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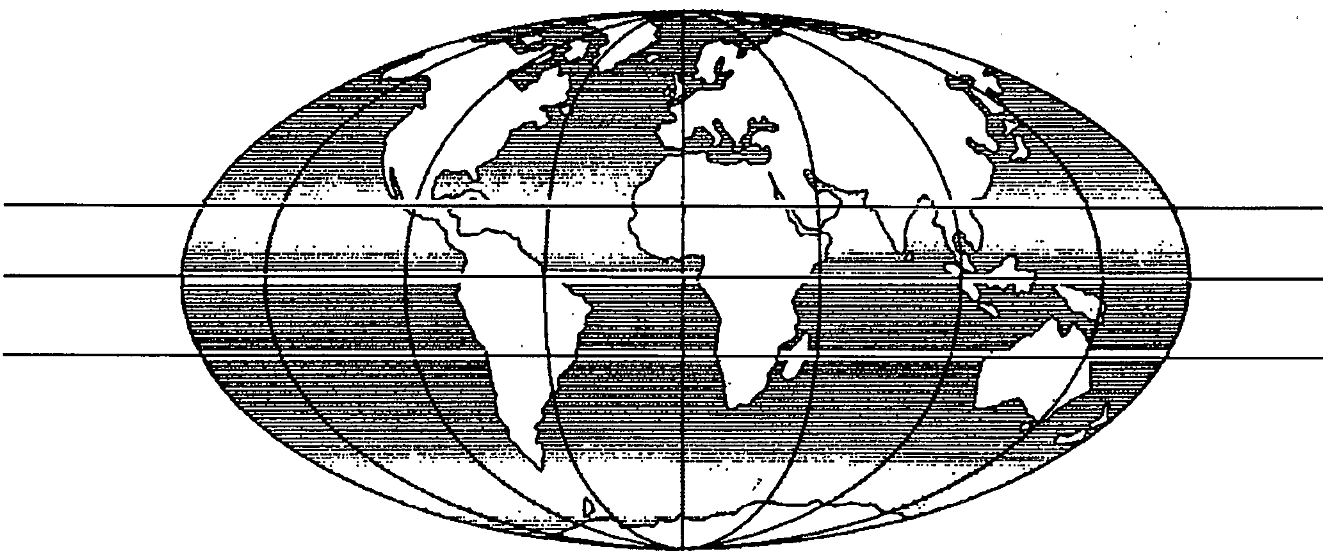
by B L Hills, N M Thompson and K Kila



Overseas Centre
Transport Research Laboratory
Crowthorne Berkshire United Kingdom

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ACCIDENT REDUCTION RESEARCH IN PAPUA NEW GUINEA

B L Hills
Transport and Road Research Laboratory, UK
N M Thompson
Department of Transport, PNG
K Kila
Department of Transport, PNG

1. INTRODUCTION

1.1 Background

Road safety became an issue of concern for the Government of Papua New Guinea in the late 1970's. From the beginning, its Department of Transport was aware of the need for reliable data on which to base future road safety programmes and in conjunction with the Police, introduced a new traffic accident report form in 1982. Over the 10 years that have passed since that time, Papua New Guinea has developed one of the best accident data recording and analysis systems in any developing country.

Since 1986, the TRRL Overseas Unit has been working with the Department of Transport in a programme of collaborative road safety research. This research covers both:

(1) ACCIDENT PREVENTION, which is concerned with standards of design and planning of new road schemes and related development

(2) ACCIDENT REDUCTION, which is concerned with the application of remedial measures to problems identified in the existing road network.

This paper describes the second aspect of this work, the Accident Reduction research.

1.2 Papua New Guinea's Road System

Papua New Guinea has a total land area of about 460,000 square kilometres; this comprises a large mountainous and very heavily forested mainland and some 600 smaller offshore islands. Its population is only about 3.5 million. The country is divided into 20 Provinces. The major areas of population have traditionally been in the Highland valleys and basins, and around one third of the population is still drawn from the five Highland Provinces. The two major urban population centres (and ports) are Port Moresby, the capital city with a population of about 200,000, and Lae with over 50,000 people.

The transport system reflects the geographic and demographic characteristics of the country, and its improvement has generally been limited to the areas of high population and those with good potential for development. In its early development, transport was largely limited to sea and air, but over the past 20 years a system of ten National Highways has been established and is being progressively upgraded. The most important of these is the Highlands Highway, which is about 500 Kms long linking Lae to the Highlands region. The present network comprises some 23,480 Kms of road, of which 2130 Kms (9%) are paved. Arterial and trunk roads (4.5 to 7 metres wide) make up 5000 Kms, the remainder being collector and feeder roads. The National Government is responsible for about 20% of the roads, known as National roads.

The number of registered vehicles in Papua New Guinea in 1988 was about 50,000, and this has not increased significantly since about 1980. Road accidents have been of concern for over ten years and the current fatality rate of 69 deaths per 10,000 vehicles is relatively high by developing country standards.

1.3 TRRL Overseas Unit's Road Safety Research

The Overseas Unit of TRRL began its research into the road safety problems of developing countries in 1972. Early research concentrated on accident rates, trends and costs, and road user behaviour and knowledge (eg Jacobs and Sayer, 1982; Downing and Sayer, 1982). In recent years, the emphasis has shifted towards techniques of accident data collection and analysis with a view to establishing the cost-effectiveness of road safety countermeasures in developing countries, for which there is, at present, very little data indeed (Hills and Jacobs, 1980; Hills and Yerrell, 1988).

Over the past 15 years, Local Authorities in the UK have developed techniques of Accident Blackspot Investigation that have proved to be highly cost-effective. The Unit believes these techniques offer considerable potential for reducing accidents in developing countries, particularly in view of the emphasis placed on low-cost engineering countermeasures. It has therefore included in its research programme the development of a number of tools and techniques (accident report forms, microcomputer software, manuals etc) designed to assist the establishment of accident blackspot investigation in developing countries. To test the suitability of the procedures involved, the Overseas Unit is engaged in collaborative research programmes with a number of developing countries, including Egypt, Ghana, Indonesia, Malaysia, Pakistan, and Papua New Guinea. The work in Egypt, Ghana and Pakistan is also described in this seminar (Sayer, Baguley and Downing, 1991).

2. COLLABORATION BETWEEN TRRL AND PNG DEPARTMENT OF TRANSPORT

Overseas Unit staff took part in the 1986 Papua New Guinea Road Safety Study, which was commissioned by the PNG Department of Transport and funded by the Asian Development Bank. As part of this, the Unit's Microcomputer Accident Analysis Package (MAAP), which has been specially designed for developing countries (Hills and Elliott, 1986), was installed on a trial basis. In January 1987, this Package became the national system of PNG, running on microcomputer systems both in the Department of Transport and in the Royal Papua New Guinea Constabulary (RPNGC) headquarters. The RPNGC had previously established a good accident reporting system but had experienced difficulties with the mainframe computing facilities. In addition, the Department of Transport found it needed more in-depth analyses of accidents than this mainframe system could provide. The police accident report form was modified both to improve its content and to enable direct entry of data from the form into the microcomputer. PNG thus became the first country to adopt the TRRL Package on a national basis. The mainframe accident data from 1982-1986, totalling over 25,000 accidents, were transcribed to the micro system. Over 40,000 accident records are now available for analysis.

