersection made it possible for a motorcyclist to make a passing manoeuvre which resulted in a rear-end collision (Accident 243). This topic is discussed in detail in Chapter 7.

4.2.2 U-TURN COLLISIONS

The seven accidents in this group all involved a car which performed a U-turn either from the left lane or from a parked position. The turning driver was older than the driver or rider of the other vehicle in each accident, with the youngest driver of a turning car being 32 years old and the oldest 66 years of age.

Only one of the 14 drivers or riders was known to have been drinking before the accident. His BAC was 0.06, but this was unlikely to have been an important, or even a relevant, factor since he had virtually no warning of the impending collision. The other driver pulled out from a row of cars parked at the kerb without signalling his intention. This other driver may also have been drinking. A BAC reading was not obtained because he refused to cooperate with our team members. Of the remaining 12 drivers, eleven had a zero BAC and the twelfth was thought not to have been drinking, although no breath alcohol reading was obtained.

These seven accidents are described below in three categories: the turning driver saw the oncoming vehicle, but still attempted to turn; the turning driver did not see the oncoming vehicle, possibly because of some obstruction to vision; and the turning driver did not see the oncoming vehicle even though there was no obstruction to vision apart from the structure of the turning vehicle. Only one of these accidents, in the second of these three categories, occurred at night.

Misjudging Speed of Oncoming Vehicle

A 66-year-old male driver, the oldest of the 14 drivers in these accidents, saw a truck approaching from his rear but judged, incorrectly, that he had time to complete a U-turn (Accident 044). The truck driver saw the car move slowly off from a standstill at the kerb, with the right turn indicator flashing, but assumed that the car driver was waiting for him to pass. The driver of the car had looked to his rear using the rear vision mirror but had not looked at the truck again. His passenger shouted a warning when the car was already across the approach path of the truck.

Obstruction to View of the Oncoming Vehicle

Figure 4.6 shows the sequence of events in Accident 195, in which a 35-year-old male driver reversed out of an angle-parking space with another car stationary in the roadway behind him, waiting to move in to park. Having reversed out, the driver then tried to do a U-turn, thinking that the road was clear. As he turned he heard the sound of a car horn and, at almost the same instant, his car was hit on the side. Although he had not seen the through vehicle approaching this driver admitted that he was unable to turn his head to look to the rear when seated in a car and, not having an outside rear-vision mirror, he had had to rely on what he could see in the interior mirror. The driver of the through vehicle saw the two cars stationary ahead of him but did not expect the front one to attempt a U-turn. This driver said that he was travelling at 55 to 60 km/h, a speed which, while legal, could be considered to be excessive under the circumstances.

The second accident in this category involved a driver who refused to talk with our investigators, as noted above. It occurred at about 1 a.m. when the driver pulled out from the middle of a row of cars parked at the kerb and immediately commenced a U-turn, without indicating (Accident 192). The driver of the other vehicle had a BAC of 0.06 but, again as noted above, this was unlikely to have been relevant to the causation of this accident.

Oncoming Vehicle Not Seen, No Obstruction to View

Three of the four accidents in this category involved a motorcycle as the oncoming vehicle.

In Accident 032 a car travelling in the kerb lane of a four-lane clearway at dusk indicated a right turn and had half-completed a U-turn when it was struck on the front of the right side by a motorcycle. The motorcyclist saw the car ahead of him indicating a right turn, but assumed that it was only changing lanes. When he realized that the car was turning across his path the rider braked, using the back brake, and skidded across to the centreline before colliding with the side of the car. The driver of the car insisted that he had merely been indicating his intention to change to the centre lane, but the front wheels of his car left braking skid marks across, and at right angles to, the centreline of the roadway.

Another motorcyclist also relied on the back brake when a car turned across in front of him, because he thought that a motorcycle became unstable under front wheel "panic" braking (Accident 134). The car driver, a 52-year-old woman, said that she checked her rear vision mirror and saw a truck approaching, but some distance away. She waited a moment for a car to pass from the other direction and then, as another car travelling in that direction appeared from around a bend about 100 m. away, she quickly started a U-turn. Almost as soon as she moved off a motorcycle crashed into the side of her car. The motorcyclist said that he noticed the car at the kerb and wondered whether it was about to pull out. He slowed down a little as he got closer but then decided that the driver was waiting for him to pass. At that instant the car suddenly started a U-turn. This accident happened in daylight, and the motorcyclist did not have the headlight switched on. Consequently it seems likely that the car driver, on looking in the rear vision mirror, may have seen only the larger vehicle, the truck, approaching and did not notice the smaller vehicle that was in front of it.

The third motorcycle accident in this category occurred in the central city area (Accident 281). A taxi driver had just taken on a fare. He turned and looked behind him and, noting that the traffic lights were red, moved off. Intending to move across to a gap in the median and perform a U-turn, he entered the second lane (Figure 4.7) and looked in his rear vision mirror to see if it was still clear for him to cross to the lane adjacent to the median. As he was doing this he heard a thump at the front of the car. On looking round, he saw a motorcycle veering across towards the median strip. The machine hit the kerb and ran along it for a short distance before sliding down. The rider of the motorcycle said that he had accelerated away from the intersection when the lights changed, and was checking that it was safe to move from the centre lane to the one adjacent to the median when he felt the motorcycle wobble. He was unable to correct this wobble before the wheels hit the median. His pillion passenger said that the front corner of the taxi hit her left leg. The headlight of the motorcycle was on at the time of the collision (mid-afternoon).

The final accident involving a U-turning vehicle happened on a 15 metre-wide unmarked road (Accident 016). A 47-year-old woman looked through the rear window of her car; seeing nothing coming, she indicated a turn and moved off. She was halfway across the road when another car crashed into the driver's side of the passenger compartment. The other driver said that he suddenly became aware of the presence of the turning car as it moved across into his path. He braked and tried to swerve to the right but was unable to avoid the collision.

Relevance of Road and Traffic Factors

Two of these accidents occurred at locations where it can be predicted that a U-turn manoeuvre is likely to be particularly hazardous. In Accident 134 the bend in the road restricts the available sight distance. In Accident 281 the number of traffic lanes, and the proximity of the signalised intersection, mean that the possible number of conflicts between a turning vehicle and through vehicles is unusually large. At such locations a case can be made for the installation of a continuous raised median to prevent U-turns.

Raised medians may have prevented all of the accidents in this group apart from Accident 281 where a car was about to turn through a gap in the median. The very wide unmarked road at the location of Accident 016 may have played a role in the causation of that collision in two ways: it may have made it more difficult for the driver of the turning car to detect the presence of the other car simply by looking through the rear window and the wide road made it easy to perform a U-turn. As this road is a traffic route, even though it was unmarked, the installation of a raised median strip would reduce the potential number of conflicts by restricting U-turns.

The value of a raised median in making it easier for a pedestrian to cross a road safely is discussed in the companion report (No.2) on pedestrian accidents.

Five of the seven U-turn collisions occurred in daylight, one at dusk and one at night. Little could be learnt about the pre-collision behaviour of the turning driver in the night accident (192) but there was some indication that he may not have bothered to look for other traffic before starting to turn. On the basis of this small number of accidents, therefore, U-turn collisions appear to be primarily a daytime problem.

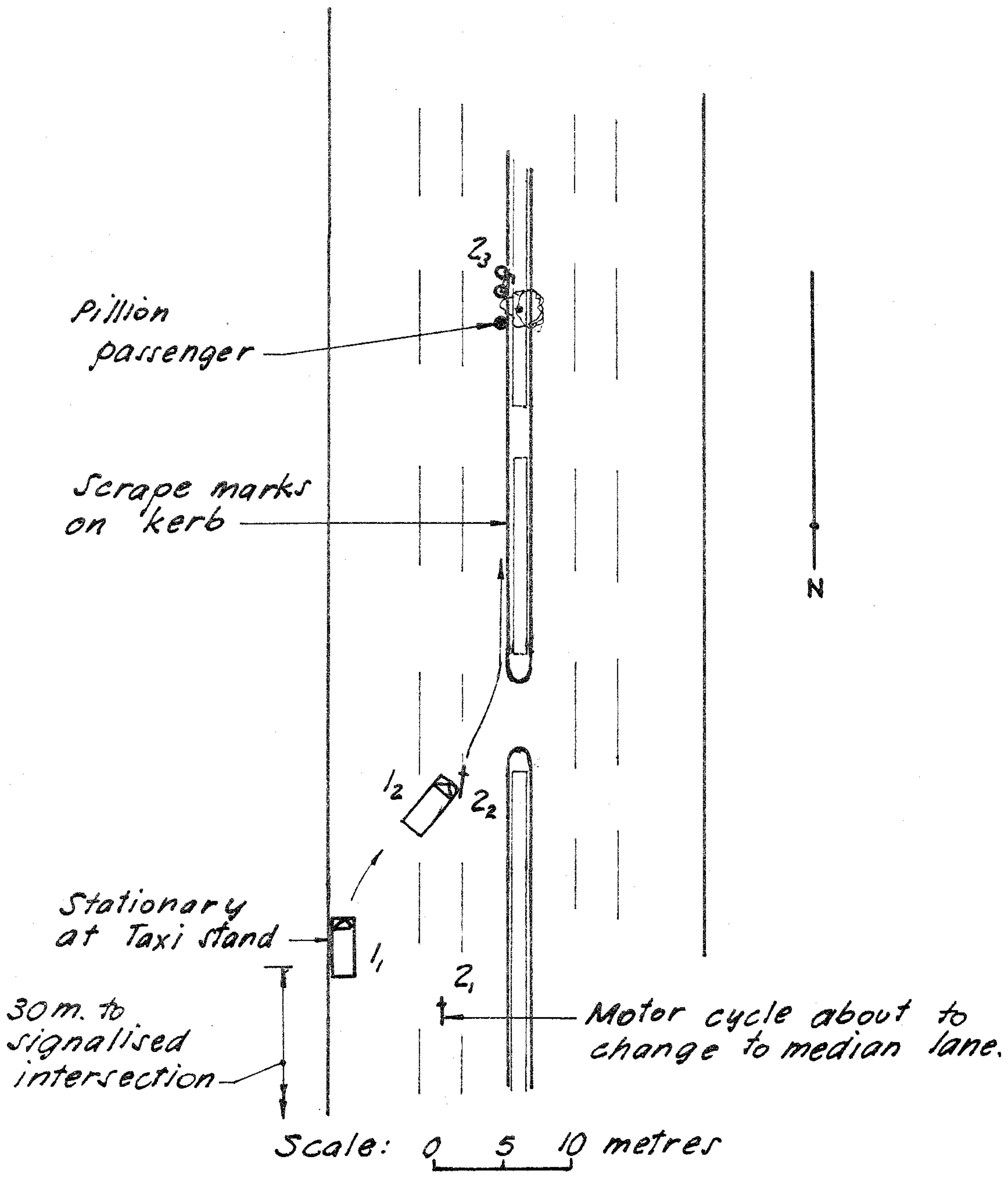


FIGURE 4.7 : Accident 281.

4.2.3 TURN RIGHT TO LEAVE ROAD: HIT BY OVERTAKING VEHICLE

Six of the seven accidents in this category involved either a pedal cycle or a motorcycle. The four pedal cyclists were all turning right, and the four motorcyclists were all proceeding straight ahead. The seventh accident was a collision between two cars.

All of these accidents occurred in daylight. One of the active participants had been drinking (Accident 177). His BAC reading was 0.03 but this may have been low because he did not follow the correct procedure when blowing into the Alcolmeter. However, as was the case with the drinking driver in Accident 192 who was involved in a collision with a vehicle making a U-turn, this driver probably would not have been able to have avoided the collision even if he had been sober.

The turning riders or drivers were, with one exception, younger than those who were overtaking, which is mainly a reflection of the fact that the four cyclists were all children.

Pedal Cyclist Turning Right

None of these four pedal cyclists looked to check that the road was clear before they started to turn. They were all children, aged from nine to 13 years, and the careless way in which they turned across the road was similar to the manner in which most of the child pedestrians in this study ran onto the road without looking (McLean, Brewer and Sandow, 1979a).

In Accident 177 a ten-year-old cyclist rode out from behind a telephone callbox on the left hand side of the road. He swerved left around a parked car, and then suddenly turned right, just as a car was about to overtake (Figure 4.8). This accident occurred at a T-junction, as can be seen in the Figure, but it is classified here as a midblock collision because the presence of the intersection had no discernable influence on the actions of either the driver or the cyclist, who was crossing to a property on the right beyond the intersection.

In a somewhat similar accident (298) a 13-year-old girl riding a pedal cycle along a residential street veered to her right to pass a parked car. A motorcyclist who was about to overtake initially thought that she was turning right but as she appeared to be continuing on past the parked car he moved across to the centre of the road to allow plenty of room to pass both the cyclist and the car. At this moment the cyclist turned right, heading for the driveway of her parent's house. The motorcyclist was unable to avoid her. He fell from his machine following the collision.

Accident 297 happened when a 12-year-old boy, riding in a group of three cyclists, decided to take a short cut home by riding through the forecourt of a service station on the right hand side of the road. He broke away from his two companions and turned right, to cross the road, having glanced back over his shoulder. He vaguely recalled having seen the motorcycle, but had not thought that it was close enough to bother him (he even thought, after the accident, that he may have mistakenly believed that it was travelling in the other direction). The motorcyclist had noticed the group of cyclists, but did not expect one to turn across in front of him. When he realized that one was doing so, he swerved to his right and tried to stop. He, too, fell from his motorcycle following the collision.

The remaining pedal cycle accident in this category (Accident 276) happened when a nine-year-old boy, who was riding a cycle which he had had for two months, suddenly turned right from the far left side of the road. Like the girl in Accident 298, this cyclist was heading for his home on the opposite side of the road. He was hit by a car as he turned. The driver had seen the cyclist as the boy rode across a four-way intersection, travelling in the same direction as the car. As he caught up with the bicycle, just past the intersection, the driver decided that the rider showed no sign of doing anything other than continuing straight ahead, and so he proceeded to overtake him. As in the three accidents described above, by the time that the driver realized that the cyclist was turning across his path it was too late to avoid a collision.

Car Turned Right, Motorcycle Overtaking

A young woman riding a motorcycle noticed a car travelling slowly ahead of her, and close to the left hand side of the road. As she was about to pass it, the car turned right. The front wheel of her motorcycle hit the side of the car just ahead of the driver's door (Accident 255). The motorcyclist did not recall seeing the turn indicator operating on the car, and did not expect the car to turn right from the far left side of the road. The driver of the car said that he had indicated his intention to turn right, into an off-road parking area, and had waited for a car travelling in the sopposite direction to pass. He did not know that the motorcycle was approaching from behind him.

In the other accident of this type the 19-year-old rider of a motor scooter saw a light truck ahead of him pull across to the right and indicate a right turn, about 75 m. before a four-way intersection (Accident 215). The rider, who was intending to turn right at that intersection, started to pass the truck on its right, to try to get to the corner first. As he did so the truck turned right, into the forecourt of a service station. His motor scooter hit the right front corner of the truck at about 50 km/h and he was

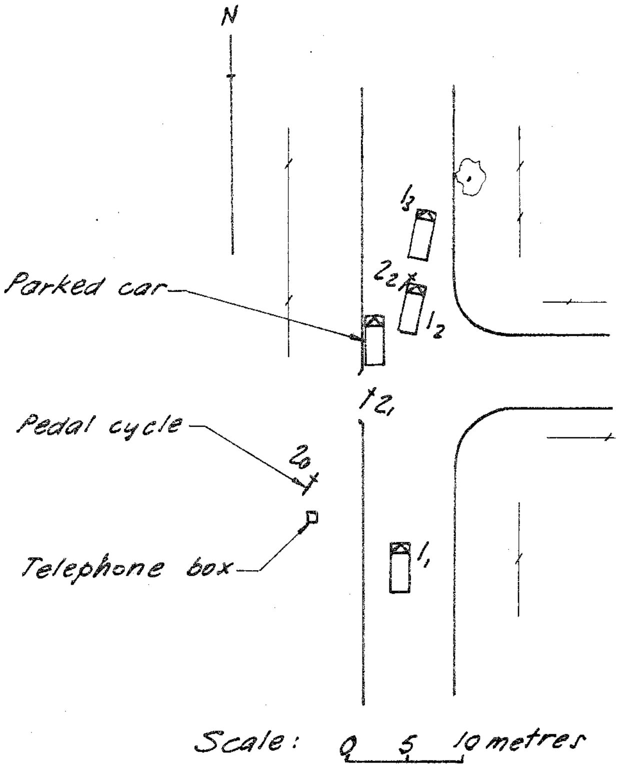


FIGURE 4.8: Accident 177.

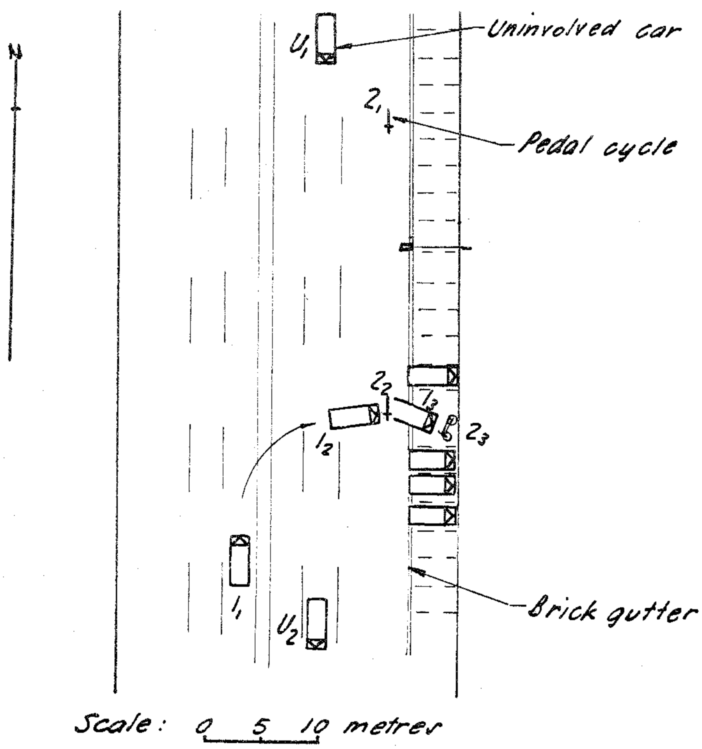


FIGURE 4.9: Accident 069.

thrown to the road. The driver had not looked in his rear vision mirror before turning and did not see the motor scooter until it hit his vehicle. The rider's actions in this accident appear to have been consistent with his previous behaviour on the road. He had received three six-month licence suspensions for speeding during the preceding two years. He also told us that he did not use the front brake because "it makes the machine become unstable".

Car Starting a Three-Point Turn

Although a vehicle executing a three-point turn does not normally leave the carriageway, the initial turn to the right hand side of the road is similar to that of a vehicle which is about to enter private property, for example. In fact the first stage of a three-point turn can prove to be even more of a hazard to a following vehicle because the turning vehicle remains on the road.

The one accident of this type in this survey involved a 17-year-old male driver who had had his car for only three days. He drove off along a residential street only to be told by a passenger that he was going the wrong way to get to their planned destination. He said that he then indicated a right turn, pulled over to the left, and started to turn to the right, intending to do a three-point turn. As he did so, another car crashed into his right front door. He did not know that this car was present, and presumably had not checked for following traffic before starting to turn. The other driver claimed that no indication was given that the car ahead of him was about to turn right (Accident 212).

Relevance of Road and Traffic Factors

The four collisions involving pedal cycles were all caused by the careless behaviour of the child cyclist but this may be able to be modified, or the consequences rendered less serious by changes to the road traffic rules for cyclists. This matter is discussed at greater length in Report No.3 in this series, Pedal Cycle Accidents (McLean, Brewer and Sandow, 1979b). The changes that are suggested for possible trial and evaluation are to make it legal for cyclists to ride adjacent to the kerb on the right hand side of the road so that they are facing oncoming traffic or for them to ride on the footpath. The relevance of the latter suggestion to this type of collision is that even if the cyclist suddenly turns right an overtaking driver will have more warning of the change in direction and so may be able to avoid a collision.

The two motorcycle accidents occurred adjacent to off-road parking areas. As it is to be expected that such areas will increase the frequency of turning movements of this type there could be value in a review of the criteria for the location of off-road parking areas in relation to the road layout and usage.

4.2.4 TURN RIGHT TO LEAVE ROAD: HIT BY ONCOMING VEHICLE

As was the case in the seven U-turn collisions described above, all of the drivers of the turning vehicles were as old, or older, than the drivers or riders who collided with them. The youngest turning driver was 25 years of age, and the oldest was 54, compared to 15 (for a pedal cyclist) and 25 for the drivers or riders who were proceeding straight ahead.

Two pedal cyclists were involved in these four accidents, and each was hit while proceeding straight ahead. These two cyclists were aged 15 and 21 years, both older than any of the cyclists in the accidents described in the previous section.

Three accidents occurred under conditions of relatively poor visibility. Two of these were at night, one of which was also during a rainstorm, and the other involved a cyclist who was riding in a shaded section of road on the approach to the collision point.

Five of the eight riders or drivers were sober. No BAC reading was obtained for the remaining three, but they showed no signs of having consumed alcohol before the accident.

Car Turned Right, Collision With Oncoming Cyclist

A 17-year-old youth (Accident 284) stopped in the centre lane of a four lane road to allow a car to pass from the opposite direction. He then turned right to enter a shopping centre parking area. As his car reached the driveway entrance it was hit on the left side by a pedal cycle. The driver had never driven this particular car before, and had not driven at all during the previous two months. The cyclist was riding along near the concrete gutter, and as he neared the entrance to the shopping centre he veered to his right to avoid a broken patch in the bitumen pavement. He was concentrating on doing this and noticed the car only as it suddenly turned across his path. He braked but could not stop in time. The driver did not see the cyclist at all before the impact, possibly because the rider was in the shade of overhanging trees and also wearing relatively inconspicuous clothing. The accident occurred during the afternoon peak traffic period.

The other collision involving a cyclist occurred in heavy rain at night (Accident 069). The car driver turned right, after waiting for an oncoming car to pass, to cross the road and enter a parking space (Figure 4.9). He slowed down to cross a brick-paved gutter, and was about to accelerate into the parking space when a cyclist hit the left front side of the car and was thrown over the bonnet. The driver had not seen the cyclist at all before the impact. The street lighting on the approach path of the cyclist was good, with a sodium vapour lamp directly above, but the conspicuity of the rider was greatly diminished by the weather conditions. The cyclists had seen the car waiting in the centre of the road, and had anticipated the possibility that it might turn across in front of him, but when it did so he found that he could not stop because the brakes on his bicycle were ineffective, because of water on the wheel rims.

Car Turned Right, Collision With Oncoming Motorcycle

In the other night-time accident a 54-year-old male car driver waited for two oncoming cars to pass before turning right and crossing the two opposing lanes to enter a driveway (Accident 078). As the cars went past he noted that the lights had changed to red at an intersection about 50 metres ahead of him and so he did not expect any other vehicles to be coming towards him. Before he had completed his turn "there was a bang and a motorcyclist tumbled through the air" and landed on the footpath to the right of the car. The car driver had poor eyesight (3:12 for his right eye, and 3:9 for his left) which was not corrected, and this may have accounted in part for his failure to have seen the motorcycle before the impact. The sodium vapour street lighting was of good quality, and the motorcycle was equipped with a conspicuous white frontal fairing, in addition to having its headlight on.

The motorcyclist had seen the car waiting to turn, with the right indicator flashing. He was in the kerb lane because he had just passed two cars which were in the centre lane waiting to turn right at the intersection and he had wanted to make sure that other drivers waiting to turn right across his path at that intersection could see that he was approaching. When he realized that the car beyond the intersection was turning across in front of him he was so close that he could only try to swerve to the left, not having time to brake. His motorcycle crashed into the front of the car.

Car Turned Right, Collision With Oncoming Car

A driver who was concerned that her car was low on petrol decided to turn right into a service station to see if it had an after-hours self-service pump. She saw a car coming towards her, but thought that she had ample time to complete the turn. As she turned, however, her car hesitated, then picked up, then hesitated again. Before it reached the driveway entrance it was hit on the left side by the oncoming car (Accident 012, Figures 4.10 and 4.11). The driver of the oncoming car said that he saw the car ahead of him with its right turn indicator operating and assumed that it was waiting for him to pass. When it started to turn he braked, but was unable to miss it because it appeared to stall right in his path.

Relevance of Road and Traffic Factors

The quality of the illumination provided by the street lighting was reasonably good at the locations of the night accidents (069 and 078) and yet the turning driver was not aware of the presence of the approaching vehicle in either case (partly because of other factors noted above). As both locations were close to signalised intersections further investigation of the lighting requirements of such sections of road may be worthwhile. Consideration might also be given to restricting turning movements of the type described here within, say, 100 metres of a signalised intersection.

The pedal cyclist in Accident 284 was distracted by the rough edge of the road surface as he approached the collision site. While this accident may well still have occurred had the road surface not been rough, cyclists are more affected by irregularities in the road surface than are other road users. Therefore the condition of the surface adjacent to the gutter or kerb should not be overlooked in road maintenance programs.

4.2.5 TURN LEFT TO LEAVE ROAD; HIT BY OVERTAKING VEHICLE

The one accident of this type in the study involved a 41-year-old woman driver who turned sharply in to the entrance to a shopping centre from the second of three lanes of a divided road (Accident 248). She had been travelling relatively slowly in heavy traffic while looking for this entrance and noticed it at the last moment. She glanced quickly over her left shoulder to see if any vehicle was close to her car in the kerb lane which was carrying less traffic. Thinking that lane to be clear she immediately turned left, only to be hit on the left front door by a motorcycle which she had not seen. The motorcyclist applied both brakes as soon as he realized that the car was turning across his lane, but could not stop in time.

Apart from the fact that the multilane road made this type of collision possible there appears to have been no direct contribution by any road or traffic factor to the causation of this accident.

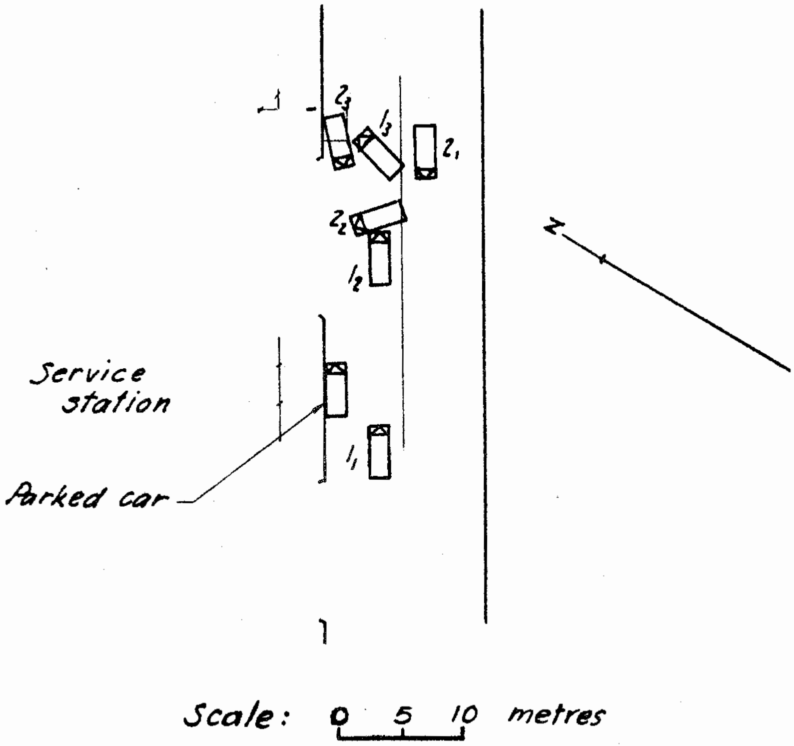


FIGURE 4.10: Accident 012.

FIGURE 4.11: Cars in final position of collision sequence shown in Figure 4.10.

4.2.6 VEHICLE ENTERING ROADWAY

Three accidents are reviewed under this heading: two in which a car entered the roadway and started to turn right when it was struck by a vehicle that approached from the right and one in which a car reversed onto the roadway.

Turn Right On Entering Road: Hit By Vehicle On Right

The two collisions of this type both occurred on two-way four-lane roads with traffic in the kerb lane obstructing the view of the turning vehicle.

In Accident 092 a 19-year-old motorcyclist, who was travelling in the centre lane, noticed the brake lights go on on a car ahead of him that was in the kerb lane. He assumed that there was some hazard ahead of that vehicle, but was still taken by surprise when another car suddenly appeared from his left in front of it. He tried to swerve to his left to go around the back of this car as it moved across in front of him but still collided with the right rear corner (Figure 4.12).

The 54-year-old driver of the car was not very familiar with the location and had never attempted this particular manoeuvre before. He saw the other car approaching in the kerb lane but thought that he could exit from the shopping centre parking lot and get across to the other side of the road before that car reached him. He did not see the motorcycle at that stage because of the car in the kerb lane and, possibly, the vehicles parked at the kerb. As he started to cross the centre lane he realized that he was cutting across the path of the motorcycle and so he accelerated in an unsuccessful attempt to get out of the way.

The traffic in the kerb lane was stationary in the other accident (257) because it was banked up behind a bus which had stopped to take on a passenger. One of the drivers in this lane had left a gap ahead of his car to enable a 16-year-old youth to exit from the driveway of a commercial premises. As this young driver moved out into the centre lane he heard a squeal of tyres and saw that he was about to be hit by a car travelling in that lane. The driver of the striking car said that he was travelling at about 40 to 50 km/h past the stationary queue of cars on his left when he saw the front of a car appear through a gap in the queue. He immediately applied the brakes, but could not stop in time.

Reversing Onto Road

In this accident a 25-year-old driver reversed out from a private driveway onto an arterial road, intending to cross to the far side of the road before driving off (Accident 188, Figure 4.13). He said that he stopped before backing onto the road and checked for traffic approaching from his left. Seeing none, he continued reversing. He had just reached the centreline of the road when his passenger shouted that a car was about to hit them. Their car was struck on the front of the left side and was pushed backwards and rotated clockwise through 180 degrees. They claimed that the striking car did not have its headlights on.

The other driver, who was also 25 years of age, said that he knew that the right headlight on his car was not working but the left light was on. The filament of the bulb in this lamp did appeared to be deformed in a way which was consistent with the light being on at the moment of impact. He also said that the other car had reversed out rapidly, without stopping in the manner described above. He had been drinking heavily with his passenger and the result of the analysis of the blood sample taken in hospital indicated a BAC of 0.35. This was challenged by the driver because the name on the blood sample record was not exactly the same as his. However his passenger had a BAC of 0.23, and so it is reasonable to conclude that the driver was severely affected by alcohol. Even so, the possibility remains that he may not have been able to have avoided the collision even had he been sober.

Relevance of Road and Traffic Factors

Turning movements out from off-road parking areas can be as hazardous as movements into them. Both Accident 092 and 257 could have been prevented by preventing traffic from turning right when entering the roadway. This could be achieved by a raised median or,possibly less effectively, by a relatory sign prohibiting right hand turns. A lower (than 60 km/h) speed limit in shopping and business districts might help to reduce the frequency of this type of collision. This practice is used in some States in the U.S.A. (eg: North Carolina, where the built-up area speed limit of 35 mph is reduced to 25 mph in business districts).

The collision involving a car reversing onto the roadway occurred midway between two widely-spaced sodium vapour lamps. These lamps were 70 metres apart and located alternately four metres away from the centreline of a 14 metre wide two-way two lane road. The high BAC level of the driver in the striking car and the fact that only one headlight was operating were the major causal factors in this accident but the non-uniform artificial lighting would have made more difficult the task of detecting the presence of the other car.

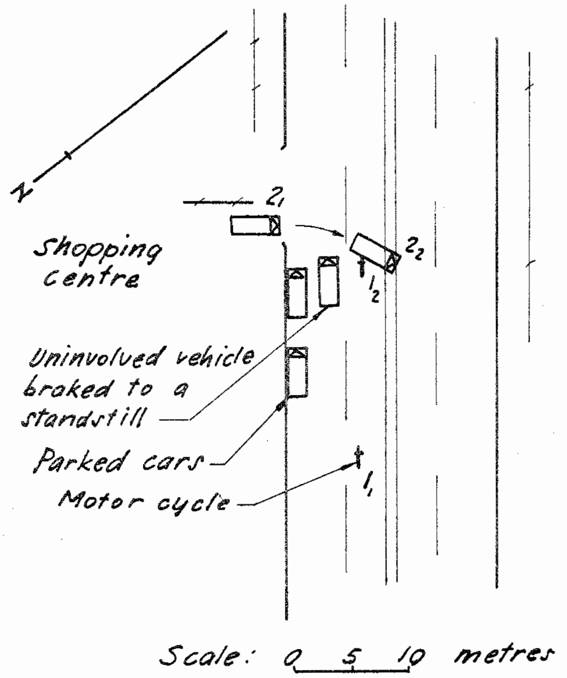


FIGURE 4.12: Accident 092.

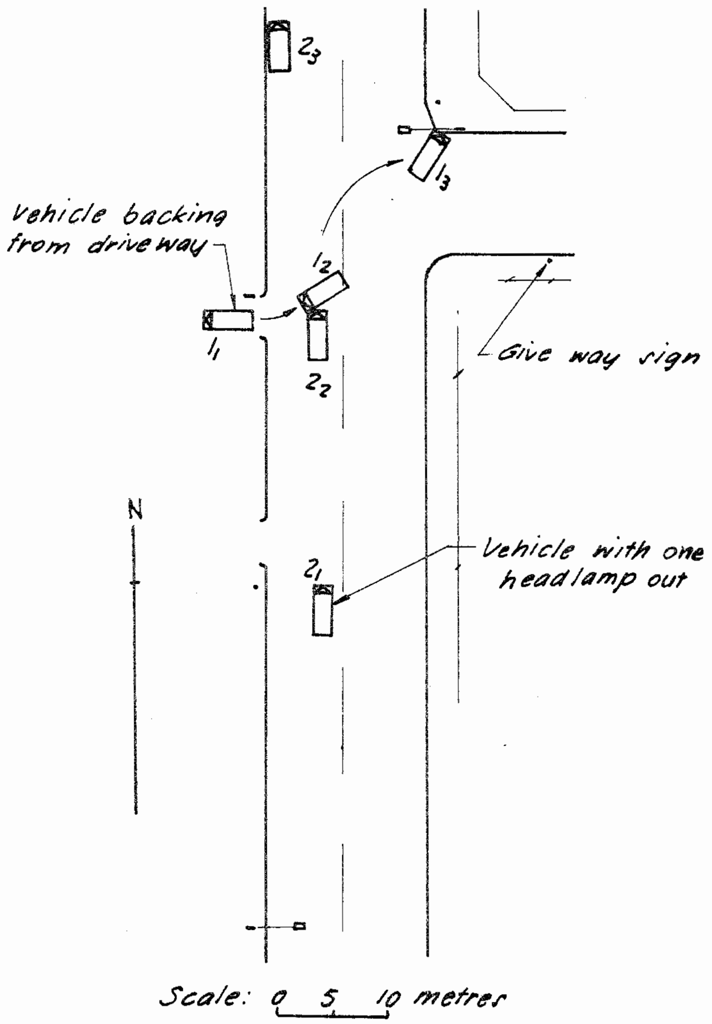


FIGURE 4.13: Accident 188.

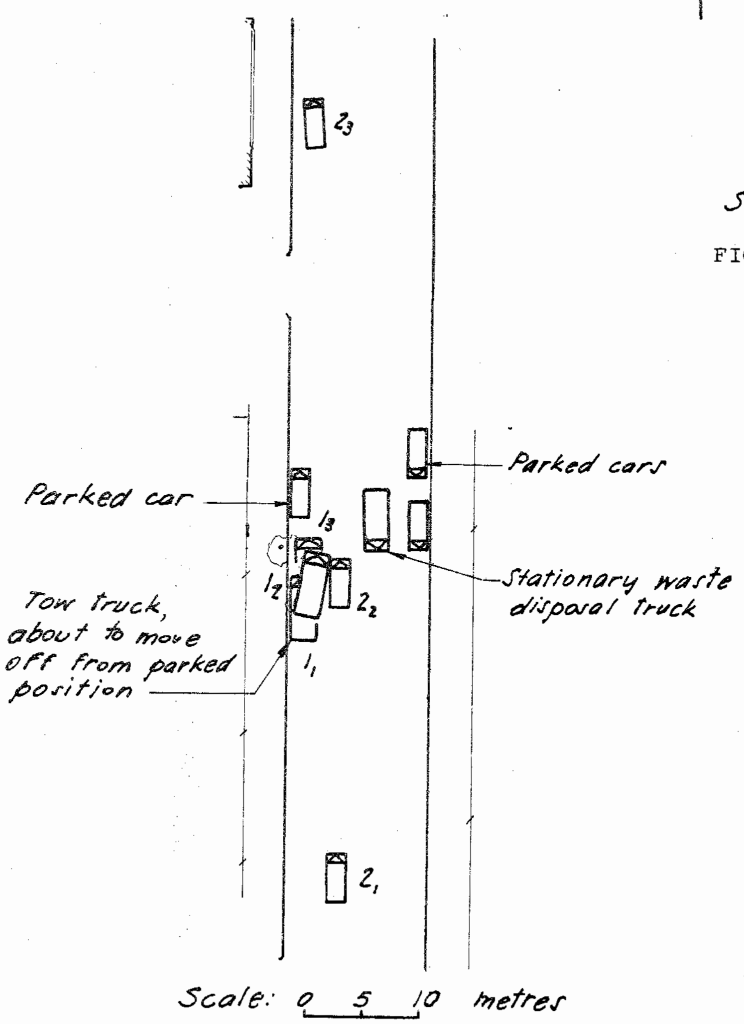


FIGURE 4.14: Accident 091.

4.2.7 MISCELLANEOUS MIDBLOCK COLLISIONS

The four remaining accidents of the 40 mid-block collisions in this study are reviewed here. They were a side-swipe collision between two vehicles travelling in the same direction, a head-on collision and an accident in which a pedal cyclist rode into an open door of a parked car.

Side-Swipe Collision

A 21 year-old female motorcyclist was returning home from work at night (Accident 043) when she noticed a car behind her weaving in and out of the traffic (as seen in her rear vision mirror). Soon after this the car began to pass her on her right hand side. It veered to the left when it was alongside, hitting her motorcycle. She was thrown off balance, and fell to the road, where she slid along partially trapped under the motorcycle.

The driver of the car had a BAC of 0.09. He thought that the motorcyclist may have panicked when he passed her, causing her to wobble and contact the side of his car. He heard the noise of the impact and, when he looked in his rear vision mirror, he saw the motorcyclist falling off.

The street lighting at the accident site was very poor, with a virtually unlit section of road extending for about 60 metres beyond the collision point and sodium vapour lamps providing isolated areas of relatively high intensity illumination elsewhere. This would have made the car driver's task slightly more difficult, but it seems likely that his blood alcohol level was high enough to have affected his ability to guide his vehicle on a straight course and that that was the major causal factor in this accident.

The second accident in this category involved a truck moving out from a parked position at the kerb and a car passing by in the same direction (Accident 091, Figure 4. 14). The driver of the truck said that he had backed up to allow room to clear the car parked in front of him, and in so doing had swung the front of the truck out into the roadway. He was about to move off when he checked his rear vision mirror and saw a car approaching rapidly. A waste disposal truck had blocked the far side of the street, and the car driver was forced to keep closer to the left than might otherwise have been the case. In so doing, his car side-swiped the right front corner of the truck. The driver of the car, a 62-year-old male, had been drinking but refused to blow into our Alcolmeter. We gained the subjective impression that his driving ability might have been affected by alcohol. He said that the truck had driven out into his path, but the damage to the vehicles, and their post-impact motions, did not support this claim.

Head-On Collision

A 52-year-old male was driving along a street in a residential area when an oncoming car swerved across to his side of the road and crashed head-on into his car (Accident 245). The other driver, who was 66 years of age, said that he first became aware of the presence of the car coming towards him on impact. He had not seen it previously. He had a BAC of 0.25 and had taken two hay fever tablets, containing anti-histamines which exacerbate the effects of alcohol on driving ability, earlier that day. A cigarette packet was found lying open in his car, with loose cigarettes scattered around, suggesting that he may have been trying to light or to retrieve a cigarette just before the collision.

Opening Car Door: Hit by Passing Cyclist

The one accident of this type in the study happened late at night (Accident 157). The 18-year-old cyclist said that he was riding quite fast through a signalised intersection, keeping well to the left on a left hand curve. On leaving the intersection he saw a car parked at the kerb ahead of him. It did not have its parking lights on, and appeared to be empty. As he was about to pass the car the driver's door was opened and he crashed into it, breaking the door off its hinges.

The driver of the car had stopped at the kerb, intending to go to a nearby shop. He had stayed in the car for a short time, talking with his passenger, before opening the car door to get out. He had not noticed the cyclist approaching.

The car had high-backed front seats which both restricted the driver's rear vision a little and may have concealed the occupants from the view of the cyclist. The bicycle was not equipped with either lights or fittings for lights and the cyclist was wearing dark, inconspicuous clothing.

Relevance of Road and Traffic Factors

No road or traffic factor played an obvious role in any of these four midblock collisions. Accident 043 occurred under non-uniform sodium vapour lighting but the critical events took place close to one of the lamps where the level of illumination was adequate.

5. UNCONTROLLED INTERSECTIONS

5.1 GENERAL CHARACTERISTICS OF ACCIDENTS AT UNCONTROLLED INTERSECTIONS

5.1.1 TIME OF DAY AND DAY OF WEEK

Sixty, or 20 per cent, of the 304 accidents in the study occurred at uncontrolled intersections. The distribution of these accidents by time of day and day of week is shown in Figure 2.3 of Chapter 2 where it can be seen that almost one-third (18 out of 60) occurred between 4 p.m. and 6 p.m. and only three accidents happened after 10 p.m. Those accidents that occurred on a Saturday or a Sunday followed this same general time of day distribution, apart from there being no accidents early in the morning.

5.1.2 ALCOHOL INVOLVEMENT

As shown in Figure 2.3, there were eight of the 60 accidents in which a driver or rider was known to have a blood alcohol level greater than 0.05 and two other accidents in which a driver chose to leave the scene of the accident before the arrival of the police in order to avoid having to take a breath test (statements from other persons indicated that these two drivers were obviously intoxicated). In seven of these ten accidents alcohol intoxication was almost certainly a significant factor in the causation of the accident. The remaining three blood alcohol levels ranged from 0.06 to 0.09 and the circumstances of these accidents were such that the role of alcohol was less readily discernible.

5.1.3 TYPES OF VEHICLES

The types of vehicles involved in the 60 accidents at controlled intersections or junctions are shown in Table 5.1 together with whether or not the operator of the vehicle was required to give way to the other vehicle that was involved in the collision. In South Australia a vehicle approaching an intersection is required to give way to another vehicle on its right. Such differences that exist in the observance of priority by type of vehicle were more apparent in accidents in which the vehicles were travelling initially on parallel paths on the same carriageway. In these accidents car drivers tended not to yield to motorcycles. The lack of any marked association between the type of vehicle and the frequency with which its operator observed the give-way rule when the vehicles approached on intersecting carriageways is discussed at some length later in this Chapter in the Section on Collisions between two cars at four-way uncontrolled intersections.

5.1.4 ROAD LAYOUT AND VEHICLE MOVEMENTS

Forty-five of the 60 accidents occurred at four-way intersections, all but two of which had the roads aligned at, or very near to, right-angles. The other 15 collisions were at T-junctions. Table 5.2 shows that the most common type of accident involved two vehicles which entered a four-way intersection on different approach roads and would have proceeded straight across had the collision not occurred. This type of collision accounted for just over two-thirds (42 out of 60) of these accidents at uncontrolled intersections. Because of this relatively large number of cases this collision type was investigated as a group of accidents in a way that was not possible for most other types of accident in the study. The results of this investigation are presented in Section 5.3.