The introduction of the microcomputer accident analysis system combined with the existing accident data base at the current stage of development of the PNG road system offered an excellent opportunity for research that could be of considerable value not only to PNG but to many other developing countries. For these reasons, a programme of cooperative research was agreed between the Department of Transport and the Overseas Unit in 1986. The programme of road safety research now covers the following areas of work:

(1) the evaluation of road safety countermeasures, especially low-cost engineering measures at accident blackspots

(2) an investigation of the relationships between the various elements of geometric design and accident rates

(3) alcohol: a survey of drinking and driving in Port Moresby

(4) the safety of passengers riding in the rear of Pick-ups

This paper is particularly concerned with research into accidents at blackspots but in order to put those accidents into perspective, the national characteristics of road accidents in Papua New Guinea are described in the next section.

3. 'ROAD ACCIDENTS PAPUA NEW GUINEA' Reports

The entry of accidents for 1987 into the micro system was completed at the end of 1988 and following a period of analysis of these data, a report entitled 'Road Accidents Papua New Guinea 1987' was published in May, 1989. This was one of the first significant outputs from the collaborative research programme. The 1988 edition was published in October 1990 and the 1989 edition is near completion (July 1991). These are intended to be the first of a series of annual reports presenting the road accident situation in Papua New Guinea and now form the basis of the Department's road safety programme. Some of the main findings presented in the 1988 report included:

(1) 15% of all vehicles on the road in Papua New Guinea are involved in a reported accident each year.

(2) 46% of all accidents in Papua New Guinea involve only one vehicle, and these accidents cause 73% of all casualties, and 76% of all hospitalised and fatal casualties (see Figure 1). These accidents involving only one vehicle are almost entirely made up of:

(a) pedestrian accidents
(b) rollover accidents
(c) "struck object off the road" collisions.

(3) rollover (or overturn) accidents are the biggest single cause of casualties in Papua New Guinea. Although they only represent 14% of accidents, they give rise to 33% of all casualties and 27% of all fatalities (see Figure 2).

(4) 45% of all casualties are the occupants of Pick-up type vehicles, whereas these vehicles make up 33% of registered vehicles (see Figure 3).

(5) 17% of all accidents in Papua New Guinea are reported as 'Alcohol Suspected'. On Saturdays, 26% of drivers involved in accidents are classed as 'Alcohol Suspected'.

(6) The National Capital District with 30% of all accidents has only 13% of fatal accidents, whereas the Highlands Region with 25% of all accidents has 38% of fatal accidents. Thus, accidents in the Highlands Provinces tend to result in more serious injuries than accidents in the National Capital District.

(7) there are, on average, 0.07 fatalities per reported accident, but for all the National Highways this figure is 0.15, with 0.33 and 0.22 for the Hiritano and Ramu Highways

respectively. The Highlands Highway has by far the largest total of injuries.

(8) although there has been an overall reduction in the total number of recorded accidents from 1981 to 1988, fatal accidents have shown a steady increase from 1982. This almost certainly indicates an increase in under-recording of minor injury and damage only accidents, rather than a genuine reduction in total number of accidents.

(9) almost as many pedestrians in Papua New Guinea are killed or hospitalised from accidents when walking along or beside the road (148) as crossing the road (163).

In addition to analyses of the accident data at a national level, lists of worst junctions and links in the National Capital District (Port Moresby) and Lae are included in these annual reports and these have formed the basis of a list of priority sites for treatment (see Figures 4 and 5). A histogram of accidents along the major rural highway of PNG, the Highlands Highway, is also presented (see Figure 6).

4. ACCIDENT BLACKSPOT INVESTIGATION USING MAAP

This section includes a general outline of the various procedures involved in Accident Investigation, and notes how particular aspects were handled in Papua New Guinea. More detailed accounts are available, such as the UK Accident Investigation Manual (Department of Transport, 1986).

4.1 The Process

Accident Investigation involves a continuous programme of identification of accident blackspot locations, analysis of the factors involved, site studies, implementation of countermeasures and evaluation of their effectiveness. The overall process is summarised in Figure 7. In the schematic diagram, the process is divided into activities at the accident SITE and those in the Accident Investigation OFFICE.

4.2 Defining accident locations

Being able to indentify the accident's location from the computer record is a basic necessity of any accident investigation system operating at the Local Authority level. MAAP uses three systems for locating accidents:

(1) rural highways - kilometre posts

(2) urban areas - node/link/cell system

(3) any area - grid co-ordinate system

In Papua New Guinea, to maintain compatibility with the earlier mainframe system, a fourth location system is used that involves giving each street name in urban areas a three-character code. Junctions are defined by the codes of the two roads involved, and links by the code of the road on which the accident occurred together with the codes of the two intersecting roads either side of the accident location.

Ideally, it should be possible to identify the accident location to within 100m or better. Whilst this should be achievable in a town or city, it is more difficult on inter-city roads where distances are usually defined using kilometre posts. In this case, locating accidents to within 1 Km may be a more achievable goal; in some circumstances, however, 1 Km can be a long distance in which to pinpoint a problem in the road during a site study. Unfortunately, in Papua New Guinea, kilometre posts only exist on sections of the Highlands Highway. However, there are frequent bridges on most sections of the National highways, and the police use these extensively to help identify the accident location.

To minimise the problems of identifying accident location, the 'Accident Location Sketch' (Figure 8) has been introduced in revised police report forms being tested in a number of developing countries, including Papua New Guinea. One of the first uses of the 'accident location sketch' was in Bahrain (Ross, 1984)

4.3 Identifying hazardous locations

The TRRL Microcomputer Package MAAP has a number of options for identifying locations with high accident rates:

(1) plotting accidents along a (Nodal) Route in a city

(2) listing the worst Links or Nodes (Junctions) in a city

(3) plotting a co-ordinate accident map for a city

(4) listing the worst accident sites by map co-ordinate

(5) plotting accidents along a rural highway using kilometre posts

(6) listing the worst accident sites by kilometre.

In assessing the worst accidents sites, the severity of the accidents is taken into account in some countries. This can be done in at least two ways (1) by allocating points (eg the Malaysia Highway Planning Unit allocates 6 for a Fatal, 3 for a Serious, 0.8 for a Slight, 0.2 for a Damage Only); or (2) by using the average estimated costs of Fatal, Severe, Slight, and

Damage Only accidents to total the costs of the accidents at each site. In Papua New Guinea, these costs were estimated in 1986 to be K37,225 for a Fatal accident, K9,680 for a Serious injury accident, K3,020 for a Slight injury accident and K1,800 for a damage only accident. The usual practice in the UK is not to weight accidents by their severity (only personal injury accidents are recorded); the underlying argument often given is that it is a matter of chance whether the injury was Fatal, Severe or Slight.

In assessing the relative accident records of sections of road between junctions, it is important to remember that the length of a link varies considerably and this must be taken into account in deciding priorities.

4.4 Further analysis of the worst sites

The next stage of the Accident Investigation process, as Figure 7 indicates, is for the worst of the accident sites to be selected for more detailed analysis in the Accident Investigation Office. MAAP offers a number of possible analyses:

(1) Cross-tabulations can be produced (using program options 6 and 7 in MAAP) with limitations defined to restrict the analyses to just those accidents occurring at an accident site under investigation. These can be useful in establish ing the overall nature of accidents at the site.

(2) a Stick Diagram Analysis can be carried out (using option 8 in MAAP) to try and establish patterns in the accidents.

(3) the serial numbers of the accidents occurring at the site can be listed from the computer (using option 5 in MAAP) and the original police reports then retrieved from the police files. It is then valuable to read the statements of those involved in the accidents and the statements of any witnesses. These sometimes reveal new factors that should be included in the earlier Stick Diagram eg. a high percentage of those involved may have been strangers to the area.

Another valuable source of information in the police report is the policeman's Collision Sketch. For a junction site, it is often useful to plot the location of each accident on a plan of the junction in an Accident Plot; more useful still is to represent diagrammatically the movements of all the vehicles in each accident in a Collision Diagram for the junction. Figure 9 shows an example of such a Collision Diagram prepared by the PNG Department of Transport. Figure 5 showed that the worst Link in the National Capital District is Link 157/159. The collision diagram in Figure 9 is based on an analysis of three years data for the site. It shows that there are two main problems:

(1) the problem of rear-end shunts associated with the pedestrian crossing

(2) the problem of vehicles turning across the road into premises with direct frontal access to the highway.

(It is proposed to construct a central median and put a high skid resistance material down on the approaches to the pedestrian crossing).

4.5 Site studies

The next phase of the procedure is to make a site study, armed with the analyses made at the office. The first task is to record the key physical characteristics of the site eg. road width, shoulder width, existence of street lighting etc. A checklist is available in the UK Accident Investigation Manual; such checklists may not always be relevant to the types of site being investigated, in which case the development of a locally applicable checklist should be considered. Photographs also provide a valuable record of the site layout.

It is frequently useful to make preliminary surveys of traffic and pedestrian flows. A short survey of traffic approach speeds on different arms of a junction can sometimes be revealing; one simple method to do this is to use one person with a stopwatch stationed 50m from the junction and a second stationed 150m from the junction flagging when a vehicles passes him.

In Papua New Guinea, the research made extensive use of pneumatic tube counters that could classify vehicles or speeds. It was found necessary to employ local villagers to guard the meters and tubes. With the latest models, one meter can classify speeds in two directions on "Low Flow" roads. Extensive use was also made of video recording sites before and after treatment.

Further site studies should generally be related to the accident problem identified in the office analysis. For example, if wet weather or skidding accidents appear to be a problem, then measurements of skid resistance would be made. If there is a clustering of accidents at a particular time of day or a particular period of the week, then the site study should be made at these times. Again, the UK Accident Investigation Manual offers extensive checklists of possible factors to look for.

When the factors leading to the accidents are not clear, then a study of Vehicle Conflicts eg. ranked on a scale of 1 to 5 as illustrated in Figure 10, can often reveal hidden problems at the site. Observations of drivers' head turning movements or observing that drivers have to stretch to see approaching vehicles can sometimes lead to identifying a visibility problem. Any other problems of visibility should be recorded, eg. shallow hillcrests or vegetation blocking the view of approaching vehicles. Talking to local residents can also be helpful, although opinions about causes should always be treated with a good deal of caution.

4.6 **Implementing the countermeasure**

Having identified the probable causes of the accidents, the possible countermeasures are listed and ranked according to cost. Normally, the lowest cost solution would be adopted unless there is good reason to believe that it would be unsuccessful. In implementing the countermeasure, due consideration should be given to whether or not advanced warning to the public is necessary, either in pre-publicity or in advance of the site with signs such as 'Experimental Junction Layout Ahead' (white-on-red). The first days of operation of a scheme should be carefully watched in case an unexpected problem has been incorporated into the design.

4.7 **Evaluation**

After a suitable elapsed period of time, the long term benefits of the scheme should be evaluated with 'Before and After' studies. For details of this, manuals such as the UK's Accident Investigation Manual (Department of Transport, 1986) should be referred to. It is most important to use 'control data' in such an analysis, comparing the 'Before and After' accident levels at the test site, either with those at similar but unchanged sites in the locality or with some regional data. Comparing the 'Before and After' accidents at the test site with those at the control sites eliminates 'global' factors that may occur in the after period, such as a period of particularly good or bad weather, a change in oil price affecting vehicle speeds or a change in traffic law. If this evaluation indicates that the scheme has been unsuccessful then further analyses and site studies may be necessary before an alternative scheme is tried. The Chi-squared statistical test with Yates' correction is the most common statistical test used in evaluating 'Before and After' studies. The 'Regression-to-mean' effect should also be taken into account (Wright et al, 1988).

4.8 Special problems of accident investigation in developing countries

It is often difficult to establish the above Accident Investigation process in full in developing countries because of such factors as: a lack of trained manpower, limited financial and physical resources, and problems of co-operation and co-ordination between departments; these are frequently combined with a lack of commitment by departments, partly attributable to the fact that Accident Investigation has yet to prove itself in the countries concerned.

In Papua New Guinea, the Department of Transport has made a commitment to establishing an Accident Investigation group with the eventual aim of establishing small teams in each Province. The Department's unit is still in its infancy but already it has made an impact both (1) in getting engineers and planners to think about and design for safety; and (2) in introducing a number of low cost countermeasure schemes, including roundabouts, lane dividers, chevron boards, footpaths alongside rural highways and speed reduction devices.

5. THE EVALUATION OF ENGINEERING COUNTERMEASURES IN PAPUA NEW GUINEA

The team identified a number of projects and Figure 11 lists the various engineering countermeasures, both installed and projected, that are under evaluation. The preliminary results presented in this section will be the subject of full statistical and cost-benefit analyses in a later report. The list of schemes is a combination of projects initiated by the team itself and those undertaken by local authorities. The primary reason for some of the measures was to improve traffic management or was for maintenance purposes rather than safety; however, the inclusion of safety benefits could considerably enhance cost-benefit values obtained and might suggest further investment in the measures.