The next most frequently-occurring collision was between a vehicle turning right from the stem of a T-junction and a vehicle on its right (seven accidents, see Table 5.2(7)). The turning vehicle was a pedal cycle ridden by a child in three of these seven accidents. The collision shown in Table 5.2(4) involved the same vehicle movements but at a four-way intersection.

The only other collision type having more than two cases is shown in Table 5.2(5). A car turned right into the stem of a T-junction and into the path of an oncoming vehicle. These vehicle movements are similar to those of the two accidents listed in Table 5.2(3) which occurred at four-way intersections.

TABLE 5.1: TYPES OF VEHICLES AND PRIORITY IN ACCIDENTS AT UNCONTROLLED INTERSECTIONS

Type of Vehicle	Operator Required to Give Way: Yes	No	Total
Car	53 (10)[1]	50 (6)	103
Motorcycle	3 (-)	8 (3)	11
Pedal cycle	3 (-)	1 (1)	4
Truck	1 (-)	1 (-)	2
Total	60	60	120

Notes: [1] Numbers in parenthesis refer to collisions in which vehicles approached on parallel paths on the same carriageway.

5.2 COLLISIONS AT UNCONTROLLED T-JUNCTIONS

5.2.1 TURNING RIGHT FROM THE STEM OF AN UNCONTROLLED T-JUNCTION

The eight collisions involving this vehicle movement are shown as categories (7) and (9) in Table 5.2. The one case in category (9) was a rear-end collision in which a car ran into the back of a motorcycle which stopped when it reached a cross-over in a raised median strip on the through road.

Three of the seven accidents in category (7) in Table 5.2 were collisions between a pedal cycle turning right and a car (Accidents 031, 226 and 296). The three cyclists were nine, ten and 15 years of age and in each case they entered the intersection without first ensuring that it was safe to do so. Two of these riders said that they did not expect a car to be coming and one, who had borrowed the pedal cycle to chase a friend who had taken his bike, said that he was not really looking for other traffic because he was in a hurry (Accident 296). The driver in this accident remarked that the sun was in her eyes and its effect was accentuated by dirt on the windscreen of her car. The driver in Accident 226 was eating a pie while driving along but neither this distraction, nor the glare from the sun noted above, were likely to have been significant factors in the causation of these accidents because the drivers probably had insufficient time to have been able to have taken effective avoiding action even in the absence of these impediments.

In the two car/motorcycle collisions the motorcycle was passing stationary (or parked) cars as it approached the junction on the through road. The stationary cars in Accident 279 were a major factor in the causation of the collision (Figure 5.1). They were banked up behind a vehicle that was waiting to turn right at a T-junction further down the road and one of the drivers had left a gap for a car to move out from the stem of a T-junction on his left. He waved the waiting car through the gap without first checking that it was safe for it to do so and it collided with a motorcycle that was passing the stationary line of cars. The parked cars in the other accident (278) were a partial, but possibly minor, obstruction to vision, as was a row of trees planted close to the edge of the footpath. The driver of the car stopped and then, thinking the way to be clear, started to turn right into the through road. When she saw the motorcycle approaching she stopped but her car was across its path. It is likely that the motorcyclist was travelling at a speed in excess of the speed limit, on the basis of the length of the braking skid mark. The 85 percentile speed for through traffic in this direction was 71 km/h.

The one collision between two cars occurred when the driver of the turning car slowed to allow traffic on his left to pass through the T-junction. The driver of the car that was approaching from the right said that she had been distracted by a child passenger and she did not notice the turning car until it appeared to stop in front of her (Accident 268). The 85 percentile speed of traffic on this road was also 71 km/h, as for Accident 278.

The collision between a car and a truck was actually between planks of timber that slid forwards off the tray of the truck under braking and penetrated the passenger compartment of the car (Accident 111). The driver of the car

TABLE 5.2: TYPES OF COLLISIONS AT UNCONTROLLED INTERSECTIONS BY TYPES OF VEHICLES INVOLVED

Type of Collision	Car Car[1]	M/c[2] Car	Car M/c	P/c[3] Car	Car P/c	Truck Car	Car Truck	Total
(1)	35[4]	1	3	-	-	-	1	40
(2)	2	-	-	-	-	-	-	2
(3)	1	1	-	-	-	-	-	2
(4)	-	1	-	-	-	-	-	1
(5)	1	2	-	1	-	-	-	4
(6)	2	-	-	-	-	-	-	2
(7)	1	2	-	-	3	1	-	7
(8)	1	-	-	-	-	-	-	1
(9)	-	1	-	-	-	-	-	1
Total	43	8	3	1	3	1	1	60

Notes: [1] The vehicle that should have yielded is described in the second row.
[2] Motorcycle
[3] Pedal cycle
[4] Includes two Volkswagen Kombi vans (see text)

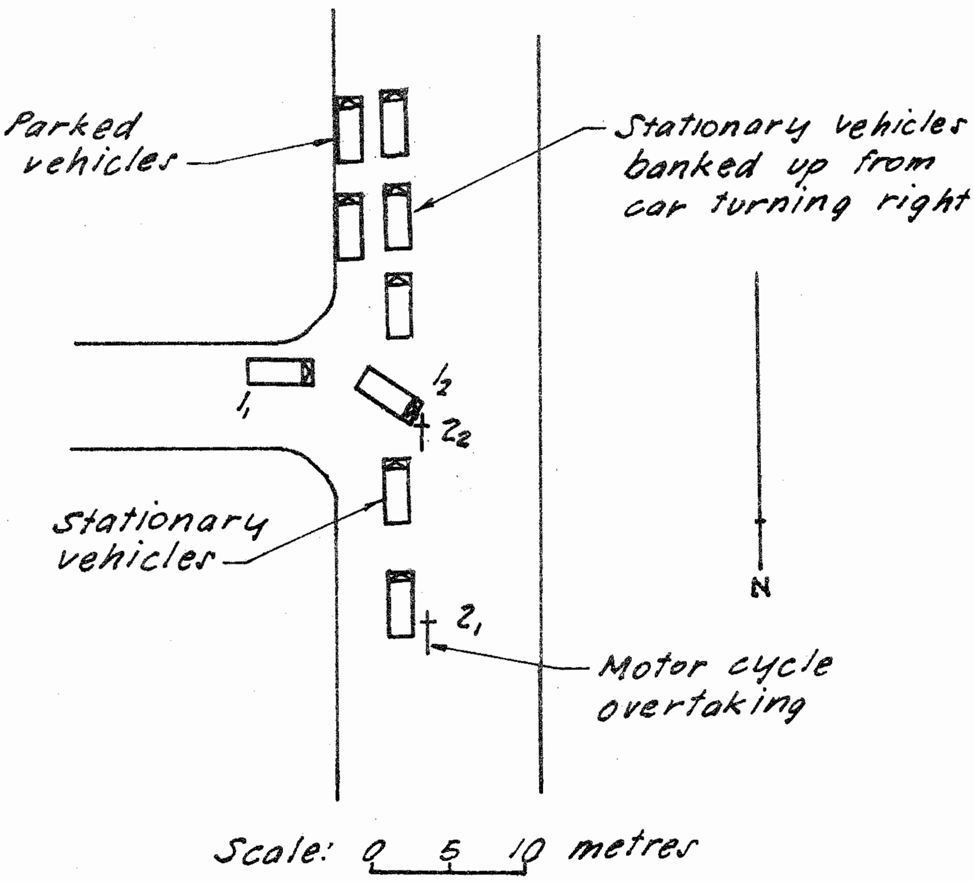


FIGURE 5.1: Accident 279.

had stopped at the through road and said that he looked right, then left and seeing a gap in the traffic he accelerated out to turn right without realizing that the truck was approaching. The car driver had poor eyesight (3.9 Snellen in his right eye and 3.36 in his left) that was uncorrected and when looking to his right at the T-junction he was facing into the sun.

Relevance of Road and Traffic Factors

All of the eight accidents described under this heading occurred in daylight between 1 p.m. and 6 p.m. The drivers and riders were familiar with the road layout in each case. With the exception of the row of trees noted in the description of Accident 278 and some large bushes close to the edge of the carriageway in Accident 296 such obstructions to vision that were present were at or behind the property boundaries.

Three of the seven drivers who collided with a vehicle on the through road had stopped before entering the junction. GIVE WAY signs or even STOP signs may not have had a significant effect on the behaviour of the four persons who did not stop before turning right since three of them were children and the fourth had seen the car on his right when it was still some distance away.

There were suggestions that the speed of the vehicle on the through road may have been in excess of the speed limit and greater than the turning driver expected in at least three of the seven collisions (other than the rear-end collision) described above. Any measure that effectively restricted traffic speeds to the legal limit of 60 km/h, or to a lower limit, may therefore have enabled these three turning drivers to have judged the speed of the approaching vehicle more accurately and thereby to have avoided the collision. This matter is discussed at greater length in connection with accidents at sign-controlled intersections (Section 6.9).

5.2.2 TURNING RIGHT INTO THE STEM OF AN UNCONTROLLED T-JUNCTION

The seven accidents involving this manoeuvre are listed as categories (5), (6) and (8) in Table 5.2. Category (5) comprises accidents in which a car turned right across the path of an oncoming vehicle. The accidents in categories (6) and (8) involved the turning vehicle and one that was following it.

Turning Right Across the Path of an Oncoming Vehicle

(Category (5) in Table 5.2)

The four accidents in this category occurred at night, unlike the eight accidents described in the previous Section, all of which took place in daylight.

The driver of the turning car in one of these accidents (061) said that the collision was entirely his fault. He was running late and took a chance that he could complete the turn before the approaching car reached the junction. However the other car was exceeding the speed limit (60 km/h) by a wide margin (possibly as much as 40 km/h) on the basis of the physical evidence at the scene.

Two of the other three collisions were between a turning car and a motorcycle. In Accident 112 both the driver and the rider thought that there was time enough for the car to turn across in front of the motorcycle but they both reported that the car faltered in the turn. The rider had not anticipated this and was unable to stop in time, possibly because he did not apply the front brake of his motorcycle (see page 34 and Section 5.5 of the companion report on motorcycle accidents for a discussion of motorcycle braking). The second car/motorcycle collision involved a rider who had a BAC of 0.17 and who said that he never used the front brake because he thought that the motorcycle would stop too suddenly and he would "fly off the front" (Accident 274). The driver of the car said that when he realized that he had misjudged the speed of the motorcycle he stopped, partially blocking the intersection.

The fourth collision was between a car and a pedal cycle (Accident 028). This accident was the only one of the four in which the turning driver did not see the other vehicle approaching. The lack of any lights on the cycle made it particularly difficult for the driver to see it approaching, as did the poor quality street lighting (tubular fluorescent lamps) which did not illuminate the cyclist's approach to the intersection. The driver of the car also said that he had been concentrating on following another car.

Struck from the Rear when Turning Right

(Categories (6) and (8) in Table 5.2)

Two of the three accidents in this category involved intoxicated drivers and the third involved a driver who admitted that he had not been looking where he was going.

In Accident 056 the driver of the following car said that he had taken his eyes off the road to wave to his brother who was reversing out onto the left-hand side of the carriageway. When he looked back he saw that the car in front had stopped, to allow oncoming traffic to pass before turning right, but although he braked he was unable to avoid crashing into it.

The driver of the striking car in Accident 029 left the scene of the accident because he was intoxicated. He had crashed into the back of a car that was stationary in a queue of three that were waiting to turn right into the stem of a T-junction (Figures 5.2 and 5.3). The collision happened at night on a road that was illuminated by sodium vapour lamps except at intersections or junctions, where mercury vapour lamps were used. This resulted in an apparently lower level of illumination at the junction (in this accident, on the approach to the junction). While this may not affect the performance of a sober driver to any meaningful degree it may make it more difficult for an intoxicated driver to realize that the vehicle in the traffic lane ahead of him is stationary (see Perrine, 1973) and so this characteristic of the street lighting may have contributed to the causation of this accident.

Accident 105 also occurred at night and the driver of the striking car (an 18-year-old male) had an elevated blood alcohol level (0.09). Unlike the other accidents in these two categories the leading car was still moving and had started to turn into the side street when the driver heard a squeal of brakes immediately before her car was struck on the right side and rolled over. This driver said that she had been having difficulty reading the names on the street signs and that as she started to turn into the street her passenger, who lived in the area, called out that it was the wrong one. She said that she had indicated a right turn but had not checked her outside rear vision mirror before starting to turn. The driver of the following car said that he did not see the car ahead of him until it started to turn. He had been licensed for seven months and reported having had two convictions for speeding in that time. The physical evidence at the scene of the accident indicated that he had been travelling well in excess of the 60 km/h speed limit. The street lighting (tubular fluorescent) was of poor quality.

Relevance of Road and Traffic Factors

The characteristics of the street lighting may have played a role in the causation of three of these accidents (028, 029 and 105) as noted above. The poor legibility of a street sign distracted one turning driver (Accident 105) and the other car in that accident was travelling at an excessive speed, as was the through vehicle in Accident 061. It is likely that the through vehicle in Accident 274 and the striking car in Accident 029 were also speeding. Two of these three drivers and one rider who were, or may have been, speeding were also the only ones in this group of eight accidents who were intoxicated.

5.3 COLLISIONS BETWEEN TWO CARS AT UNCONTROLLED FOUR-WAY INTERSECTIONS
(Category (1) in Table 5.2)

In all of these accidents the two vehicles entered the intersection on different approach roads and would have proceeded straight across had the collision not occurred. The intersections were between two roads aligned at right angles, or very nearly so, and with zero or minimal offset. In two accidents (049 and 130) one of the "cars" was a Volkswagen Kombi van but they have been included here because the circumstances of these accidents were such that neither the shape of the vehicle nor the forward and higher location of the driver appeared to be relevant in any way to the causation of the accident.

These accidents are discussed in greater detail than are the other types of accidents in this Report because they form a relatively large group for one type of accident and because they appear to be accidents which could be prevented by traffic control measures in most cases.

5.3.1 TIME OF DAY, LIGHTING AND WEATHER

The distribution of these 35 accidents by time of day is similar to that shown in Figure 2.3 for all collisions at uncontrolled intersections and junctions.

None of these crashes occurred during inclement weather conditions, although three accidents occurred when the road surface was still damp from earlier showers of rain. Eleven of the 35 accidents happened at night and one at dusk.

5.3.2 THE LOCATIONS

With the gradual introduction of a priority road system in Adelaide it is not surprising that only five of these accidents were on an arterial road. The remaining 30 were on local, or local-collector streets. Three crashes occurred in industrial or commercial areas, and 32 in residential neighbourhoods. Two crashes occurred at one residential intersection, both involving the same approaches (Accidents 088 and 116). This means that there were 34 different locations for these 35 accidents.

The most common obstruction to vision across the included corner was a boundary fence, hedge or garden shrubs (Figure 5.4 to 5.7). At some locations the corner was clear back to the house or other building but this was less common than obstructions located on or near the property boundary. Trees or shrubs on the footpath, or even in the carriageway, and utility poles were additional obstructions to vision at seven intersections (eg: Figures 5.5 and 5.6) and parked cars at the one intersection at which there were two accidents.

FIGURE 5.2: Car struck when stationary waiting to turn right. (Unit 2 in Figure 5.3.)

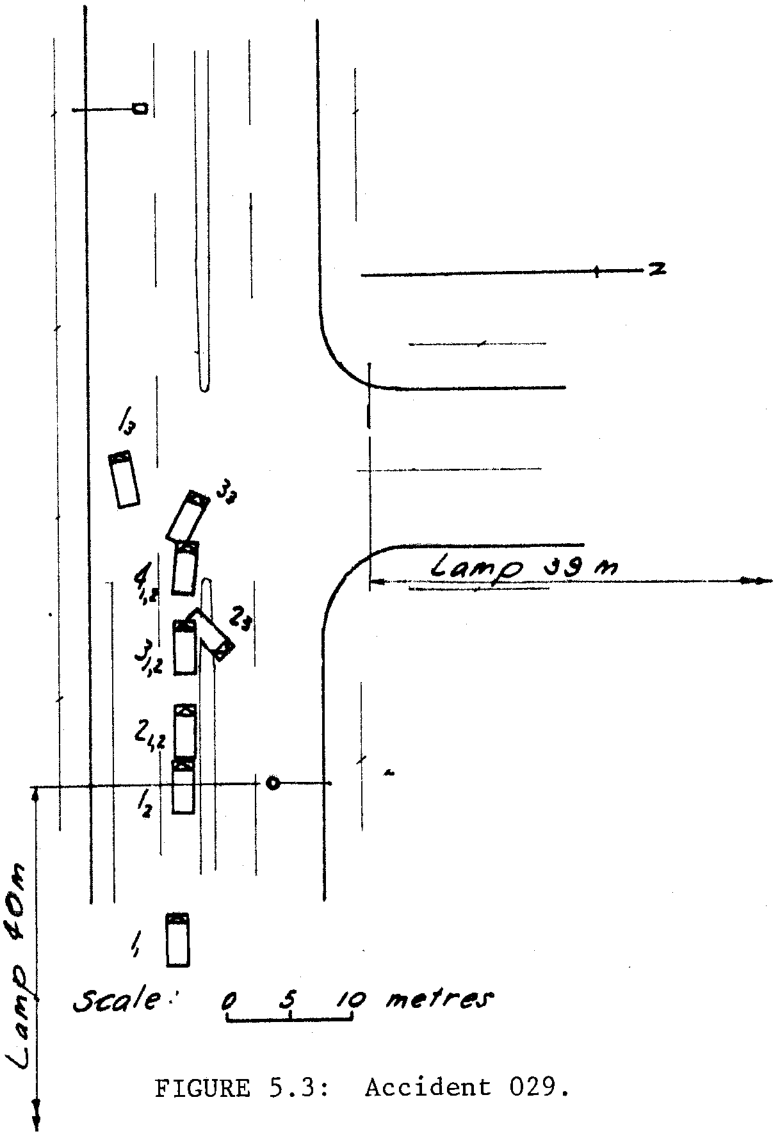


FIGURE 5.3: Accident 029.

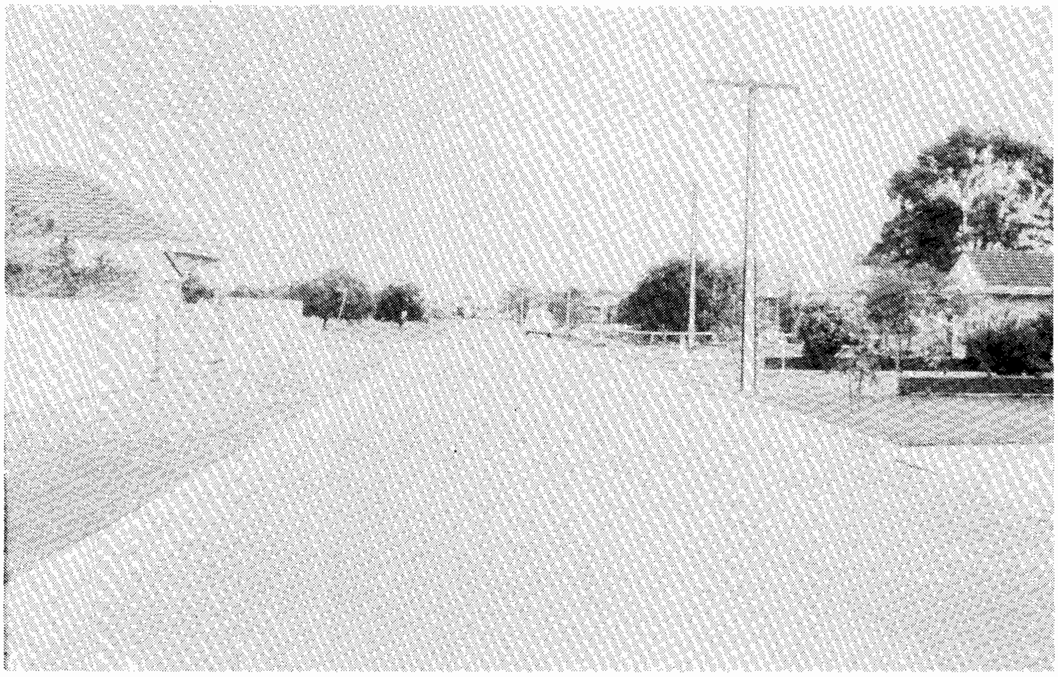


FIGURE 5.4: Approach path for vehicle on the left in Accident 207 (see also Figure 5.15)

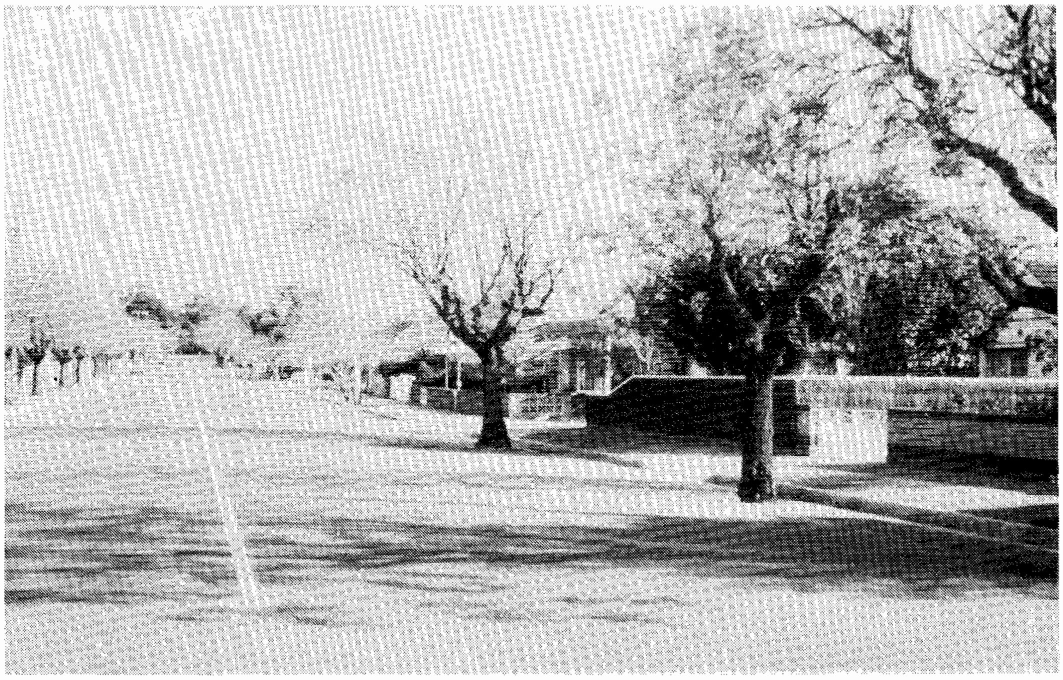


FIGURE 5.5: Approach path for vehicle on the left in Accident 009. Accident occurred at night.

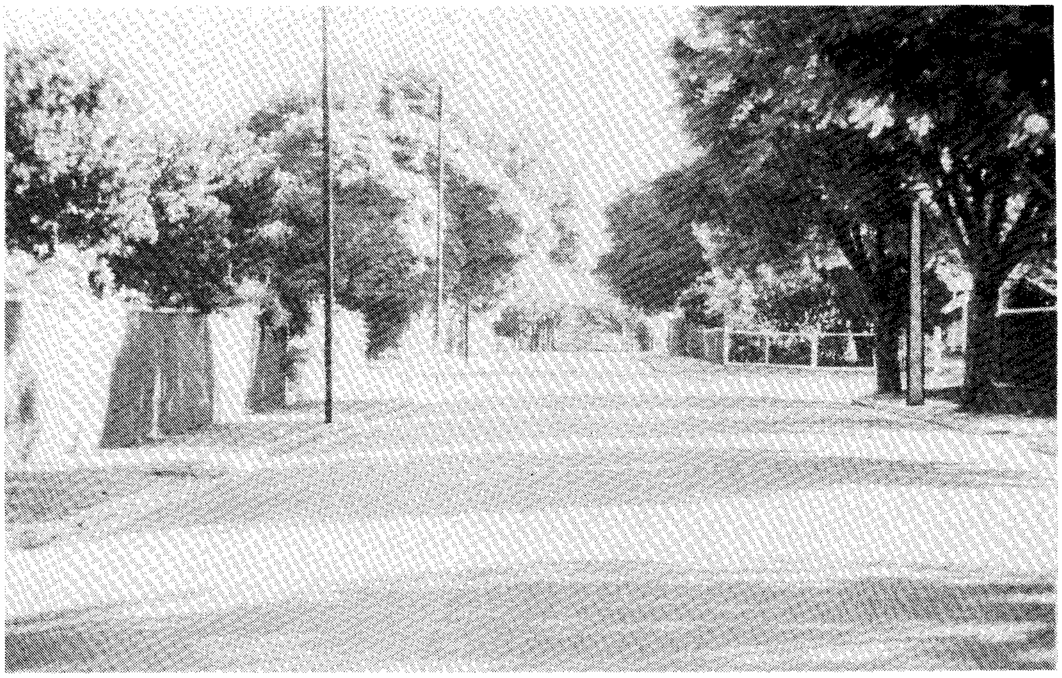


FIGURE 5.6: Approach path for vehicle on the left in Accident 033 (see also Figures 5.8 and 5.9). Accident occurred at night.

FIGURE 5.7: Severely restricted sight distance in Accident 017.

Five drivers entered the intersection without realizing that it was there (see later in this Section for a discussion of driver familiarity with the location). Four of these accidents occurred at night (009, 033, 104 and 126) and one at dusk (286). Two drivers (009, 286) were intending to turn right at the intersection but did not realize that they were about to cross it.

At only one of these locations was there a reasonably good indication of the presence of the intersection (and that was provided by sodium vapour lighting on the intersecting road). The relevant driver in that accident (126) was looking for a church hall, which may have accounted in part for his failure to have noticed the intersection. The tubular fluorescent street lighting on the approach taken by the driver on the right in Accident 009 (who was intending to turn right) gave no indication of the presence of the intersection, nor did the similar lighting in Accident 104. There were cross road warning signs on the approaches to the intersection at which Accident 104 occurred but they were not reflectorized and were not obvious. One driver in that collision was severely emotionally disturbed and had never driven on that road before. One other of the ten drivers in these five accidents was reported by witnesses to have been intoxicated but the remainder had no known physical impairment at the time of the accident.

Gaps in the row of houses and reflectorized street name signs were among the most frequent indications of the presence of an uncontrolled four-way intersection. The alignment of the street lighting rarely appeared to be effective in this regard. At some locations a white centre-line was painted on the approach to the intersection (eg: Figure 5.5). It may be that this tempts some drivers to assume that if the road warrants a centre-line it is therefore a "major" road.

Safe Approach Speeds

Safe approach speeds were calculated for each of these locations by means of the method used by the Highways Department of South Australia (form number H.D. 1639). This method assumes a total perception and break-reaction time of 1.5 seconds, a coefficient of friction of 0.5, and that the car on the right stops with a clearance of 4.6 metres between its driver and the path of the driver of the other car. The car on the intersecting road is assumed to be travelling at a steady speed which is set at the 85 percentile of measured traffic speeds on that approach (although in practice in the metropolitan area a speed of 60 km/h is used).

This last assumption has been modified here by taking the 85 percentile speed only when it was greater than 60 km/h, which happened at four locations with the highest such speed being 72 km/h. These speeds were measured with a radar meter at the time of day and day of week on which the accident had occurred at each location. The resulting values for the safe approach speeds range from 3 km/h to 29 km/h, with an average of 14.6 km/h (Table 5.3).

These assumptions on which the calculation of safe approach speeds is based may appear initially to be unduly conservative, but there are good reasons for claiming that, in some respects, they err in the other, unsafe, direction.

The 1.5 seconds allowed for perception and brake reaction time is longer than an alert, skilful driver needs *if* he is looking to his right and is ready to brake. Of this time interval, half a second can be allowed for the brake reaction time (De Silva, 1936). This leaves one second to check for approaching traffic from both the right and the left and to decide what is the appropriate response to make. In addition to checking the side roads the driver must still watch the road ahead and any other vehicles. This can be a very complex task, and the time needed to assess a situation and to decide what to do is known to be greater for complex tasks than for simple ones (Welford, 1968, p.60 et sez.).

It is difficult to extrapolate with confidence from the results of choice-reaction time experiments, commonly used as predictors for the times taken for decisions to be made in driving tasks such as the one being considered here. But the results of some of these experiments do suggest that the general range of time intervals which we should allow for may be between 0.75 to one second on each approach road (Szafran, 1951). The lower value is probably adequate for young drivers, but older drivers, even those in their fifties, are likely to require one second longer.

This means that we should be using an overall reaction time of at least 2.5 seconds in safe approach calculations, and this is still based on the general assumption that the driver is sober, not preoccupied, and even bothers to look for vehicles on the intersecting roads.

As noted above, the Highways Department uses 60 km/h as the speed of traffic entering from the left when calculating safe approach speeds for intersections in the metropolitan area. Independently, we decided to do this except at four intersections in which the 85 percentile speed of this traffic was greater than 60 km/h. At one of these locations this speed was 72 km/h. Whether selecting the 85 percentile speed provides a sufficient level of safety under such circumstances is debatable, and it may be that the 90 or 95 percentile speed should be used.

The coefficient of friction value of 0.5 is reasonable in South Australia. We have measured dry-road values of 0.8 at many of the locations reviewed here, by means of locked-wheel skid testing with a car, and 0.5 has been assumed to be close to the wet-road value. But even variations within these ranges in the values

TABLE 5.3: SPEEDS IN TWO-CAR COLLISIONS AT UNCONTROLLED FOUR-WAY INTERSECTIONS

Accident Number	Approach Speeds (km/h): Estimated for this crash[1], Car on Left	Estimated for this crash[1], Car on Right	Measured by radar[2], Car on Left (Mean)	Measured by radar[2], Car on Right (85%)	Calculated safe approach speed, Car on Left	Impact Speeds (km/h): From computer simulation[3], Car on Left	From computer simulation[3], Car on Right
9	40	55	52	–[4]	8	48	64
17	30	–[4]	29	–	3	–[4]	–
20	65	–	48	–	10	61	53
27	–	40	34	–	11	–	–
33	80	60	–	66	7	–	–
48	–	40	14	47	18	30	48
49	25	50	47	41	20	–	–
52	65	–	19	22	17	32	24
64	50	–	38	40	25	–	–
68	50	–	25	24	6	–	–
75	–	–	37	14	10	32	50
83	–	40	18	43	28	–	–
88	50	65	31	19	14	56	56
90	–	60	10	43	8	–	–
104	–	50	–	–	21	–	–
109	50	–	–	–	10	48	40
114	–	40	18	46	22	–	–
116	40	10	40	28	12	24	24
126	65	55	7	63	16	48	40
130	–	–	37	66	16	–	–
147	–	50	3	52	12	40	32
149	65	15	51	8	20	–	–
151	–	–	–	–	29	–	–
162	65	15	64	–	15	40	45
174	40	50	3	56	20	50	70
187	35	–	28	52	18	32	50
197	50	50	49	–	12	–	–
199	40	40	41	23	11	–	–
207	–	40	38	15	13	–	–
220	45	–	35	–	19	–	–
225	–	55	–	–	7	–	–
228	40	50	0	72	6	–	–
239	–	25	49	7	16	–	–
266	35	40	30	13	13	–	–
286	–	–	–	–	14	–	–

Notes:
[1] From drivers' and witnesses' statements
[2] Speeds were measured at the time of day and day of week of the accident that occurred at the intersection
[3] Simulation Model of Automobile Collisions (SMAC) (McHenry, 1971)
[4] Blanks indicate no recollection of the crash, the intersection had been modified, an impact speed could not be computed, or no vehicles were observed on that approach.

assigned to the overall reaction time and to the coefficient of friction are unlikely to result in practically meaningful changes in the calculated values of the safe approach speeds, although they can affect compliance with traffic engineering warrants for STOP signs, as discussed later in this Section. This is because most drivers appear to choose to travel very much faster than the safe speed when approaching an uncontrolled intersection.

Prior Accident Record

During the three calendar years preceding the year in which the investigated accident occurred no similar accidents were reported at ten locations. Eleven sites had one such accident in the preceding three calendar years and the largest number of similar crashes in that period in any one site was thirteen. Overall there was a total of 75 similar accidents at the 34 intersections. Nineteen of those 75 accidents were injury-producing. Figure 5.10 illustrates evidence of a prior collision at the site of Accident 266.

Subsequent Collisions

The risk of a subsequent collision occurring following a collision between two cars at an intersection is dependent largely on whether or not one of the vehicles leaves the carriageway and on the characteristics of the roadside. A collision with a third vehicle depends on both the speeds of the two cars in the initial impact and on the traffic conditions.

Neither of the cars left the carriageway as a consequence of the initial collision in 10 of these 35 accidents (see, for example, Figure 5.11). In seven accidents a car came to rest on the footpath but without another collision (Figure 5.10). There was at least one subsequent collision in 18 accidents, including collisions with other cars, and four cars rolled over following the initial impact (eg: Figure 5.15). Subsequent collisions between the original cars are not included here.

Boundary fences or garden walls were the most commonly hit fixed objects (Figure 5.13). One of these nine such collisions was with a fence which was being rebuilt following an earlier crash at the intersection. Four months later the fence was demolished again. In another accident one of the drivers was looking at the remains of a fence which had been struck by a car, instead of watching for traffic on the intersecting road.

Collisions with fences are rarely hazardous, but this is generally not true of collisions with utility poles (eg: Figure 5.14). Six cars hit a pole after the initial collision. In one of these cases the car was rolling very nearly end over end after sliding into a high kerb when it struck a utility pole with its roof. The highest impact point on the pole was almost three metres above the ground. The only survivable seating position was that for the driver, who was alone in the car and who was uninjured (Figures 5.8 and 5.9).

Two stationary cars, and one parked at the side of the road, were involved in subsequent collisions in three accidents. One of these stationary cars was hit by a car which was rolling over following the initial collision (Figure 5.16).

5.3.3 APPROACH AND IMPACT SPEEDS

In 13 of these 35 accidents we were able to collect sufficient information to make use of a computer program to reconstruct the collision events. The program is the Simulation Model of Automobile Collisions, known as SMAC (McHenry, 1971). It gives estimates of the impact speeds which have been shown to be accurate to within ten per cent when applied to controlled crashes in which these speeds were measured. The speeds that were computed in this way are listed in Table 5.3.

Estimates of approach speeds based on statements from the drivers and any witnesses, (estimates of varying and often unknown levels of accuracy) are also listed in Table 5.3, together with the relevant safe approach speed.

In all of those accidents for which we have an estimated approach speed for the car which should have yielded it is greater than the calculated safe approach speed. This difference ranges from five to 73 km/h, with a mean of 35 km/h. Even the computed impact speeds are all above the relevant safe approach speeds.

The average speed on impact was 44 km/h for the 26 cars for which this information was available. The highest relative impact velocity between any two cars was 86 km/h and the lowest was 34 km/h. There was no meaningful difference between the average impact speed of cars which should have yielded and that of cars on the intersecting road, nor between those cars on the "major" and those on the "minor" roads using a priority classification based on local attitudes and practices.

5.3.4 THE DRIVERS

Age, Sex and Marital Status

The drivers' ages ranged from 16 to 73 years, with 47 per cent being under 25 years of age. One quarter of these 70 drivers were females. At the time of the accident almost half of the drivers were

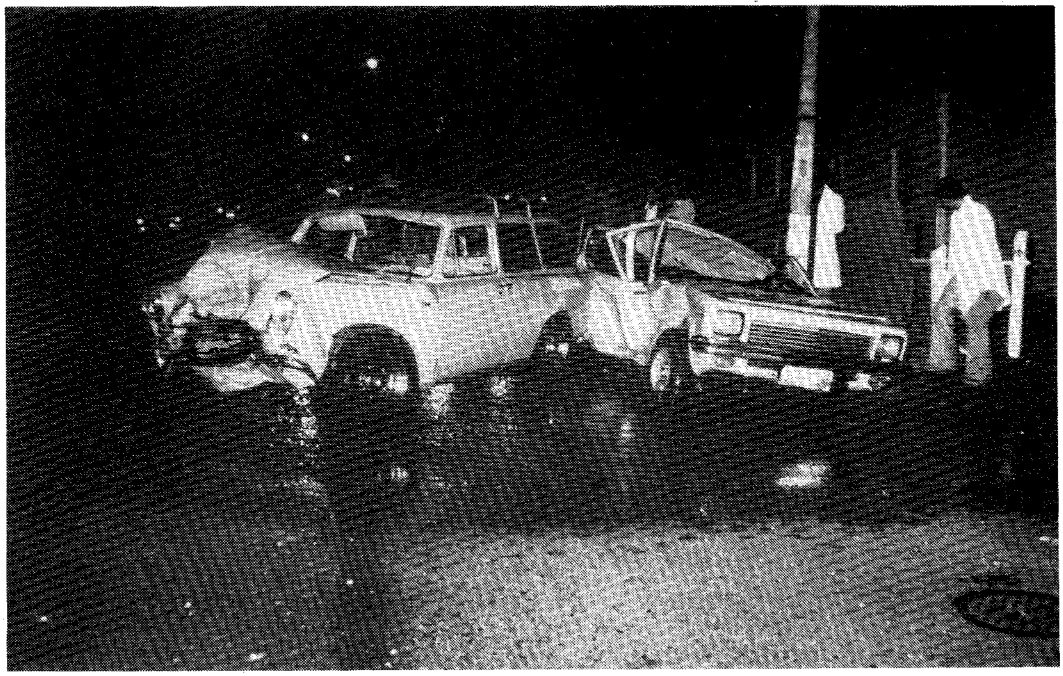


FIGURE 5.8: Final position of cars in Accident 033. Road has been hosed down to remove spilt petrol (see also Figures 5.6 and 5.9).

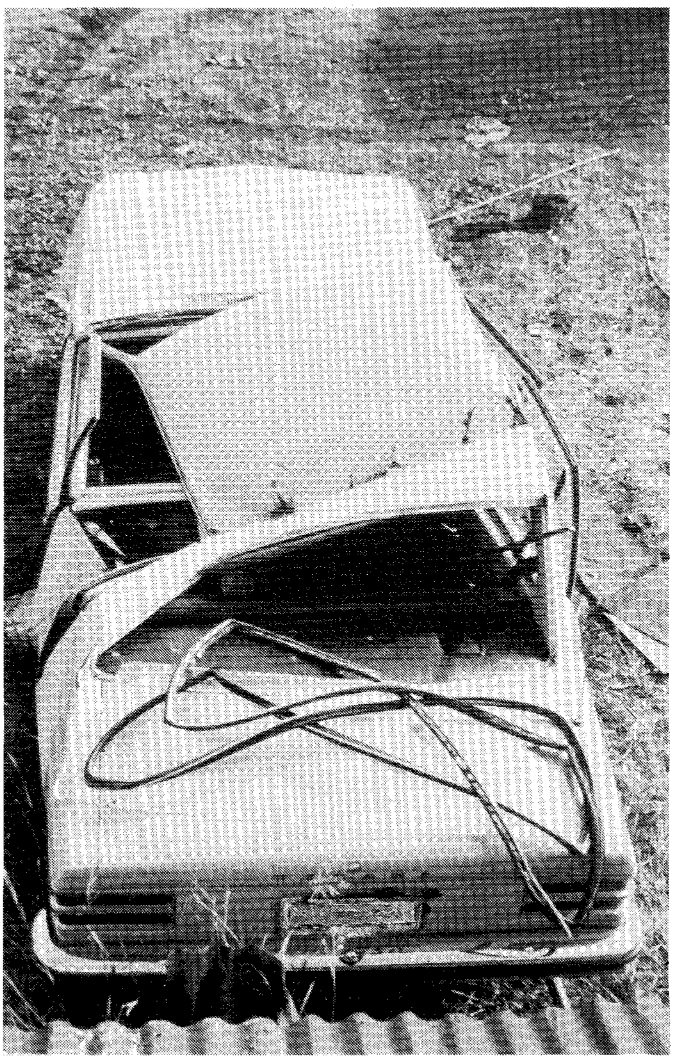


FIGURE 5.9: Damage to car (shown in Figure 5.8) due to secondary collision with a utility pole.

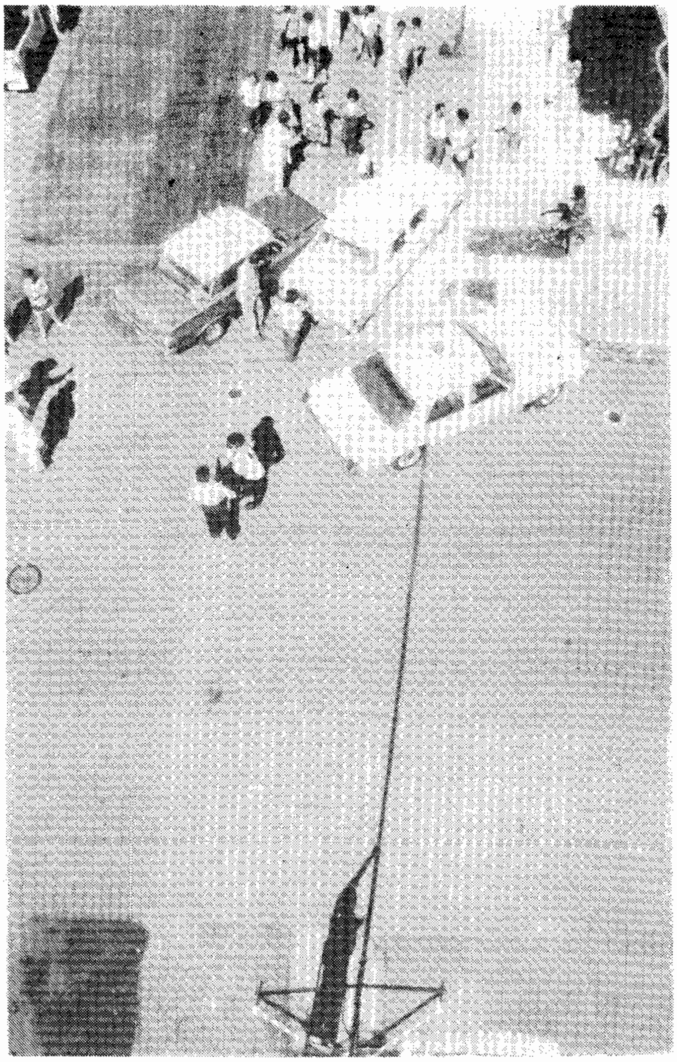


FIGURE 5.10: Final positions of cars following collision at an uncontrolled intersection. Marks painted on road are from a previous collision. Accident 266.

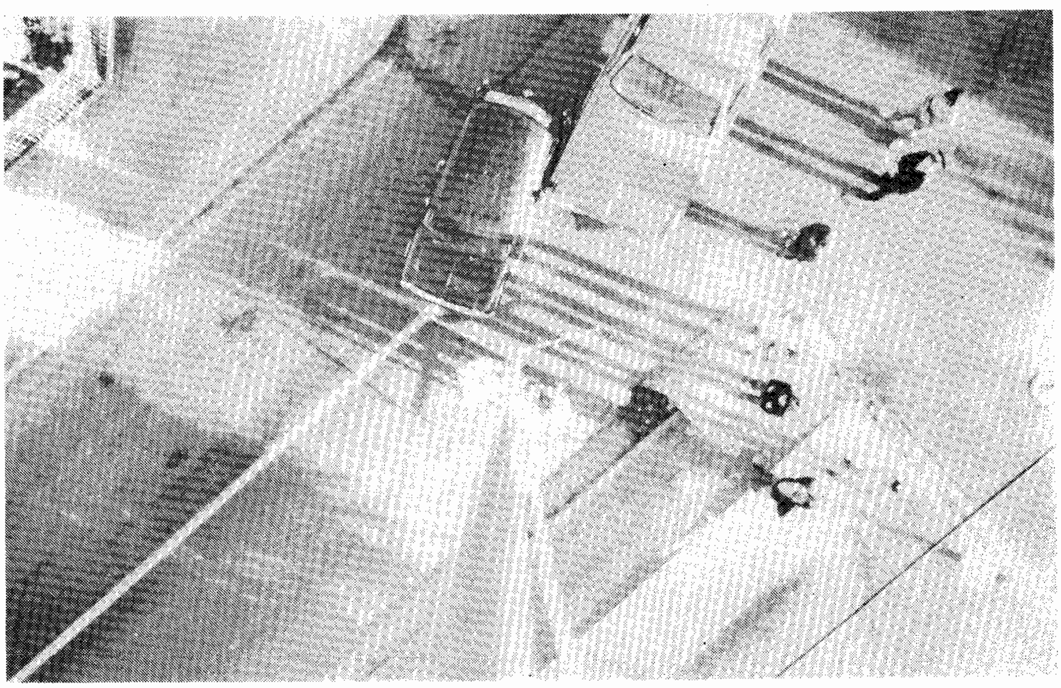


FIGURE 5.11: Final positions of cars in Accident 048. The larger car has rotated anti-clockwise through 100 degrees.