5.1 Roundabouts

Following research by the TRRL, roundabouts have been more widely used in recent years in the United Kingdom and Australia to solve both traffic management and road safety problems at junctions (eg Summersgill, 1991). In many developing countries, on the other hand, particularly in the Middle East and South East Asia, roundabouts are being replaced by traffic lights. The failure of roundabouts in these countries can very frequently be attributed to the failure of drivers to give way on entering the roundabouts.

Between 1982 and early 1986, six roundabouts were installed in PNG's National Capital District at uncontrolled major/minor junctions that had both traffic management and road safety problems. As in some African countries, PNG drivers do seem to understand the concept of 'Give Way' and these roundabouts are generally regarded as being a successful innovation. Five roundabouts have recently been constructed at the worst junction blackspots in Lae, the second largest city in PNG. These were half funded by the Department of Transport's Accident Investigation Unit.

TABLE 1(a)

Analysis of accidents 1982-1988 at roundabout sites in the National Capital District (Port Moresby). Roundabout 1 installed in 1983/84, the other roundabouts in 1985/86.

SITES	Number of accidents per year			
	Injury Accidents		Damage Only	
	Before	After	Before	After
Waigani Drive / Wards Road	2.0	0.4	15.0	9.2
Waigani Drive / Cameron Rd	1.0	1.3	9.2	15.0
Waigani Drive / Koura Way	1.2	0.3	11.7	8.3
Waigani Drive / Goro Keaga	1.2	1.0	4.2	4.0
Angau Drive / Lahara Ave	1.2	0	8.5	5.7
Bisini Prde / Kaubebe St	0.2	0.3	2.7	2.0
Average Rate for 6 sites	1.17	0.55	8.6	7.4

TABLE 1(b)

Analysis of accidents at all junctions in the National Capital District (Port Moresby).

Year	82	83	84	85	86	87	88
INJURY ACCIDENTS							
All coded junctns in NCD	140	122	127	132	133	130	115
All Stop, Give Way and Traffic Signals in NCD	21	32	36	39	37	39	33

Table 1(a) shows an analysis of the accident data so far accumulated for the roundabout sites in the NCD. Except for one site, the analysis is based on four years 'before' data and three years 'after' data; the exception is Waigani Drive/Wards Road for which there are two years 'before' data and five years 'after' data. It will be seen that generally the figures look encouraging, with on average a halving of injury accidents per year per site. For purposes of comparison with this analysis of roundabouts, the Table 1(b) is an analysis of injury accidents over the same seven year period for (1) all junctions in NCD; and (2) junctions with Stop, Give Way and Traffic Signals as traffic controls. It can be seen that over the seven year period there has been little change in the general injury accident rate at junctions in NCD, suggesting that the introduction of roundabouts at the sites listed in Table 1(a) has indeed reduced injury accidents over that period.

Figure 12 shows accident trends at two closely located junctions on a major urban arterial, Waigani Drive. The junctions are separated by less than 200m. They are encountered at the end of a fast dual carriageway, first the Cameron Road junction and then the Wards Road junction. The Wards Road roundabout was constructed in 1983 and the Cameron Road roundabout in 1986. The Waigani/Cameron roundabout clearly increased accidents at that location during its first year (1986) but, at the same time, seems to have reduced accidents at the already existing Wards/Waigani roundabout 200m down the road. The Waigani/Cameron roundabout, which was previously a T-junction, is encountered before the Wards/Waigani junction from the fast dual carriageway section, so it would appear that it now bears the brunt of the fast entry traffic. The accident types need to be analysed to confirm this. Figure 12 shows the apparent crossover effect, with the combined data showing an overall decline in accidents.

5.2 Central reservation

During 1986, a 300m section of the Hubert Murray Highway between Taurama and Boroko was upgraded from a single carriageway to a dual carriageway. This involved associated road widening and the closure of one T-junction. The scheme was carried out more for traffic management purposes than for road safety. For the pedestrian, the median helps the crossing task but the inevitable increase in vehicle speeds will have made judgements more difficult. ('Before and After' speed measurements are not available as the scheme began before the research programme got under way). Table 2 shows an analysis of accidents along the stretch of road for the period 1982-1989. It can be seen that Head On, Rear End, 90 Degree and Sideswipe accidents halved after the scheme; these accidents were large in number but their severity was almost exclusively minor injury or damage only. 'Hit object off the road' and Pedestrian accidents show a completely

TABLE 2

Hubert Murray Highway, Boroko, NCD: The effects on accidents of constructing 300m of central reservation in 1986.

	BEFORE SCHEME					AFTER SCHEME		
ACCIDENT TYPE	82	83	84	85	86	87	88	89
Head On	5	1	6	8	3	1	0	0
Rear End	24	30	22	17	17	8	8	12
90 degree	6	6	10	7	1	2	3	2
Sideswipe	7	10	11	10	7	5	3	7
SUB-TOTAL	**42**	**47**	**49**	**42**	**28**	**16**	**14**	**21**
Hit Object Off Road	0	1	0	2	0	3	1	3
Pedestrian	1	0	1	2	1	2	2	3
SUB-TOTAL	**1**	**1**	**1**	**4**	**1**	**5**	**3**	**6**
ALL ACCIDENTS	**43**	**49**	**50**	**46**	**30**	**21**	**18**	**28**

TABLE 3

Hubert Murray Highway, Boroko, NCD: The effects on accidents of constructing a pedestrian footbridge in 1985.

	BEFORE SCHEME				AFTER SCHEME			
ACCIDENT TYPE	82	83	84	85	86	87	88	89
Pedestrian	4	4	2	1	1	1	2	2
Other Accidents	23	21	18	26	14	14	21	16
Total	27	25	20	27	15	15	23	18

opposite picture: they have doubled since the scheme was introduced, and although they are small in number, they are high in severity, with eight out of the 22 accidents being fatal or resulting in hospitalisation (six were pedestrians). The need to prevent pedestrian accidents on this section of road has thus become a high priority.

5.3 Pedestrian Footbridge

During 1985 and early 1986, a pedestrian footbridge was constructed over the Hubert Murray Highway in Boroko, NCD, at one end of the section of road described in 5.2. Table 3 shows an analysis of the accidents within about 100m of the bridge. The numbers are small, but suggest the bridge has reduced pedestrian accidents from an average of three per year to 1.5 per year.

5.4 Rural Footpaths - Goroka

A major area of neglect throughout the developing world is the provision of pedestrian footpaths alongside major rural highways. On some of these highways, large numbers of pedestrians can be observed but it is clear that highway designers have not taken their needs into consideration. Indeed, the authors know of no surveys that have ever been carried out to establish potential pedestrian needs when a major rural highway has been constructed or upgraded in a developing country.