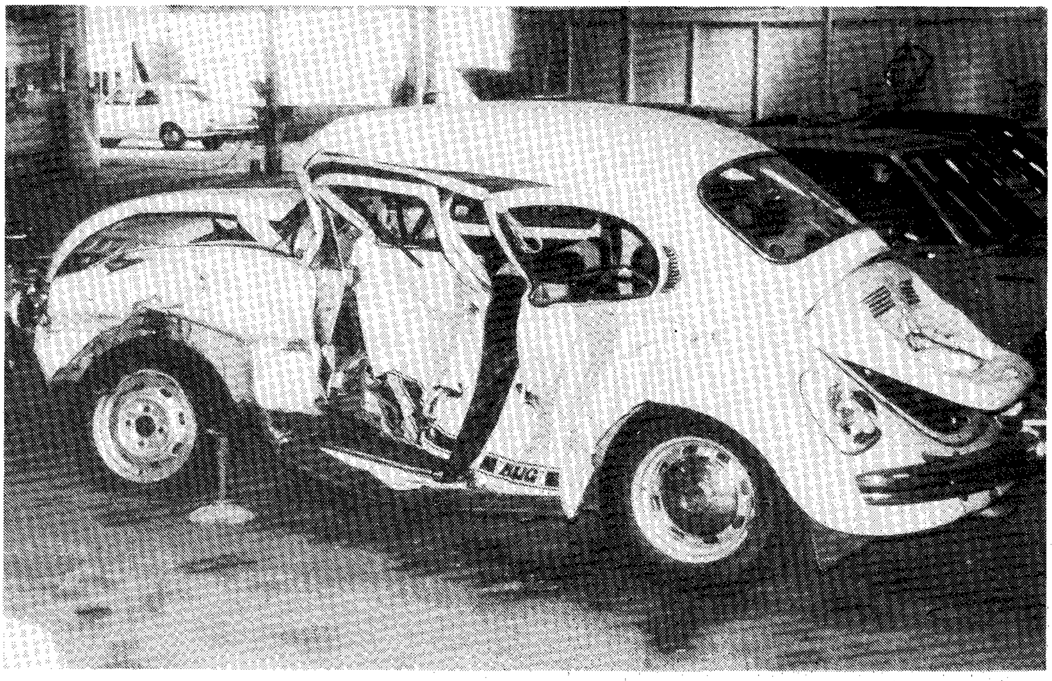


FIGURE 5.12: Damage to car involved in a two car collision at an uncontrolled intersection: Accident 286 (see Figure 5.13).

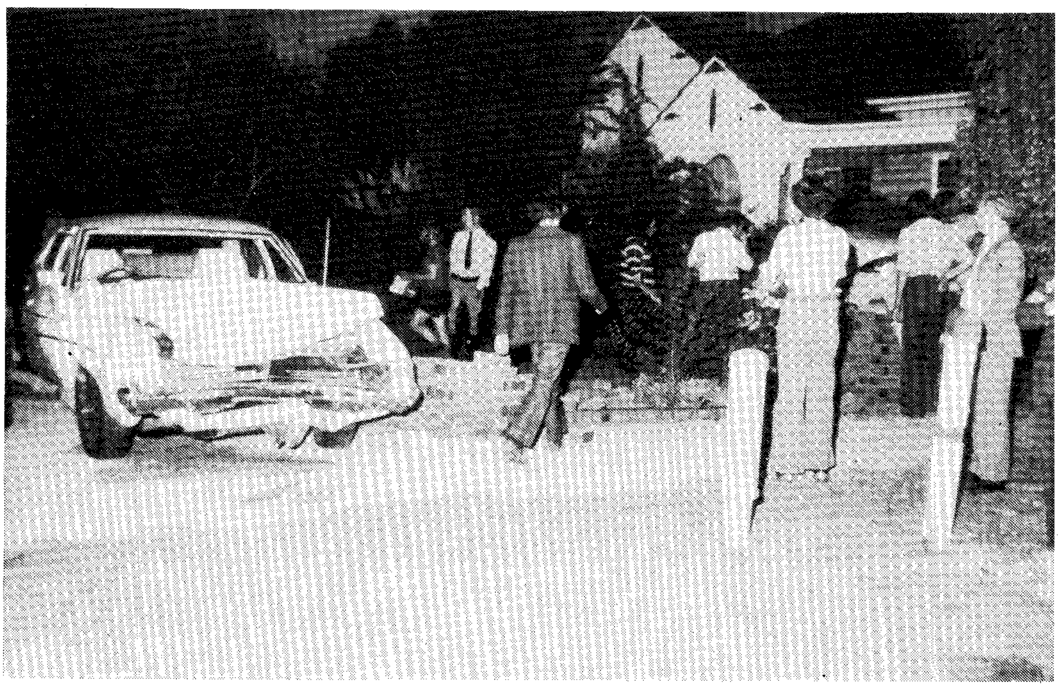


FIGURE 5.13: Striking car in Accident 286. The roof of the struck car is just visible on the right (see Figure 5.12).

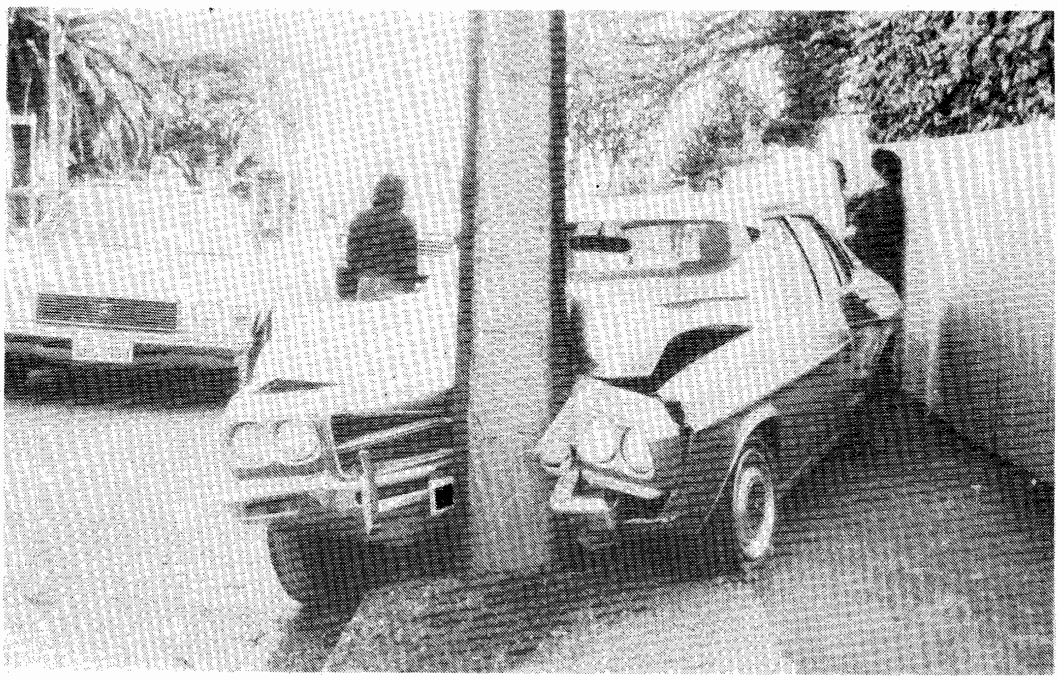


FIGURE 5.14: Subsequent collision with utility pole (Accident 090).

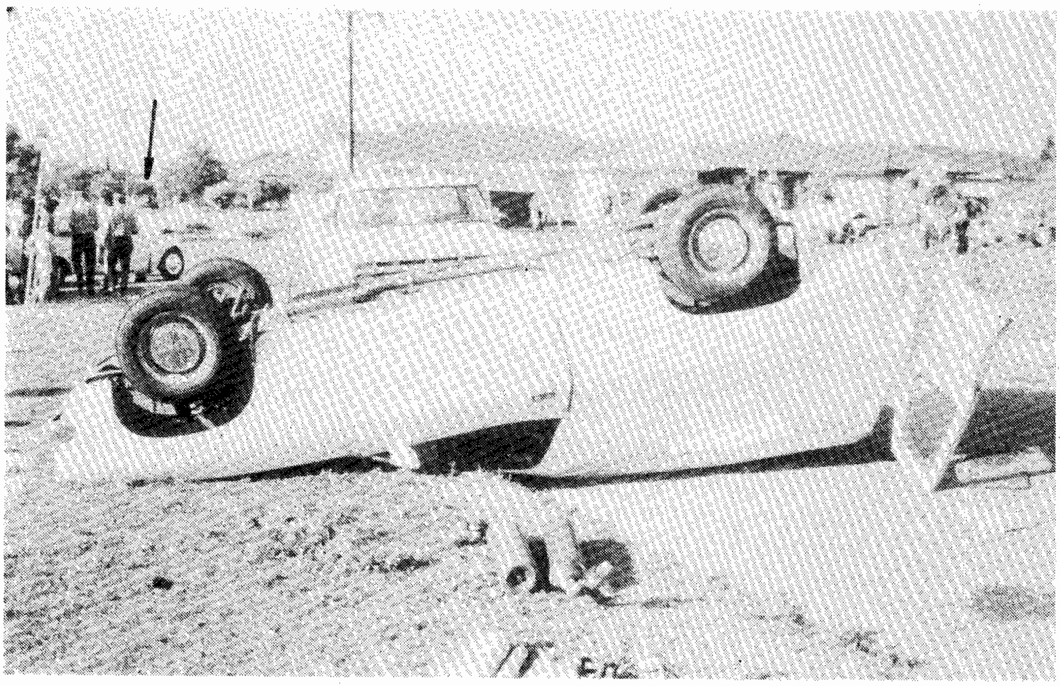


FIGURE 5.15: Rollover following collision with car (arrowed) at uncontrolled intersection : Accident 207.

FIGURE 5.16: Final position of car following a collision at an uncontrolled intersection : Accident 149.

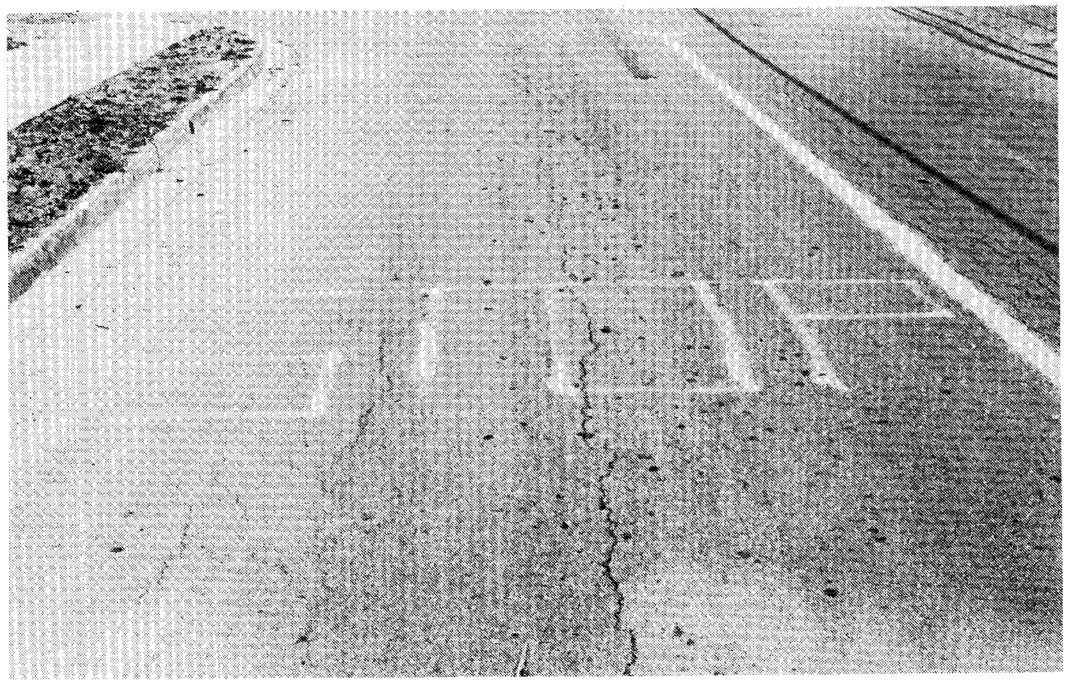


FIGURE 5.17: Local residents' attempt to prevent accidents at an uncontrolled intersection : Accident 104.

single and one-third were married.

There were no significant differences in age or sex distribution between those drivers who should have given way and the other group. Marital status also did not distinguish one group of drivers from the other.

Alcohol Usage

Blood alcohol concentrations (BACs) were obtained for all but three of these 70 drivers. One of these three was reported by witnesses to have shown signs of having been drinking and almost certainly was illegally intoxicated. The other two showed no signs of having consumed alcohol before being involved in the accident.

Ten of the 67 persons who were tested had positive BAC readings and four of them were above the legal limit of 0.08. The highest was 0.24.

In general, alcohol intoxication was likely to have been a factor in no more than one seventh of these 35 accidents and so one could characterise the uncontrolled intersection collision as being an accident involving sober drivers when compared with some other types of crashes in this study, such as single vehicle accidents, in which half of the drivers were illegally intoxicated.

Driving Experience

The distributions of the lengths of time that these two groups of drivers had been licensed were virtually identical. Eleven per cent in each group had been licensed for less than a year and one-third, again in each group, for less than five years. Inexperience in driving did not appear as a particularly significant factor in the causation of these crashes.

Familiarity with Accident Site

One-fifth of the 68 drivers from whom the information was obtained stated that they were not familiar with the area in which the accident happened. Three of them failed to detect the presence of the intersecting road and so they did not take any precaution such as slowing down or looking for other vehicles. Two drivers who claimed to be familiar with the area, but not very familiar with the road on which they were travelling, also appeared to have entered the intersection without any indication that they realized that it was there. One of these drivers was intoxicated but the other was sober and intending to turn right at that intersection. This latter accident occurred at night, at a location where there are no adequate indications of the presence of an intersecting road. The alignment of the street lighting along this approach road does not change at the intersection.

The effect of the drivers' familiarity with the accident site was reflected in their behaviour with respect to the common local recognition of some roads being "major" and others "minor". The 25 drivers who believed that they were on the "major" road failed to give way to their right in 60 per cent of their accidents, whereas those who recognized that they were on the "minor" road failed to do so in 43 per cent of the 21 such cases. This difference is not statistically significant but it is in accord with our subsequent observations of driver behaviour at these locations. (These observations were made during the radar speed surveys and on other occasions.) This does not imply that the "major" road drivers could have yielded, but rather that they were travelling faster and perhaps less alertly than were those on the "minor" roads.

The conventional criticism of the "Sunday driver" may also relate to his familiarity with his surroundings. The 24 drivers involved in these crashes on a Saturday or Sunday were almost twice as likely to have been unfamiliar with the area than were those whose accidents occurred on a weekday (29 per cent compared to 16 per cent, a difference which is most unlikely to have arisen by chance).

Awareness of Presence of Other Vehicle

Most of these drivers did not realize that the other vehicle was approaching until it was too late to attempt any avoiding action which was likely to be successful. The remaining 16 per cent of the 63 drivers for whom this information was available (several could not recall the events leading up to the accident, often because of being concussed) claimed to have seen the other car in time, they thought, to have avoided a collision. Seven of these ten drivers assumed that the car on their left would stop, or pass behind them. The other three drivers should have yielded but instead chose to either accelerate or expected the other car to swerve to its left. Although these ten drivers claimed to have been aware that the other car was there this does not necessarily mean that they were in a position to have avoided the collision, even if they had reacted in some other way.

Distractions

Twenty drivers commented that their attention was distracted from monitoring the other road immediately before the collision. The most common reported distraction was a third car entering the intersection on the left of the car which collided with one approaching from its right. Some of the drivers in the other group were similarly distracted by concentrating on their right to the exclusion of monitoring the intersecting road on the left. One driver may have been concentrating on a road junction beyond the intersection at which the collision occurred.

Preoccupation with personal matters, being late for an appointment, and looking for or watching a person or thing at the roadside were mentioned by a total of seven drivers and three reported that they were dazzled by the sun.

Whose Fault?

In the follow-up interview the drivers were asked whether they or the other driver were in any way responsible for the collision. Not all of the drivers were willing to commit themselves or had an opinion and so the following percentages are based on a total of about twenty-eight responses for each of the two groups of drivers: those on the right and those on the left.

Seventy per cent of those on the right acknowledged that they were wholly or partly to blame, compared to 22 per cent of those on the left. A quarter of the former group thought that the other car was going too fast and a third of those who were on the left thought so. Almost half of those drivers who should have yielded admitted that they had been travelling too fast whereas only ten per cent of the other group of drivers were prepared to concede this. The drivers on the left tended to assume that the other car would stop much more frequently than did the drivers on the right (29 compared to seven per cent).

Three of the drivers who should have given way claimed that they should not have been expected to do so because they were on the "major" road and one driver in each group regarded the crash as being purely an accident. One of these last two drivers said that there was nothing that he could have done to have avoided the collision "apart from slowing *right* down".

Prosecutions

Eighteen of the 35 drivers who should have yielded were charged with failing to give way to a vehicle on their right at an intersection. A further one driver from this group of 35 was prosecuted for having a blood alcohol level greater than 0.08. Fourteen of these 19 drivers were also charged with driving without due care but almost all of these charges were subsequently withdrawn.

5.3.5 OBSERVED DRIVER BEHAVIOUR

As noted previously these accident sites were revisited on several occasions to measure traffic speeds with a radar meter and to watch how drivers reacted, or failed to react, to the presence of the intersection. These visits were all made at the same time of day and on the same day of the week as that on which the accident had occurred. Care was also taken to ensure that lighting conditions were similar.

Insofar as we are able to generalize, the characteristic behaviour on "major" roads is effectively to ignore the presence of intersections with "minor" roads. This is almost certainly not a consequence of not realizing that the intersection is there, since some of the worst offenders had entered the approach road from private property only a block or two away and presumably were very familiar with the area.

Where there is no obvious "major" or "minor" road most drivers, but not all, do slow down to about 30 km/h, which is still faster than the safe speed at these locations. Shallow spoon drains appear to have more effect on vehicle speeds than does the presence of an intersection.

Traffic on "minor" roads presumably is more likely to slow down or stop if the driver is familiar with the area. If he is not, there is often nothing about the appearance of the intersection which would inform him that he is on the "minor" road.

Observed Approach Speeds

Six intersections had been modified in some significant way, as will be described below, before we started to measure approach speeds. The following data therefore relate to 29 accidents, two of which occurred at one intersection at different times and so there are twenty-eight locations.

Traffic volumes were low at almost all of these intersections and two or three sessions lasting up to an hour each were needed to obtain a total of five observations at some places. Even then we were left with fewer than five recorded speeds at the same number of sites for vehicles which were on the "give-way" approach in terms of the accident configuration which we were studying. The average number of observations was eight on these approaches, excluding one busy intersection at which 227 vehicle speeds were measured. On the other approaches this situation was virtually repeated with the average being ten observations, not counting 129 measurements at one other location.

Eighty-seven per cent of 450 drivers were exceeding the safe approach speeds to these intersections by an average of 24 km/h. When the biasing effect of the one location at which 227 speeds were recorded is removed this percentage is reduced to 73, with an average speed difference of 16 km/h.

4.3.6 CHANGES SUGGESTED AND IMPLEMENTED AT THESE INTERSECTIONS

Changes Suggested by the Drivers

The drivers involved in these accidents were asked what measures they thought could be taken to reduce the risk of further collisions at the intersection. Fewer than half of them had any opinion, but ten suggested STOP signs, eight said that there should be a complete major and minor road system, two suggested a roundabout and one driver said that one of the approaches to the intersection should be closed.

Changes Suggested by Residents Adjacent to the Intersections

Residents adjacent to these intersections were also interviewed. They were asked, among other things, whether they thought that intersection was hazardous. If they answered "yes", they were then asked what changes they would like to see made to the intersection, if any, whether they had approached any authorities with a request for such changes and if so, were they satisfied with the response which they had received.

Twenty-one residents said that they wanted STOP signs installed, four preferred a roundabout, three a street closure and three thought that traffic lights would be appropriate.

Very few residents had taken any active steps to have their suggested changes implemented. The Local Council had been approached by eight residents, with half of them being satisfied with the response. One woman said that the Council had told her husband initially that theirs was not a bad intersection because there had been only six reported crashes in nine years. She believed that STOP signs had eventually been installed because her husband telephoned the Council after each subsequent accident.

The Road Traffic Board and the Police Department were each approached once but the residents were not satisfied with the responses that they had received. A Member of Parliament was able to respond in a manner that satisfied one other resident's request.

At one location an (unidentified) resident had acted independently of the above organizations (Figure 5.17).

Subsequent Changes

Eleven of the 34 intersections were no longer uncontrolled by November, 1977. The most frequent modification was the installation of STOP signs at six locations, followed by two road closures, one roundabout and one location was, by then, on a Priority Road.

The initiative for these changes, according to Local Council spokesmen, came from residents in six cases, nearby schools in two, and from the Council itself in a further two. The MITERS (Minor Improvement Traffic Engineering and Road Safety) program paid for two of these changes, the Highways Department for one (not counting the Priority Road), and the Council for six. In one case the Council spokesman stated that it would be too much bother to find out who had paid for the modification.

5.3.7 PREVENTIVE MEASURES

Driver Education

As noted earlier in this Section, most of these crashes involved sober, law-abiding drivers who were not consciously accepting any unusual risk. Despite this, many of them placed themselves in a situation in which a collision was inevitable because they were travelling too fast to give way when the need arose.

Supposing that an education program could be developed which would be effective in persuading most drivers to approach uncontrolled intersections at a safe speed, how is the individual driver to decide what this safe speed is in each case? As can be seen in Table 5.3, it varied from 3 km/h to 29 km/h in the cases which we have investigated, and sight distance alone does not provide adequate information on which to base a decision.

Even when one is aware of the potential risk of collisions at uncontrolled intersections it is often impractical to negotiate such locations in a safe manner. When on a collector road, for example, slowing down to below the safe approach speed at all cross roads will greatly increase the risk of being struck from behind by a following car if its driver is not behaving in a similar manner.

These issues are, of course, relevant only when the driver realizes that the intersection is there. The most common cues to the driver that he is approaching the intersections reviewed in this survey are, by day: pavement profiles, kerb continuity and property boundary alignments. By night, very often the only adequate cue, if any, is a reflectorized street-name sign.

It may be that many drivers could be persuaded to recognize the dangers inherent in uncontrolled intersections and to react appropriately by approaching each one at or below the safe speed. But this would require a dramatic change in normal driving behaviour, and the prospects for this occurring do not appear to be good. This is partly because this "normal" behaviour is reinforced by the fact that it is possible to driver in this way for many years without being involved in a collision of this type.

Enforcement

The requirement to give way to the vehicle on the right was acknowledged by most, but not all, of the drivers in these accidents. In practice, however, this rule of the road is irrelevant to the prevention of crashes of this type because by the time that most of these drivers were able to see the other car approaching on a collision course it was too late to take any effective avoiding action. Therefore it is concluded that this type of accident is unlikely to be prevented by the threat of enforcement because at all of the accident sites reported on in this Section it was possible to drive dangerously at a speed that is half that of the legal limit of 60 km/h.

However if the cases reviewed here are a reliable guide, prosecuting only half of those drivers who do fail to give way presumably will diminish any deterrent effect that enforcement might have. More seriously, this practice may reinforce in those drivers who were legally at fault, but who were not prosecuted, the belief that their driving behaviour is reasonably safe and that it is the other driver who should change his ways. Even so, the number of drivers who may react in this way in these circumstances is such a small proportion of the total number on the roads that their attitudes cannot have a marked effect on the frequency of occurrence of crashes of this type in subsequent years.

Traffic Signs and Control Devices

As noted earlier in this Section most of the 34 intersections were in residential areas. At such locations signs, roundabouts and road closures are the most commonly used traffic control measures.

The street closure obviously has great potential for reducing the frequency of intersection accidents, despite the associated difficulties arising from a redistribution and restriction of traffic flow patterns in the neighbourhood. Roundabouts do not have such an effect on traffic flow patterns but they may not be suitable for all uncontrolled intersections and are relatively expensive to instal when compared to STOP signs.

Warning signs, in the urban area, are of little value unless the driver slows down to below the safe approach speed. A GIVE WAY sign has the same potential deficiency as an effective control measure. The STOP sign appears likely to both indicate the presence of the intersection and to slow traffic down to a safe speed but it is often claimed that a proliferation of STOP signs would lead to their being disregarded by drivers. This view is discussed below in more detail but it can be noted here that it is at variance with observed driver behaviour in many urban areas in the United States where virtually all minor intersections are controlled by STOP signs.

The installation of STOP signs in South Australia is dependent on compliance with the conditions specified in what is referred to as the COSTCE (Conference of State Traffic Control Engineers) warrants (See the Appendix). These warrants make allowance for the number of vehicles using the intersection but they also have an absolute requirement that there be a history of reported accidents before STOP signs can be installed.

A rationale underlying the COSTCE warrants appears to be a concern that STOP signs will be ignored if they are installed where they do not appear to be needed. Whether or not these warrants accurately reflect the driver's awareness of the need for caution is not clear, but they certainly permit the installation of STOP signs at only the very hazardous intersections. The accident experience and other conditions at 26 of the 34 intersections considered in this Section would not justify the installation of STOP signs according to our understanding of these warrants.

Psychological studies of human behaviour have demonstrated that any signal, such as encountering a STOP sign, is most likely to be detected and responded to correctly if it appears 50 per cent of the time (Colquhoun, 1961). If it appears less frequently, the operator is more likely to make mistakes. The major/minor road system does, of course, require a driver who is unfamiliar with an area to respond to a regulatory sign at, on average, 50 per cent of all intersections.

In addition to the response of the driver on the minor road, it is important that the driver on the major road be able to rely on a consistent treatment of consecutive intersections. In one accident (009) a driver assumed incorrectly that the "minor" road on his right had a STOP sign on it because he thought that this was the case at preceding intersections.

Finally, the basic requirement in the COSTCE warrants is that an uncontrolled intersection must have an accident history before any action can be taken to instal a STOP or GIVE WAY sign. This philosophy is in marked contrast with that now virtually universal in measures aimed at protecting the health of the community, in which a potential hazard, once recognized, is countered before it can cause harm.

5.4 OTHER COLLISIONS AT UNCONTROLLED FOUR-WAY INTERSECTIONS

5.4.1 ONE VEHICLE TURNING RIGHT (Categories (3) and (4) in Table 5.2)

Three accidents in the study involved a car turning right at an uncontrolled four-way intersection. In two cases the car was turning from a main traffic route into a side street and in the third accident it was entering a busier road.

Accident 006 happened when an elderly female driver turned right from the centre lane of an undivided four-lane road (two lanes in each direction) to enter a side street. She had not noticed a car approaching from the opposite direction and her car was struck on the left side and rolled over. The other driver said that he saw the car as it turned but by then it was too late to stop. This accident occurred near mid-day in clear weather and light traffic conditions. There was no indication that either driver had been speeding and their blood alcohol levels were zero.

Accident 101 also occurred in daylight but in morning peak hour traffic. A driver who had been waiting for some time to turn right into a side street moved off when oncoming traffic, that was banking up from nearby traffic signals, left a gap for him to turn through. He turned across the two lanes of stationary vehicles and was watching a car that was about to come out from the side street when his car was hit on the left side by a motorcycle (Figure 5.18). The rider of the motorcycle said that he had been passing the stationary traffic by travelling close to the kerb, with the intention of turning left at the traffic signals. A bus was stationary in the kerb lane just before the side street and it prevented the rider and driver of the car from seeing each other until immediately before the collision.

The third accident in this group of three occurred at night. A car driven by a middle-aged male moved off into the intersection to turn right when the driver saw a car that was approaching from his right indicate a left turn. A motorcycle that was overtaking the left-turning car then crashed into the front of the other car (Accident 102, Figure 5.19). The motorcyclist had seen the car stationary at the intersection but he assumed that it would wait for him to pass through. The car driver said that he did not see the motorcycle at all before the impact. He had very poor vision (3:24 in both eyes) that was not corrected and a blood alcohol concentration of 0.13. The motorcycle was partially obscured from the view of the car driver by the left-turning car and the mercury vapour street lighting did not provide good quality illumination of the approaches to the intersection.

5.4.2 VEHICLES PROCEEDING STRAIGHT AHEAD ON INTERSECTING ROADS

Roads Not Aligned at Right Angles
(Category (2) in Table 5.2)

Two accidents in the study occurred at the same four-way intersection at which the roads intersected at an angle of 108 degrees (Accidents 216 and 269, Figure 5.20). In each of these daytime two-car collisions obstruction to vision across the included corner was a queue of stationary cars that had formed at a boom barrier at a railway level crossing. Both drivers who failed to give way said that they had not seen the other car approaching and that it must have been travelling very fast. One of these two drivers had never crossed the intersection before and the other, although he passed through the intersection daily said that he had been concentrating on listening to the two-way radio in his taxi. The driver on the intersecting road in Accident 216 acknowledged that he had been travelling faster than was safe for the limited sight distance but the corresponding driver in Accident 269 denied that he had contributed in any way to the causation of the accident. He had a blood alcohol level of 0.07 that may have affected his monitoring of the traffic at the intersection but not his ability to have avoided the accident once he saw the other car because that happened at the last moment before the collision. There were 36 similar collisions at this intersection in the previous three calendar years. This accident is discussed further in Section 5.4.3

Roads Aligned at Right Angles
(Category (1) in Table 5.2)

This was the most common type of collision at uncontrolled intersections or junctions, accounting for two-thirds (40) of the 60 accidents. As shown in Table 5.2, there were 35 collisions between two "cars" (including two collisions between a car and a Volkswagen Kombi van), four collisions between a car and a motorcycle and one between a car and a truck. The 35 collisions between two cars are discussed as a group in Section 5.3. The five remaining accidents, all of which occurred in daylight, are reviewed here.

As shown in Table 5.1, only three of the eleven motorcycles involved in collisions at uncontrolled intersections should have given way to the other vehicle. These three were all involved in the type of collision being discussed here (Category (1) of Table 5.2). Two of the riders were 16 years old, one was 17 and none of them had been licensed for more than four months. Despite having been licensed for only three months the 17 year-old rider had been prosecuted twice for speeding offences before being involved in this accident (128). He saw a car

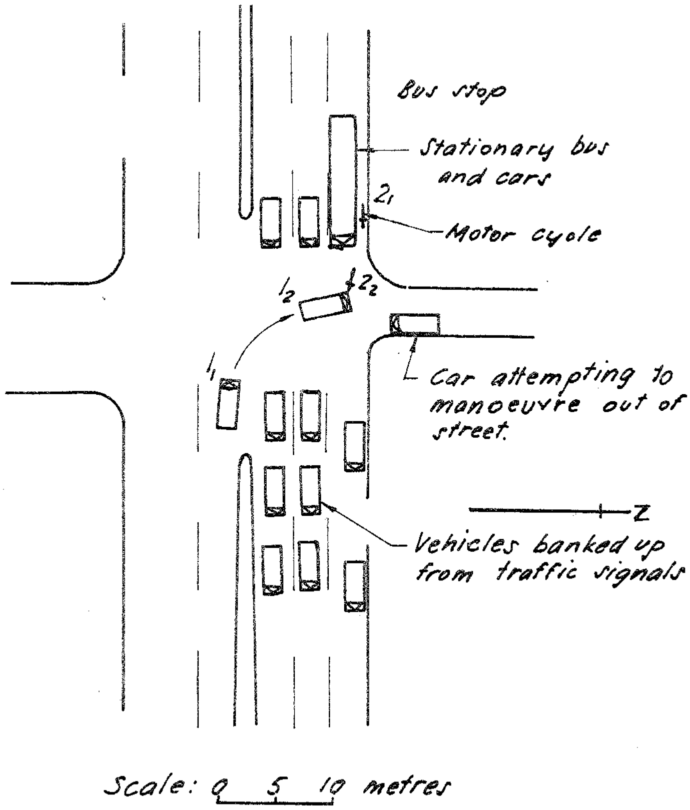


FIGURE 5.18: Accident 101.

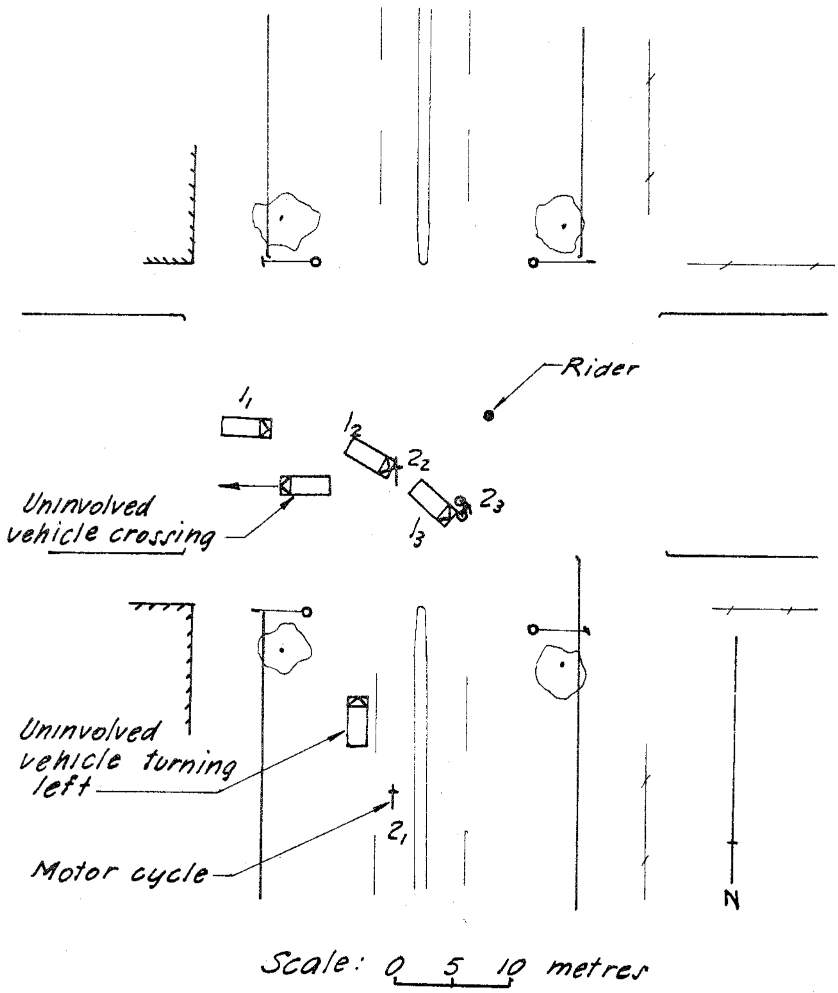


FIGURE 5.19: Accident 102.

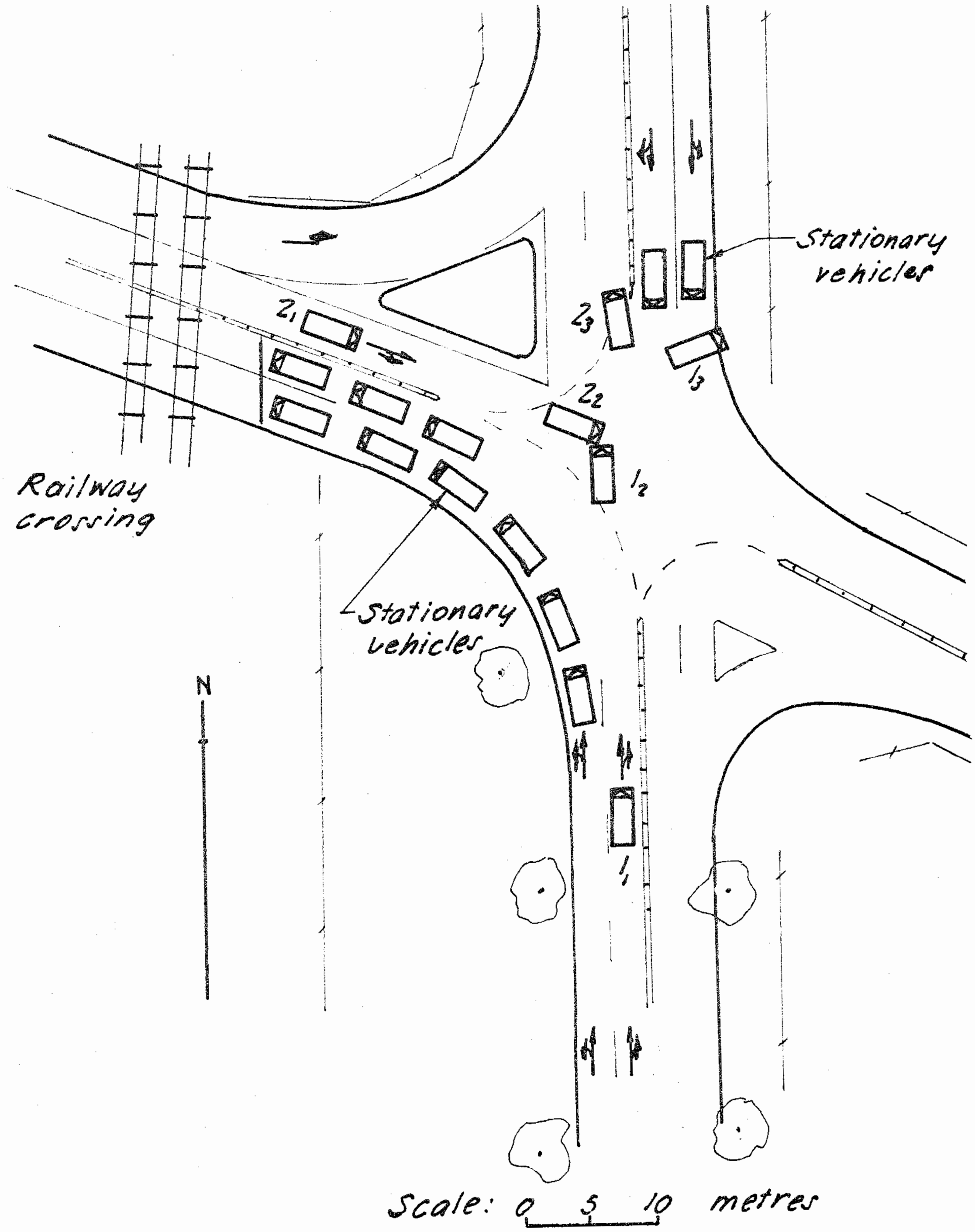


FIGURE 5.20: Accident 216.

approaching the intersection on his right but assumed, incorrectly, that it was giving way to him when it slowed down. The car driver, a middle-aged female, said that she slowed down to cross a spoon drain and because she wanted to be sure that nothing was approaching from her right. She looked first to her left but did not see the motorcycle, possibly because she had poor (and uncorrected) vision in her left eye (3:18).

Accident 002 was similar to Accident 128 in that one of the participants saw the other well before the actual collision. In this instance the car driver saw the motorcycle stationary at the intersection on his left and assumed that it would wait for him to pass by. The motorcyclist said that he had given way to a car on his right and then realized that cars on his left had stopped for him. He moved off while still looking to his left and was struck on the right side by the car that he had not seen approaching.

The third accident of this type in which the motorcycle should have given way was more characteristic of the majority of these accidents (see Section 5.3) in that by the time that the participants saw each other it was too late to avoid a collision (Accident 282). The 16-year-old rider, who had been licensed for two months, said that he slowed to less than 40 km/h as he entered the intersection. He was hit by a car that approached from the right at a speed that the driver said was "about 40 mph" (the braking skid marks indicated 80 km/h or 50 mph) and which he insisted was "quite safe because very little traffic crosses this street".

The fourth accident (261) involving a motorcycle in this category differed from the three described above in that the car should have given way to the motorcycle. The 30-year-old male rider, who had been licensed to ride a motorcycle for one year (and a car for five) saw the car on his left slow down as it neared the intersection. He assumed that the driver had seen him and so he accelerated, only to realize too late that the car was continuing on into the intersection. The driver said that she had slowed down because there was a spoon drain across the entrance to the intersection (as did the driver in Accident 128). She claimed to have looked to her right, left and then right again before she saw the motorcycle which was approaching "at high speed".

These four motorcycle/car collisions occurred in daylight. In one of the two accidents in which the driver failed to see the approaching motorcycle the motorcycle headlight was on (Accident 128) but there was insufficient evidence available on this item in Accident 261.

The collision between a car and a truck (Accident 161) occurred at the same intersection (and the same approach roads) as Accident 128 and was also similar to Accident 261 in that the car slowed down to cross a spoon drain. The car driver was concentrating on the intersecting road on his right and did not see the truck at all before the collision. The truck driver said that he had been travelling at "about 50 km/h" and saw the car at the last moment. His passenger also saw the car but thought that it was stopping and was surprised when it struck the truck on the right side. This accident occurred in daylight, as did the four car/motorcycle collisions.

5.4.3 RELEVANCE OF ROAD AND TRAFFIC FACTORS

The two accidents (216 and 269) at the one skew intersection (Category (2) in Table 5.2) illustrate that although the sight distance across the relevant corner of this intersection is entirely adequate in the absence of other vehicles this is not the case when a queue of cars forms around the corner. This happens often, because of the adjacent railway level crossing, and so it should be taken as the operating condition of the intersection.

Shrubs and trees behind property boundaries were the most common obstructions to vision in the five accidents from Category (1) of Table 5.2. Four, or possibly five (including Accident 002) of these accidents may have been avoided had STOP signs been installed. GIVE WAY signs may not have been as effective, since in three accidents one vehicle slowed down to negotiate a spoon drain (as might be expected for a GIVE WAY sign) but the driver still did not check adequately for traffic on both arms of the intersecting road, possibly because of the spoon drain.

In one accident (282) one of the vehicles was exceeding the speed limit of 60 km/h. While this increased the potential hazards associated with the collision it was unlikely to have had much bearing, if any, on the causation of the accident since the safe approach speed (as defined in Section 5.3) would have been well below the legal limit.

Accident 101, in which a car turned through a gap in traffic banked up from traffic signals, could have been prevented had the turning manoeuvre itself been prevented by a continuous raised median strip (see Figure 5.4). This may be a reasonable measure to adopt at a location where traffic can be expected to bank up across an intersection or junction.

The relatively poor quality of the street lighting may have contributed to the causation of Accident 102 to a minor degree although, as discussed in Section 5.2.2, the effect on the visual performance of an intoxicated driver may be of greater significance.

6. ACCIDENTS AT SIGN-CONTROLLED INTERSECTIONS

6.1 GENERAL CHARACTERISTICS OF ACCIDENTS AT SIGN-CONTROLLED INTERSECTIONS

Forty-seven of the 304 accidents studied occurred at intersections controlled by STOP or GIVE WAY signs or, for two accidents, roundabouts. At a STOP sign a vehicle is required to stop and to yield to all vehicles travelling on the intersecting road. A GIVE WAY sign also requires the vehicle to yield but not to stop. In 16 of the 47 accidents the presence of the sign was not obviously relevant to the causation of the accident.

The 47 accidents were distributed throughout the day (Figure 2.4) but occurred most frequently between 11 a.m. and 8 p.m. A similar time of day distribution was followed by those accidents which occurred on a Saturday or a Sunday.

In seven accidents a driver or rider had a BAC greater than 0.05. An additional two drivers who were reported by witnesses to have shown obvious signs of intoxication managed to evade having their BAC measured. In four of the accidents in which these nine drivers were involved their level of intoxication was considered to have been a probable factor in the causation of the accident. The role of alcohol as a possible causal factor cannot be firmly established in the remaining five cases. Overall, alcohol intoxication was not a major factor in the causation of the accidents at sign-controlled intersections.

6.1.1 TYPES OF ACCIDENTS

The types of collisions and the types of vehicles involved in them at these locations are listed in Table 6.1. The characteristics of the accidents in which the sign was relevant are reviewed first (the type of collision is referenced back to Table 6.1 at the end of each heading).

6.2 SIGN CONTROL RELEVANT: T-JUNCTIONS

6.2.1 TURN RIGHT FROM SIGN, OTHER VEHICLE ON RIGHT

Table 6.1(a)

Ten of the 12 accidents in this category involved locations where a GIVE WAY sign controlled vehicles entering a multi-lane road. The other two accidents were at STOP signs; one at a junction with a four lane road and one at a junction of two streets in a residential area.

Obstruction to Vision

When a turning vehicle has to cross two or more lanes of traffic before being able to complete its turn, the opportunity exists for a vehicle in the left lane to conceal the presence of a faster vehicle in the right lane. This happened in eight of these 12 accidents on multi-lane roads. In Accident 011 the car in the left lane was about to turn left, and a similar situation may have existed in Accident 172 (Figure 6.1) in which the driver at the GIVE WAY sign thought that the car in the left lane was slowing either to stop and reverse into a parking place or to turn left. This driver had been waiting for a gap in the traffic and the truck driver behind her had started blowing his horn, presumably to show his impatience.

Even when the vehicle in the left lane continues on through the junction it is possible for it to conceal a car following it but in the right lane (Accident 292, Figure 6.2). In this accident the rider of the motorcycle saw that the right lane opposite was vacant, checked for traffic from his right, and moved off as soon as the car approaching from his right had passed. As he moved off he was concentrating on traffic approaching on his left and failed to see the other car coming on his right.

A parked vehicle can play a similar role as an obstruction to vision, even when located some distance back from the intersection as in Accident 063 (Figure 6.3). There were several other factors which appeared likely to have contributed to the causation of this accident. The driver who was attempting to turn right was relatively inexperienced, having been licensed for only three months. This may explain why, having looked to her right and not seen any traffic approaching, she then moved off concentrating almost totally on the heavy flow of traffic on her left. The driver of the other car said that he had been watching for the possibility of cars entering from the road on his right, and when he looked back it was too late to avoid a collision with the car which moved across slowly from his left. It is likely that he was also travelling a little in excess of the 60 km/h

TABLE 6.1: TYPES OF COLLISIONS AT SIGN CONTROLLED INTERSECTIONS BY TYPES OF VEHICLES INVOLVED

Type of Collision	Car Car[1]	Car P/c	P/c[3] Car	Car M/c	M/c[4] Car	Car Truck	Truck Car	Bus Car	Total
Sign relevant:									
(a)	8	-	-	1	1	-	2	-	12
(b)	-	1	-	-	-	1	-	-	2
(c)	1	-	-	-	-	-	-	-	1
(d)	4	-	-	-	1	-	-	-	5
(e)	3	-	-	-	1	-	-	1	5
(f)	-	-	-	-	1	-	-	-	1
(g) Other[2]	1	1	-	-	1	-	-	-	3
(h) Roundabout	1	-	1	-	-	-	-	-	2
Total (relevant)	18	2	1	1	5	1	2	1	31
Sign not relevant:									
(p)	1	-	1	-	3	-	1	-	6
(q)	2	-	-	-	-	-	-	-	2
(r)	1	-	-	2	-	1	-	-	4
(s) Other[2]	2	-	-	-	2	-	-	-	4
Total (not relevant)	6	-	1	2	5	1	1	-	16
Overall Total	24	2	2	3	10	2	3	1	47

Note: [1] The vehicle that should have yielded is described in the second row.
[2] See text.
[3] Pedal cycle
[4] Motorcycle

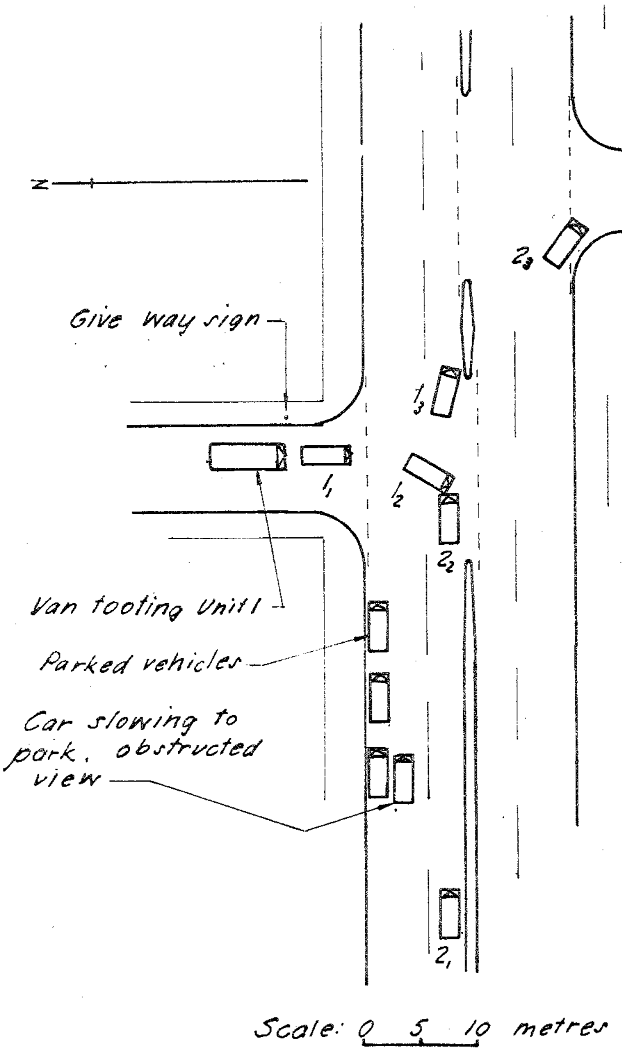


FIGURE 6.1: Accident 172.

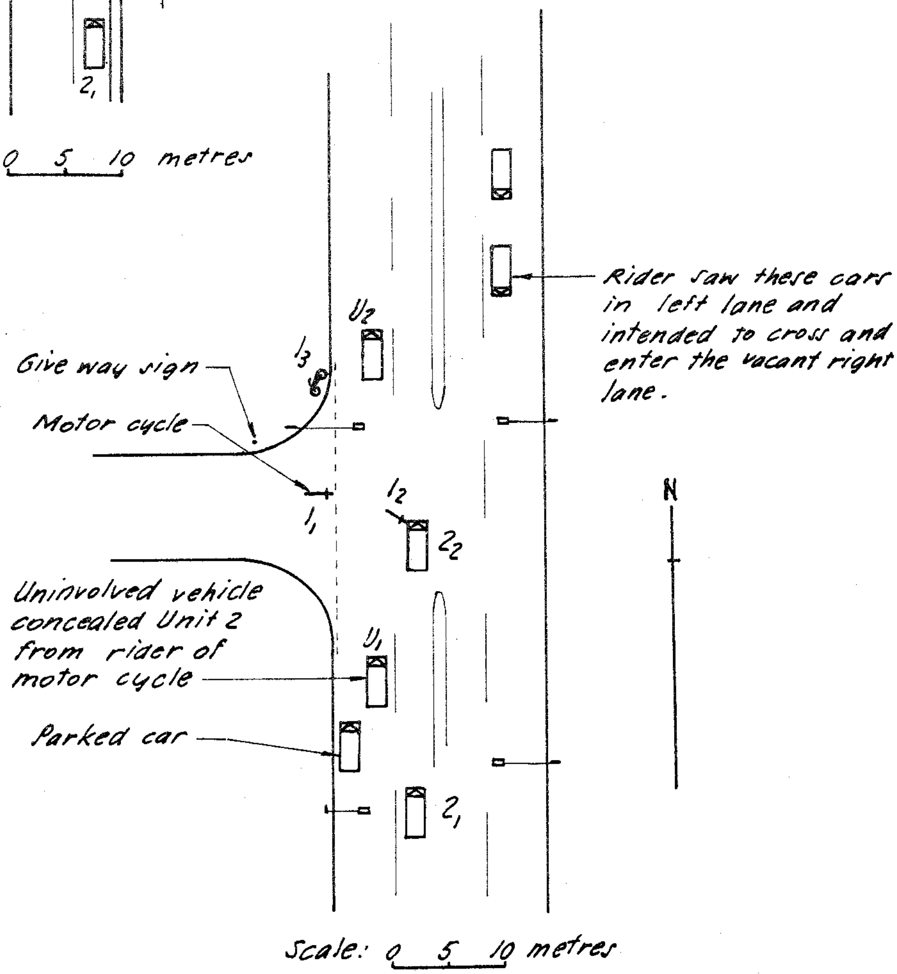


FIGURE 6.2:
Accident 292.

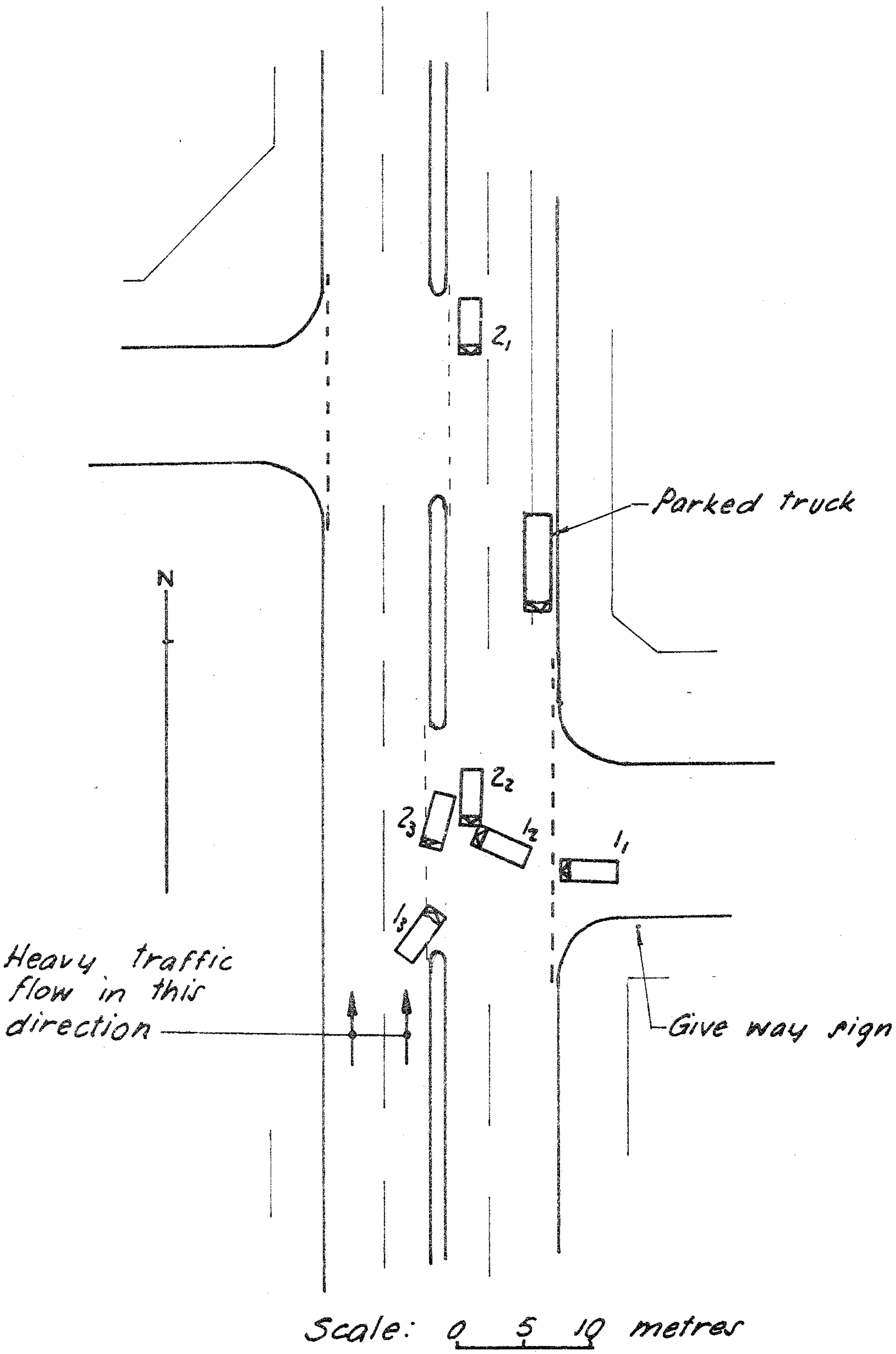


FIGURE 6.3: Accident 063.

speed limit.

The three remaining accidents in which there was an obstruction to vision all involved traffic which had banked up from a traffic signal installation. In Accident 182 (Figure 6.4) the cars stationary in the left lane had left a gap to keep the intersection clear. A car in the right lane did not slow down for this intersection and collided with the car which was attempting to turn right. The driver of the through vehicle told a member of the research team that the other driver "couldn't have been more wrong if he had tried".

The other two of these three accidents were similar to this one, but with some variations. In Accident 082 the driver stationary at the head of the queue fronting the side road waved the turning driver across, and in Accident 054 the turning driver had a blood alcohol level of 0.13. This driver was on his way home from work, having had his customary "few drinks". He noted that he often had trouble getting out of that side street, and occasionally took another route to avoid it.

No Obstruction to Vision

There were two accidents in which the turning driver looked to the right, and decided that there was ample time to turn before any vehicles reached the intersection. These drivers then looked to their left, waited briefly for a gap in the traffic, and moved off without checking again to their right. The through vehicles were both in the right lane and their drivers were both aware of the presence of a car waiting at the intersection.

In Accident 148 (Figure 6.5) it simply did not occur to the driver approaching on the priority road that the other car might pull out in front of her. This may reflect a lack of experience, this driver having held a licence for only three months. In Accident 164 the driver of the through car sounded the horn, but did not slow down, when he saw the turning car start to move. By the time that he realized that the other car was not going to stop it was too late to avoid the collision. This driver said that he should have slowed down as well as trying to warn the other car of his presence. The turning driver had not seen him at all until she heard the sound of his horn.

The turning driver in Accident 142 saw a motorcyclist approaching on his right, but decided that he could follow another turning car and still clear the intersection in time, or at least in time for the motorcycle to be able to pass easily behind him. But the first car to turn had to stop in the median to wait for a gap in the traffic approaching from the left, and this meant that the following car had to stop while still across the right-hand through lane (Figure 6.6). The young (16 years old) motorcyclist had been riding for four months and had never attempted to use the front brake, believing that it would cause the motorcycle to become unstable. Had he done so he probably could have stopped in time, or slowed enough to swerve to his left and pass behind the car.

One of the eleven accidents in this group of 12 (see Table 6.1) that occurred on a multi-lane road differed in that the through vehicle was in the left, or kerb, lane (Accident 240). The driver of the turning car saw it approaching, but claimed that its left turn indicator was operating. Acting on the assumption that this meant that the through vehicle, a light truck, was in fact about to turn left, this driver moved off to start a right turn. The driver of the truck saw the car waiting at the GIVE WAY sign and then checked his rear vision mirror anticipating the possibility of having to slow down. When he looked back at the road in front of him he saw that the car was moving across his path and he was unable to avoid it.

The fifth and final collision (Accident 222) in which there was no obstruction to vision involved a driver who had very poor eyesight (a static visual acuity of 3.36 for each eye). Having stopped at a STOP sign, this driver then moved off slowly into the path of a car approaching from the right. There were witnesses in vehicles behind both cars, and their accounts are consistent with the turning driver not seeing the other car. The driver in question sustained a head injury and was unable to remember the events leading up to the crash.

6.2.2 TURN RIGHT FROM SIGN, OTHER VEHICLE ON LEFT
Table 6.1(b)

One of the two accidents in this category happened because an adult pedal cyclist rode out past a GIVE WAY sign and onto a priority road without first looking to his left (Accident 250).

The other accident was considerably more complex, with both parties making significant errors (Accident 025, Figure 6.7). A heavily laden van turned right from a GIVE WAY sign onto a six lane divided road. The driver of the van saw a truck approaching on his left and in the centre lane. He decided that he could cross ahead of this truck, and so he did so, moving across into the left lane because he intended to turn left into a private entrance a little further down the road. However a car was travelling in this left lane and rapidly overtaking the truck. When the car driver saw the van pull into the left lane he was unable to slow down in time to avoid a rear end collision. He told us that he had been travelling at about 130 km/h (the speed limit on the road is 80 km/h). The driver of the van, who did not see the car before the impact, said later that he should have waited at the median crossover and allowed the truck to pass before continuing on across the road.

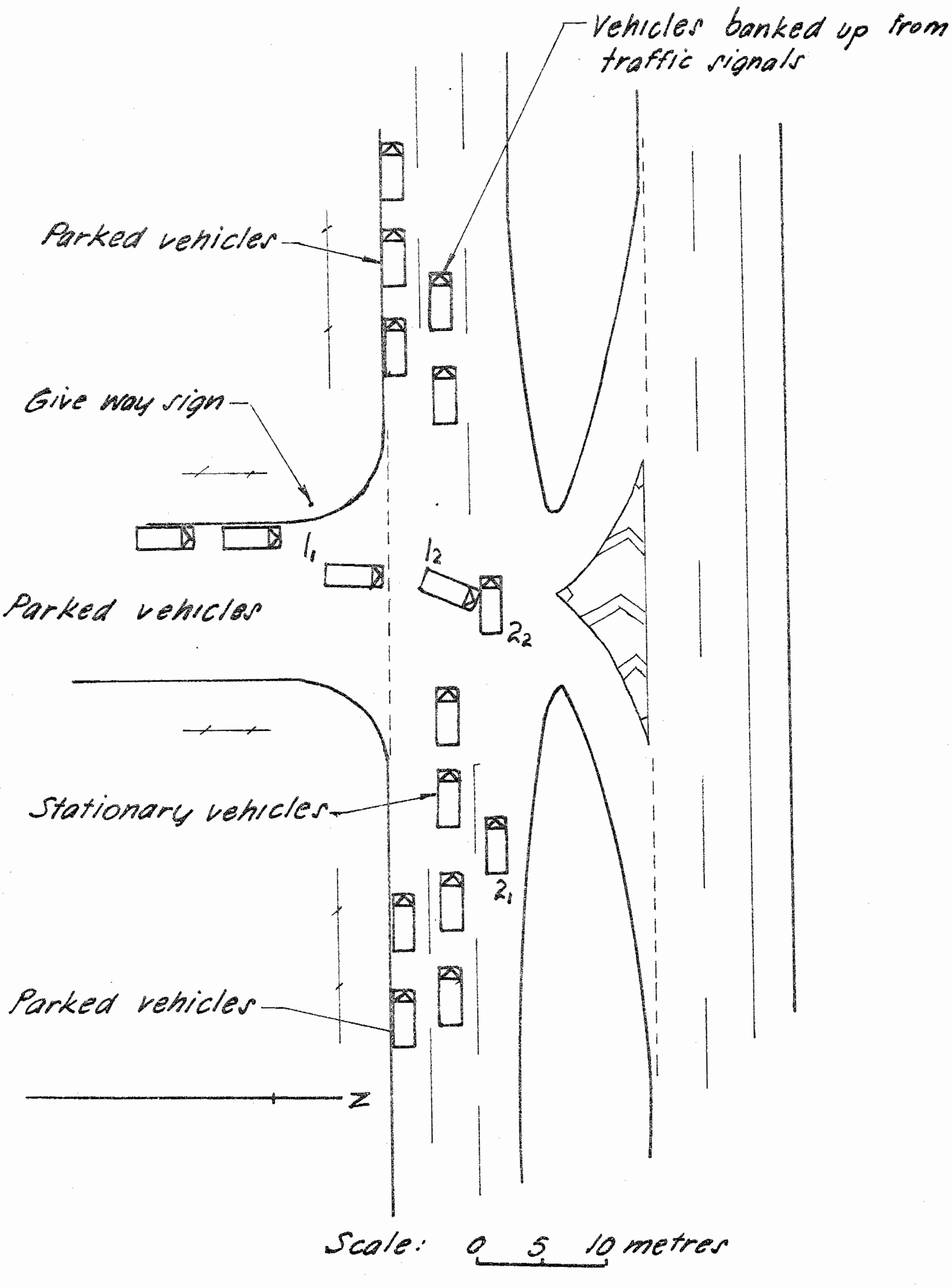
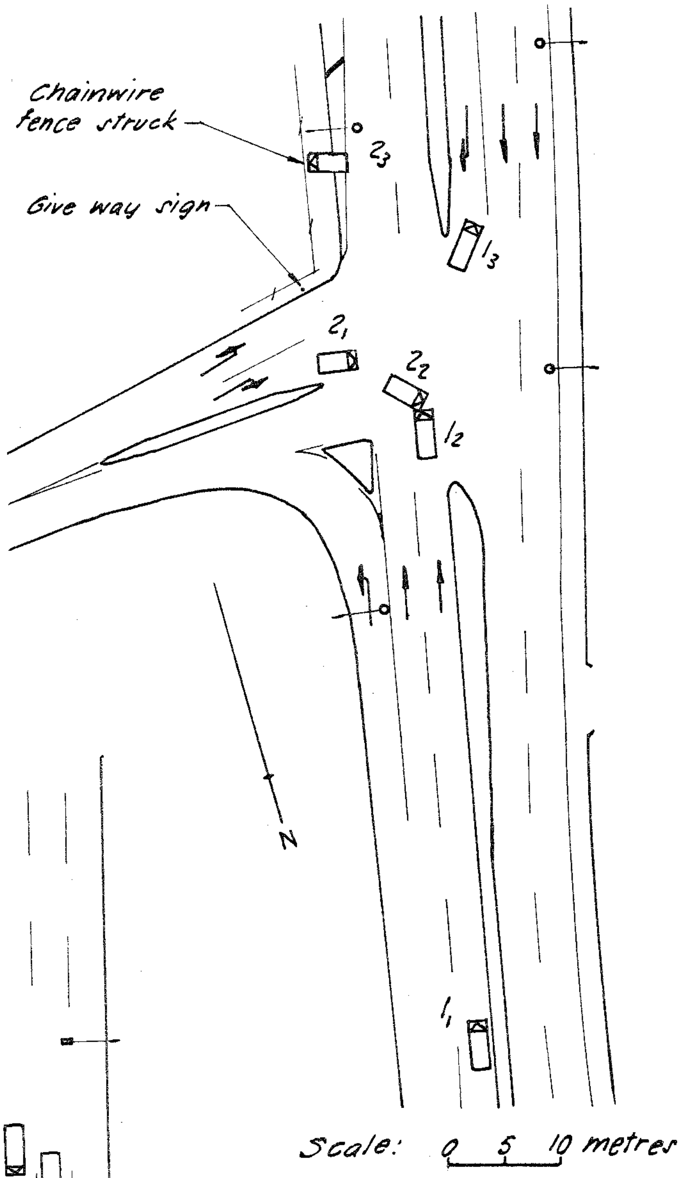


FIGURE 6.4: Accident 182.

FIGURE 6.5: Accident 148.



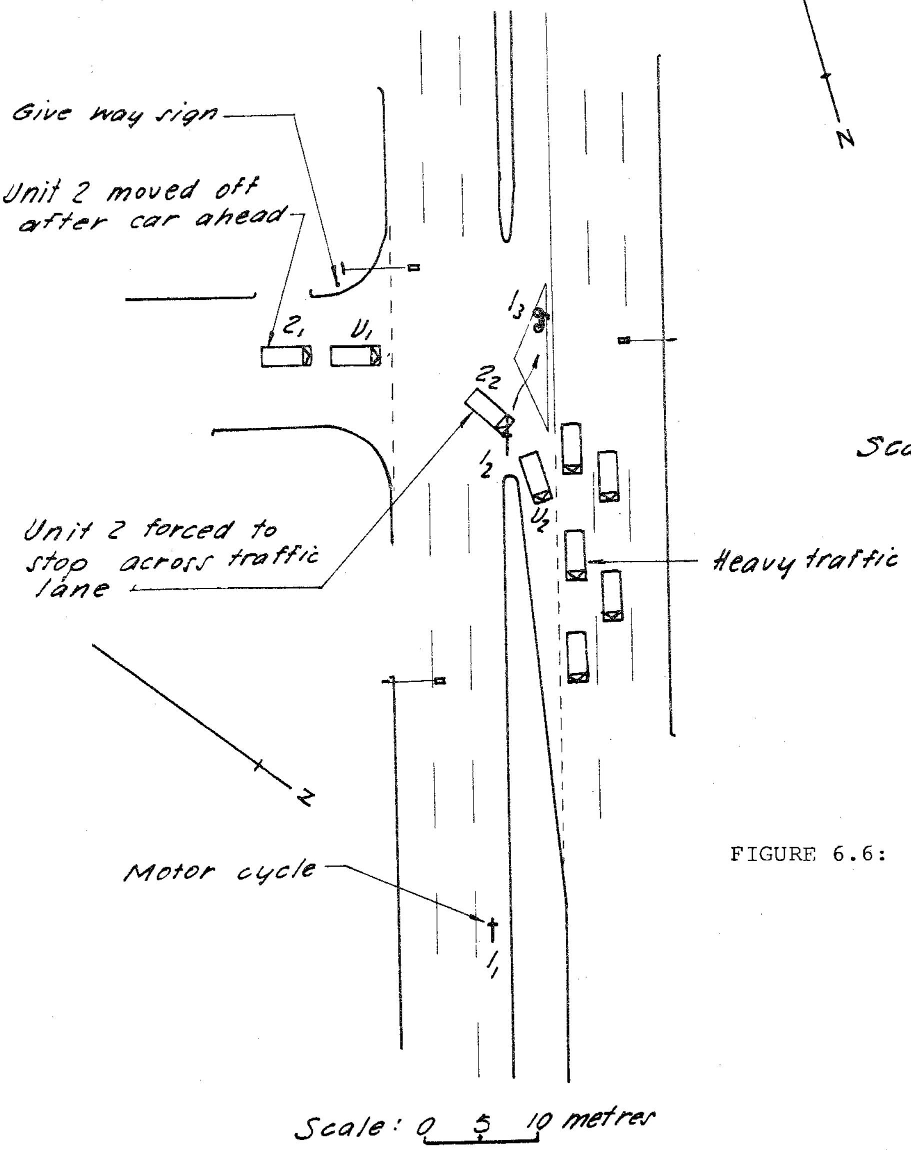


FIGURE 6.6: Accident 142.

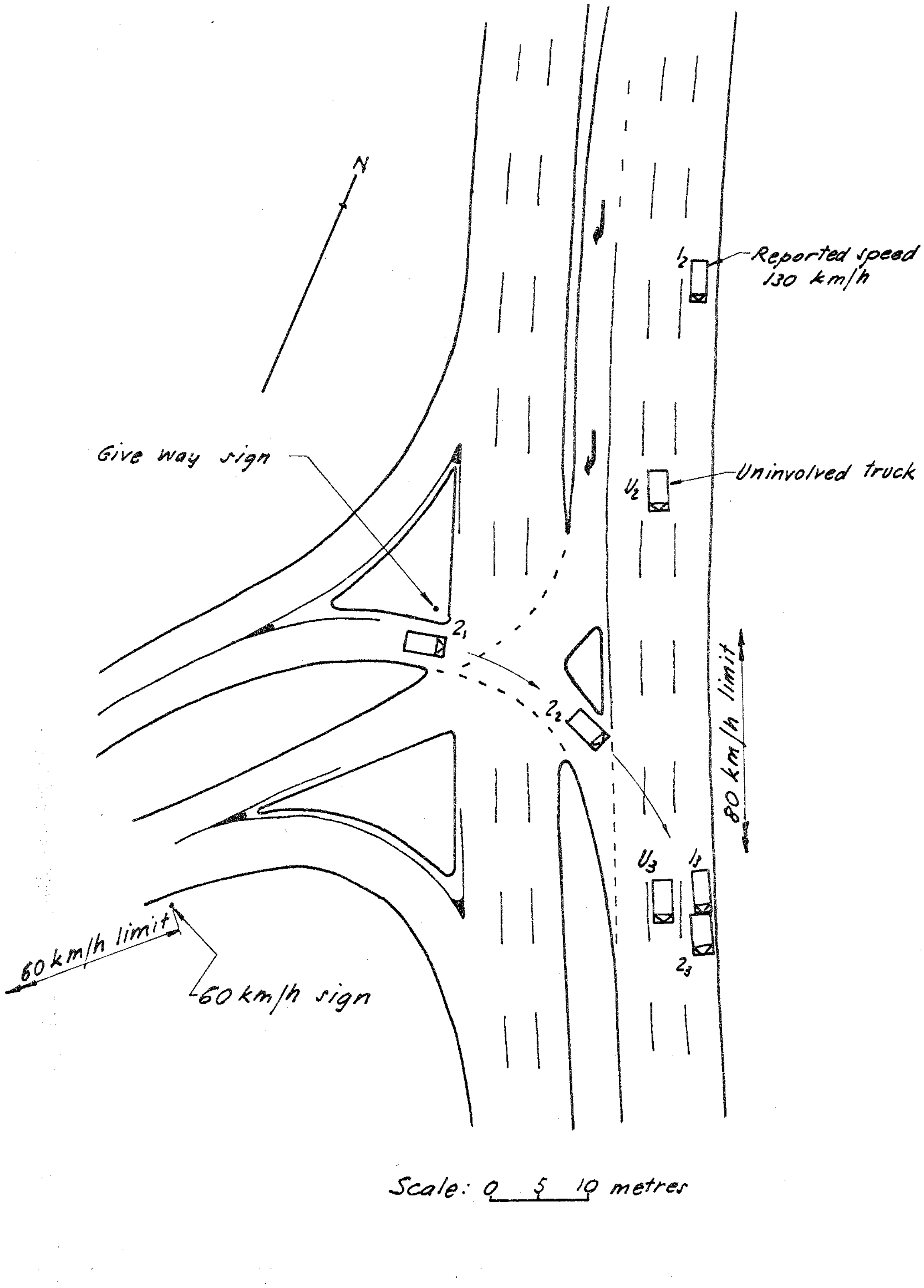


FIGURE 6.7: Accident 025.

6.2.3 GIVE WAY SIGN ON A THROUGH ROAD Table 6.1(c)

The single case in this category (Accident 211) was the only one of the 15 collisions at sign-controlled T-junctions in which a driver required to yield at the hold line failed to do so before proceeding on across the intersection (the other relevant cases are those in Figures 1a and 1c). As can be seen in Figure 6.8, priority was assigned to traffic which turned right into the obliquely-angled stem of the junction. The driver who was proceeding straight ahead claimed to be reasonably familiar with the location and was aware of the presence of the GIVE WAY signs. He attributed the accident to the "carelessness" of the other driver, but he himself appeared to be slightly intoxicated (his blood alcohol level is not known because he refused to blow into our breath-alcohol meter) and had been talking with a passenger as he approached the intersection.

There were 43 similar crashes at this intersection in the preceding three calendar years, out of a total of 155 accidents. The GIVE WAY sign was later replaced by a STOP sign, and the corresponding figures for the year before, and the year after the change were nine and 12 accidents respectively. The intersection is contiguous with a railway level crossing and with other complex road sections which made control by means of regulatory signs particularly difficult.

6.2.4 SIGN CONTROL RELEVANT: T-JUNCTIONS: RELEVANCE OF ROAD AND TRAFFIC FACTORS

Obstruction to Vision by Stationary or Parked Vehicles

Drivers attempting to turn right into a multi-lane road are faced with a very difficult task when, on their right, there are vehicles stationary in the left lane of that road. The available sight distance may not be sufficient to enable the turning driver to avoid a collision with a vehicle which is passing the stationary cars on their right. The three locations noted here at which this occurred could all reasonably be predicted as being prone to having a queue of stationary vehicles form across the intersection. This applies also to four cases in category (p) of Table 6.1. Consequently there may be a good case for closing the stem of the T-junction at such locations, assuming that adequate alternative access is available, or for the installation of a continuous raised median strip to prevent the turning manoeuvre.

At such locations the provision of a pavement message "KEEP CLEAR" is sometimes used to reduce the risk of traffic being prevented from entering or leaving the stem of the T-junction when other traffic is banked up along the through road. As is shown by the accidents reviewed here, the KEEP CLEAR message could be counter-productive on safety grounds.

Parked vehicles may also be a significant obstruction to vision for the turning driver, as noted in Accident 063. Where an intersection of this type has a high frequency of accidents which involve a vehicle turning right out of the stem of the T, a prohibition on parking for up to 50 metres from the junction may prove to be worthwhile. Ideally this would be achieved by the elimination of the parking lane over this distance, thereby reducing the temptation for a driver to attempt to overtake on the left on the approach to the intersection, as happened in Accident 098.

6.3 SIGN CONTROL RELEVANT: FOUR WAY INTERSECTIONS

6.3.1 STRAIGHT ACROSS FROM SIGN, OTHER VEHICLE ON RIGHT Table 6.1(d)

One of these five accidents involved an obstruction to vision. A bus was stationary at a stop to the right of the car which had stopped at the STOP sign (Accident 194). When this car moved off to cross the intersection another car suddenly appeared on its right, having passed the bus. The driver who should have yielded claims that he looked to his right before he started to cross, and did not see the other car until immediately before the impact.

In three of the remaining four collisions the driver at the STOP sign did not see the vehicle approaching from the right. These three drivers all said that they had been concentrating on looking to their left as they entered the intersection. A car approaching from the left attracted one driver's attention (Accident 181) and another driver was trying to make sure that the cars parked on his left in the intersecting road were not concealing any vehicles coming towards him from that direction (Accident 089).

The third accident happened because both drivers were watching a car which was turning left (Accident 169, Figure 6.9). The driver who was on the priority road sounded his horn when he saw this car turning left, even though it was not entering his traffic lane. The other driver in the accident was also talking with his passengers and was not familiar with the location. Neither driver could offer any other explanation for their failure to see the other car.

The final accident in this category differs from the preceding ones in that both drivers saw each other but one assumed that he had time to cross (possibly encouraged by a car which had just started to cross from the opposite side of the intersection) and the other assumed that the first driver would wait for him to pass (Accident 136). The driver who chose to attempt to cross from the STOP sign admitted that he had misjudged the speed of the other car but he did say that he thought that it must have been exceeding the speed limit. This remark was commonly made by drivers who did see the other car well before the impact. It will be considered further in the general discussion which follows later on these accidents at sign-controlled intersections.

6.3.2 STRAIGHT ACROSS FROM SIGN, OTHER VEHICLE ON LEFT

Table 6.1(e)

Speeding Vehicle on Priority Road

The vehicle on the priority road was unquestionably exceeding the speed limit by a wide margin in two of these five accidents. In Accident 047 this vehicle skidded under braking for 22 metres before colliding with the other car. This represents a speed reduction of about 60 km/h before the collision, and is consistent with the report of an independent witness who said that this car had been travelling at more than 100 km/h as it approached the intersection. The driver told us that he had been looking at something on the left side of the road and so did not see the other car in time to avoid it. The driver of the car which was at the STOP sign said that she had seen a car far away on her left before she moved off. She did not see it again until the last moment before the impact.

Accident 167 also appears to have involved a vehicle which was speeding along the through road (Figure 6.10). A car driver moved off from a STOP sign and slowed as she reached the median so as to check again for traffic from her left, because shrubs planted on the median obstructed her view when she was further back. Thinking the road to be clear, she continued across only to be hit by a motorcycle just before she reached the far side of the intersection. Her car was spun around by the impact and contacted another car which was stationary at the adjacent STOP sign. The motorcycle came to rest 30 metres further down the road. The rider, who was concussed and was unable to remember the accident, had a blood alcohol level of 0.13. At this location the road was unlikely to have been a significant factor in the causation of the accident.

Failure to Detect the Approaching Vehicle

One driver, having stopped at the STOP sign, then drove across in front of a car coming from her left (Accident 072). She remembers a car passing from right to left but did not see the car on her left at all before the impact. There were several factors which may have accounted for this mistake. The sun was shining in her eyes and so she had both internal sunvisors in the down position. There were cars parked on both sides of the road to her left and these may have acted as both an obstruction to vision and as a confusing background against which to view an oncoming car. The driver was not familiar with this intersection.

Failure to Stop at a STOP sign

Two drivers did not stop before entering intersections controlled by STOP signs. One of these drivers was 16 years of age and was driving on a learner's permit which he had had for three months (Accident 053). He claimed to be familiar with the area in which the accident happened, but still drove past the STOP sign and collided with a bus. The bus driver had seen the car approaching the intersection but, assuming that it would stop, then looked to check for traffic approaching from his left. When he looked back he saw the car entering the intersection but it was too late to avoid a collision.

The STOP sign was about seven metres to the left of the approach path of the driver at this intersection when, as in this case, there were cars parked at the kerb. The sign was viewed against a background of a steel and concrete utility pole and a house on the far corner of the intersection. Despite repeated attempts we were not successful in obtaining a follow-up interview with this driver and so we can only speculate on the importance of the conspicuity of the sign (the accident occurred on a bright, cloudy day).

Three other factors do appear likely to have been relevant to the causation of this accident. The car was fitted with a black plastic strip across the upper half of the windscreen. This strip, following the curvature of the screen, was much lower at the sides than in the centre, and may have severely restricted the driver's view to his left. The braking system on the car was in very poor condition and the braking performance was therefore almost certainly inadequate. The car was also carrying nine people, the youngest being eight years of age.

The second accident (070) in which a driver did not stop involved an elderly man who had not driven through the intersection for some years and who did not know that a STOP sign had since been erected. He slowed on approaching the intersection and was looking for traffic approaching from his right when he collided with another car. He was also in ill-health and this may have affected his performance.

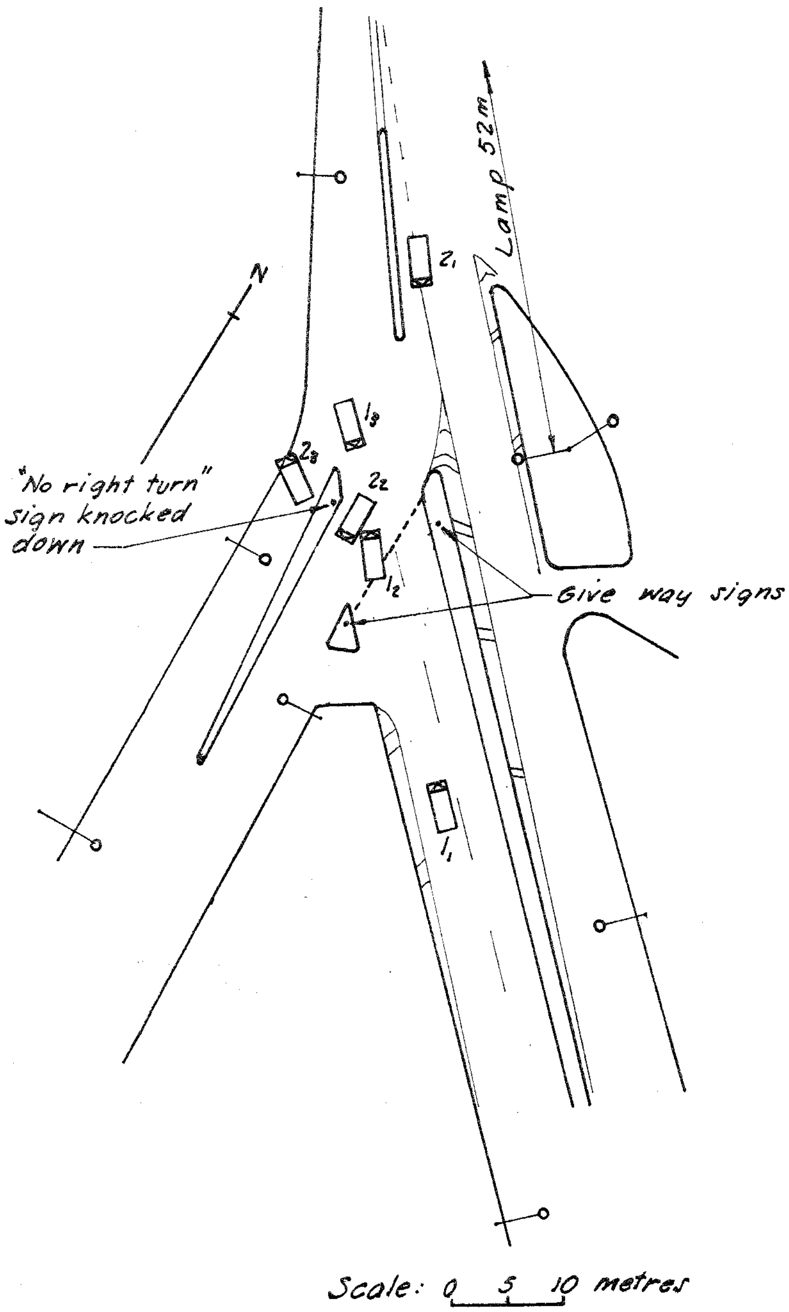


FIGURE 6.8: Accident 211.

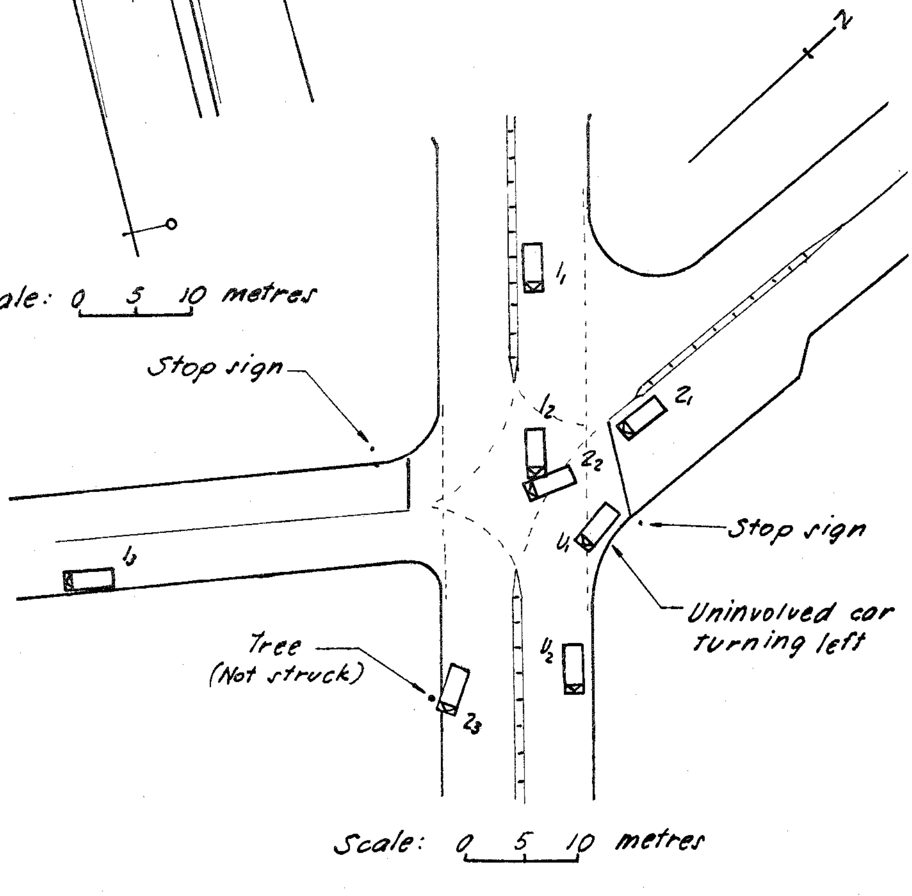


FIGURE 6.9:
Accident 169.