The Highlands Highway in PNG is one such highway. It is the major rural highway of the country with very heavy pedestrian usage in the Highlands regions. Analyses of the accident data confirmed that rural pedestrian casualties were a major problem on the highway. One of the major blackspots was on the approaches to the Eastern Highland's Provincial Capital, Goroka. Pedestrians were making their own tracks in many places to get away from the traffic - in one extreme case, they were prepared to walk on slopes of 45 degrees to achieve this. In another case, pedestrians used embankment benching as a footpath. (This could be adopted as a formal design in many such situations).

As an initial trial, the Department of Transport is half-funding 13 kilometres of footpath, one metre wide, to be hand-dug alongside the drainage ditch from Goroka towards Asaro. Approximately 5 Km has so far been constructed. A survey indicated that the footpath is being used by about two-thirds of the pedestrians (68%), but there remains a significant proportion who continue to walk along the highway itself. More studies of its use are required, particularly to establish the reasons for pedestrians not using it, and whether its use is increasing or decreasing. To improve pedestrian usage, it is already planned to widen and generally upgrade the standard of the footpath so far constructed; and estimates for sealing it are being obtained.

5.5 Chevron Boards
Three accident-prone sections of rural highways containing difficult curves were identified. These were: (1) from Goroka to Kamaliki Creek on the Highlands Highway, one of the worst blackspots along the Highlands Highway; (2) on the Buruni Coast Road in the National Capital District; and (3) Gusap Bridge on Ramu Highway (see Section 5.5 below). They were found to have single vehicle night-time accidents as a predominant type. Chevron boards have been erected at each of the sites and are under evaluation. This was the first use of chevron boards other than at roundabouts in Papua New Guinea. Analyses of their effectiveness will have to wait for the 1990 accident data to be completed.

5.6 Accident Blackspot at Gusap Bridge, Ramu Highway
From December 1988 to April 1989 there were three fatal accidents and several injury accidents at the Gusap and Bora River bridges, which are a short distance apart on the Ramu Highway some three kms from the Ramu Sugar factory. The road carries only about 200 vehicles/day.

The bridges are on a recently sealed section of the Highway. This section of the road is very straight, and therefore fast, from Wataris to the Gusap Bridge, where the road then does a greater than 90 degree bend to cross the Gusap River - a classic accident producing situation. Before the beginning of the bend, there was a 40 kph speed limit sign at approximately 150m and a 'dangerous curves' symbolic warning sign at approximately 50m. There were no other advance warnings of the bends nor any chevron boards at the bends. When first sealed, there were apparently more signs but a number were stolen. There is no background, just open sky, to the Gusap River bend, giving no other visual clues.

Before the road was sealed, there were only a few accidents at the bridges; it has been suggested that this was due to the large potholes on the approaches to the bridges. To improve safety, bar patterns (originally developed at TRRL) covering some 200m were painted on the road on the approaches to the bridges and four reflectorised chevron boards were also erected on the 90 degree bend. Approach speeds were measured 'Before and After' the installation of the chevron boards and bar patterns. These showed, as has been found in various studies (eg Jarvis, 1989), that the bar pattern had little effect on the entry speeds to the bend. However, research in the UK (Helliar-Symons, 1981) has demonstrated that speed-related accidents at rural roundabouts are dramatically reduced by the bar pattern, suggesting that the pattern acts as an alerting device rather than a slowing device. So far, no fatal accidents have occurred since the installation, but accident monitoring is continuing. Eventually, it is planned to re-align the road in the vicinity of Gusap Bridge.

This accident blackspot emphasises the need to anticipate potential new problems when a road is upgraded, and the need to "over-design" warning devices to alert drivers of the impending problem.

It is planned to paint the TRRL bar pattern on the approaches to all single lane bridges on the Highlands Highway. An analysis of accidents has identified the bridges with the worst accident records and a detailed analysis of the accidents is being carried out. It is planned to treat all single lane bridges in one Province on the Highway at the same time; those with high accident rates will get the full TRRL bar pattern, those with low accident rates a half-length pattern.

6. CONCLUSIONS

This project has shown how important a sound accident reporting and analysis system is to a developing country. It has enabled Papua New Guinea to investigate its accident problems in depth, and determine priorities and introduce improvements on a rational basis. Also, it has provided a much improved evaluation capability.

The wide range of schemes that have been or are being implemented has been listed in Figure 11. These schemes, combined with the availability of sound historical accident data, provide an invaluable opportunity for research. Many of the accident remedial measures have only recently been implemented and others are yet to come. It is therefore too early to present general conclusions relating to the effectiveness or otherwise of the countermeasures. However, in the case of roundabouts, preliminary evidence is presented which suggests that they have been effective in reducing accidents. Special studies planned for the future include the introduction of parking bays on the Highlands Highway and trials with high skid resistance surfaces in the National Capital District.

7. ACKNOWLEDGEMENTS

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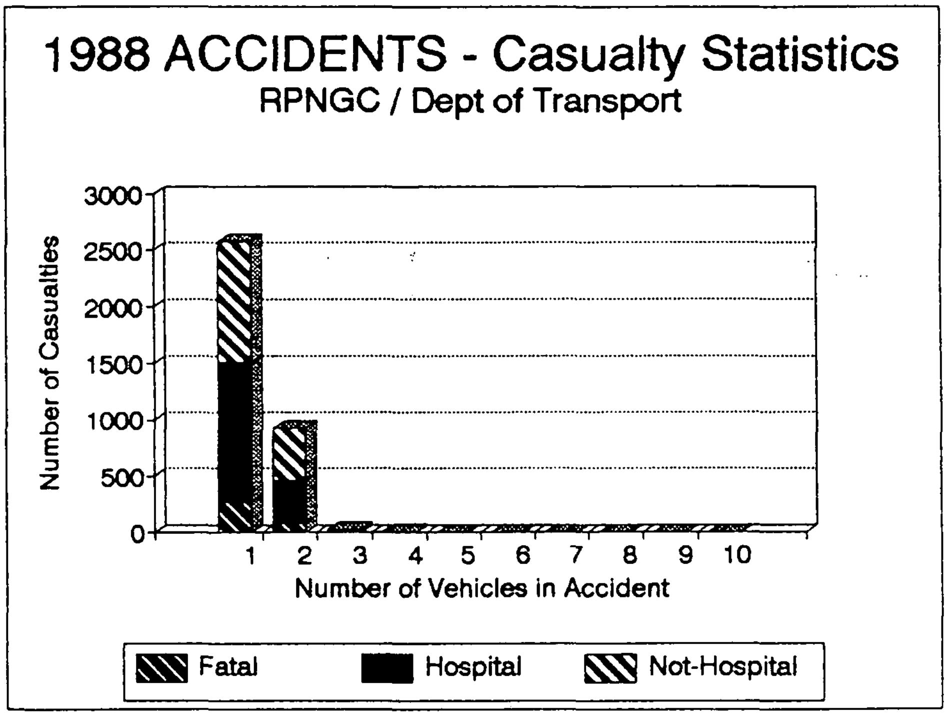