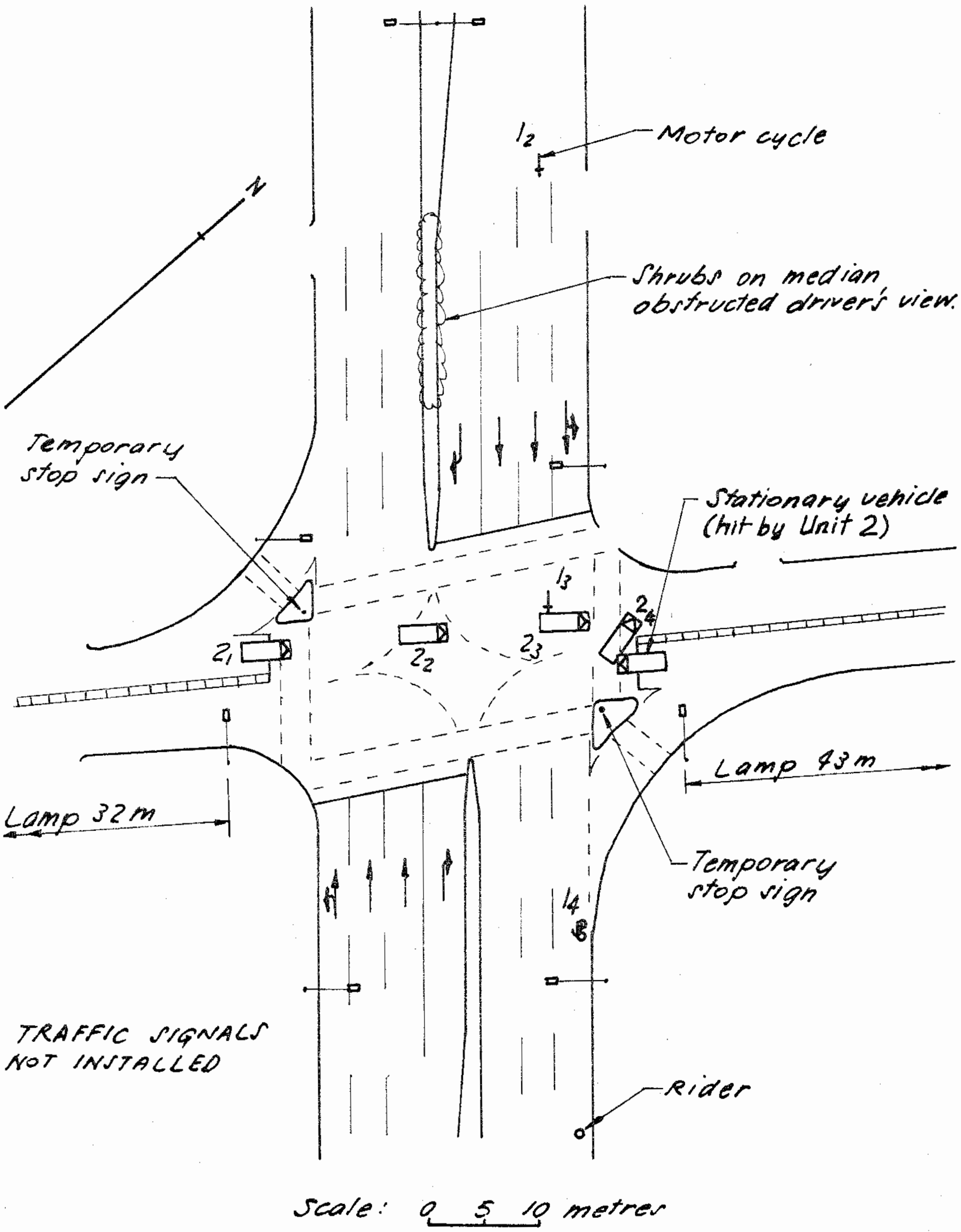


FIGURE 6.10: Accident 167.

6.3.3 TURN RIGHT FROM SIGN, OTHER VEHICLE ON RIGHT
Table 6.1(f)

The one accident in this category is similar to those in group (d) of Table 6.1 but the turn right manoeuvre is more difficult than proceeding straight across, particularly when there is traffic waiting at the STOP sign opposite. In this accident (139, Figure 6.11) the driver at the STOP sign had the added difficulty of a restricted view of traffic approaching on the left from an overpass. This driver had never driven through this intersection before from this direction, and encountered very heavy peak hour traffic. After waiting at the STOP line for some time she saw a car on her right slowing, apparently to turn left. Deciding that the vehicles on the other two approaches would allow her to complete her turn, she moved off, only to collide with a motorcycle that she had not seen. It seems likely that this motorcycle was hidden from her view by the car which was turning left, and then, assuming there to be no other vehicles approaching on her right she concentrated on those opposite and to the left.

The motorcyclist was 16 years old and had been riding for only one month. He saw the car pull across his path and he tried to stop, but without making full use of the front brake because he believed that if he did so he would go over the handlebars.

6.3.4 SIGN CONTROL RELEVANT: FOUR WAY INTERSECTIONS: RELEVANCE OF ROAD AND TRAFFIC FACTORS

Obstruction to Vision

In Accident 194 a bus stationary at a stop was an important obstruction to vision. For this reason it would be desirable for bus stops to be located mid-block rather than adjacent to intersections.

Cars parked close to the intersection were noted as obstructions to vision in Section 6.2. In Accident 089, described in Section 6.3.1, a driver failed to see a motorcycle approaching from his right partly because he was concentrating on looking for vehicles approaching from his left, the view in that direction being obscured by parked cars.

Shrubs planted on a median strip prevented one driver from detecting the presence of an approaching motorcycle (Accident 167).

Speeding Vehicle on the Through Road

In two, or possibly three, of the eleven accidents reviewed in Section 6.3 the vehicle on the through road was exceeding the speed limit. This topic is discussed in detail in Section 6.7.

Failure to Observe a STOP Sign

In one of the two accidents in which a car failed to stop at a STOP sign the elderly driver was looking to his right and did not know that the sign had been installed since he last drove through the intersection (Accident 070). We have less information from the other driver who failed to stop (Accident 053) but at that location the sign was, as noted, about seven metres to the left of the approach path of the driver. In both cases it is possible that a second STOP sign on a median island might have attracted the attention of the driver.

It can be noted that only two of the 15 accidents in which a STOP sign was relevant were caused by a driver failing to observe the sign.

6.4 SIGN CONTROL RELEVANT, OTHER INTERSECTIONS
Table 6.1(g)

Three accidents are grouped under this heading because they differ in one or more important respects from the two main categories of accidents which have already been discussed.

One of these three collisions occurred at a relatively complex intersection (Accident 171, Figure 6.12). A car travelling along a divided road turned left at an intersection, only to collide with another car which moved off from a STOP sign on a third road at that intersection. The driver of the first car saw the second one stationary at the STOP sign, which is located a short distance back from the STOP line, and assumed that it would wait there until she had passed across in front of it. The other driver, not having driven that way before, was being given directions by her passenger and she moved off from the STOP sign without realizing that there was a car coming on her right. She could not explain why she had not seen this car, and wondered whether it might have been travelling rather fast. The driver of the first car said that a truck parked in a bus zone may have been a significant obstruction to vision, even though it was some distance back from the intersection.

The other two accidents in this group of three occurred at intersections on a road which has a very wide median reserve. The first of these, Accident 042, involved a car which was moving from a crossover in the median to a side road (Figure 6.13). The driver said that he stopped at the GIVE WAY sign, looked to his left and, not seeing any vehicles approaching, continued on. He was mid-way across the lane

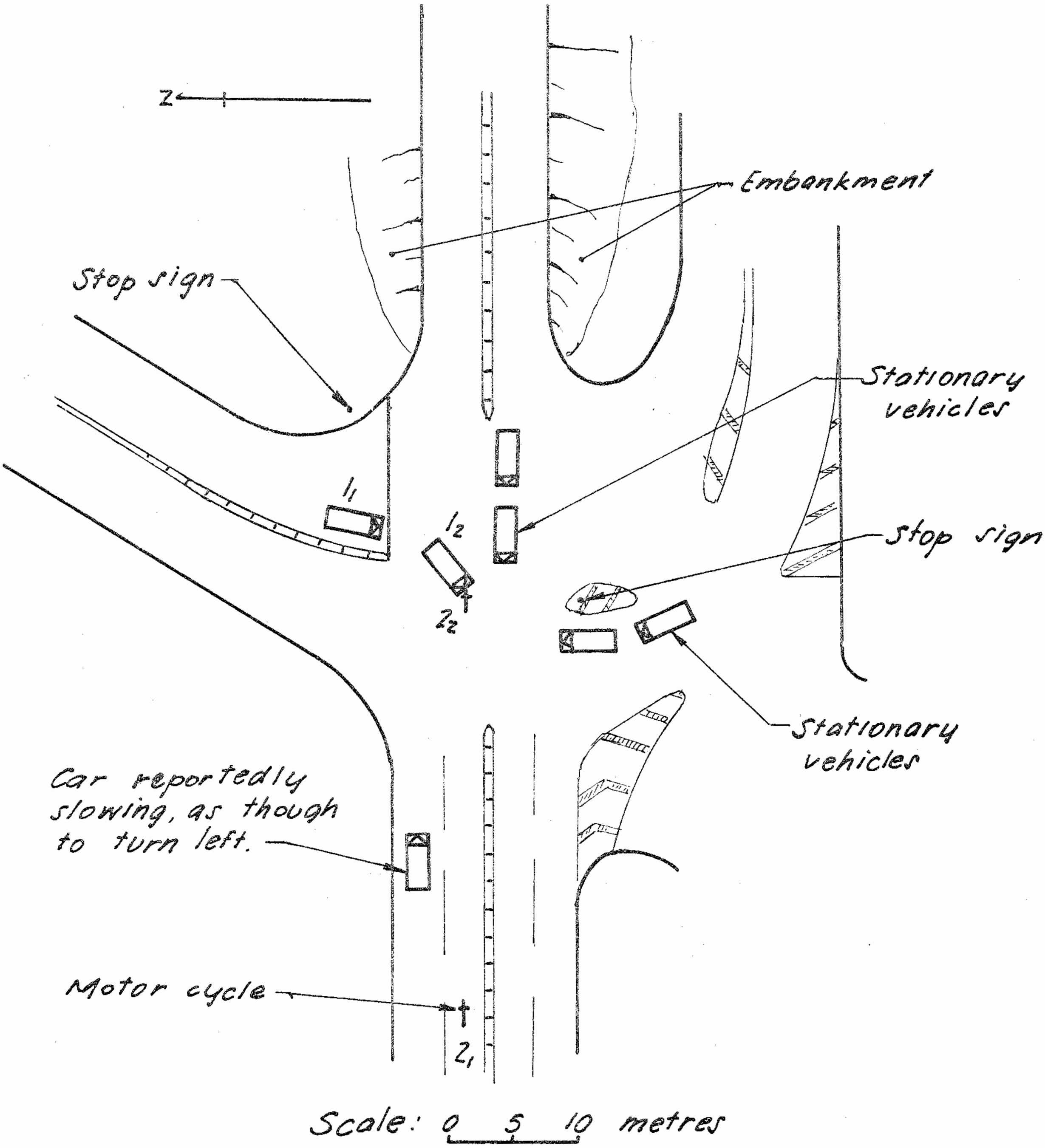


FIGURE 6.11: Accident 139.

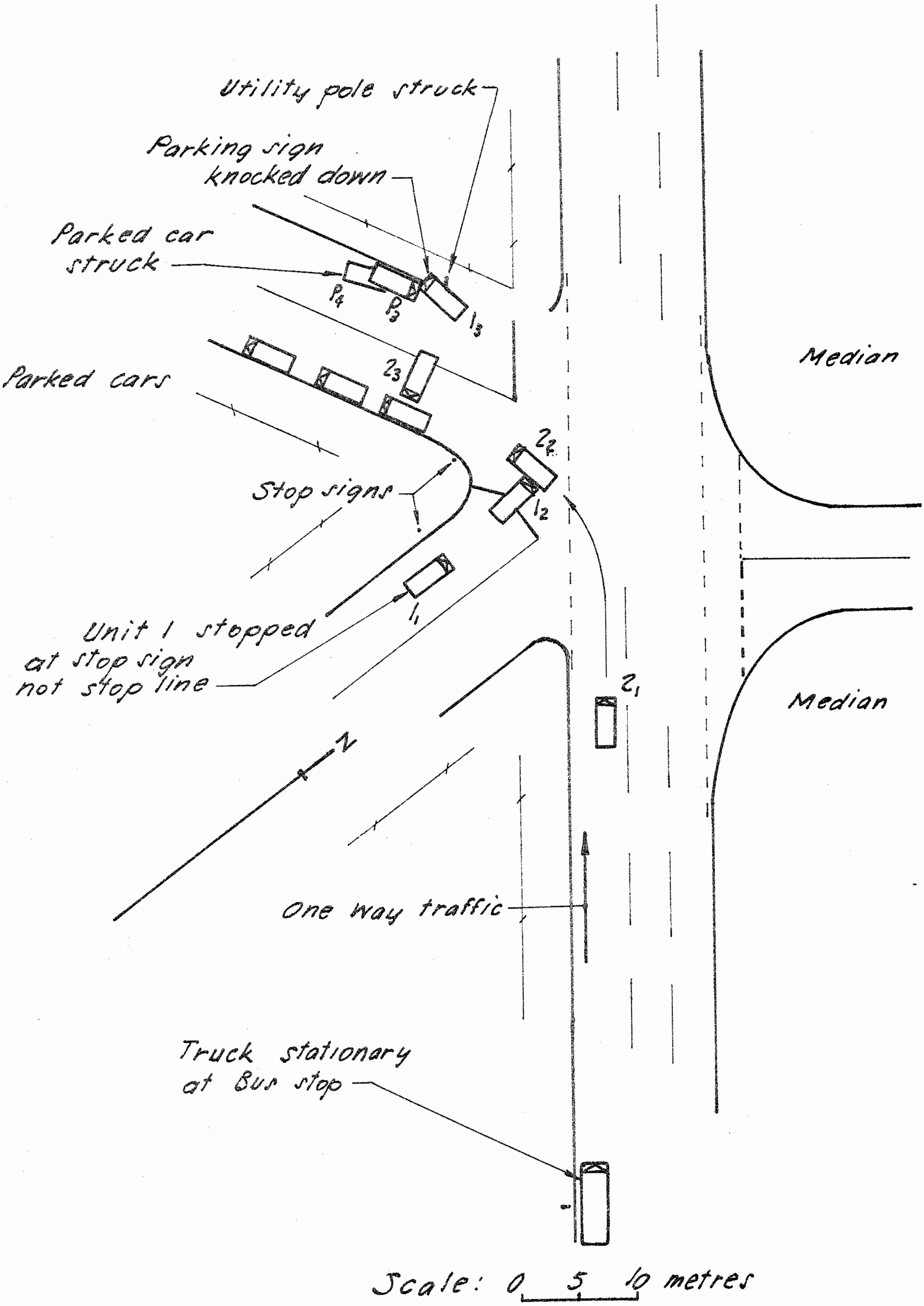


FIGURE 6.12: Accident 171.

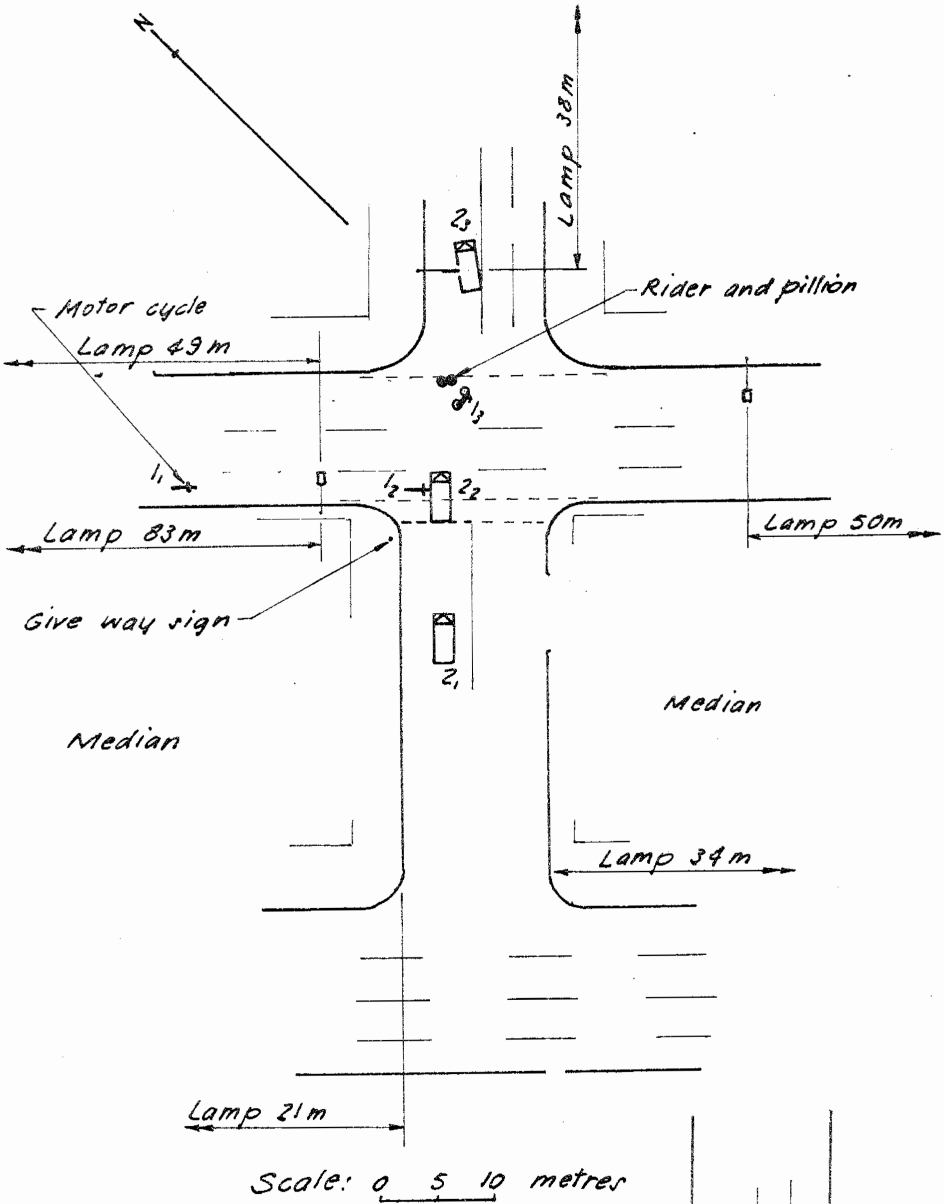


FIGURE 6.13:
Accident 042.

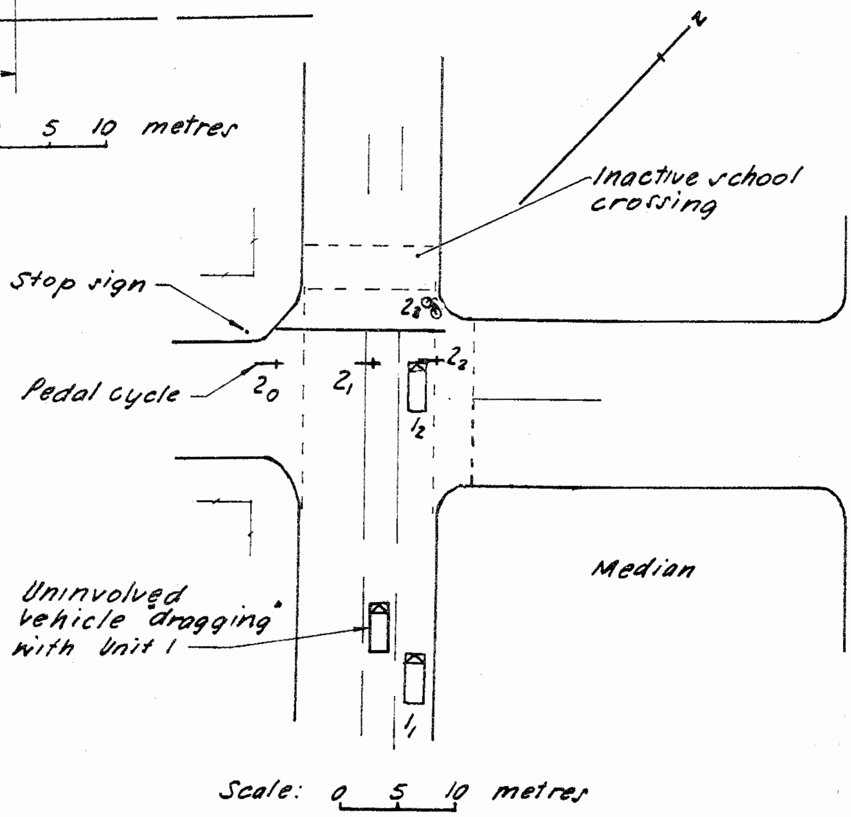


FIGURE 6.14:
Accident 238.

closest to the median when his car was hit by a motorcycle. The rider and pillion passenger on the motorcycle were both severely injured and unable to recall the events immediately before the crash. The rider did say that he remembered travelling at about 75 km/h along that road as he approached this intersection. He had a blood alcohol level of 0.15, but this was unlikely to have been significant in the causation of this accident. The rest position of the motorcycle suggested that the car was going faster than would be expected had it stopped at the GIVE WAY sign.

The second accident at a crossover on this road involved a 70-year-old pedal cyclist who rode across towards the median after having seen some cars a long way off on his right (Accident 238, Figure 6.14). Before he reached the median he realized that two cars were approaching very rapidly, and he tried to ride faster to get out of their way but the back wheel of his bicycle was hit by one of the cars.

A witness who was driving behind these cars said that they appeared to be having a drag race away from the previous traffic signals and were certainly exceeding the speed limit by the time that they reached the intersection where one of them hit the cyclist. The driver involved in the accident had left the scene by the time that our research team arrived. He was extremely aggressive when a follow-up interview was attempted, and claimed that he had been doing 50 to 60 km/h when the cyclist failed to stop at the STOP sign and rode straight across in front of him. His car had skidded under braking for 30 metres, which corresponds to a speed reduction of about 80 km/h. Our radar speed measurements at this site at the same time of day and day of week gave the following results from 215 observations: average speed of traffic, 57 km/h; eighty-fifth per centile speed, 63 km/h; and a maximum speed of 89 km/h.

6.5 INTERSECTION CONTROLLED BY A ROUNDABOUT

The two accidents in this category occurred at four-way intersections that were controlled by roundabouts but with no erected signs. Despite the absence of such signs these accidents are included in this section partly as a matter of convenience in presentation.

One of these collisions took place at a location where a STOP sign had been removed 19 months before (Accident 186, Figure 6.15). As shown in Figure 6.16, the two cars in this accident were both intending to proceed straight ahead through the intersection, and were able to do so despite the presence of the roundabout. Both drivers looked to their right as they approached the intersection and, thinking the road to be clear, continued on. A building, together with cars parked along one approach, acted as an obstruction to vision and each driver saw the other's car only at the last moment. They both thought that the other car had been travelling too fast. The driver who was on the left, and who should have yielded at the stop line at the entrance to the intersection, said that he had slowed down but that he should have stopped and made quite sure that the road was clear before proceeding.

The STOP sign which had been located at this intersection was removed on the day before the legal meaning of the STOP sign was last changed in South Australia (the change became effective on March 1, 1975). It was thought that the new regulation, which over-rode the "Give Way to the Right" rule to take all priority away from a vehicle at a STOP sign, would interfere with the normal operation of the roundabout. The STOP sign was replaced on December 14, 1976 after it was found that its removal had increased the accident frequency at that intersection. Accidents involving the same vehicle movements as those shown in Figure 6.15 increased from none at all in the three years from 1971 to 1974 to five in 1975.

Both drivers in this accident could remember that there had been a STOP sign at this intersection, but it is unlikely that this recollection affected their driving behaviour on this occasion.

The other intersection controlled by a roundabout was also unusual in that there were no hold lines painted on the entrances to the intersection or any signs erected to indicate that traffic already negotiating the roundabout had priority over entering traffic. A 13-year-old boy on a bicycle was struck from the left rear by a car when he was negotiating the roundabout (Figure 6.17). The 47-year-old driver of the car said that he did not see the cyclist before the impact. The cyclist had no recollection of the accident. He was very severely injured because he was trapped, with his bicycle, beneath the front of the car which struck the kerb at the far side of the intersection and continued on for 60 metres beyond the impact point. The lack of road markings or signs may not have been relevant to the causation of this accident, but the dimensions of the roundabout and the adjacent kerbing appear to have been such as to have permitted unsafe approach speeds.

6.6 SIGN CONTROL NOT RELEVANT

6.6.1 TURN RIGHT INTO STEM OF A T-JUNCTION, HIT BY ONCOMING VEHICLE

Table 6.1(p)

Although the six accidents in this group occurred at controlled T-junctions the presence of the regulatory sign appears not to have been directly relevant since neither vehicle was subject to the restraint imposed

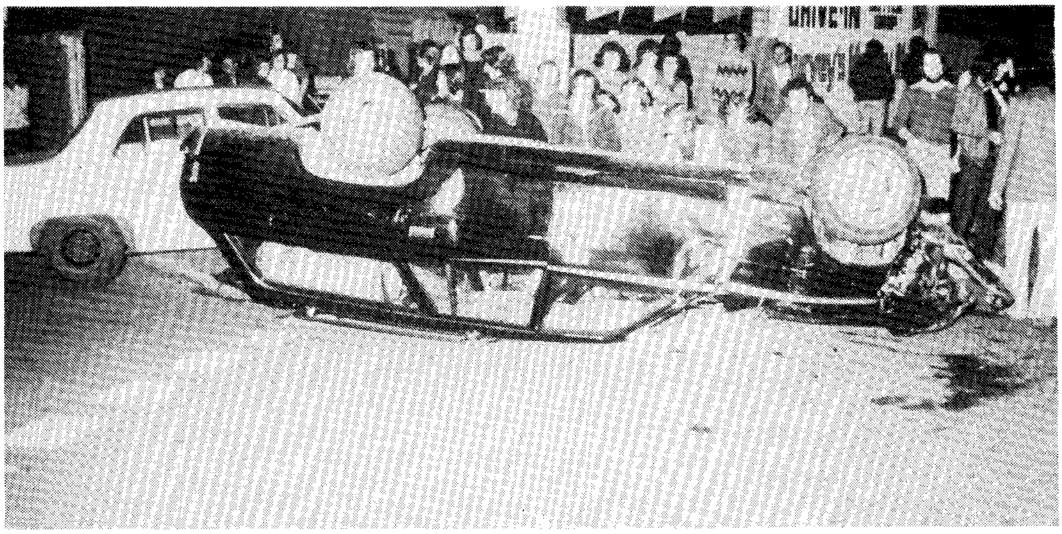


FIGURE 6.15: Final position of cars after collision at roundabout (Accident 186).

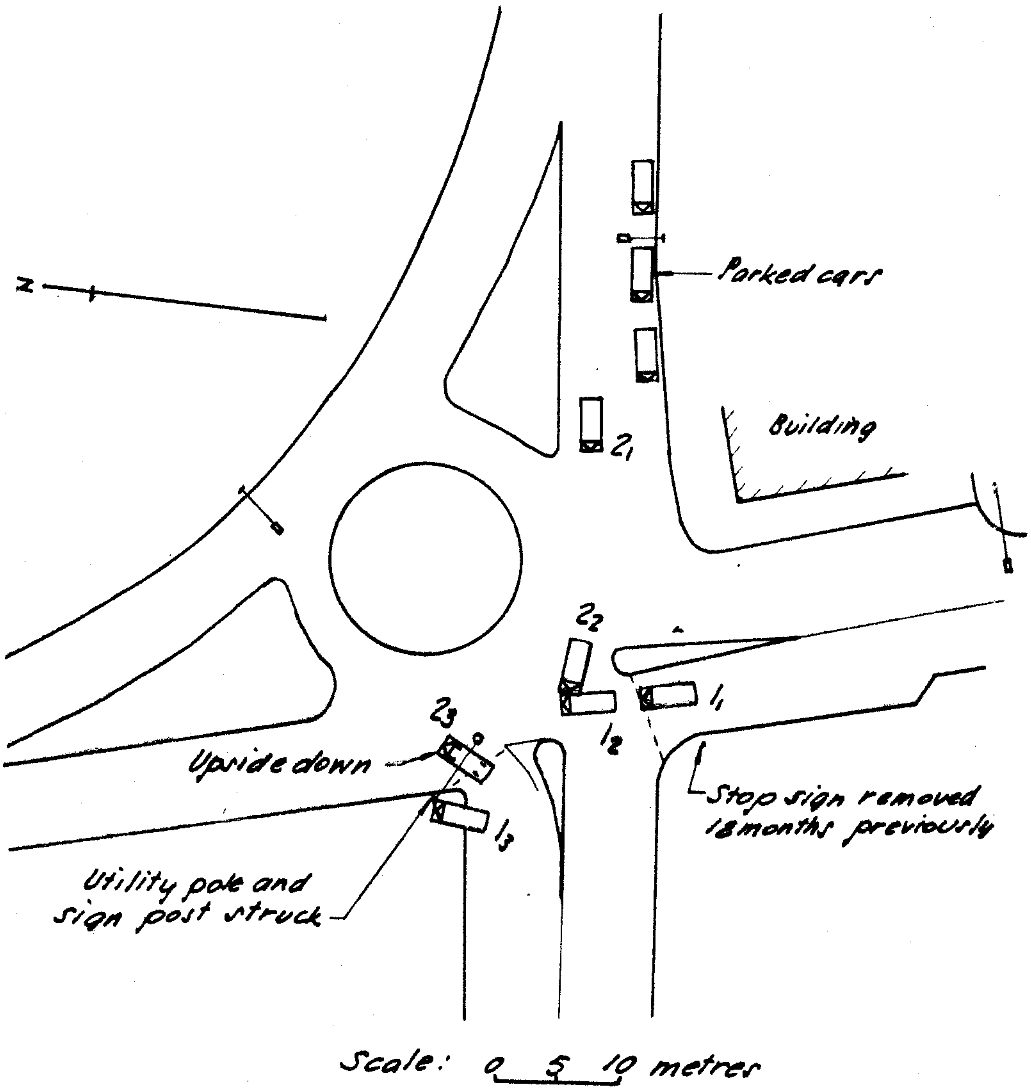
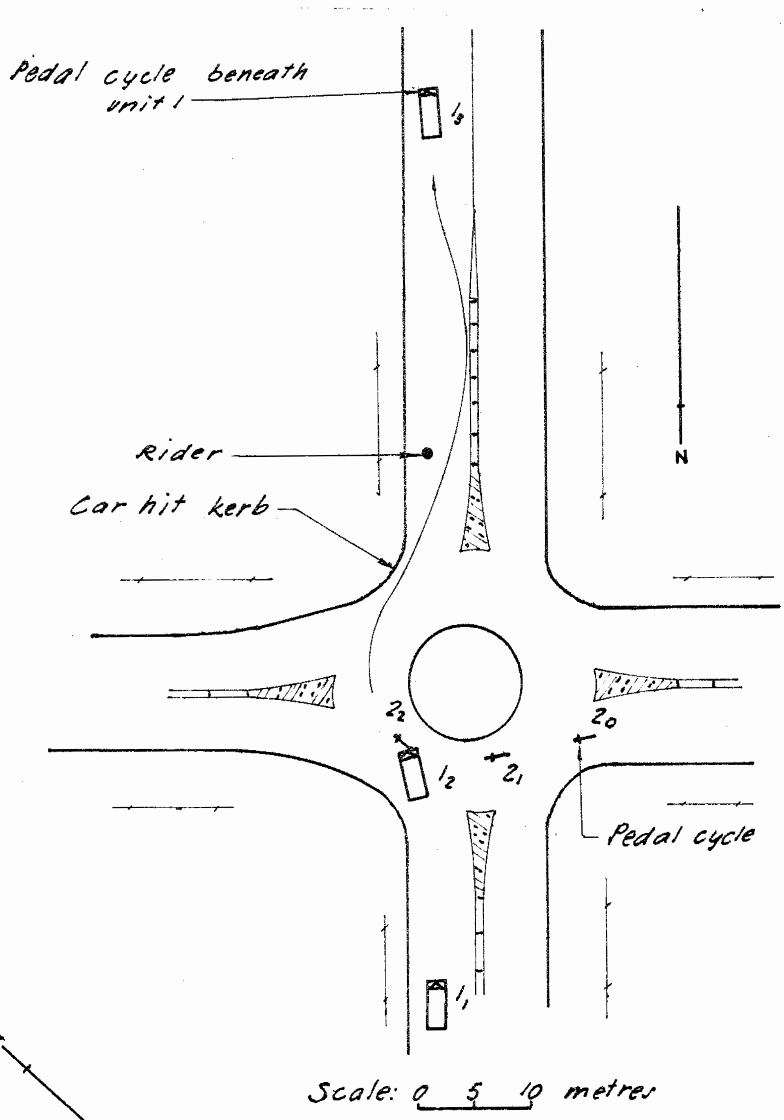


FIGURE 6.16: Accident 186 (see Figure 6.15).

FIGURE 6.17: Accident 254.



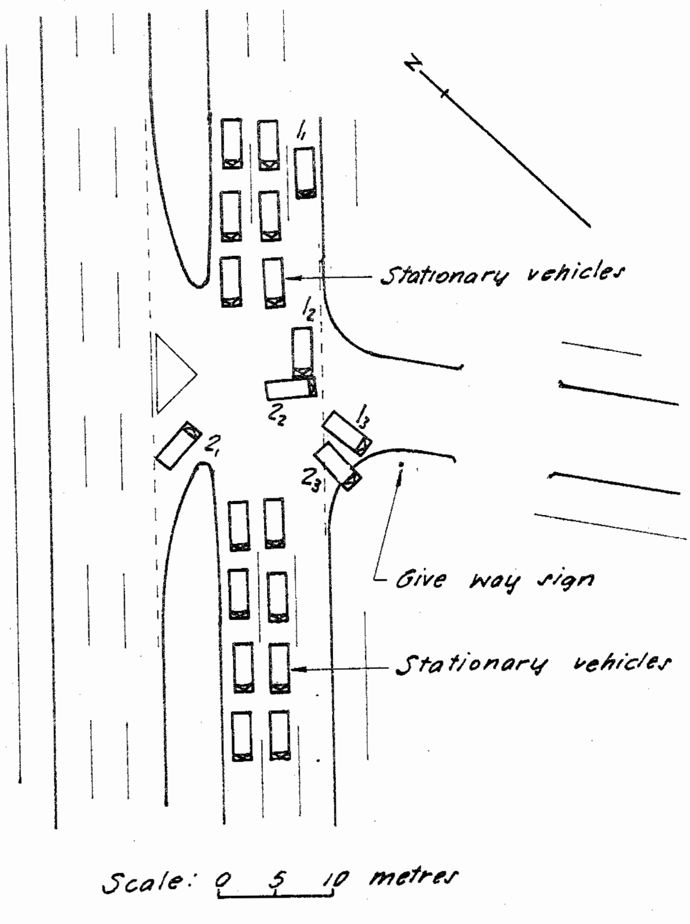


FIGURE 6.18: Accident 156.

by the sign.

Obstruction to Vision

Four of these six accidents happened at locations where traffic was banked up from a set of traffic signals. The turning driver was waved through by a driver who had stopped to avoid blocking the junction in three cases.

Accident 156 is an example of a two car collision which occurred in this way (Figure 6.18). The driver who was moving through in the left lane may have been distracted a little by talking with his passenger, but the turning driver said, perhaps too generously, that the accident was all his own fault.

In the other three accidents in which the traffic was banked up the through vehicles were two motorcycles and a pedal cycle, respectively. In each case the riders were taking advantage of their vehicle's ability to move up alongside a stationary queue of cars. The cyclist was passing a stationary bus on its left by riding virtually in the gutter, at a speed of about 30 km/h (Accident 005). The bus driver had stopped, in the left of two lanes, to allow a car waiting to turn right to complete its turn, and he waved it through. As the car passed across in front of the bus the cyclist suddenly entered the intersection and collided with the side of the car. The cyclist denied that he had contributed to causing the accident in any way at all.

The two motorcyclists were executing similar manoeuvres. One was passing two lanes of stationary cars by riding along in the kerb lane, which was otherwise empty because it was blocked by a parked car about 200 metres back from the intersection (Accident 098). The turning driver, realizing that the other cars had left the intersection clear for him, moved off only to see the motorcycle approaching in the kerb lane at the last moment. This driver, like the one in Accident 222 in category (a) of Table 6.1, had very poor eyesight (static visual acuity of 3/36 in both eyes) and was colour blind. His driver's licence was not endorsed with any restriction requiring him to wear corrective lenses when driving. This accident occurred at dusk, and his poor vision may have contributed to his failure to see the motorcyclist in time, but it was unlikely to have been a major factor. The motorcyclist, like the pedal cyclist in the previous accident, denied any responsibility for the collision.

The remaining collision of this type that involved a motorcycle differed mainly in that the rider recognized that passing on the left under such circumstances was potentially hazardous. He told us that he had had several near misses there before and should have known better (Accident 249, Figure 6.19 and 6.20). Again, a driver in one of the stationary cars had waved the turning car through.

No Obstruction to Vision

One of the two crashes in which there was no obstruction to vision occurred in daylight, and the other at night. In the first (Accident 076), the driver of a car saw a truck approaching in the distance and decided, incorrectly, that he had time to turn right across two traffic lanes, into a side road.

In the accident at night, a motorcyclist was riding in the right lane, of two available lanes, when he noticed a car approaching from the other direction with its right turn indicator operating. This car suddenly turned right, and the motorcyclist crashed into it (Accident 303, Figure 6.21). The car driver had obviously been drinking, but his blood alcohol level was not determined because he got out of the ambulance en route to the hospital.

6.6.2 TURN RIGHT INTO STEM OF A T-JUNCTION, HIT BY FOLLOWING VEHICLE
Table 6.1(r)

The operators of two of the four vehicles which hit the stationary cars in these accidents had both been drinking. One, a motorcyclist, had a blood alcohol level of 0.05 and the other, a car driver, a level of 0.175. This driver was eating a pizza while driving.

The motorcyclist was following a car which braked unexpectedly (Accident 159, Figure 6.22). He swerved to the left to pass the car, only to find the back corner of a car jutting out across the lane markings. He hit his leg on the bumper bar of this car. The driver of the stationary car had entered this road from a junction on the left, and was waiting for oncoming traffic to clear so that he could turn down a street on his right. He claimed that he had been stationary for some seconds before the accident. This accident occurred at dusk, but the level of illumination was still adequate.

The car driver in Accident 205 had just left a well lit road and started driving along one which was relatively poorly lit. He did not see the car in front of him until the last moment, by which time it was too late to avoid the collision, even though the driver of the stationary car claimed that his turn indicator was operating. There is ample room for two lanes of traffic in this direction at this location. This accident is similar to many of the collisions with parked vehicles in this study, in which the driver had been drinking and the struck vehicle was poorly illuminated by the street lighting.

The remaining two accidents occurred during the day. One involved a 16-year-old motorcyclist who was operating on an expired learner's permit. He was following a car when he heard a noise which he

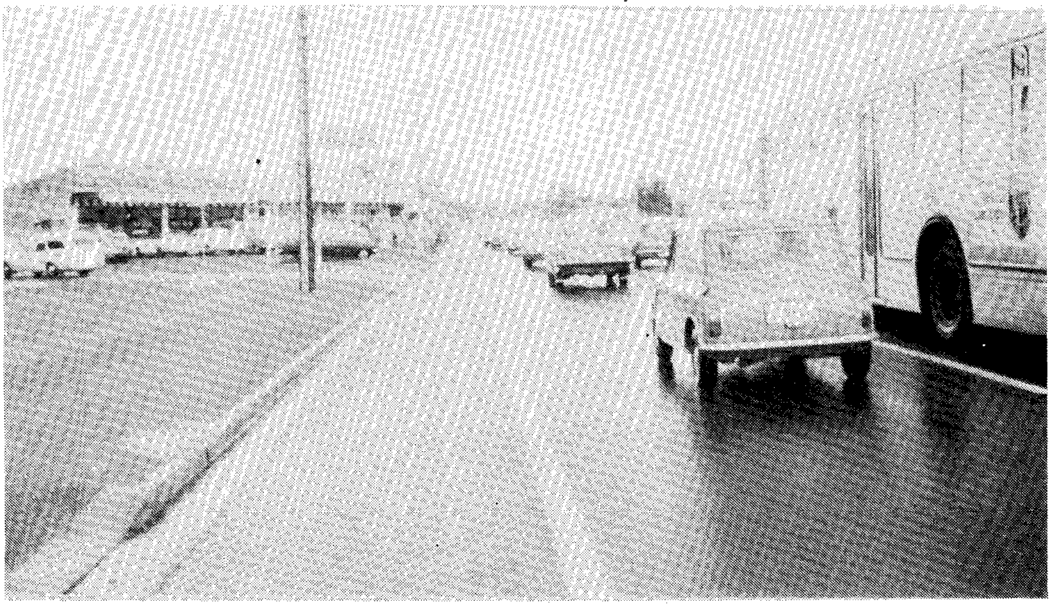


FIGURE 6.19: Approach path of motorcyclist in Accident 249. (see Figure 6.20).

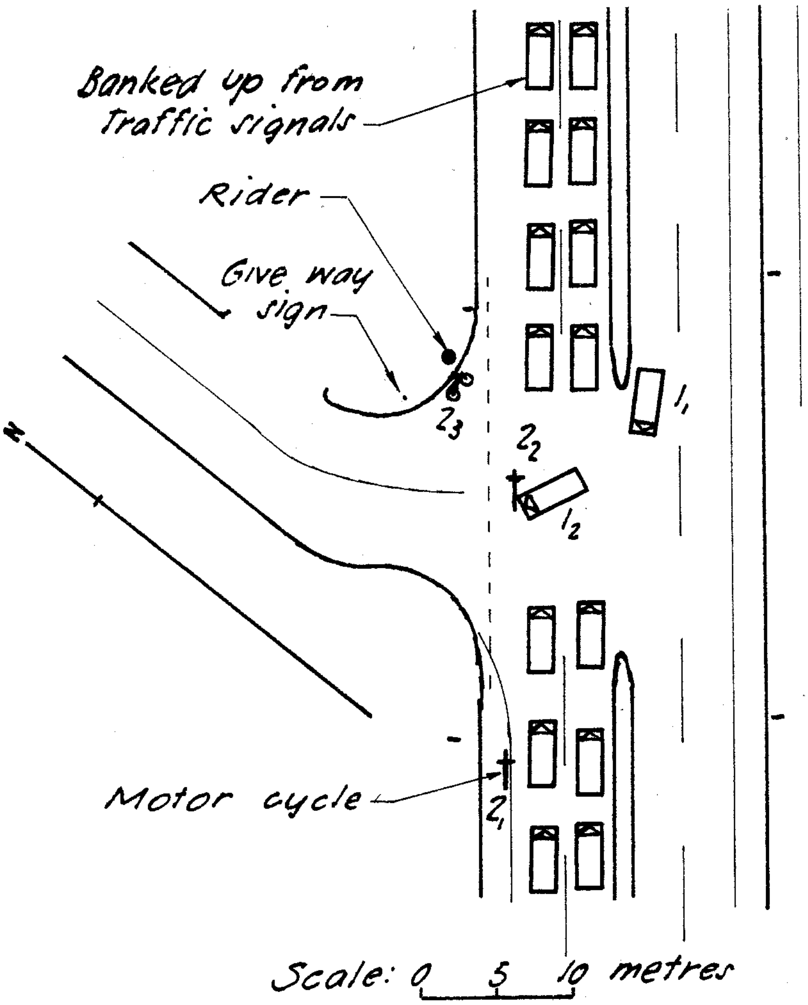


FIGURE 6.20: Accident 249.