FIGURE 1 Casualties by Number of Vehicles involved in the accident - Figure from "Road Accidents Papua New Guinea 1988"

INJURY SEVERITY by COLLISION TYPE 1988

	Fatal	Hospital	Not-Hosp	TOTAL
Head On	38	180	184	402
Rear End	7	27	53	87
90degree	7	47	100	154
Sideswipe	23	98	104	225
Overturn	90	534	506	1130
Object On Rd	8	27	22	57
Object Off Rd	35	305	267	607
Parked Vehicle	0	6	13	19
Pedestrian	88	242	180	510
Other	32	108	76	216
TOTAL	328	1574	1505	3407

FIGURE 2 Table from "Road Accidents Papua New Guinea 1988"

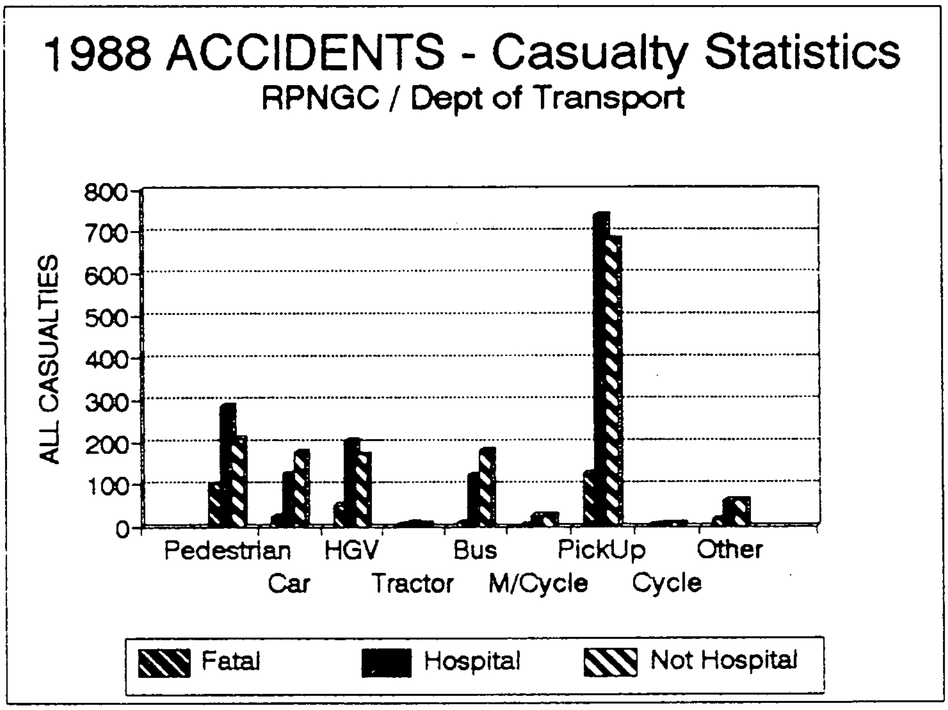


FIGURE 3 Casualties by Class of Road User - Figure from "Road Accidents Papua New Guinea 1988"

NCD Junction Accidents 1988

Junction Number	Road Names	All Accidents	Injury Accidents
253	Hubert Murray/Waigani	40	1
250	Hubert Murray/Taurama Wards	38	3
359	Waigani/Spring Garden	15	1
441	Lapwing/Woodcock	14	1
251	Hubert Murray/Lahara	13	0
255	Hubert Murray/Boroko	13	2
363	Waigani/Cameron	13	1
364	Waigani/John Guise	12	2
058	Ela Beach/Lawes	10	2
365	Waigani/Koura	10	1
159	Hubert Murray/Korobe	9	0
254	Hubert Murray/Hagwa	9	0
157	Hubert Murry/Scratchley	8	4
274	Taurama/Gavamani	8	1
362	Waigani/Wards	8	0
080	Healy/Hiri	7	0
165	Hubert Murray/Korobose	6	1
303	Boroko/Bava	6	1
313	Boroko/Kaubebe	6	0
488	Gerehu/Modiki	6	1
Junctions with 2 or more Injury accidents not above			
261	Morea Tobo/Kanage	5	4
352	Spring Gdn/Wards	5	2
263	Morea Tobo/Saraga	4	2
296	Angau/Turua	2	2
446	John Guise/Godwit	2	2
457	Mokoraha/Pipit	2	2
Junctions with Fatal Accidents			
274	Taurama/Gavaman	1	
331	Hiritano/Sogeri	1	
464	Pipi/Matabudi	1	

FIGURE 4 Table from "Road Accidents Papua New Guinea 1988"

NCD LINK ACCIDENTS 1988

Link Number	Road Names	All Accidents	Injury Accidents
157/159	Hubert Murray: Scratchly-Gorobe	31	6
252/253	Hubert Murray: Nita-Waigani	25	2
250/251	Hubert Murray: Wards-Lahara	17	2
364/365	Waigani: John Guise-Koura	16	6
291/311	Angau: Nita-Bisini	13	0
164/250	Hubert Murray: Guilana-Taurama	12	1
253/356	Waigani: Hubert Murray-Stores	10	4
261/262	Morea Tobo: Hubert Murray-Dogura	10	3
155/156	Hubert Murray: Koki-Moyon	9	2
037/058	ElaBeach: Durville-Lawes	9	3
019/020	Musgrave: Ela Beach:Mary	9	2
352/353	Wards: Spring Garden-Kamarere	9	2
366/457	Mokoraha: Waigaini-Koisere	9	1
441/442	Spoonbill: Lapwing-Kingfisher	8	2
024/037	Ela Beach: Hunter-Durville	8	1
361/362	Waigani: Ahula-Wards	7	0
094/099	Champion: Spring Garden-Goldie	7	3
424/431	Boroko: Gabaga-Spring Garden	7	0
269/290	Chinsurah: Korobosea-Taurama	7	5
251/252	Hubert Murray: Lahara-Nita	7	1
059/080	Healy: Koki-Le Hunte	7	3
380/383	Boragaino: Ebony-Ginata	7	5
253/254	Hubert Murray: Waigani-Hagwa	6	0
365/391	Koura: Waigani-Gari	6	3
106/111	Baruni: Boe Vagi-Idubada	6	4
351/352	Wards: Silkwood-Spring Garden	6	2
272/273	Taurama: Laurabada-Pipi Gari	6	3
018/027	Douglas: Hunter-Musgrave	6	0
159/160	Hubert Murray: Gorobe-Muniogo	6	0
356/357	Waigani: Stores-Garden Hill	6	2

FIGURE 5 Table from "Road Accidents Papua New Guinea 1988"