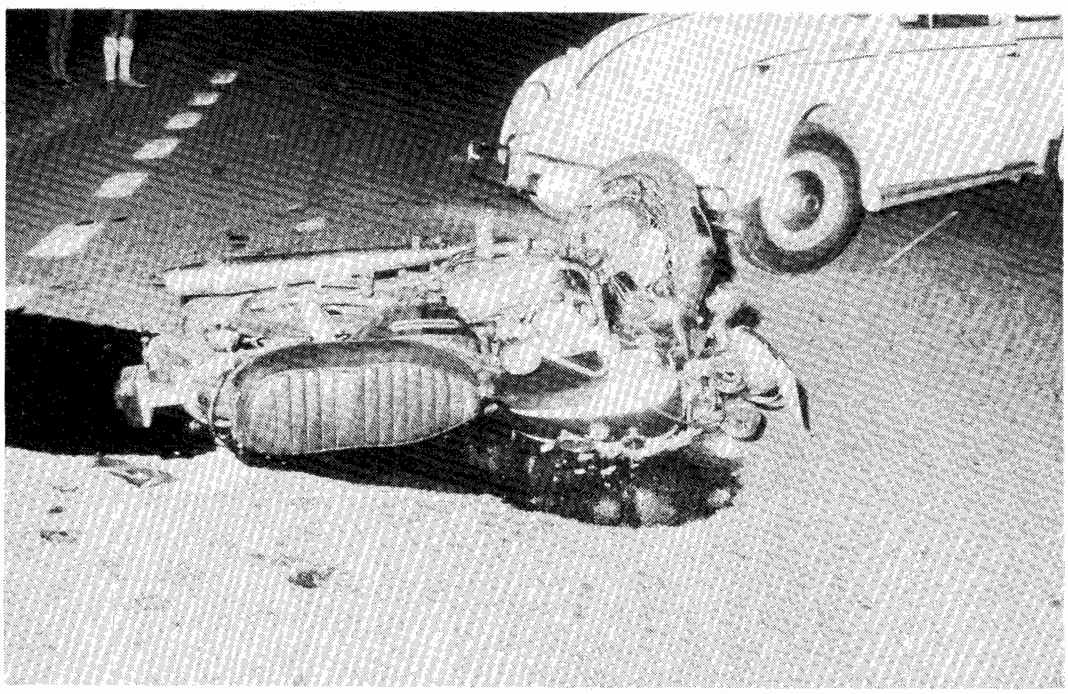


FIGURE 6.21: Final Positions of Vehicles Involved in Accident 303.

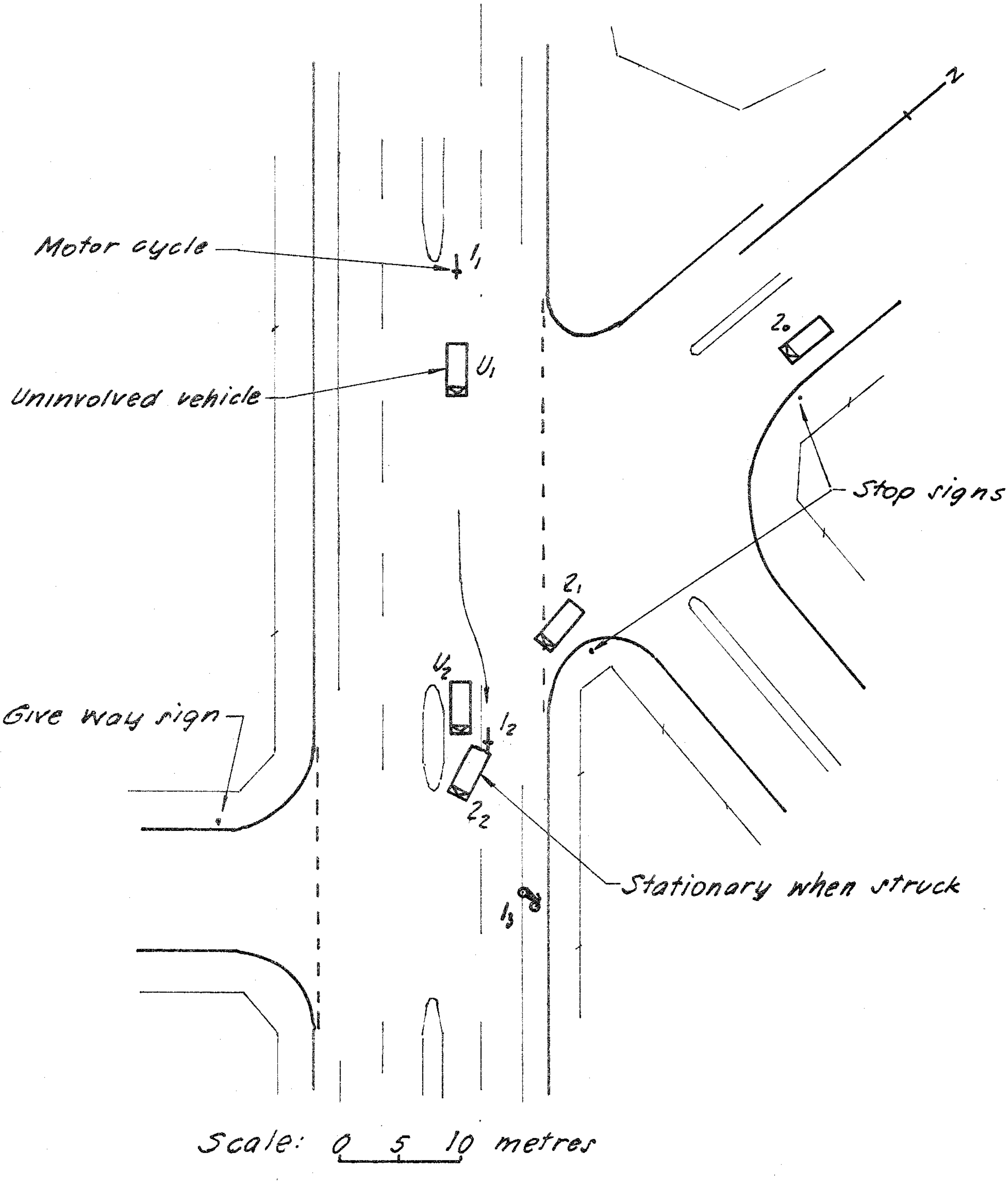


FIGURE 6.22: Accident 159.

thought was due to the stand of his machine dragging on the road and so he looked down to check on this. When he looked up again he saw that the car had stopped and he was unable to avoid it. He had noticed that the car was slowing before he looked down but he had not expected it to stop (Accident 039).

In Accident 081 the driver of a Volkswagen van saw a car ahead of him waiting to turn right from the right lane (of two). He braked gently, expecting the car to turn. When he realized that it was not about to move he braked harder and looked in his left side rear vision mirror to see if the left lane was clear for him to move across. Partly because it was carrying an unusually heavy load the brakes on the van were not as effective as they usually were and the van crashed into the back of the car before the driver was able to swerve to the left.

6.6.3 TURN RIGHT AT FOUR WAY INTERSECTION, HIT BY ONCOMING VEHICLE

Table 6.1(q)

The often difficult task of finding a street name sign at night was a significant factor in one of these two accidents (Accident 232). The driver who was intending to turn right noted the headlights of an oncoming car in the distance and then suddenly saw a street sign bearing the name of the street that he was looking for. This sign was partially concealed behind a shop verandah on his right. On seeing the sign he immediately turned right, assuming incorrectly that the oncoming car was still some distance away and watching a car on his right which was waiting at the STOP sign. The other driver, who had a blood alcohol level of 0.12, was not aware of the presence of the turning car until it actually began to turn across in front of him. He may have been distracted by his passenger who was changing a cassette in the tape-player as they approached the intersection. The accident site was well illuminated.

In Accident 146 the turning driver said that he checked for oncoming traffic and, seeing none, then checked for traffic coming out from the side street (Figure 6.23). He started to turn only to collide with a car that had just pulled out from a row of cars parked at the kerb. The driver of the other car did not notice the turning vehicle until it started to move across her path. This accident happened just before mid-day.

6.6.4 SIGN CONTROL NOT RELEVANT, OTHER INTERSECTIONS

Table 6.1(s)

Three of the four accidents under this heading involved a car driver who attempted to cross a multi-lane road from a service station forecourt with the intention of entering a street forming the stem of a T-junction. Both collisions happened at about 2 p.m. on a weekend.

In Accident 219 a 34-year-old female driver failed to see a motorcycle approaching on her right before she drove out from the service station. The motorcyclist, a 19-year-old girl, had been riding for just over three months and the headlight of her motorcycle was not switched on. However, the driver of the car said that she had been careless and had not been concentrating, so the inexperience of the rider and the relative inconspicuity of the motorcycle may not have been relevant factors in the causation of this accident.

The most complex sequence of vehicle movements in any accident in this study took place in Accident 040 (Figure 6.24). A 67-year-old female driver thought that she had right of way when driving out from a service station. Consequently she expected a car approaching from her right to give way to her, even though she misjudged its speed and distance from her. The driver of the other car was able to avoid a collision at this stage, but not later. The first-mentioned car crossed to the far side of the road where it was struck on the rear left side by a car which approached from the left. This spun the struck car around; it headed back across the road, colliding with a fourth car and then crashing into the car that it had narrowly missed in the initial manoeuvre. It finally struck a fifth car that was stationary at a STOP sign.

The third collision in this group occurred at night at a location where there were two T-junctions with an arterial road (Accident 288, Figure 6.25). A 17-year-old male attempted to turn right into a side street by passing to the right of a car that was stationary facing him, waiting to turn right. The stationary car prevented the driver from seeing a third car approaching in the kerb lane, where the collision occurred. In this accident, as in the others described in Sections 6.6 to 6.8, the fact that the T-junctions were controlled by signs appears to have had no relevance to the causation of the accident.

Accident 038 was similar to the six accidents in category (p) of Table 6.1 in that a vehicle (a taxi) turned right into the stem of a T-junction and across the path of an oncoming vehicle (a car). Unlike those six accidents, the turning vehicle in Accident 038 was not physically involved because the driver of the oncoming car swerved to right, only to collide with a motorcycle that had been travelling behind the taxi (Figure 6.26). The accident occurred soon after 8 a.m. and the driver of the taxi, which did not stop, was looking into the sun as he approached the T-junction. It is therefore possible that glare from the sun obscured his view of the oncoming car.

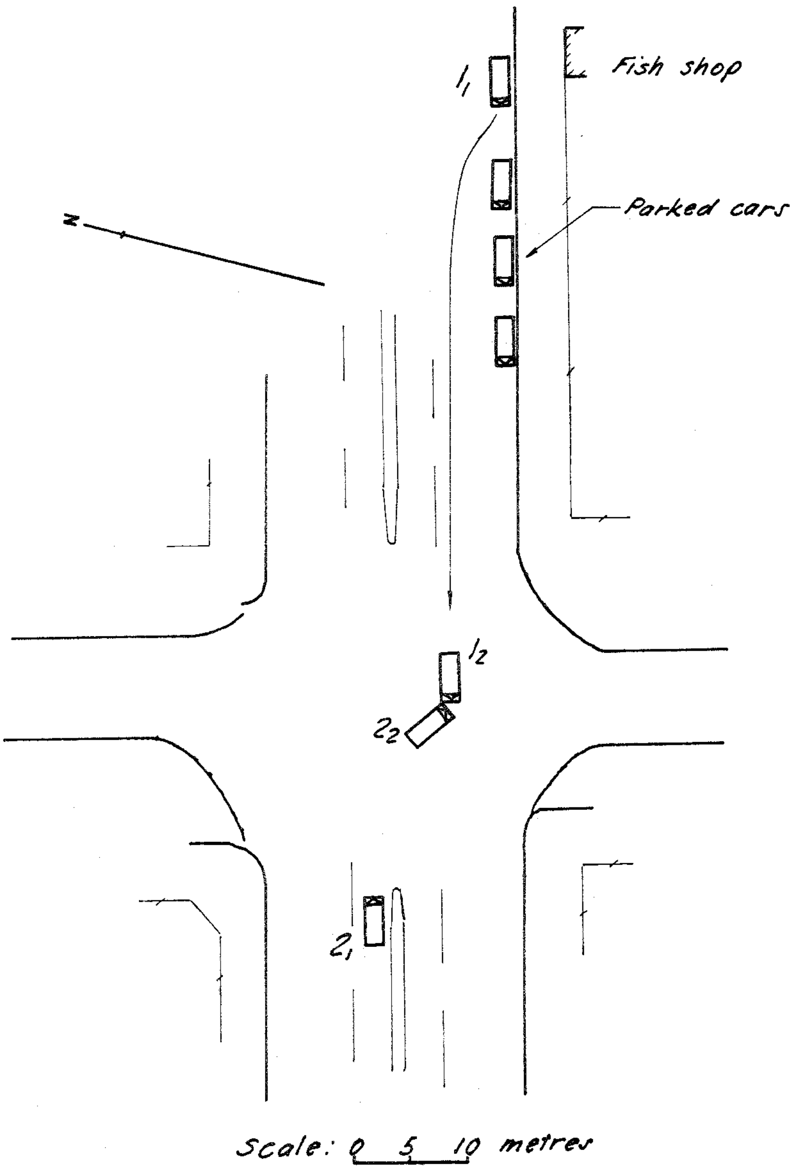


FIGURE 6.23:
Accident 146.

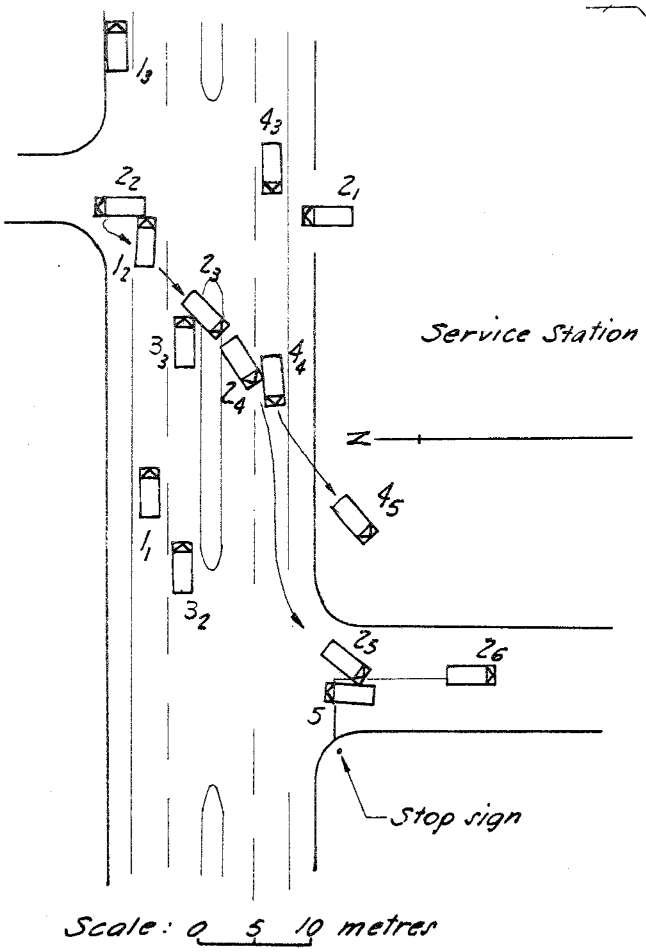


FIGURE 6.24: Accident 040.

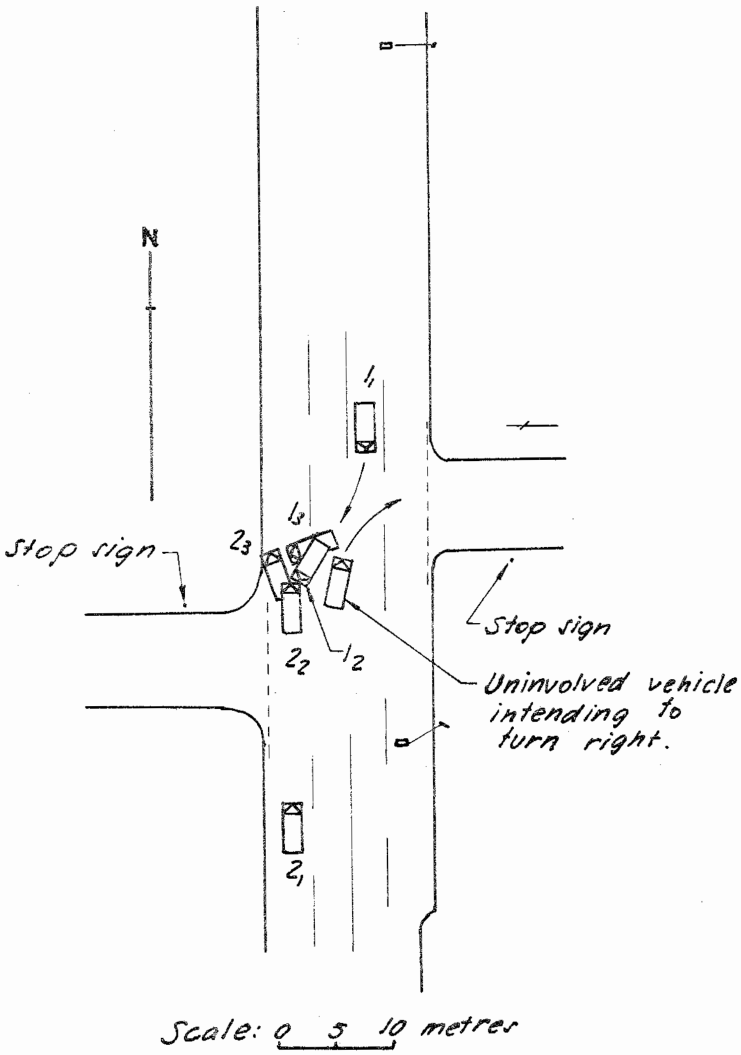


FIGURE 6.25: Accident 288.

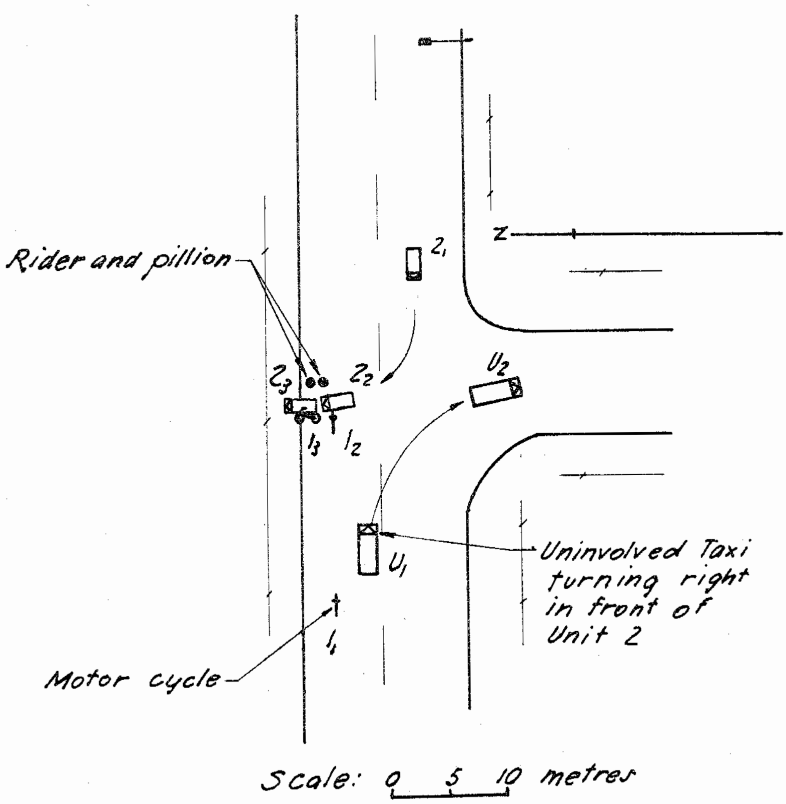


FIGURE 6.26: Accident 038.

6.6.5 SIGN NOT RELEVANT: RELEVANCE OF ROAD AND TRAFFIC FACTORS

Turning Through a Gap in Banked Up Traffic

The hazards associated with turning through a gap in a queue of vehicles banked up from a set of traffic signals were even more apparent in the accidents described in Section 6.6.1 than they were in those in group (a) of Table 6.1. This reinforces the previous recommendation (Section 5.4.3) that continuous median strips be installed to prevent turning movements or that existing junctions should be closed if they are subject to being obstructed in this way.

Educating drivers of the need to exercise extreme care when attempting to execute a turn, or pass a queue of stationary cars, under such circumstances may prove to be of value.

Conspicuity of Street Name Signs

Difficulty in locating a street sign was a factor in the causation of Accident 232.

Control of Access at Service Stations

Three accidents (Section 6.6.4) involved a vehicle entering the roadway from the forecourt of a service station with the intention of crossing to the stem of a T-junction. While the retention of reasonable access to a service station is an important consideration, at some locations it may be thought necessary to restrict manoeuvres such as the one described here by a measure such as the installation of a raised median strip.

6.7 SPEEDS ON THE THROUGH ROAD

In some of the accidents presented here we have been able to conclude that the vehicle on the through road was speeding and that this was a significant factor in the causation of the accident. We have also reported comments made by drivers of the vehicles entering the through road who thought that the vehicle on that road must have been speeding (in excess of the speed limit and faster than normal expectations).

Unfortunately we do not have sufficient evidence from these accidents alone to be able to conclude with confidence that speeding is a major factor in most accidents of this type. But we did ask each of the drivers involved in these accidents (those who agreed to being interviewed) to tell us what prior convictions they had received for offences against the Road Traffic Act.

The results are shown in Table 6.2 for the 35 accidents in which we were able to obtain this information from both drivers. This Table lists the number of drivers who reported having had one or more convictions for speeding, and those who had none. These data are presented for those drivers who were on the through roads in these accidents, and for the other drivers.

As can be seen from this Table, those drivers who were on the through road in these accidents were four times more likely to have had a prior conviction for speeding than were the other drivers.

The possibility exists that the drivers who had not been on the through road, and hence were legally responsible for their accident, might have been more reluctant to admit to prior convictions. We can check on this to some degree by looking at convictions for offences other than speeding. This comparison still shows the driver on the through road to have a higher probability of having one or more offences but the ratio is about two to one, compared to four to one for speeding.

Based on these results, it appears as though accidents at sign-controlled intersections are likely to result in part from the driver on the through road exceeding the speed limit, or exceeding a safe speed under conditions where there is an obstruction to vision such as a queue of stationary cars. This is consistent with the fact that these accidents generally did not result from one vehicle failing to observe a STOP or a GIVE WAY sign. Consequently there is much more to commend measures aimed at ensuring the observance of speed limits and a more critical investigation of individual accidents of this type before apportioning responsibility to the drivers involved.

TABLE 6.2: SELF-REPORTED SPEEDING CONVICTIONS

(Accidents at Sign-Controlled Intersections)

Driver On:	Prior Conviction for Speeding: None No.	None %	One or More No.	One or More %	Total No.	Total %
Through Road	15	43	20	57	35	100
Other Road	30	86	5	14	35	100
Total	45	64	25	36	70	100

Chi square = 14.0, $p < 0.001$.

7. ACCIDENTS AT SIGNALISED LOCATIONS

7.1 GENERAL CHARACTERISTICS OF ACCIDENTS AT SIGNALISED LOCATIONS

This Chapter contains a review of the 52 accidents in the study that occurred at signalised locations. Not all of these 52 accidents are classified in this category in the comparison of accident types in Chapter 2. Two crashes (010 and 030) are listed under single vehicle accidents and five are listed as pedestrian accidents. Therefore there are 45 accidents in the signalised locations category in Chapter 2. The aspects of the other eight accidents that are relevant to signalised locations are discussed below in Section 7.4 in order to present a comprehensive view of the characteristics of the signalised locations covered by the study.

7.1.1 TIME OF DAY AND DAY OF WEEK

The 45 accidents classified in Chapter 2 as being at signalised locations were distributed relatively uniformly by time of day (Figure 2.5) from 7 a.m. to 1 a.m. except for fewer cases between 10 a.m. and 2 p.m. Twenty per cent occurred between 7 a.m. and 10 a.m., a much higher percentage than the 9.3 per cent for the other categories of accident listed in Chapter 2 (Chi square = 4.56, $p < 0.05$). One third of the 45 accidents occurred on a Saturday or Sunday, a proportion that is similar to that for the other accidents in the study (with the exception of pedestrian accidents where it was one-eighth).

7.1.2 ALCOHOL INVOLVEMENT

Figure 2.5 also shows the time of day and day of week on which alcohol-involved accidents occurred. The criterion for listing alcohol involvement is that one or more of the drivers or riders had a BAC above 0.05. There are eight accidents that are in this category and a further four accidents in which a driver appeared to be intoxicated but no BAC reading was obtained. This indicates that alcohol intoxication may have played a role in about one quarter of these 45 accidents.

7.1.3 TYPES OF VEHICLES

The types of vehicles involved in the 45 accidents are shown in Table 7.1 together with an indication of the number of each vehicle type that should have given way. The apparent over-representation of "trucks" in the group of vehicles that should have given way is discussed later in this chapter.

7.2 CHARACTERISTICS OF SPECIFIC TYPES OF COLLISIONS AT SIGNALISED LOCATIONS

The types of vehicles involved in these 45 accidents are shown again in Table 7.2 in relation to the general road layout and the vehicle movements. One type of manoeuvre, turning right across the path of an oncoming vehicle, accounted for about two-fifths (28) of the 45 accidents. This relatively large number of similar accidents (for a study of this type) has made possible a detailed review that is presented in Section 7.3. The remaining 17 accidents are discussed below.

7.2.1 COLLISIONS BETWEEN VEHICLES PROCEEDING STRAIGHT ACROSS AT A SIGNALISED INTERSECTION

Category (3) in Table 7.2

Each of the seven accidents in this category involved a collision between two vehicles which approached each other on intersecting roads. Had the collision not occurred each vehicle would have continued on without stopping or changing direction.

Running a Red Light

Five of the seven accidents happened because a driver drove through a red light but we were not able to identify any feature of the road layout or traffic control system which contributed to the causation of any of these five crashes.

TABLE 7.1: TYPES OF VEHICLES AND PRIORITY IN ACCIDENTS AT SIGNALISED LOCATIONS[1]

Type of Vehicle	Operator Required to Give Way Yes	No	Total
Car	36	37	73
Motorcycle	3	5	8
Truck[2]	5	1	6
Pedal cycle	1	1	2
Train	-	1	1
Total	45	45	90

Notes: [1] 45 accidents as noted in Section 7.1; excludes five pedestrian accidents and two pedal cycle accidents.

[2] Includes one truck, one prime-mover, three semi-trailers and a bus.

In one accident (180) the offending driver claimed to have entered the intersection on a green light but there is good evidence that this was not correct. Another driver (Accident 099) claimed that the lights had been red for so long that he decided they were faulty and so he drove on, not noticing the other car entering the intersection from his right. The accident occurred soon after sunrise and the view of the approaching car may have been obscured by sun glare. We have no data on the length of the red phase at this intersection but the vehicle detectors appeared to be functioning normally.

A driver in Accident 110 was talking with his passengers and had not wiped the condensation off the inside of his windscreen before starting the journey. Possibly as a consequence of these two factors he did not notice that the lights had changed to red some seconds before he reached the intersection.

In the fourth of this group if five accidents (230, Figure 7.1) one of the drivers was not familiar with the area and said that he failed to see the red light because he was dazzled by the lights of an oncoming car. This effect was accentuated by the dirty windscreen on his car. We believe that this may have been a partial explanation for his failure to see the red light. Taken together with the distraction of a conversation with his passenger and drinking beer from a glass which seems, from our inspection of the car, to have been held in his right hand, there is little reason to be concerned about the conspicuity of the traffic signals. The accident history of this intersection suggests that the configuration of this accident (the approach paths of the vehicles) is relatively unusual, accounting for only five of a total of 189 accidents at that location in the previous three calendar years.

The fifth accident (259) was caused by a driver who appeared knowingly to ignore the red light. A witness said that he had driven through the two previous intersections on the red phase also. This driver refused to talk to us and refused to allow a blood sample to be taken at the hospital but he appeared to be intoxicated.

In two of these five accidents one driver moved off from a standstill when the signal changed from red to green. These two intersections had inter-green phases of five and four seconds respectively. The yellow period was three seconds at each location and the all-red periods were two and one seconds. In one accident this driver saw the other car coming at the last moment, but was unable to get out of the way. In the second accident the driver did not see the other car at all.

Inoperative and Flashing Yellow Signals

Late at night some traffic signals are switched to flashing yellow. (When this is done the normal priority rules apply.) We attended one crash at such an intersection (Accident 229). The driver who should have yielded said that the other car must have been speeding because he did not see it until immediately before they collided. The other driver was concussed in the crash and could not remember approaching the intersection. He had a blood alcohol level of 0.13, and was charged with exceeding 0.08. The driver

TABLE 7.2: TYPES OF COLLISIONS AT SIGNALISED LOCATIONS BY TYPES OF VEHICLES INVOLVED

	Types of Vehicles Involved								
Type of Collision[5]	Car Car[1]	M/c[2] Car	Car M/c	Car P/c[3]	Car Truck[4]	M/c Truck	Truck Truck	Train Car	Total
(1)	19	3	2	1	2	-	-	-	27
(2)	-	-	1	-	-	-	-	-	1
(3)	6	-	-	-	-	-	1	-	7
(4)	2	-	-	-	-	-	-	-	2
(5)	2	-	-	-	-	-	-	-	2
(6)	1	-	-	-	-	-	-	-	1
(7)	-	-	-	-	-	1	-	-	1
(8)	-	-	-	-	-	1	-	-	1
(9) Railway level crossing	-	-	-	-	-	-	-	1	1
(10) Other (see text)	1	-	-	1	-	-	-	-	2
Total	31	3	3	2	2	2	1	1	45

Notes:
1 The vehicle that should have yielded is described in the second row.
2 Motorcycle
3 Pedal cycle
4 "Truck" includes truck, prime-mover, semi-trailer and bus.
5 Sketches do not show exact road alignment in all cases.

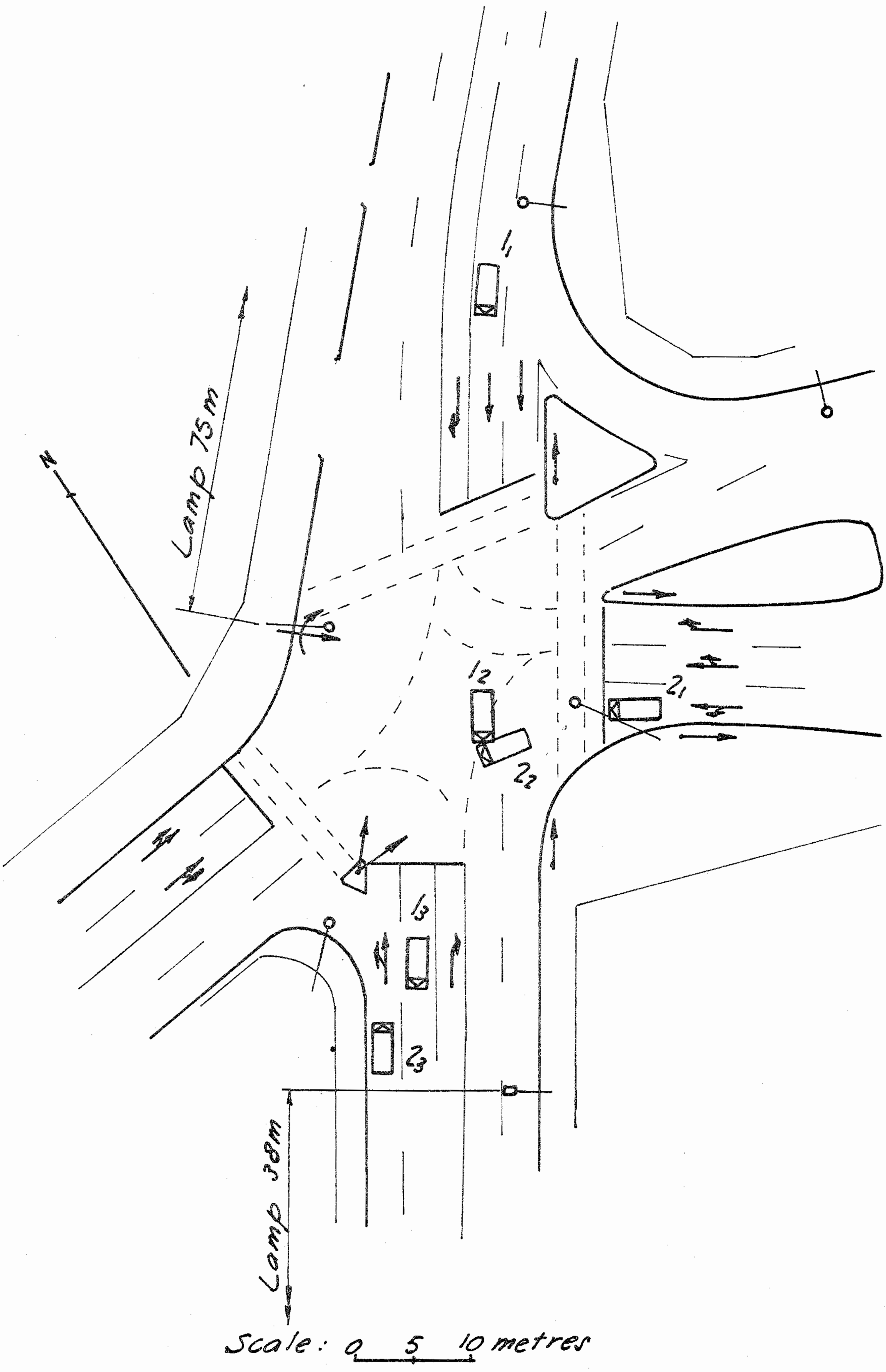


FIGURE 7.1: Accident 230

who should have yielded was not charged.

At one location the traffic signals had been switched off by a maintenance crew about five minutes before a prime mover crashed into the side of a bus (Accident 210). The truck driver had been waiting for traffic to pass through the intersection from his right. When the way was clear he moved forwards, noting one bus stationary in the centre lane on his left and a second bus moving up alongside it, in the kerb lane. This second bus did not stop but continued on into the path of the prime mover.

This accident illustrates the fact that many cues may be used by a driver in addition to or even, as in this case, in place of the information conveyed by the traffic signal itself. The bus driver appeared not to have realized that the signals were not operating, and to have assumed that the "light" was green, possibly because there were vehicles travelling in the opposite direction which had just passed through the intersection. We understand that he had also driven through the intersection in the other direction earlier that morning, when the lights were operating normally.

The police had been notified, as is normal practice, that the signals were to be turned off but no action is taken to put a police officer on point duty unless it is thought that severe traffic congestion might otherwise result. In this instance it is possible that the collision would still have occurred even if a police officer had been controlling the traffic, since a bystander reported that immediately after the crash the bus driver told him that the light was green as he approached the intersection. There was a warning sign erected on one of the other approaches to the intersection but it warned only of workmen ahead. It had been blown over and was lying face down.

Relevance of Road and Traffic Factors

Flashing Yellow Operation of Traffic Signals

The Australian Standard Manual of Uniform Traffic Control Devices (AS 1742-1975, Part 2) recommends that "At intersections controlled by fixed-time signals flashing operation may be considered as an expedient to reduce delays in off-peak periods. However, it is preferable to improve the intersection control by installing vehicle-actuated traffic signals." (para. 11.12.5) Drivers who are on the roads late at night are likely to be fatigued and possibly intoxicated. They are therefore less able to modify their driving as needed to safely negotiate an intersection which is uncontrolled when the physical cues and any familiarity with the location reinforce behaviour appropriate to a signalised intersection. Flashing yellow operation should therefore be restricted to use as an emergency measure.

Traffic Signal Maintenance

As was the case in Accident 210 it may be necessary to switch off a complete traffic signal installation to enable repairs or extensive maintenance to be carried out. This practice can greatly increase the risk of a collision occurring at the intersection, for the reasons noted above in the discussion of Accident 210, but AS 1742-1975 contains no warning of this nor any recommendation of ways in which the risk might be minimized. It seems reasonable to require advance warning signs adequate for major road works and a speed limit of, say, 25 km/h over the last 50 metres on the approaches to the intersections.

7.2.2 REAR END COLLISIONS AT SIGNALISED INTERSECTIONS

Category (5) in Table 7.2

There were two accidents (036 and 115) in the study in which a driver who had been drinking crashed his car into the back of another car which was stationary at, or in a queue at, a red signal.

In the first accident of this type (036) the car in front stopped at a yellow light. The driver following claimed that he was not expecting this, and had no time to stop. He appeared to have been drinking, but he left the scene before a breath-alcohol measurement could be obtained. His passenger said that the driver had taken his eyes off the car in front "only for a second" to pass her a cigarette.

The driver who should have yielded in the other accident (115) had a blood alcohol level of 0.23 (his passenger had a level of 0.32). A witness reported that this driver had narrowly avoided initiating a similar type of accident at the previous signalised intersection. The car which was struck was pushed into the car which was stationary in front of it and this car, in turn, was pushed forwards and hit a motorcycle which was at the head of the queue. The rider said that he had time to begin to dismount before his machine was knocked over.

One of these two accidents (115) occurred at night. The car which was at the rear of the queue of stationary vehicles was an automatic and the driver had his foot on the brake, with the result that the brake lights were on, as well as the tail lights.

7.2.3 OVERTAKING A TURNING VEHICLE

Category (7) in Table 7.2

In Accident 014 a truck turned left from the second lane from the kerb at a signalised intersection and collided with a motorcycle which was attempting to pass it

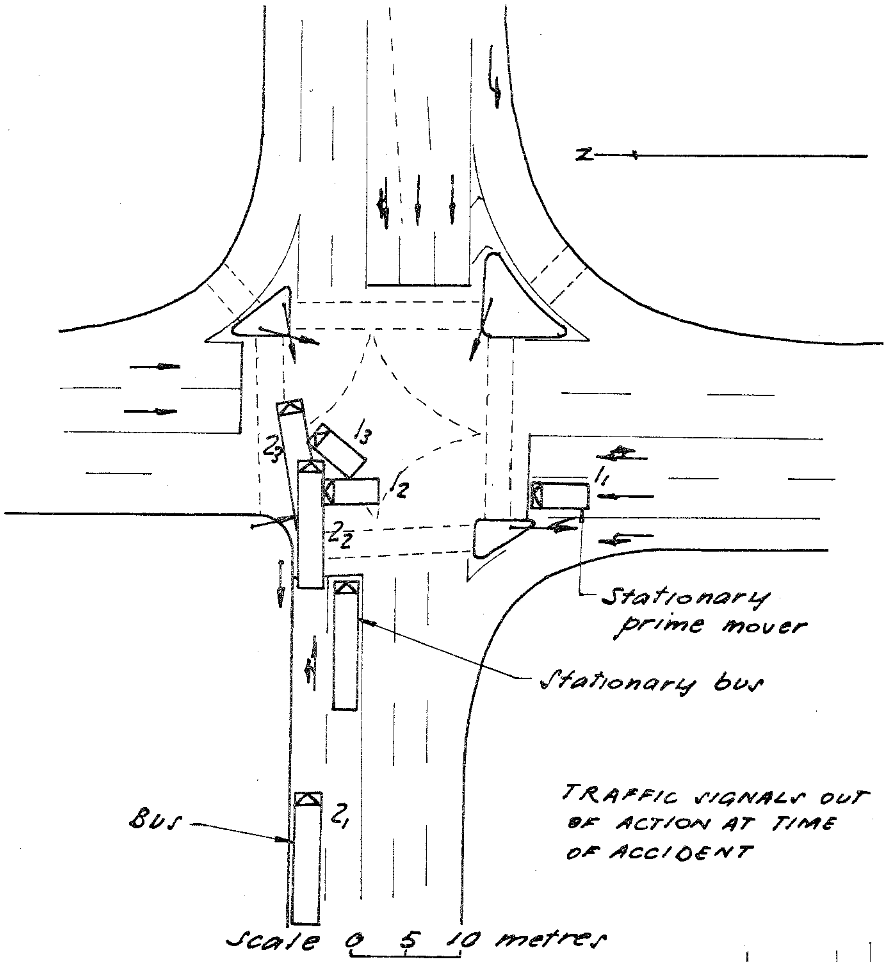


FIGURE 7.2:
Accident 210.

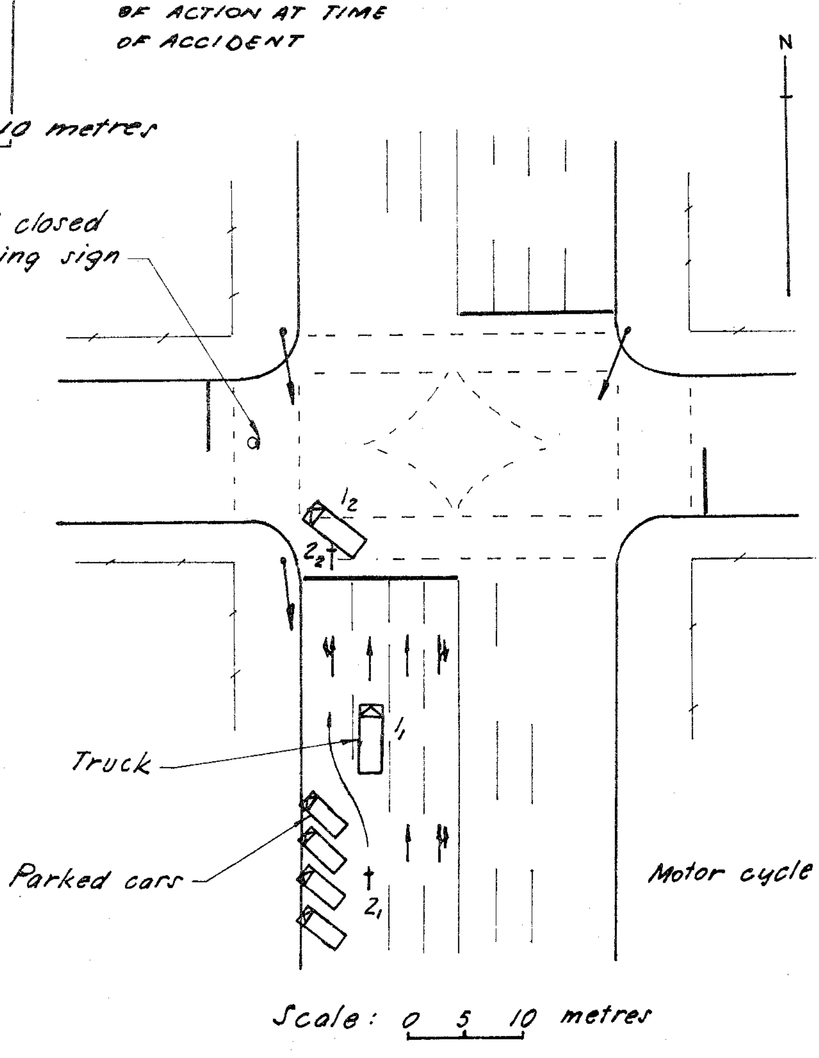


FIGURE 7.3:
Accident 014.

on the left (Figure 7.3). A temporary works barrier had been erected in the centre of the street on the left and the truck could not negotiate the turn from the left lane. This left lane is also not continuous, there being cars angle-parked along most of the block, and so the truck had been travelling in the second lane as it approached the intersection. The motorcyclist was following the truck, and expected to be able to pass on the left quickly enough to get back into the second lane before the next angle-parking area beyond the intersection. Unfortunately the left rear turn indicator on the truck was not working although the front one was. The truck driver had seen the motorcyclist behind him in his rear vision mirror but did not see her move up alongside him, possibly because the field of view of the left side mirror was small, being partially obstructed by the tray of the truck. The motorcyclist received no warning of the truck being about to turn left because the rear left turn indicator on the truck was not working.

Relevance of Road and Traffic Factors

References are made elsewhere in this report (eg: Section 4.2.1 and later in this Chapter) to the hazards that may be associated with auxiliary lanes at signalised intersections. At this location the auxiliary lane is formed by the restriction of parking on the approach to, and exit from, the intersection rather than by a physical widening of the carriageway. Even so, the lane formed in this way does allow for and appears to encourage hazardous passing manoeuvres.