KILOMETRES	ACCIDENTS	
0 - 9	1	x
10 - 19	27	***xxxxxxxxxxxxxxxxxxxxxxxx
20 - 29	5	xxxxx
30 - 39	2	xx
40 - 49	2	xx
50 - 59	11	*xxxxxxxxxx
60 - 69	0	
70 - 79	2	*x
80 - 89	5	xxxxx
90 - 99	0	
100 - 109	2	*x
110 - 119	1	x
120 - 129	2	*x
130 - 139	0	
140 - 149	3	*xx
150 - 159	5	*xxxx
160 - 169	0	
170 - 179	3	xxx
180 - 189	7	*xxxxxx
190 - 199	24	***xxxxxxxxxxxxxxxxxxxxx
200 - 209	16	*xxxxxxxxxxxxxxx
210 - 219	21	*xxxxxxxxxxxxxxxxxxxx
220 - 229	1	x
230 - 239	5	*xxxx
240 - 249	3	xxx
250 - 259	2	xx
260 - 269	3	xxx
270 - 279	8	****xxxx
280 - 289	15	xxxxxxxxxxxxxxx
290 - 299	24	****xxxxxxxxxxxxxxxxxxxx
300 - 309	10	xxxxxxxxxx
310 - 319	13	*xxxxxxxxxxxx
320 - 329	6	xxxxxx
330 - 339	0	
340 - 349	3	xxx
350 - 359	2	**
360 - 369	11	*xxxxxxxxxx
370 - 379	17	*xxxxxxxxxxxxxxxx
380 - 389	15	*xxxxxxxxxxxxxx
390 - 399	16	*xxxxxxxxxxxxxxx
400 - 409	2	xx
410 - 419	8	*xxxxxxx
420 - 429	31	***xxxxxxxxxxxxxxxxxxxxxxxxxxxx
430 - 439	13	**xxxxxxxxxxx
440 - 449	5	xxxxx
450 - 459	14	**xxxxxxxxxxxx
460 - 469	16	*xxxxxxxxxxxxxxx
470 - 479	39	*******xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
480 - 489	1	*
490 - 499	0	
Total=	422	

FIGURE 6 Accidents along the Highlands Highway in 1988 - Figure from "Road Accidents Papua New Guinea 1988"

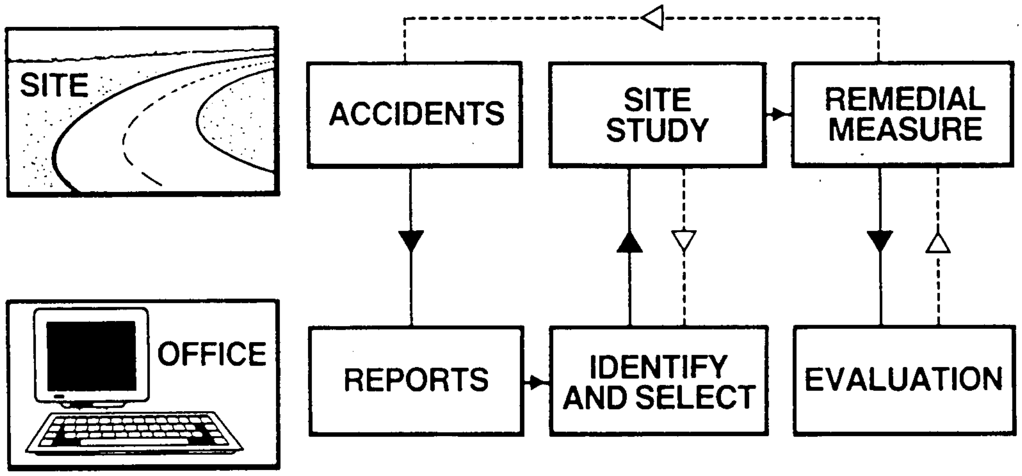


FIGURE 7 The process of Accident Blackspot Investigation

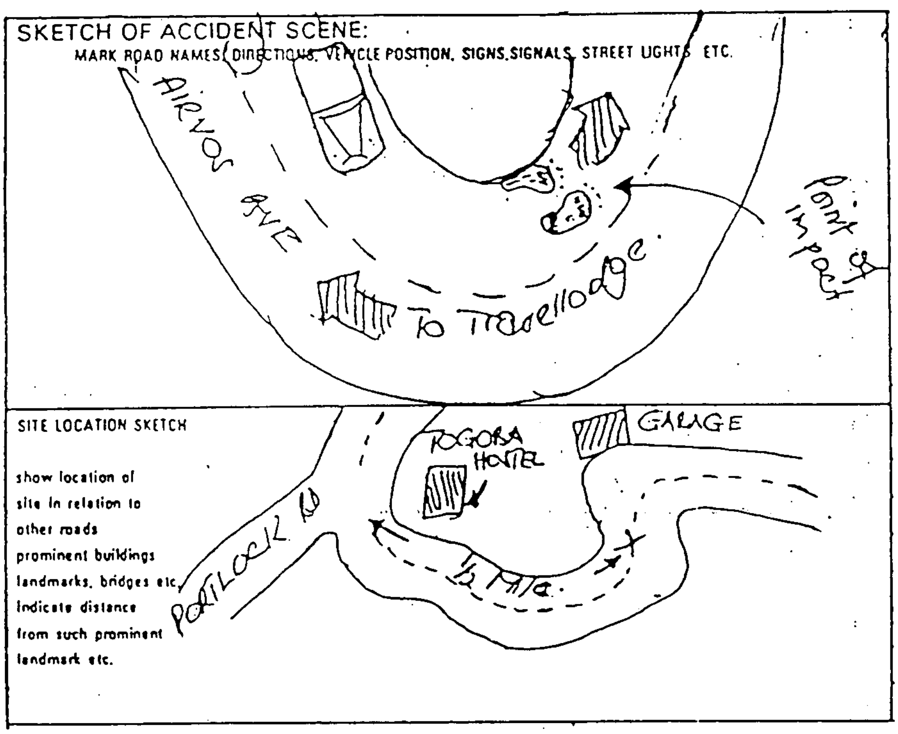


FIGURE 8 An example of an Accident Sketch and a Site Location Sketch from the records of the Royal Papua New Guinea Constabulary