7.2.4 TURN LEFT: COLLISION WITH VEHICLE ON RIGHT

Category (8) in Table 7.2

Figure 7.4 shows the road layout and vehicle movements in Accident 127 in which a motorcyclist who turned left from the kerb lane when the signal changed to green was run down from the rear by a semi-trailer that was late in crossing the intersection. The rider, on turning left, had swung across to the centre lane, of two, intending to make a right hand turn into a side street, but was run down from behind by a semi-trailer which had failed to clear the intersection during the preceding intergreen period. The semi-trailer was probably about five to ten metres away from the far side of the intersection when the motorcyclist reacted to the green light and accelerated off into the street on his left. The rider had not looked to his right and did not see the truck before the impact. He sustained extremely severe leg injuries and now has a major permanent physical disability.

The distance across this intersection in the path of the semi-trailer is 35 metres. The intergreen period is 5.5 seconds, comprising three seconds yellow and 2.5 seconds all red. The approach to the intersection has an average uphill slope of one in twenty over the last 200 metres and so there is some incentive, in addition to avoiding being delayed by the lights, for the driver of a semi-trailer to avoid stopping if at all possible.

We could not determine whether or not the driver of the semi-trailer did run the red light. He was charged with that offence but it was subsequently withdrawn, leaving a charge of driving without due care. Although it is possible that this accident resulted largely from this driver disobeying the traffic signals, the safe operation of a signalised intersection does depend in part on the adequacy of the intergreen period in relation to the layout of the intersection. The issues involved here are well known (eg: Gazis, Herman and Maradudin, 1964; McGill, 1970) but, as illustrated by the phasing of the signals at this intersection, knowledge is not always translated into practice.

The two options available to the driver of a heavy vehicle on seeing the signal change from green to yellow as he approaches an intersection are to stop or to continue on at a steady speed (assuming negligible acceleration in the circumstances of Accident 127). Allowing one second for the driver to recognize that the light has changed, to decide to stop, and to start braking and taking a deceleration of 0.3 g for a semi-trailer when braking under normal circumstances then at a speed of, say, 50 km/h the driver must be at least 47 metres back from the stop line if he is to be able to stop without encroaching on the intersection. But if he decides to continue on at this speed, even if the yellow light has just come on when he is 47 metres back, he will not reach the far side of the intersection before the end of the intergreen period. He will, in fact, still have about five metres to go to reach this point, and fifteen metres, or just over one second, to go before he is fully clear of the intersection. So, over about five metres of his approach to the intersection, if the light changes to yellow, he can neither stop in time nor get to the far side of the intersection. This "booby-trap" distance is 15 metres if he is to fully clear the intersection. The same outcome can be shown to apply to all approach speeds in the range of 40 to 55 km/h. At speeds above and below this range this difficulty is accentuated. Therefore an all-red period of 3.5 seconds (an intergreen period of 6.5 seconds) would seem to be a more reasonable setting at this intersection than the actual all-red period of 2.5 seconds.

It can be argued that all drivers should check for vehicles "running the lights" before moving off when they get the green light. While this is a practice to be recommended, casual observation of driver behaviour suggests that it is not very common and so should not be relied

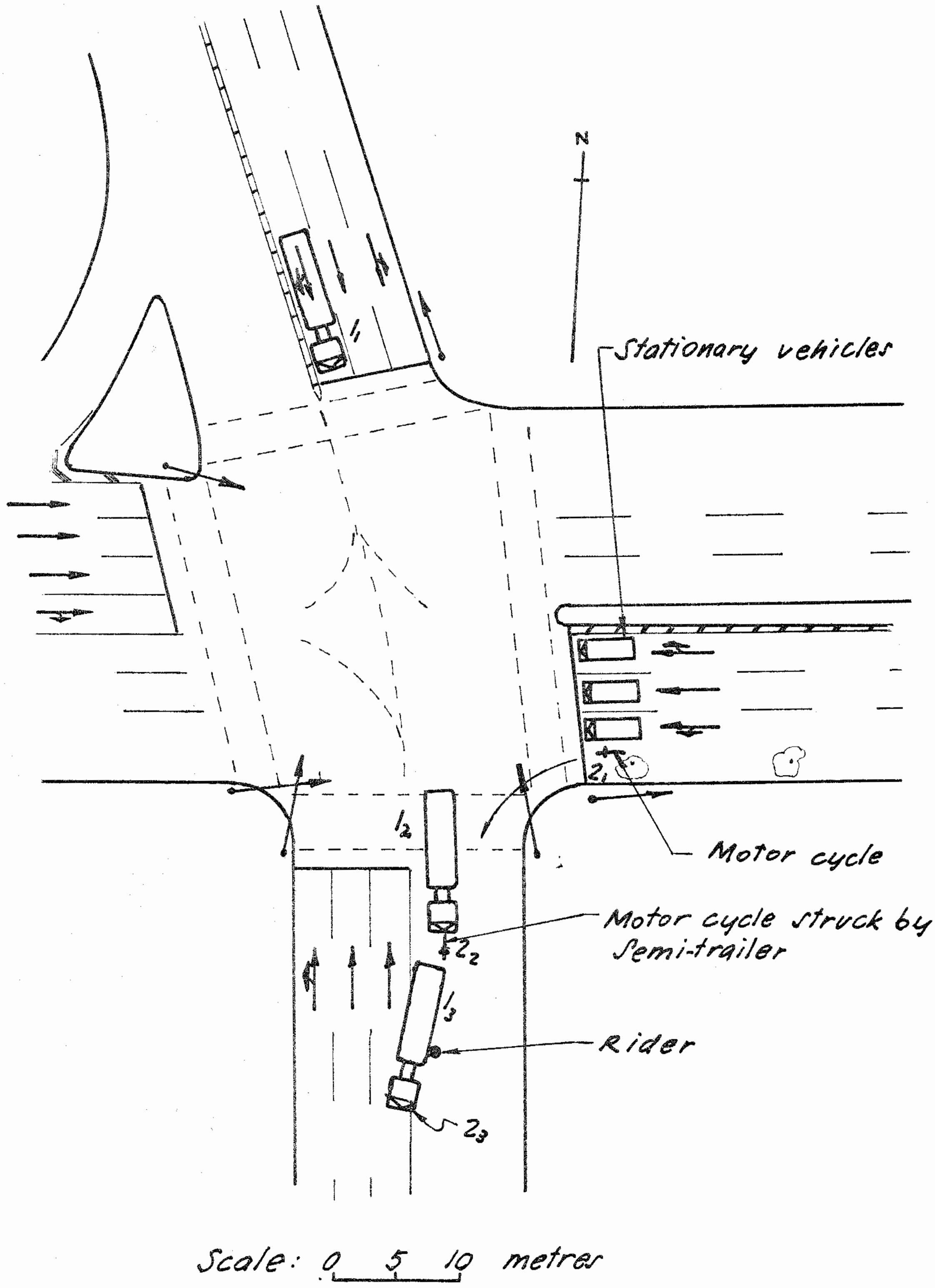


FIGURE 7.4: Accident 127.

upon when calculating the timing of traffic signals. Furthermore, the potentially most dangerous situation is when a driver approaches the intersection and is able to go through as the signal changes to green without slowing down. If this vehicle is in a nearside (left) lane and other vehicles are still stationary in the other lane/s, then they may obstruct this driver's view of the intersection. This increases both the risk of a collision with a vehicle which is still crossing the intersection and the probable severity of the consequences.

It is recognized that the value of the safety factor provided by the all-red period is diminished, or lost altogether, if many drivers habitually try to take advantage of it by entering the intersection after the light has changed to red or by starting off before the green signal appears. This tendency, which may be greater with longer all red periods, may be able to be adequately controlled by the current police practice of observing driver behaviour at signalised intersections and apprehending those drivers who do not stop when the light has changed from yellow to red.

7.2.5 TURN RIGHT: COLLISION WITH VEHICLE ON RIGHT

Categories (4) and (6) in Table 7.2

The three accidents in these categories all involved a car that moved off, with the intention of turning right, as the signal changed to green only to collide with another car that approached from the intersecting road on the right. Two of these locations were T-junctions, with one car initially stationary at the stem of the "T" and the third was a four-way intersection, again with one car initially stationary.

Alcohol intoxication appears to have been a significant factor in the failure of two drivers to respond appropriately to the signal changing to red. In one of these accidents (004, Figure 7.5) the driver saw the light change to yellow, then red, but decided to continue on across the intersection. When a car appeared from the road on his left he braked but was unable to avoid colliding with it. The other driver, who was intending to turn right, did not realize that a collision was likely until the last moment. He then tried to accelerate out of the way. The driver who ran the light was breathalyzed by the police and was found to have a blood alcohol level of 0.10. (He was charged with exceeding the legal limit of 0.08). The other driver was found to have a blood alcohol level of 0.07, from a blood sample taken at the hospital.

The second accident (242) involving an intoxicated driver occurred at a T-junction. This driver passed a queue of cars which had stopped in the kerb lane when the signals changed to red and collided with a car which had moved off from the stem of the "T" on his left. He claimed, incorrectly, that he had a green light. He agreed to blow into our breath alcohol meter, which registered a level of 0.12. However he was not tested by the police and so was not charged with any offence in relation to this accident. The other driver was sober and had noticed the stationary cars on his right but because of the presence of these cars he could not see the other car approaching.

The third accident of this type also occurred at a T-junction (Accident 024, Figure 7.6). Both drivers were sober and we suspect that the one who ran the red light, which had been red for almost a minute, may have been paying more attention to his passengers whom he had picked up only a minute or two before than to his driving. It is possible that he mistook a green left turn arrow for a regular green signal light but this seems to be unlikely. This car was travelling in the third lane of five on a 10 lane divided road. The two green arrows are located to the left of the carriageway and there are four red signals also illuminated during that phase; two primary signals, one on the median and one cantilevered out over the kerb lane and two secondary signals on the far side of the intersection. The other driver was looking to his left as he entered the intersection from the stem of the "T", since traffic had been turning right across in front of him during the previous phase of the signals and he was making sure that no-one was running the lights from that direction.

Relevance of Road and Traffic Factors

Two of the three drivers who failed to stop for a red signal were intoxicated and the third may have been distracted by his passengers. The conspicuity of the signals appeared to be adequate but there may be value in an investigation of the effects that BACs above 0.10 may have on a driver's perception of and reaction to standard signal installations.

7.2.6 RAILWAY LEVEL CROSSING

Category (9) in Table 7.2

The young male driver of a small car was killed, and his passenger injured, in a collision with a diesel-powered commuter train (Accident 264). He had stopped at a level crossing where both a STOP sign and flashing lights and bells were installed. The lights were operating, and continued to operate after the train had passed through because a second commuter train was approaching from the other direction. Although the bells were still ringing the driver drove into the path of this second train, which was approaching from his right, on the track nearest to him. The car was struck broadside-on and pushed

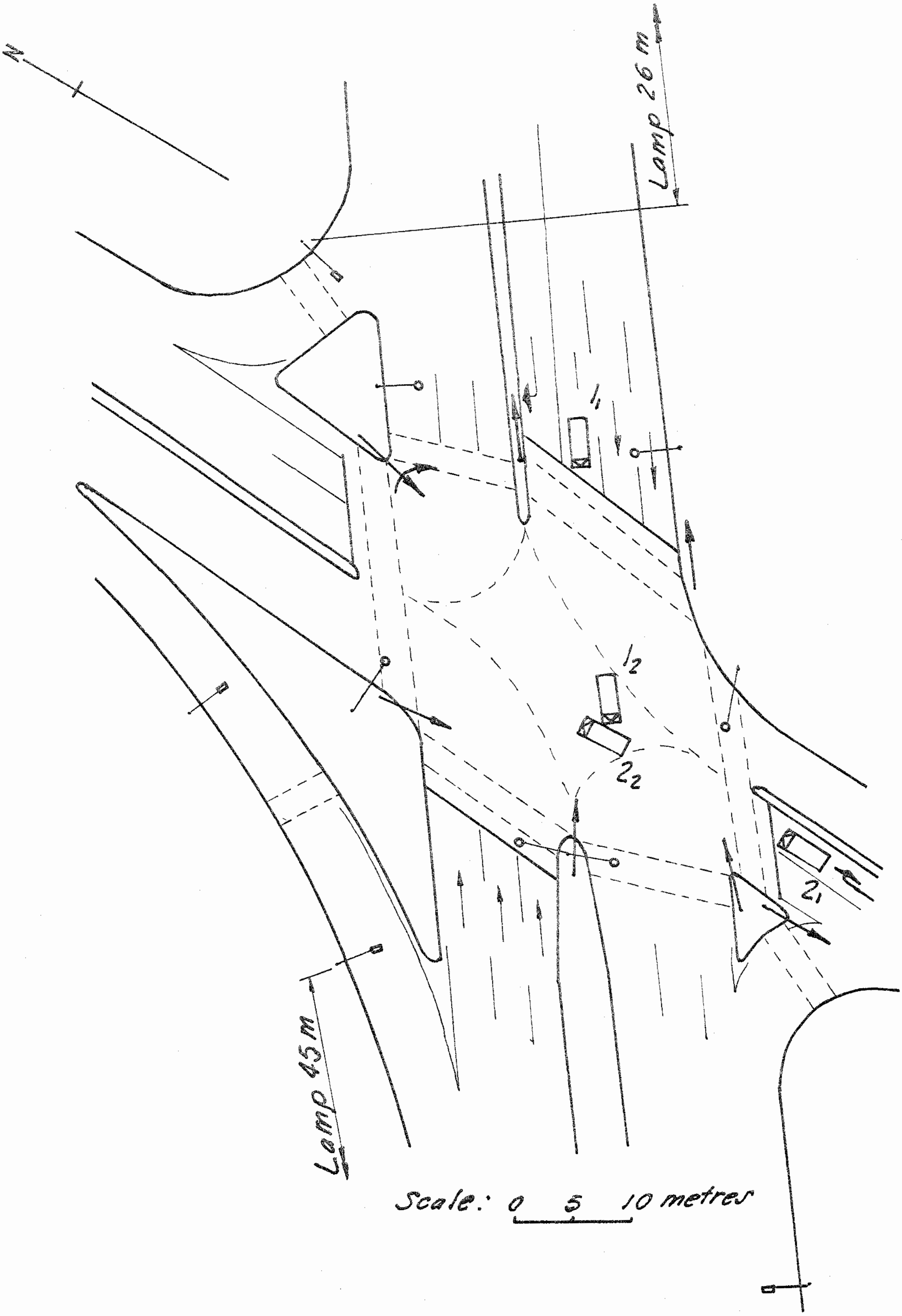


FIGURE 7.5: Accident 004.

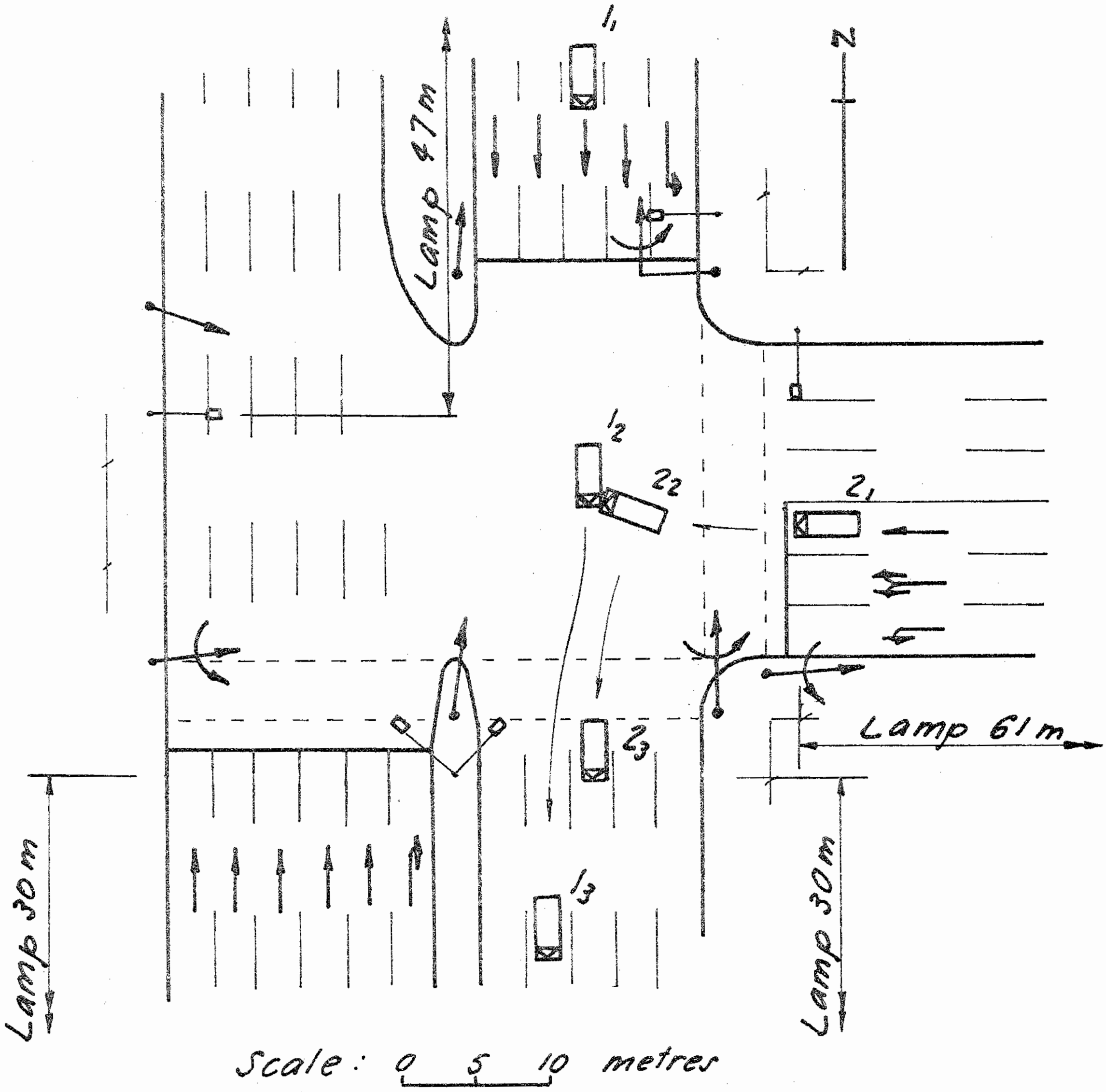


FIGURE 7.6: Accident 024

146 metres along the track. The initial contact was made by the coupling on the front of the train. The car was then pushed along by the fender mounted across the front of the train, below the coupling (Figure 7.7).

We do not know whether it occurred to the driver of the car to look to his right to check whether a second train was approaching, but even if he did he could be excused for not seeing it. Two large controlboxes are located in such a way alongside the railway line as to almost completely obscure from view an approaching train (Figures 7.8 and 7.9).

A small sign does warn motorists that there are two tracks at this level crossing but it does not note the consequent importance of ensuring that the warning bells have stopped before moving forwards after a train has passed. In any event, the message on this sign is likely to be of little value because the sign is located on the near side of the intersection where neither it nor the flashing lights on that side can be seen by the driver of a car stopped at the STOP line (Figure 7.10).

The warning bells started 45 seconds before a train approaching from the left reached the crossing and 85 seconds before one coming from the right. The bells continued to ring for two seconds after the rear of the train cleared the crossing. During the subsequent period of observation none of three consecutive trains approaching from the right, including one that "overlapped" an oncoming train, sounded a warning.

When the train came to rest after the collision and the passenger had been removed from the car, the train driver ran about 150 metres along the tracks to the nearest railway telephone box. He was unable to use this telephone because the necessary party line codes were not displayed. He then ran on, along the tracks, to the next station, some 300 metres further on. Had the train been equipped with two-way radio emergency aid could have been summoned much more quickly and the railways notified of the occurrence of the collision. Since the time of this accident two-way radios have been installed in suburban railcars. This was done not for safety reasons, in the sense of accidents of this type, but because of a spate of attacks on train drivers and guards on off-peak trains ("The Advertiser" July 26, 1978).

Relevance of Road and Traffic Factors

This accident would almost certainly have been prevented had boom barriers been installed. With a boom barrier the driver's response to the warning bells, his awareness of the "2-tracks" warning sign (which was outside his field of view) and his severely obstructed view of the approaching train all become secondary factors and the risk of fatal errors is very greatly reduced.

7.3 RIGHT TURN IN FRONT OF OPPOSING TRAFFIC AT A SIGNALISED INTERSECTION

Categories (1) and (2) in Table 7.2

Twenty-eight of the 45 collisions at signalised intersections involved a vehicle turning right and colliding with a vehicle proceeding straight through the intersection from the opposite direction. One other accident (030) that has been classified in this report as a single vehicle accident is included here because it resulted from a narrowly-avoided collision with a right-turning car. This means that there are 29 accidents reviewed in this Section. They are classified according to the main driver error in each accident in Table 7.3. This system of classification is not exclusive and some of these and other driver errors were relevant to more than one accident, as indicated by the data in Table 7.4.

7.3.1 ILLEGAL RIGHT TURN

One driver, knowing that right turns were prohibited, nevertheless attempted to turn right across the path of an approaching car immediately after the green signal appeared (Accident 272). He said that his car faltered and then accelerated rapidly. It crashed into the oncoming car and then continued accelerating down the road to the right. The occupants of the struck car were both wearing seat belts, and received only a minor injury, but the cost of the damage to their vehicle was estimated at the scene to be about $2,000. The other car was found abandoned at the back of a service station 300 metres away from the intersection. The driver, who dropped a carton of bottled beer in his haste to leave the car, did not go back to the intersection to see whether anyone had been injured. He reported the accident to the police on the following day and was later charged with driving without due care and fined $20. A charge of failing to obey a NO RIGHT TURN sign was withdrawn and he was not charged with failing to stop after an accident.

This accident has no apparent relevance to the road layout or traffic control system at this intersection, but it does suggest that the police may have to overcome more difficulties than is generally realized in securing convictions for breaches of the Road Traffic Act and hence may be reluctant to press charges unless they expect to be able to do so successfully.

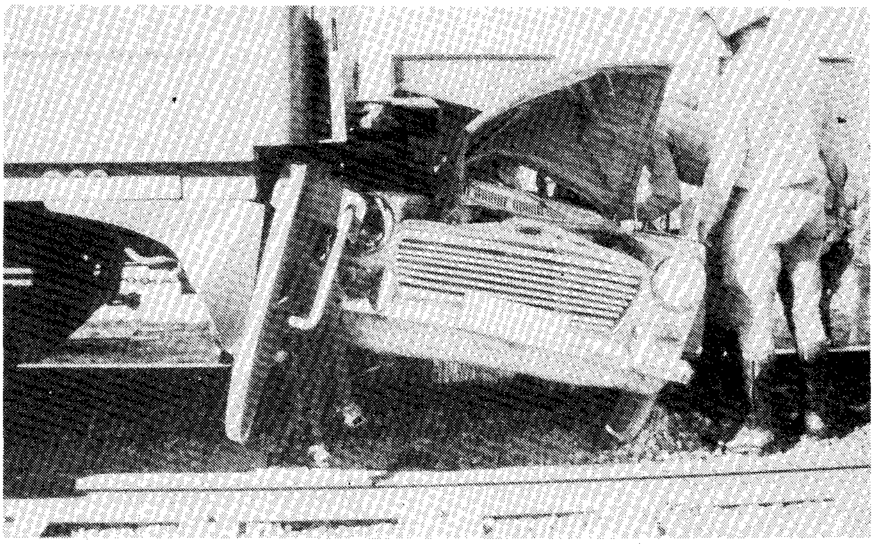


FIGURE 7.7: Final positions of car and train, Accident 264.

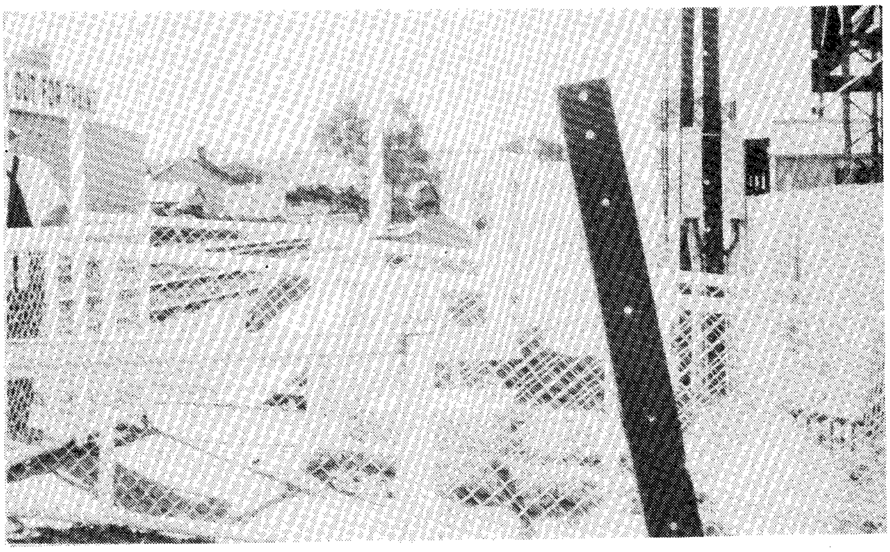


FIGURE 7.8: Approaching train hidden from driver by control boxes, Accident 264 (see Figure 7.9).

FIGURE 7.9: See Figure 7.8.

FIGURE 7.10: Location of warning signs and flashing lights at the level crossing (Accident 264).

FIGURE 7.11: Damage to car from secondary collision with signal pole (Accident 173).

TABLE 7.3: RIGHT TURN IN FRONT OF OPPOSING TRAFFIC AT A SIGNALISED INTERSECTION: MAIN DRIVER ERRORS

Main Causal Factor	Number of Accidents
Failure to allow for obstruction to vision by stationary vehicles in centre lane/s	13
Turning driver did not see oncoming car (no obstruction to vision)	11
Through vehicle ran the red light (no obstruction to vision)	2
Through vehicle entered on yellow light after vehicles in the left lane had slowed or stopped, turning vehicle assumed all oncoming vehicles would stop (no obstruction to vision)	2
Illegal right turn	1
Total number of accidents	29[1]

Note: [1] Includes Accident 030 that is classified in this report as a single vehicle accident (see text).

7.3.2 TURNING VEHICLE ASSUMED ALL ONCOMING VEHICLES WOULD STOP

In five accidents the driver of the turning vehicle saw a car slow down and stop when the lights changed to yellow. Although there were two or three through lanes these drivers assumed that the other vehicles approaching would also stop. They were mistaken. Two of these approaching vehicles were semi-trailers and their drivers both said that they saw the lights change but, because they thought they could not stop in time, they just continued on across the intersection. The intergreen periods at these two locations are five (Accident 123) and six (Accident 170) seconds, with the yellow period being three seconds. The collision in Accident 123 occurred during the yellow phase. In Accident 170 the semi-trailer ran the red light.

The two intersections at which these accidents occurred are on one of the main routes followed through the metropolitan area by heavy vehicles which use the main interstate highway through the Adelaide hills. These semi-trailers were both on an interstate run.

The other accident of this type, in which the turning driver could see another vehicle approaching but assumed that it, too, would stop, involved two cars (Accident 050). The driver who passed the slowing or stationary cars still had a yellow light and he expected the turning car to wait until he had passed.

The remaining two accidents in this category differ from the three above because the turning driver could not see any other vehicles approaching. The stationary or slowing vehicles were in the right hand lane and they blocked the turning driver's view. The significance of the road layout and traffic controls in these accidents will be considered later but it is of interest to note that one through vehicle ran a red light and was almost certainly speeding (Accident 152) and the other one was a motorcycle ridden by a sixteen-year-old who had held a licence for three weeks (Accident 143). When this rider saw the light change to yellow he decided that he would not be able to stop in time so he continued on. The collision occurred before the lights had changed to red.

7.3.3 TURNED RIGHT AT START OF GREEN PHASE

One of the four accidents in which the turning driver moved off as soon as the lights changed to green has been discussed above under "Illegal Right Turn".

Two other accidents occurred at intersections at either end of a relatively new two kilometre stretch of six lane divided road. One turning driver thought that he could complete his turn ahead of the facing cars when the light turned green (Accident 150). He collided with a car which came through in the kerb lane (of three) at about 50 km/h. The second accident (Accident 206) was almost identical

TABLE 7.4: RIGHT TURN IN FRONT OF OPPOSING TRAFFIC AT A SIGNALISED INTERSECTION: SIGNIFICANT DRIVER ERRORS

Significant Driver Errors	Number of Times Observed
Failure to allow for obstruction to vision by stationary cars in centre lane/s	13
Turning driver did not see oncoming car (no obstruction to vision)	11
Through vehicle ran the red light (no obstruction to vision)	5
Turning vehicle moved off when signal changed to green, despite oncoming traffic	4
Through vehicle approached the intersection without slowing down and entered as the signal changed to green (obstruction to vision in each case)	3
Through vehicle entered on yellow light after vehicles in the right lane had slowed or stopped, turning vehicle assumed all oncoming vehicles would stop (obstruction to vision in 2 cases)	3
Through vehicle entered on yellow light after vehicles in the left lane had slowed or stopped, turning vehicle assumed all oncoming vehicles would stop (no obstruction to vision)	2
Illegal right turn	1
Total number of significant driver errors	42

to this one except that the through vehicle was reported by an independent witness to have been speeding and the driver of the turning vehicle claimed that he mistakenly thought that he had a green arrow because there was one for traffic on the intersecting road, with which he was more familiar. However he did have a full load of passengers and may not have been concentrating on the signals and traffic conditions.

The final accident in this group of four was another hit-run (Accident 173). The car that was travelling straight ahead was pushed across into a signal pole (Figure 7.11). We calculated a mean speed for through traffic at this location of 60.7 km/h and a maximum observed speed of 77 km/h. These figures are based on radar meter measurements of the speeds of 96 vehicles taken at the same time of day and day of week as that on which the accident occurred. We do not have reliable information on the speed of the through vehicle in this accident, although we do know that it did not have to slow down because the signal changed to green as it approached the intersection. The turning car then started to move, so the through driver sounded his horn, but did not attempt any other evasive action. Immediately after the impact someone got out of the turning car, looked at the damage, and got back in. The car then drove away.

As we learnt more about this accident, and interviewed the female driver, we came to suspect that the male passenger may in fact have been driving. He had been convicted of driving under the influence of alcohol two years before, and a second conviction would have carried with it a mandatory gaol sentence. The person who claimed to have been driving appeared to find it difficult to describe what had happened in the events leading up to the accident.

7.3.4 FAST THROUGH VEHICLE ENTERS AS SIGNAL CHANGES TO GREEN

Two accidents in which the through vehicle entered the intersection without slowing down just as the signal changed to green have been described in the previous Section (Accidents 150 and 206). The third accident of this type involved a cyclist who was turning right across four through lanes (Accident 107). Although turning with a green arrow, the cyclist failed to clear the intersection during the intergreen period and was hit by an oncoming car which entered the intersection from the kerb lane. There were stationary vehicles in the other three lanes (Figures 7.12 to 7.14).

The road layout at these locations encourages through traffic to take the risks which resulted in these three crashes. Accident 150 occurred at a location where the third (kerb) lane becomes a parking lane (defined by a continuous separation line) soon after leaving the intersection. In Accident 206 a three lane road is reduced to a single lane on an unmarked two-way road 200 metres beyond the intersection. In Accident 107 the kerb lane becomes one in which parking is legal at the time at which this accident happened. In each of these accidents the driver in the kerb lane had passed cars which had been waiting at the lights. Unless he had gone fast enough to get ahead of the cars at the front of the queue, he would have risked being blocked in the terminating kerb lane.

The provision at the approach to an intersection of a lane which continues for a limited distance only on the exit side can increase the capacity of the intersection considerably without the expense of constructing the lane midblock where it is not required for capacity purposes (Australian Road Research Board, 1968). Unfortunately it also entices the through driver into a situation in which he is travelling too fast to avoid a collision by the time that he can see the turning vehicle. Similarly, the driver of the turning vehicle has no chance of avoiding such a collision. The fact that the through vehicle has reason to pass through the intersection as rapidly as possible means that when a collision of this type does occur the consequences are likely to be very serious. For example, the 21-year-old left front passenger in the through car in Accident 206 was wearing a seat belt and yet sustained multiple injuries which required 44 days hospitalization. For these reasons we suggest that this method of increasing the capacity of a signalised intersection is dangerous.

The cyclist in Accident 107 had an additional problem with which to contend. The distance that a turning vehicle has to cover from the stop line to clear the intersection is 45 metres. This cyclist had covered 37 metres from the stop line when struck by the car which had entered the intersection rapidly from the kerb lane. The intergreen period here is four seconds, with a three second yellow. This means that a vehicle which starts a right turn as the arrow signal changes from green to yellow must average 40 km/h to clear the intersection before oncoming traffic gets a green light. This is obviously an unrealistic requirement for a pedal cyclist.

An all-red period of only one second may have been selected for this turning movement on the assumption that the oncoming vehicles have a clear view of any turning vehicles. This is not so, as this accident demonstrates. Increasing the period to four seconds would make the intersection safer, but even then a cyclist starting to turn as the light changes to yellow would have to average 23 km/h.

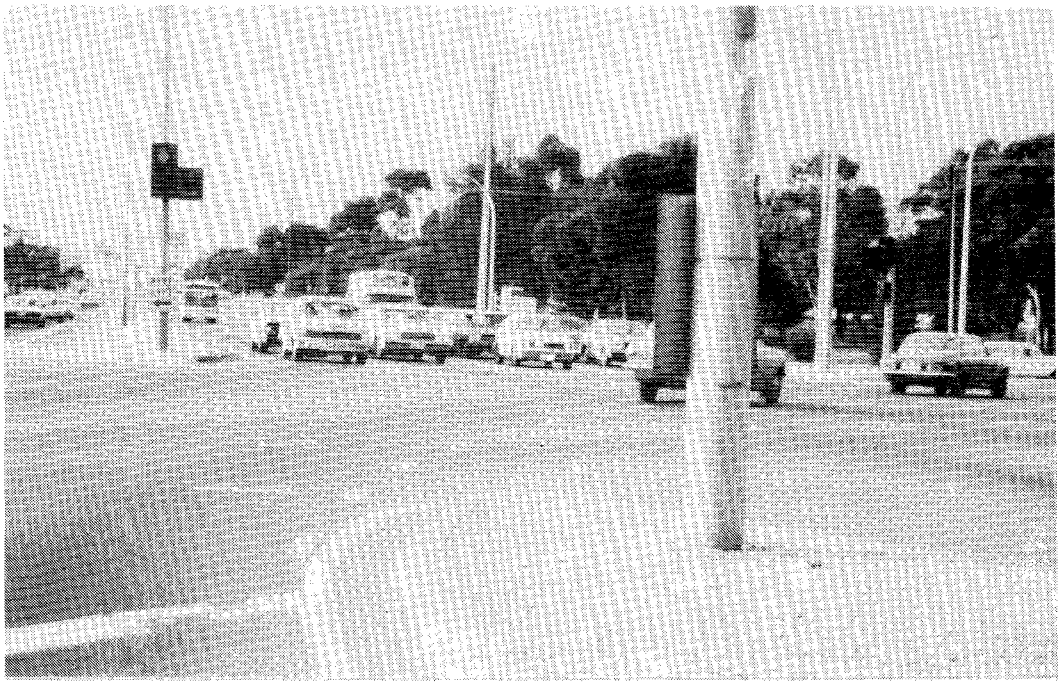


FIGURE 7.12: Cyclist's view of path across intersection (Accident 107).

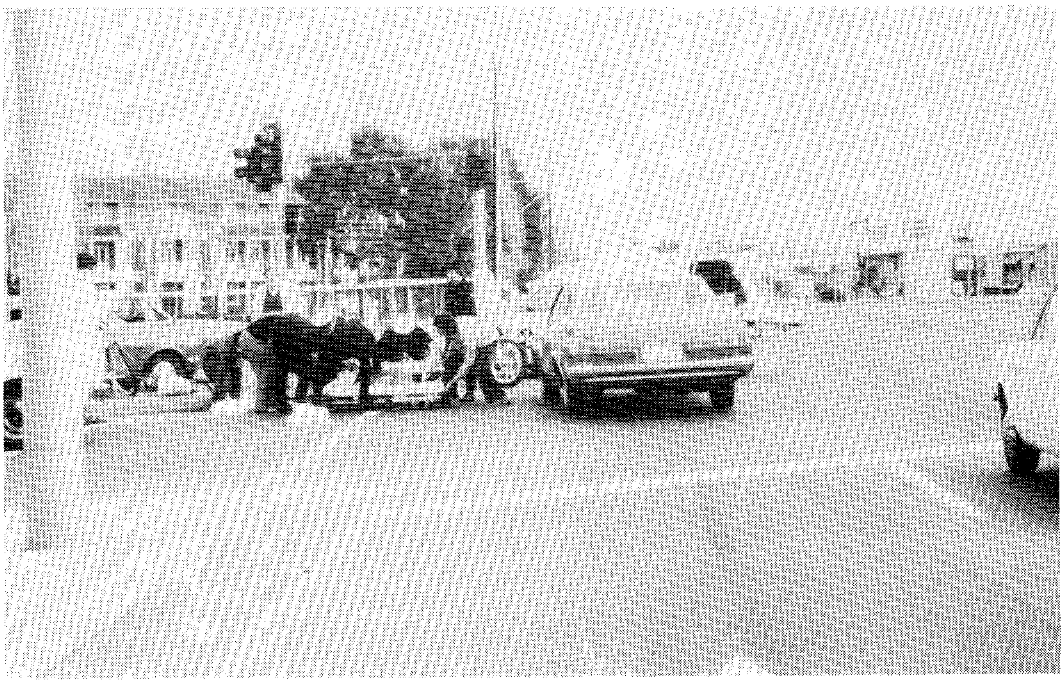


FIGURE 7.13: Driver's view of approach to the intersection, and final position of car (see Figure 7.12).

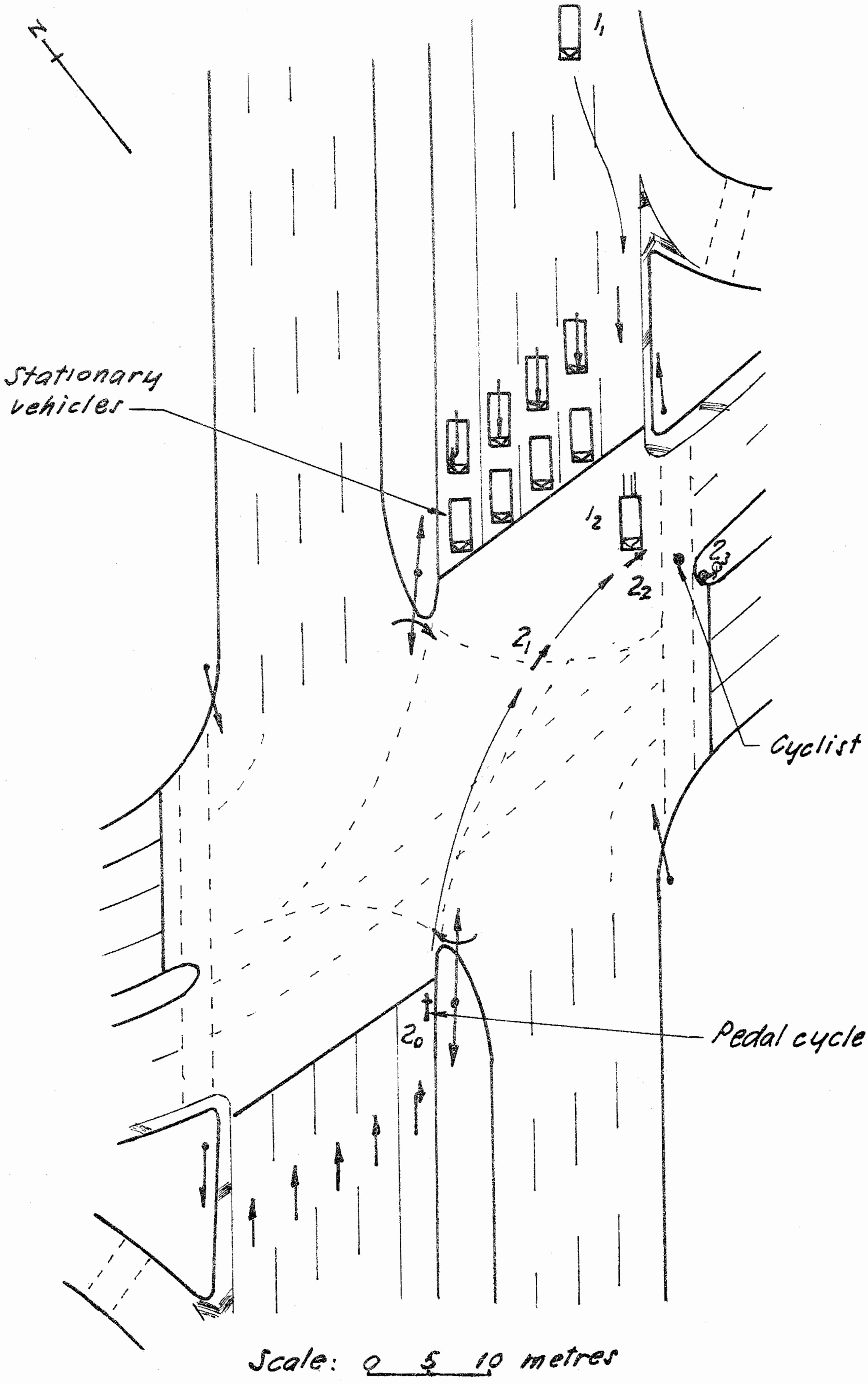


FIGURE 7.14: Accident 107.

7.3.5 THROUGH VEHICLE RAN THE RED LIGHT

The common conception of the main cause of collisions at signalised intersections may be that one driver runs the red light. But we believe that this happened in only eleven of the 38 applicable accidents which we attended at these locations. In 29 of the 38 accidents a vehicle turned right across the path of an oncoming vehicle but in only five cases did a driver run a red light.

Three of these five accidents have been discussed previously. They are the two accidents involving semi-trailers (123, 170) and one in which the car saw an oncoming vehicle slow down to stop in the right lane and so it moved across only to be hit by a car which came through, probably on the red light, in the left lane (Accident 152).

Accident 260 is similar to Accident 152 except that the vehicles in the right hand lane had been stationary for some time, waiting to turn right. Witnesses reported that the through vehicle was travelling very fast. In the fifth accident in this group (073) a motorcyclist rode into the side of a turning car. Again, a witness stated that the motorcycle continued on even though the signal had changed to red. The rider told us that he had a green light but he also mentioned that he had been distracted by a car reversing out into his path as he approached the intersection. Both the rider and driver were aware of the presence of the other vehicle.

7.3.6 TURNING DRIVER DID NOT SEE ONCOMING VEHICLE: NO OBSTRUCTION TO VISION AT THE INTERSECTION

Many of these accidents in which one vehicle turned right across the path of an oncoming vehicle happened because the driver or rider of the turning vehicle did not see the other party approaching. In this Section we review eleven accidents in which there was no reported obstruction to vision at the intersection itself although in one of these accidents (066) the turning driver's view of the approach to the intersection was blocked by a fence on the median.

One of these cases we have discussed previously and noted that we suspect that the passenger may in fact have been the driver (Accident 173). Whoever was driving presumably did not see the other car coming, but we do not know why.

Mention has already been made of an accident in which a pedal cyclist lost control of his bicycle when forced to swerve to avoid a collision with a car which turned right in front of him (Accident 030). The driver of the car did not know why he had not seen the cyclist. He could not recall following another car which was also turning right but a witness said that this had been the case.

In another accident (124) the turning driver received severe head injuries and could not remember any of the events leading up to the crash. He turned at an intersection where there is a green right turn arrow, but did so, apparently, without waiting for the arrow to appear.

Two drivers admitted that they simply turned without looking to check that the way was clear. One was concerned that a police motorcyclist who was waiting for the lights to change on the intersecting road would stop him because his car was excessively noisy, having a blown muffler (Accident 084). Consequently the driver was accelerating into the turn as slowly as possible, keeping one eye on the police officer. He allowed one oncoming car to pass, but did not see another car which was some distance behind it. In the other accident the driver of the turning car followed another car into the intersection (Accident 193). When the lead car completed its right turn, this driver tried to follow, but was struck by the through vehicle.

The remaining six accidents are notable in that five of the turning drivers had held a licence for eight months or less, the average time being less than four months. One of these drivers had not driven through the intersection before and did not appreciate that the approach from the far side was curved and that the adjoining building prevented him from being able to see very far down that road (Accident 059). The accident occurred at night. The driver of the through car may not have been paying attention to his driving; he was eating a pasty as he approached the intersection.

Two other novice drivers could not explain why they had not seen the other vehicle approaching (Accidents 055 and 295). One driver who had held a licence for two months admitted that she was busy talking with her passengers as she started to turn, suggesting that this could have accounted for her failing to see the other car (Accident 302).

A motorcyclist, licensed for one month (although having held a car licence for a year), turned right before a green right turn arrow appeared and collided with a car driven by an elderly male driver whose blood alcohol level was 0.14 (Accident 223). The rider claimed that he had a green arrow but his pillion passenger reported otherwise. Neither party was charged with an offence against the Road Traffic Act.

In the last accident of this type the turning car was following a car driven by a friend (Accident 066). They both had been balked by a car which had stalled at the front of the right turn lane, and they had passed this vehicle on the left. This meant that they started to cross the intersection at a greater angle to the oncoming traffic than would otherwise have been the case and a chain-wire fence and bushes on the median strip on the far side of the intersection could have concealed the presence of the car which was coming towards them in the lane adjacent to the median. The driver of the second turning car was also unfamiliar with this intersection.

Most of the eleven cases in this category may be attributed in part to the inexperience of the turning driver. This suggests that the potential hazards associated with this manoeuvre should be emphasised in driver training courses.

7.3.7 NEITHER DRIVER SAW THE OTHER VEHICLE APPROACHING: STATIONARY VEHICLES OBSTRUCTED VISION AT THE INTERSECTION

There were 15 accidents (or 54 per cent) in which one or more vehicles which were stationary in the opposing right lane/s obstructed the turning driver's view of the through vehicle, and vice versa. In one other case, which has been discussed previously, the through vehicle was a semi-trailer which could still be seen above the stationary vehicles (Accident 170). This is a much higher percentage than the 21 per cent reported by Simpson (1973) who studied police reports of accidents of this type in Adelaide.

Six of these 15 accidents have been discussed under previous headings. The presence of stationary vehicles was noted, but to facilitate a review of these accidents the case numbers are: 107, 143, 150, 152, 206 and 260. Some of these cases prompted a discussion of the hazards associated with the provision of an additional through lane at the intersection. Accident 095 is yet another illustration of an accident at such an intersection.

A motorcyclist, with a pillion passenger, rode from a single lane stretch of road up to a three lane approach to the intersection (the kerb lane becomes a parking lane beyond the intersection). He was in the centre lane following a car which began to slow down. As the signal was still green the motorcycle went across to the third, or kerb, lane and passed the car. At this moment another car which had been at the head of a queue of vehicles waiting to turn right from the other direction decided to move off, possibly assuming that the car in the centre lane was about to stop, even though the lights had not changed. The front of the car hit the right side of the motorcycle, fracturing the pillion passenger's right femur. He was hospitalized for 42 days and now has a minor permanent disability.

The car driver refused to talk with us, both at the scene and subsequently. He also refused to give the police any information apart from his name and address. Consequently our information on the phase of the signals came from the rider, and from an independent witness.

The remaining case involving a motorcycle (Accident 234) resulted in even more severe leg injuries. The rider entered the intersection from the left lane after the yellow light had come on because he thought that he did not have time to stop. He had held a motorcycle licence for three months. The car waiting to turn did so when the lights changed and he thought that no vehicle was approaching in the opposing left lane.

Two other accidents involved relatively inexperienced road users. The through driver in Accident 200 had been licensed for four months. When he was about to enter the intersection he saw the car that was waiting to turn start to edge forward. He assumed that it would stop, but the other driver assumed that the through car would go around him. It did not.

Accident 120 involved two relatively inexperienced drivers, one with ten months experience and the other, in the turning car, with sixteen. The latter driver admitted to having had "about five drinks" but declined our invitation to blow into our breath alcohol meter. The signal changed to yellow just before the through car reached the intersection and, as in previous cases, the driver chose to continue on. The other driver tried to brake at the last moment. He told us later that he should have accelerated, which suggests that he learnt little from his involvement in this accident.

The remaining case in this group of 13 may have been caused, in part, by the turning driver being late for an appointment (Accident 077). She slowed as she approached the intersection but then accelerated as she turned right, assuming, incorrectly, that there were no vehicles approaching in the left lane. She was not accustomed to turning right at this intersection.

This type of situation, in which neither driver has a clear view of the other, can only be handled safely if the turning driver is prepared to wait virtually until the traffic on the intersecting road starts to move off. Consequently it is not surprising that collisions of this type were relatively frequent in this survey.

7.3.8 RIGHT TURN IN FRONT OF ONCOMING VEHICLE: CONSEQUENCES

Most of the vehicles involved in these 28 collisions (excluding the single vehicle accident, 030) were severely damaged. While the associated costs are considerable, our main concern is with the resulting injuries to people involved.

Fifty-seven of the 110 people involved in these accidents were injured and 21 of them were admitted to hospital. The average stay in hospital was between seven and eight days with a combined total of 158 days. The total time off work for the 57 injured persons was at least two years, including four people who were each off work for more than three months (and twelve injured people who we could not trace to get this information). One person was left with a major permanent disability and three others with less severe but permanently disabling conditions.

7.3.9 PRIOR ACCIDENT EXPERIENCE: ALL LOCATIONS AT WHICH ONE VEHICLE TURNED RIGHT IN FRONT OF AN ONCOMING VEHICLE

Information was obtained on the number of accidents of a similar type to those which we have investigated and the total number of accidents at these locations. Considering only those which resulted in injury to one or more persons, the total number of similar accidents at 28 sites during the previous three calendar years was 72. The total number of injury accidents (including these 72 cases) was 514. The corresponding total numbers of all reported accidents at these intersections were 290 and 3,686. From this it can be seen that the percentage of personal injury accidents is much higher (25%) among cases of the type discussed in this section than it is among all accidents at these intersections (14%).

7.3.10 RIGHT TURN IN FRONT OF AN ONCOMING VEHICLE AT A SIGNALISED INTERSECTION: RELEVANCE OF ROAD AND TRAFFIC FACTORS

Few of these drivers made any comment on the road layout or traffic control measures at the intersection. One said that these factors had no relevance to his accident. He thought that the other driver had been careless and had turned too quickly. The turning driver thought that the through vehicle driver had been speeding.

Those drivers who did comment on the traffic control system mostly referred to the lack of a turn right signal (eight drivers) and some suggested that all signalised intersections should have a separate right turn phase. Two drivers said that offset right turn lanes (offset to the right) would make it much easier for the two drivers to see each other from a safe distance when there are stationary vehicles waiting to turn right (across from the turning vehicle).

Each of these suggestions can be supported by reference to the accidents which we investigated. An offset right turn lane reduces the extent to which a queue of other vehicles in the opposing turn lane acts as a significant obstruction to vision but it does not overcome the problem presented by the person who chooses to pass other vehicles by using the kerb lane when entering the intersection. As noted above, this problem of passing on the left at the approach to an intersection is accentuated in two ways when an auxiliary kerb lane is provided for through traffic at the intersection. The number of lanes of traffic which can obstruct through driver's view of the turning car, and vice versa, is increased and there is often good reason for the through driver using the auxiliary lane to travel through the intersection as quickly as possible. This can result in a very dangerous situation and we recommend that the approach to the intersection should not include through lanes which are not continuous beyond the intersection.

The provision of a right turn arrow can eliminate or minimize many of the difficulties which have been illustrated in the case histories presented here. Allowing for right turning traffic in this way decreases the capacity of the intersection and this costs money because of the increase in travel times (although there may well be a decrease for right turning traffic). But the absence of a right turn phase also costs money, in terms of hospital beds, time off work and permanent disability.

7.4 PEDESTRIAN AND SINGLE VEHICLE ACCIDENTS AT SIGNALISED LOCATIONS

As noted in Section 7.1 there were five pedestrian accidents and three single vehicle crashes at signalised locations. These eight accidents are discussed below, as is Accident 087 which is listed under Category (10) in Table 7.2. Accident 087 involved a pedal cyclist who was wheeling her cycle across a midblock crossing at which flashing lights were installed but were not operating.

7.4.1 ACCIDENTS AT MIDBLOCK FLASHING LIGHT CROSSINGS

Types of Crossings

Two types of midblock flashing light crossings are used in South Australia: the zebra crossing and the school crossing.

A zebra crossing consists of alternate black and white stripes painted parallel to the road centreline and extending the full width of the crossing. The crossing is delineated by pairs of yellow lights that are mounted side by side and flash alternately. At least two such pairs of alternating flashing lights, mounted on black and white striped posts, face motorists approaching from either direction. Standard warning signs and pavement messages, each saying PEDESTRIAN CROSSING AHEAD, are used in advance of the crossing. These crossings operate at all times and vehicular traffic is required to yield to a pedestrian who is on the crossing.

A school crossing differs in that the zebra stripes are replaced by two transverse broken lines that define the width of the crossing and by an unbroken stop line that precedes it. The warning signs and pavement markings say SCHOOL CROSSING AHEAD. The twin flashing lights are mounted on blue and white striped posts and the left hand lens of each pair bears the numeral 2, with 5 on the right hand lens, emphasising the speed limit of 25 km/h which applies over the final 30 metres of the approach to such a crossing. The flashing lights operate only during predetermined periods when children are known to cross in appreciable numbers. When the lights are operating vehicular traffic must yield to all pedestrians and it must not exceed 25 km/h on the final 30 metres of the approach to the crossing. When the flashing lights are not operating the crossing has no legal significance. A small notice stating this fact is attached to the signal post.

It is common practice for school children to act as monitors at school crossings. These monitors, who are instructed in their task by the Police Department, control pedestrians wishing to use the crossing by making them wait until a suitable gap appears in the traffic. The monitor then displays a STOP sign to approaching vehicular traffic and, when that traffic has stopped, then allows the pedestrians to cross. While it is an offence for a pedestrian to disobey the instructions of a monitor a vehicle is still required to yield to any pedestrian using the crossing regardless of whether or not they are doing so with the agreement of the monitor, if present.

As traffic volumes increase it becomes more difficult for young monitors (some only nine years of age), to select suitable gaps in the traffic. This means that the haphazard halts in the flow of vehicular traffic resulting from pedestrians using school and zebra crossings increases the risk of rear end collisions and of accidents involving pedestrians. Mainly for these reasons such crossings are being replaced, on arterial roads, by pedestrian-actuated traffic signals.

School Crossings

One of the two accidents that occurred on a school crossing in this study (Accident 087) happened soon after the flashing lights had been switched off on a weekday afternoon (and so the crossing had no legal significance). It involved a collision between a car and a 33-year-old female cyclist, who was walking her cycle across the road on the school crossing (Figure 7.15). The striking car had changed from the left lane to the right to pass another car shortly before the collision. The cyclist sustained head injuries and was unable to remember the accident, and the driver did not see her until just before the impact, so we have no information on whether or not she may have looked to her right or whether she may have misjudged the speed of the overtaking car.

This accident is included in the signalised location category even though the signals were not operating because the cyclist reported that she always used the crossing on her way home from work. This would be a reasonable action because the crossing has a median island whereas only a painted median was available elsewhere along this road in this vicinity. At the time of the accident there was a heavy flow of traffic in both directions along this four lane road.

The second accident (001) on a school crossing occurred almost exactly at the time that the flashing lights were set to switch off. The driver, the pedestrian, and bystanders all said that the lights were still operating, although the crossing monitors (school children with handheld STOP signs) had left. The pedestrian, who had been playing with other school children, ran onto the crossing and was struck by a car which was moving slowly in the kerb lane in very heavy traffic.

Zebra Crossings

The one accident (305) on a zebra crossing involved a pedestrian who had been drinking (BAC 0.10) and a truck. The accident occurred at night but both parties saw each other well before the pedestrian was hit. Their versions of the events which resulted in this accident do not agree. The driver stated that he was travelling at about the legal speed limit of 60 km/h and the skid mark at the scene does not conflict with this estimate. Even so, this is the 90 percentile of the speeds which we measured at this site at the same time of day and day of week (based on 182 vehicles), and so the pedestrian may well have underestimated the speed of the truck (both driver and pedestrian were familiar with the location). The driver also reported that the pedestrian was unsteady on his feet and appeared to decide to cross the road at the last moment. Although he claimed that he began to slow down when he saw the pedestrian, he obviously did not allow himself sufficient time to react to what would appear to have been a likely action by the pedestrian.

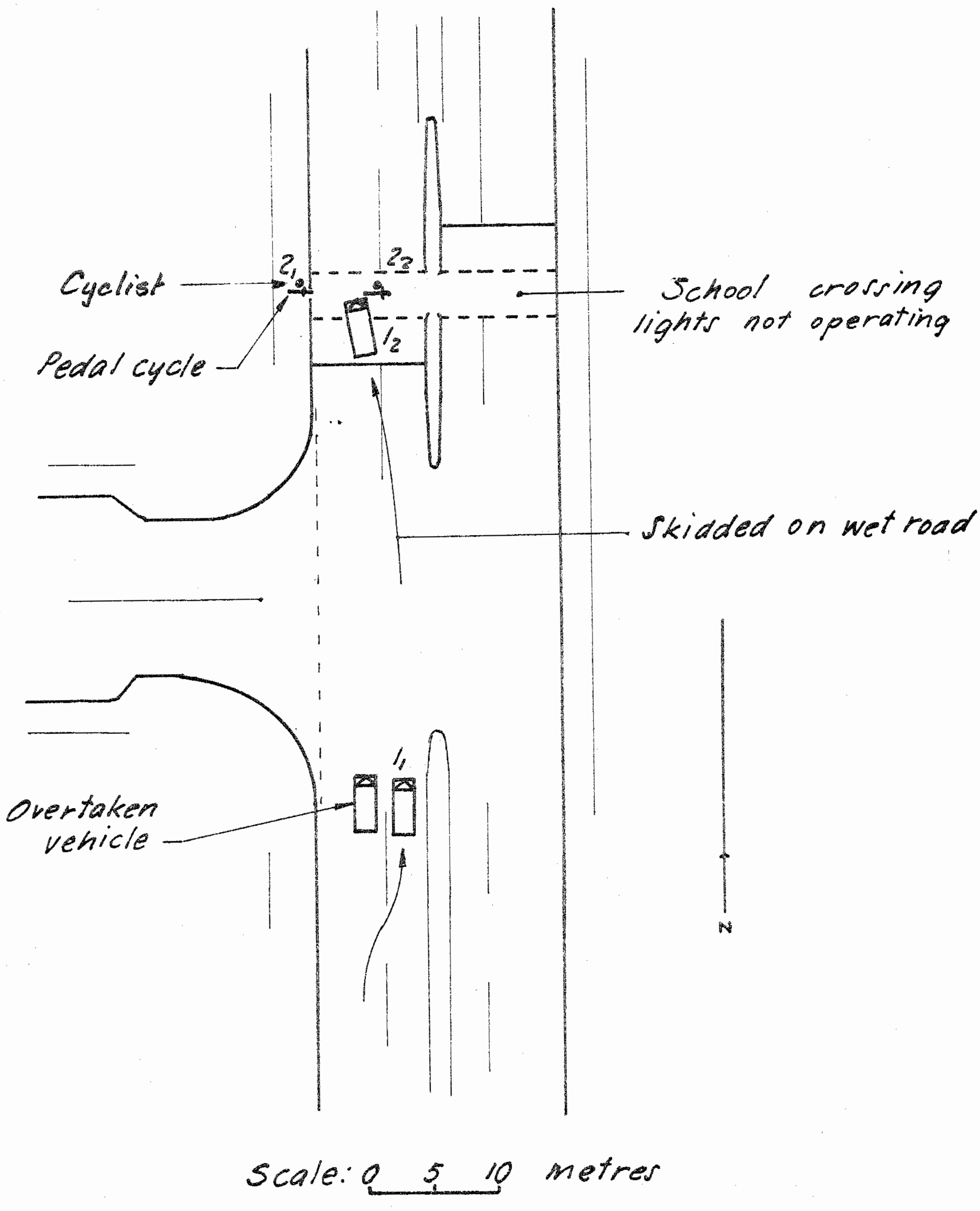


FIGURE 7.15: Accident 087.

Crosswalks at Signalised Intersections

One of the three accidents in this category involved a collision between a pedestrian who stepped off the kerb as soon as the WALK signal was displayed and a car which had just crossed the intersection (Accident 183). The pedestrian acknowledged that he had not looked to his right and the car driver claimed to have been unaware of the presence of the pedestrian, until he heard a "thump" from the front left side of his car. Pedestrian traffic was heavy at this location, but the car was in the second of three marked traffic lanes and so both participants had ample opportunity to detect the approach of the other party.

The other two pedestrian accidents on crosswalks at signalised intersections each involved a vehicle that was turning left (Accidents 196, 224) and therefore was required to yield to the pedestrian (there being no green arrow for left turning vehicles at either location). In both accidents the turning vehicle was longer than a car, in one case a large bus, and in the other a car towing a trailer. Each of the pedestrians stated that they had not looked to their right before starting to cross the road. Had they done so these accidents may not have happened. However the drivers involved could have been expected to have watched the pedestrians who were both walking towards the crossing and to have allowed for the possibility that they would continue on to cross the road. This is particularly important with vehicles which are longer than the conventional passenger car, since they take correspondingly longer to clear the pedestrian crossing and the rear wheels may track closer to the inside of the corner.

In one of these accidents the pedestrian was crossing with the WALK signal. In the other case the signal may have changed to DONT WALK, either flashing or steady. This latter case had a tragic outcome; an infant in a pusher was crushed beneath the rear wheels of a bus.

Relevance of Road and Traffic Factors

Midblock Flashing Light Crossings

While a school crossing may provide adequate protection for pedestrians when it is activated it may, by inducing a false sense of security, tempt a pedestrian to adopt unsafe crossing behaviour at other times. Although it is possible that Accident 087 may still have occurred had the signal lights been flashing there was one other pedestrian accident in the study that may have been prevented had a nearby school crossing been functioning at night (Accident 191). This accident is discussed in the companion report on pedestrian accidents in Section 6 which deals with road and traffic factors in the causation of pedestrian accidents. The policy of the Highways Department is to replace school crossings on arterial roads with pedestrian-actuated signals, as noted above. This policy can be supported by reference to the accidents reviewed in this Section and its extension to all school crossings is to be strongly recommended.

The zebra crossing does have the advantage, compared to a school crossing, that the protection it affords is available at all times. Even so, Accident 305 shows that uncertainty about a pedestrian's intentions can result in an accident. This uncertainty can be reduced by a change to pedestrian-actuated signals (although such a change may not have affected the outcome in Accident 305).

Crosswalks at Signalised Intersections

It is obvious that pedestrians crossing on the "down-stream" side of a signalised intersection have less protection from the all-red phase of the traffic signals than do those crossing on the "up-stream" side but it is by no means clear how this situation can be improved. Despite, or possibly because of, this lack of an obvious solution this topic is worthy of further investigation.

Accidents 196 and 224 illustrate that it is not reasonable for a driver to assume that a pedestrian realizes that he is about to turn left at a signalised intersection. The legal onus is already on the driver to yield to the pedestrian. The frequency with which this requirement is observed may be increased by selective enforcement by the Police. There may also be value in presenting frequent reminders in the media of the need for both the pedestrian and the driver to take particular care when a pedestrian wheeling a child in a pusher is about to cross a street.

7.4.2 CRASHES RESULTING FROM OPERATOR LOSING CONTROL

One of the three accidents of this type has been mentioned in Section 7.3.5 (Accident 030). It involved a cyclist who fell from his bicycle when he had to swerve to his left to avoid a car that turned across his path at a four-way intersection.

One of the other two accidents has no relevance to the traffic control installation. A learner driver failed to negotiate a left turn, crossed a raised median strip, and crashed into two cars which were stationary at a red light (Accident 041).

The remaining accident (010) is of greater interest, even though we cannot be certain why it occurred. A motorcyclist lost control of his machine as he approached a Y-junction. He then fell with his machine and slid into a steel post bearing the push-button actuator for the pedestrian signals. The post is on a raised traffic island. This accident is discussed in greater detail in Section 3.6.3

8. RELEVANCE OF ROAD AND TRAFFIC FACTORS

8.1 ASSESSMENT OF RELEVANCE

In the Introduction it was noted that the inclusion of the accident descriptions in the main text has been done to emphasise the many factors that can play a role in accident causation and to try to place road and traffic factors in the correct overall context. This multi-factorial nature of accident causation means that it is rarely possible to state that a given factor was the most important, let alone the only, one in a particular accident. Consequently, in the assessment of the relevance of road and traffic factors the categories of "yes", "probable", "possible" and "no" have been used in an attempt to rate the probability that a factor contributed to the causation of an accident.

Table 14 of the overview report in this series (McLean and Robinson, 1979) contains a summary of the relevance of road and traffic factors in the causation of the accidents covered by the study. A similar Table is repeated here (Table 8.1) but some of the percentages listed differ from those of Table 14. This is because Table 14 was drawn up during the initial data processing stage of the study. Since then the relative importance of various factors in specific accidents has been more clearly understood as a result of continuing analysis of the data. The criteria for the assessment of relevance to accident causation has also changed, having become somewhat more stringent in most cases.

Any general summary of the relevance of road and traffic factors to accident causation, as in Table 8.1, cannot allow for the fact that the contribution made by a particular factor may vary according to the type of accident or the circumstances under which the accident occurs. For example, the width of the road can be relevant because it is too narrow, as in Accident 026 (see Figure 5 of Report No.2; McLean, Brewer and Sandow, 1979a) in which pedestrians standing in the middle of the road were struck by a car that was forced across to the right by the car alongside it also moving across to pass a parked car, or because the road is too wide, as in Accident 166 (see Figure 3 of Report No.2) in which a pedestrian was struck by a car that was not in sight when the pedestrian started to cross the roadway.

Because of the way in which the nature of the relevance of a factor may vary according to the circumstances of the accident it is not meaningful to state that, for example, wide roads are safer, or more hazardous, without relating the statement to a certain type of accident at a certain type of location. The relevance of road and traffic factors has been discussed in this Report in relation to specific types of accidents for this reason, as well as for the reason noted earlier in this Section. The Chapter therefore is not intended to be a general discussion of the relevance of road and traffic factors that can be read in isolation but rather as a means of drawing together, and referring back to, the comments that have been made earlier in the Report.

Road and traffic factors relevant to the causation of pedestrian accidents are included in Table 8.1 but are discussed in Chapter 6 of Report No.2 (McLean, Brewer and Sandow, 1979a).

8.2 TRAFFIC RULES

Traffic rules, or the infringement of a traffic rule, remain the most commonly-occurring traffic factor in the causation of the accidents. This does not necessarily mean that 69 per cent (see Table 8.1) of these accidents would have been prevented if all of the erring drivers were to learn the road rules and be encouraged to obey them. The record of infringement of a priority rule, for example, often is a description of what happened rather than an explanation. As is emphasised in Chapter 5, most of the collisions at uncontrolled intersections were a consequence of the failure of one of the drivers to yield but by the time that he was able to see the other vehicle it was already too late to do so and a collision was inevitable. The discussion of this topic is continued in Section 8.4.5.

At sign-controlled intersections collisions more often resulted from a driver, having stopped at the STOP sign, then moving off into the path of an approaching vehicle even though the driver was aware of the presence of that vehicle. It seems likely that, in many cases, the approaching vehicle was speeding (see Section 6.7). The driver at the STOP sign may be aware of the requirement to yield to the approaching vehicle but if he greatly underestimates its speed a collision can result.

For reasons such as these travelling

TABLE 8.1: ROAD AND TRAFFIC FACTORS IN ACCIDENT CAUSATION[1]

Road or Traffic Factor		Relevant to Accident Causation	
		Yes or Probably	Possibly
Traffic rules :	priority	54%[2]	2%
	other	15	-
Traffic flow characteristics		19	5
Traffic control devices :	signals	2	4
	signs	2	1
	geometric	1	-
	road markings	0[4]	1
	absence of control[3]	17	1
Road layout :	in general area	0	1
	at accident site	3	3
Road surface		2	-
Road works		0	-
Parked vehicles		10	1
Roadside :	between property boundaries	4	12
Artificial lighting		5	4

Notes: [1] Some of the percentages listed here differ from those in a similar listing in Report No. 1 of this series (Table 14) for the reasons noted in the text.

[2] Percentage of 304 accidents

[3] Refers to uncontrolled intersections

[4] Percentage is greater than zero (shown "-" but less than 0.5

(More than one of the listed factors may have been relevant in a given accident.)

at a speed in excess of the legal limit or, possibly of more consequence, greater than that which is customary, can be particularly hazardous (much lower, legal speeds can also be hazardous, as noted in Section 5.3). The risks involved relate not simply to the driver's ability to control his vehicle, although there were some accidents that derived from that, but from the mistakes made by other road users when they fail to see the speeding vehicle or, seeing it approaching, misjudge its speed. The enforcement of the legal speed limit can be supported as an activity of considerable potential value, the potential being dependent on the effectiveness of the procedures used.

8.3 TRAFFIC FLOW CHARACTERISTICS

Traffic banked up at traffic signals, behind a bus at a bus stop or a car waiting to complete a right turn was a major factor in the causation of 20 accidents (or about seven per cent). Most of these accidents occurred at sign-controlled T-junctions (see Sections 6.2.1 and 6.6.1) with some at uncontrolled intersections (Section 5.2.1) and others involving pedestrians at midblock locations (Report No.2; McLean, Brewer and Sandow, 1979a). In many instances a driver had deliberately left a gap in the queue so that another vehicle could enter, or exit from the side road. Having left the gap it was then common for that driver to wave the waiting driver across, without realizing that a third vehicle was about to overtake.

This situation has several implications for traffic engineering and road design. At locations where it can be predicted that queues of stationary vehicles are likely to form, such as at traffic signals on busy roads, steps should be taken to prevent turning movements across the queue. This may be able to be achieved by the installation of a raised median strip, by closing the stem of a T-junction or, less effectively, by prohibiting turning movements. If none of these countermeasures can be adopted then there are good reasons not to attempt to keep the junction open for turning traffic by means of pavement messages saying KEEP CLEAR. Encouraging drivers to create gaps in a queue of traffic is one way to set up the conditions for accidents of the type referred to here.

The regulation of pedestrian movements through queues of stationary traffic may be very difficult because the pedestrians who do so may be in a hurry and careless, based on the relatively few accidents of this type in the study. There may be some locations where physical barriers can be used, such as along a median strip, to direct pedestrians to controlled crosswalks.

Accidents involving gaps in queues of stationary traffic are unusual in that, even though they may involve careless pedestrians, none of the drivers involved in vehicular collisions of this type was intoxicated. This suggests that the possibilities for success in reducing the frequency of such collisions may be greater than for, say, collisions with utility poles which frequently are a consequence of impaired driving due to alcohol intoxication.

8.4 TRAFFIC CONTROL DEVICES

8.4.1 TRAFFIC SIGNALS

Fail-to-Stand Accidents

The most common type of accident at traffic signals was a collision between an oncoming vehicle and one turning right. The various factors that appear to be important in the causation of these collisions are discussed in Section 7.3. Despite the relatively high frequency of collisions of this type in the study there were not enough accidents to enable us to investigate, on a statistical basis, the role of measures such as offset right turn lanes. Nevertheless, the impressions gained in the investigation of these accidents and in repeated visits to many of the accident sites to observe driver behaviour do suggest that measures that improve the view that the turning driver has of oncoming traffic are likely to reduce the frequency of this type of collision. Simpson (1973), in his thorough analysis of police reports of these accidents, was unable to show any benefit from offset right turn lanes. This may have been a consequence of incomplete reporting of the presence of opposing right-turning vehicles. He did note that the greater the number of through lanes the greater the risk of these collisions. This is consistent with our observation of the hazards associated with auxiliary through lanes at signalised intersections (see below under Section 8.5.2). The seriousness of this problem of fail-to-stand accidents at traffic signals is indicated by the severity of their consequences, described in Section 7.3.8. Right turn phases or prohibition of right turns both have undesirable consequences in terms of delays and rerouting of traffic but there is much that should be unacceptable in the existing situation at many signalised intersections.

Duration of the All-Red Phase

Accidents 107 and 127 (Section 7.2.4) indicate that the phasing of traffic signals may not be adequate for the geometry of the intersection. Calculation of adequate phasing is a relatively straightforward matter but the consequences of under-estimation of the necessary duration of the all-red phase can be considerable.

Inoperative and Flashing Yellow Signals

Two accidents were largely a consequence of an inoperative signal installation in one instance and flashing yellow operation in the other. They are discussed in Section 7.2.1 where it is suggested that changes and additions be made to the relevant sections of the Australian Standard Manual of Uniform Traffic Control Devices. The lack of any reference to procedures to be followed to ensure the safety of traffic negotiating an inoperative signal installation is a serious deficiency in the Manual.

8.4.2 TRAFFIC SIGNS

The STOP sign was the regulatory sign in 15 of the 29 accidents studied in which such a sign was relevant but there were only two accidents in which a driver failed to stop. These two accidents are described in Section 6.3.2. In one (Accident 053) we were unable to interview the driver and so we do not know whether or not he was familiar with the area and knew that the STOP sign was there. In the other accident the driver's familiarity with the area as it had been some time previously contributed to his failure to observe the sign, which had been recently installed.

Two other accidents were at least partially a consequence of a driver turning right suddenly on reading the name of a street on a street sign that was difficult to read in one accident (105, Section 5.2.1) and difficult to detect in another (Accident 232, Section 6.6.3). The signs involved were of customary design which suggests that there may be value in an investigation of ways in which the legibility of street name signs can be improved.

8.4.3 GEOMETRIC TRAFFIC CONTROL DEVICES

In Accident 254 a driver was able to approach a roundabout, with the expectation of negotiating it, at a speed that gave him insufficient time to avoid a collision with a cyclist who entered the intersection on his right. As noted in Section 6.5, a change in the dimensions of the roundabout may have reduced the severity of this collision, if not prevented it,by reducing the approach speed of the car.

Two other accidents (066, 167) occurred at intersections where the driver's view of the other vehicle was restricted by bushes on the median in one accident (167, Section 6.3.2), and by a chain-wire fence and bushes on the median in the other (Accident 066, Section 7.3.6). Both intersections and the divided roads were well lit and so the need for a glare screen was not great. The restricted visibility was a major factor in the causation of these two accidents.

8.4.4 ROAD MARKINGS

Although very few of the accidents occurred on wet roads there were two in which the driver commented on the fact that they had not been able to see the painted lane markings on the wet road. One driver allowed her car to veer to the left and crash into a parked car (Accident 179, Sections 3.2.3 and 3.2.8), the other drove off from a signalised intersection on the wrong side of the centreline and hit a pedestrian who was standing in the centre of the road (Accident 144, Report No.2, Section 6.1; McLean, Brewer and Sandow, 1979a).

The skid resistance of painted road markings may possibly have been a factor in Accident 010, in which a motorcyclist fell from his machine on the approach to a signalised intersection, the skid starting on a painted arrow on a dry road. However, as mentioned in Section 3.6.3 the reasons for the rider losing control are not known.

8.4.5 ABSENCE OF A TRAFFIC CONTROL DEVICE

The absence of some form of traffic control at uncontrolled intersections was one of the major factors in the causation of the accidents in the study. This topic is discussed in Chapter 5 (in detail in Section 5.3) and all that will be repeated here is the conclusion that the basic philosophy underlying the warrants for the provision of controls at intersections is undesirable and that, in a metropolitan area, intersections should not be uncontrolled.

8.5 ROAD LAYOUT

8.5.1 ROAD LAYOUT IN THE GENERAL AREA

At one location a driver said that he thought that the intersecting road was controlled by a STOP sign because an earlier intersection had been (Accident 009). Two other uncontrolled intersections appeared to two drivers to be of minor importance because they were not marked with cross road warning signs whereas the preceding intersection had been in each case (207 and 220). These examples relate as much to signing practices as to the general area road layout but they do draw attention to the desirability of viewing an area as a whole when considering the adoption of any traffic control measure, no matter how isolated the particular problem might be.

8.5.2 ROAD LAYOUT AT THE ACCIDENT SITE

Auxiliary kerb lanes or lanes that were not continuous on the far side of signalised intersections played an important role in six fail-to-stand accidents, as described in Section 7.3, and in one rear-end collision (Section 4.2.1). These accidents showed that the auxiliary lane is used as a passing lane. As such, a driver attempting to turn right from the opposing traffic stream has the doubly-difficult task of detecting the presence of a rapidly-moving (because it is over-taking) vehicle that is concealed behind two or more lanes of stationary or slowly-moving vehicles. This increases the risk of a collision occurring and, because of the speed of the through vehicle, it also tends to increase the severity of the crash. Fail-to-stand accidents are the major accident problem at signalised inter-sections, a problem that to some extent is exacerbated by signalisation (see Simpson, 1973). It therefore seems to be reason-able to suggest that safety should not be degraded by introducing auxiliary lanes to increase the capacity of an intersection.

The road layout played a role in the causation of two pedestrian accidents (144 and 166). These accidents are des-cribed in Section 2.1 of Report No.2 (see Figures 4 and 6) in this series (McLean, Brewer and Sandow, 1979a). In Accident 144 the road layout, as defined by the lane markings at a signalised inter-section, led a driver to depart from the intersection on the wrong side of the centreline (as noted in Section 8.4.4 above). In Accident 166 a four-lane one-way road around a city square has a sight-distance such that a pedestrian can step off the footpath when no vehicles are in sight and yet not be able to walk to the other side of the road before a car reaches him.

In several other accidents some aspect of the road layout at the accident site played a role but rarely in such a way as to be of certain or even probable signifi-cance in the causation of the accident.

8.6 ROAD SURFACE

The characteristics of the road surface contributed to the rider or driver losing control of his vehicle in five accidents and distracted a pedal cyclist in one other. Again it should be noted that this study was based almost entirely on dry-road accidents by virtue of the weather conditions in Adelaide. Only 13 of the 304 accidents occurred when it was raining and the road surface was damp in only a further nine cases.

A motorcyclist fell from his machine when the stand caught on a manhole cover in Accident 113 (Section 3.5.1). The stand was lower than usual because of the weight of a pillion passenger but the major contributing factor was the zeal with which the rider attempted to negotiate a curve.

A motor scooter rider fell off when, on a test ride, his machine hit a pot hole in a residential street (Accident 203, Section 3.7.2) and two car drivers lost control when, in one accident (163, Section 3.3.2) swerving to pass a car on the irregular surface of a level crossing and in another (Accident 168, Section 3.6.2) encountering loose sand on an S-bend in a 25 km/h zone.

An intoxicated driver veered off a straight road into a tree at a point where camber changes due to a junction with a side road will lead a vehicle onto that collision path if the steering is not corrected (Accident 019, Section 3.4.1 and Figure 3.29).

The cyclist who paid more attention to the rough edge of the pavement adjacent to a concrete gutter than to the traffic ahead of him was involved in a collision with a car in Accident 284 (Section 4.2.4).

Spoon drains affected the speeds with which a vehicle approached an uncontrolled intersection (Sections 5.3.5 and 5.4.2) and also may have distracted the driver (Section 5.4.3). Accident 267 occurred when the tailgate of a station wagon came open as the car crossed a spoon drain (Section 3.7.5).

In summary, even allowing for the dry weather in which the study was conducted, the characteristics of the road surface were rarely relevant to the causation of any of the accidents. This is an indicat-ion more of the generally high quality of the road surfaces in the Adelaide metro-politan area than of the potential contri-bution of this factor to accident causation.

8.7 ROAD WORKS

Apart from the work being performed at the inoperative signal installation in Accident 210 (see Section 8.4.1) there was only one accident (155, Section 3.6.5) in which road works played a role. In that accident an intoxicated motorcyclist rode through a warning barrier at a road closure. This one case is not, of course, statistical evidence of any association between intox-icated road users and this type of accident but it is similar in some respects to other alcohol-related crashes. This suggests that the likely effectiveness of road works warning barriers should be assessed on the basis of knowledge of the relevant effects of alcohol on the perception of and reaction to such warning devices.

8.8 PARKED VEHICLES

The 19 accidents that were collisions with parked vehicles are the most direct example of the relevance of these vehicles to accident causation. In other respects parked vehicles played a role as obstructions to vision, particularly in pedestrian accidents involving children. Two accidents at sign-controlled intersections (063, Section 6.2.1 and 089, Section 6.3.1) and one at an exit from a shopping centre parking lot (092, Section 4.2.6) may not have happened had parked vehicles not obstructed the operators' view of the approaching vehicle. The importance of the visual restriction associated with vehicles parked near uncontrolled intersections was more difficult to assess because it is possible that the collisions would still have occurred had they not been there.

8.9 ROADSIDE : BETWEEN PROPERTY BOUNDARIES

In Table 14 of Report No.1 (McLean and Robinson, 1979) in this series (see note [1] to Table 8.1) the likely role of the roadside on or beyond property boundaries was listed. This item is not included here because it is essentially descriptive unless we are to argue that our metropolitan environment should be adapted to the needs of the road system rather than vice versa. The characteristics of the roadside between property boundaries, while fulfilling many roles, can justifiably be changed to reduce certain traffic hazards should the need be demonstrated.

In the accidents studied, objects as diverse as telephone booths, a verandah (that obscured a street name sign) and trees and shrubs were each thought to have played a causal role on one or more occasions. Overall there were eleven accidents in which the restricted visibility probably contributed to the occurrence of the accident and just over three times that number in which the visual restriction possibly could have been a factor. Of the eleven probable cases, removal of the object may have prevented perhaps four or five accidents, there being other factors operating in all eleven accidents. In many locations realignment of the kerb to narrow the carriageway may be as effective as removal of the object that restricts a driver's field of view.

8.10 ARTIFICIAL LIGHTING

The quality of the illumination provided by the artificial lighting was a certain or probable factor in the causation of 15 accidents and possibly a factor in a further eleven.

The ways in which the street lighting was important ranged from a virtual absence of any illumination of a parked car, either direct or in silhouette, on a street lit by tubular fluorescent lamps (eg: Accident 008, Section 3.2.8) to the same type of lamp giving a misleading indication of the alignment of the through road at a Y-junction in which one of the exits was a no through road (Accident 293, Section 3.6.1). Even roads lit by sodium vapour lamps were not always well illuminated because of the large distances between the lamps (more than 70 metres in some installations). This wide spacing of the lamps results in brightly lit sections of roadway alternating with sections that are, by comparison, poorly lit (although often better illuminated than adjoining side streets). Accident 097, in which a driver did not see a stationary car in his path and Accident 188, in which a car reversed onto a road into the path of an approaching car, both occurred midway between widely-spaced sodium vapour lamps. These two accidents are discussed in Sections 4.2.1 and 4.2.6.

Compared to most of the other factors discussed in this Section, artificial lighting is particularly closely associated with intoxicated drivers. Six of the 15 drivers whose performance was affected by poor quality artificial illumination were intoxicated as were five of the eleven drivers whose performance may have been affected. This suggests that the assessment of the likely hazards associated with poor quality artificial lighting should be made on the assumption that the drivers involved are likely to be intoxicated.

8.11 RELEVANCE OF ROAD AND TRAFFIC FACTORS TO THE CONSEQUENCES OF THE ACCIDENT

Table 8.2 shows the frequency with which the listed items were relevant to the consequences of the accident.

Objects at the roadside were the category most often relevant to the consequences of the accident and of those objects collisions with utility poles were both the most frequent and the most damaging. Eleven per cent of the accidents involved a collision with a utility pole as either the initial or as a secondary event. The probability of a secondary collision of this type occurring was related to the impact geometry, with secondary collisions being more likely to occur following an intersection collision than one midblock, and to the speeds of the vehicles in the initial collision. Collisions with utility poles as the initial impact were strongly alcohol-related as were initial collisions with parked cars. Possible ways to minimize the frequency of occurrence of collisions with roadside objects and with parked cars are discussed in Section 3.

Geometric traffic control devices affected the consequences of the accidents when a motorcyclist fell from his machine on the approach to a roundabout and then struck the kerb of the roundabout while sliding along the road. The other accidents in this category were of a similar nature.

TABLE 8.2: ROAD AND TRAFFIC FACTORS IN THE CONSEQUENCES OF THESE ACCIDENTS

Road or Traffic Factor	Relevant to Accident Consequences	
	Yes or Probably	Possibly
Roadside : on or beyond property boundaries	9%[1]	-
Between property boundaries	20	0[2]
(utility pole)	(11)	-
(road sign)	(5)	(0)[2]
(signal installation)	(1)	-
Road layout at accident site	3	1
Geometric traffic control	2	0[2]
Road surface	1	1
Road works	0[2]	-
Parked vehicles	8	-

Notes: [1] Percentage of 304 accidents.

[2] Percentage is greater than zero but less than 0.5. (More than one of the listed factors may have been relevant in a given accident.)

8.12 SUMMARY : RELEVANCE OF ROAD AND TRAFFIC FACTORS

One or more factors related to the road and traffic characteristics were relevant to the causation of approximately 40 per cent of the accidents studied. These are the accidents in which the contribution of the road or traffic factor to the causation of the accident was certain or probable. As shown in Table 8.1, these factors may possibly have played a role in about one third of the accidents (this third overlapping the above-noted 40 per cent to some extent). It is important to realize, however, that it was most exceptional for an accident to be attributed to one causal factor. Other factors, such as alcohol intoxication and inexperience in driving, were almost always present.

The figure of 40 per cent does not include accidents at uncontrolled intersections for which the absence of a traffic control device was listed as a causal factor in 17 per cent of all of the 304 accidents. This means that, with this wider definition of road and traffic factors, they played a causal role in at least half of the accidents.

As shown in Table 8.2, a road or traffic factor other than an object on or beyond property boundaries was relevant to the consequences of about one third of the accidents in the study.

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APPENDIX : COSTCE STOP SIGN WARRANTS

SIGNING

Stop Signs

78. A STOP sign may be used on a side street as follows:

(a) When reported accidents have occurred at the intersection and the safe approach speed from the side street is less than 8 km/h.

(b) When there have been reported accidents at the intersection, the visibility is poor (safe approach speed from the side street is less than 13 km/h) and traffic flow on the main street exceeds:

(i) in the metropolitan area, 4000 vehicles per 24 hours or, alternatively, if a 24-hour count is not available, 250 veh/hour over the two hours between 10 a.m. and noon on an average day, or

(ii) in all other areas, 3000 vehicles per 24 hours or, alternatively, if a 24-hour count is not available, 175 veh/hour averaged over the two hours between 10 a.m. and noon on an average day.

(c) When there are more than four reported accidents per year involving vehicles entering that approach and no other less restrictive type of traffic control device has been found to be effective in reducing accidents.

(d) When there are three or more reported accidents per year involving vehicles entering from that approach and either:

(i) the visibility is poor (safe approach speed is less than 13 km/h), or

(ii) the traffic flow on the main street exceeds:

(1) in the metropolitan area, 4000 vehicles per 24 hours or, alternatively, if a 24-hour count is not available, 250 veh/hour averaged over the two hours between 10 a.m. and noon on an average day, or

(2) in all other areas, 3000 vehicles per 24 hours or, alternatively, if a 24-hour count is not available, 175 veh/hour averaged over the two hours between 10 a.m. and noon on an average day.

NOTES

79. (a) If an intersection is geometrically symmetrical, STOP signs may be used on both side roads if a STOP sign is justified on one side road by warrant (c) or (d) as appropriate.

(b) Reported accidents referred to are those of a type which may be prevented by the erection of a STOP sign.

(c) Safe approach speed is determined using forms HD 1639 Figs 3.1a and b and HD 2919 Figs 3.2a and b for urban and rural areas respectively. Such determination of safe approach speed should be carried out only after any practicable physical improvements have been made.