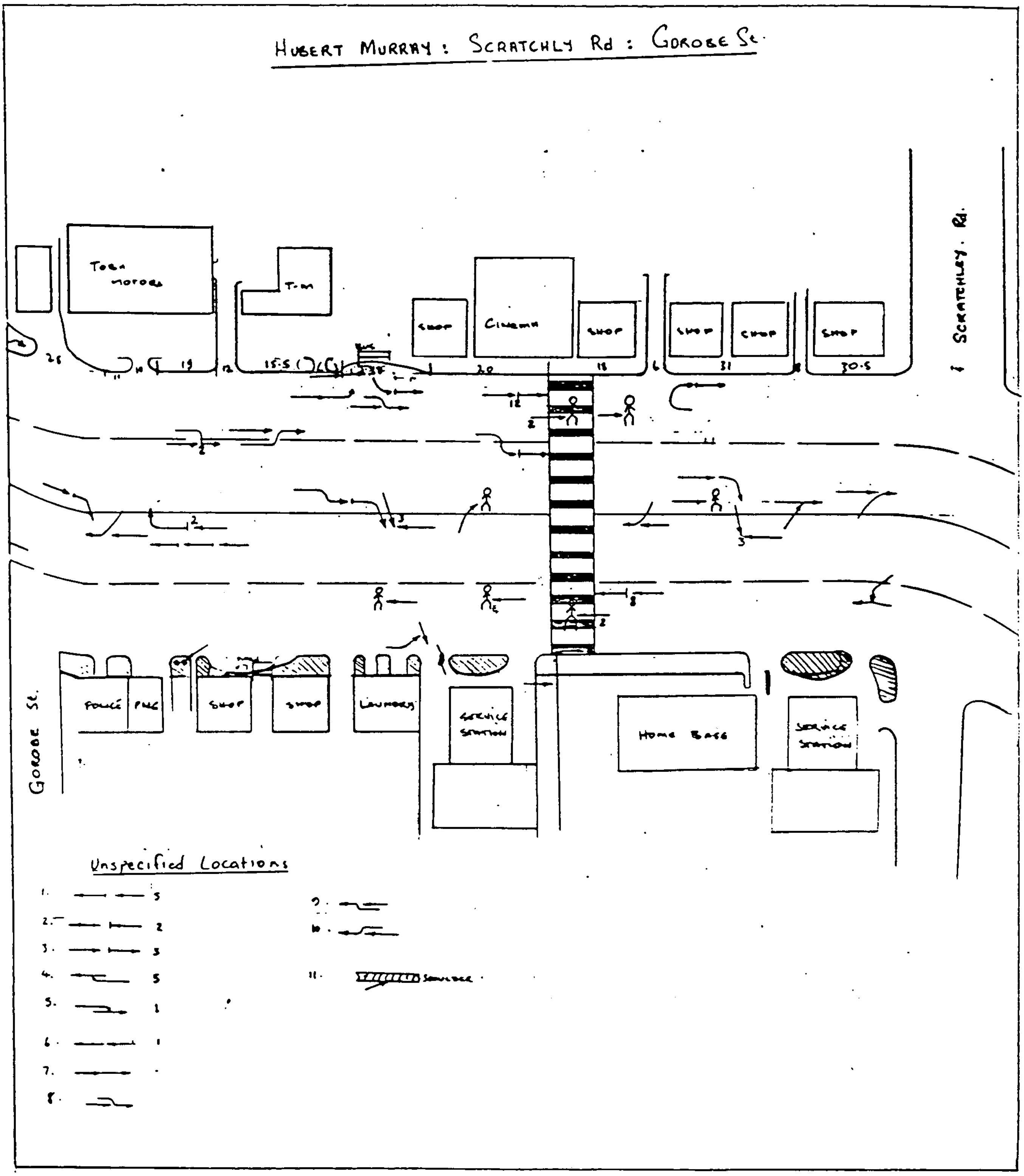
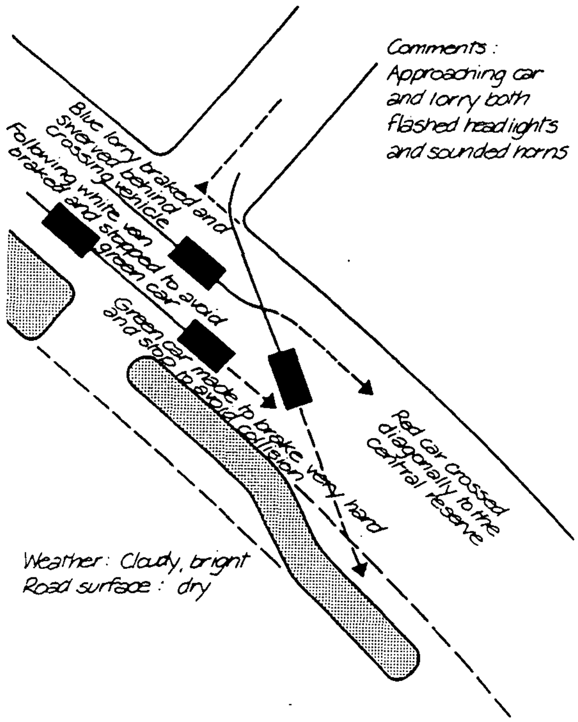


FIGURE 9 Collision Diagram prepared by member of DoT staff



CONFLICT REPORT SHEET		DATE	
DIAGRAM OF OCCURRENCE		CONFLICT SEVERITY	
	1	Precautionary conflict (ie. braking for vehicle waiting to emerge, precautionary lane change, or anticipatory braking).	
	2	Controlled braking or lane change to avoid collision but with ample time for the manoeuvre.	
	3	Rapid deceleration, lane change or stopping to avoid collision, resulting in a near miss situation. No time for steady, controlled manoeuvre.	✓
	4	Emergency braking or violent swerve to avoid collision resulting in very near miss situation or occurrence of a minor collision.	
TIME: 15 30 — Note on diagram directions of travel, colours and vehicle types, and evasive actions taken	5	Emergency action followed by a collision	

FIGURE 10 Conflict study rating scale adopted by the TRRL

Department of Transport/TRRL
CO-OPERATIVE ROAD SAFETY RESEARCH PROGRAMME

ENGINEERING COUNTERMEASURES UNDER EVALUATION

	Location		Date Installed	Implementing Authority
Roundabouts - Installed				
•	NCD	Waigani Drive/Wards Road	1983	NCDIC
•	NCD	Waigani Drive/Koura Way	Aug 85	NCDIC
•	NCD	Waigani Drive/Goro Keaga Rd	Sept 85	NCDIC
•	NCD	Angau Drive/Lahara Avenue	Dec 85	NCDIC
•	NCD	Bisini Prde/Kaubebe/Okari	Dec 85	NCDIC
•	NCD	Waigani Drive/Cameron Rd	Feb 86	NCDIC
•	NCD	Waigani Drive/Spring Garden (Gyratory)	87	NCDIC
•	Lae	Central Avenue/9th St	1985	Lae City
•	Lae	MilfordHaven Rd/Markham Rd	Nov 88	MorobeDoW/DoT
•	Lae	Milford Haven Rd/Air Corps Rd	Nov 88	MorobeDoW/DoT
•	Lae	Milford Haven Rd/Malaita St	Nov 88	MorobeDoW/DoT
•	Lae	Huon Rd/Bumbu Rd	Sept 88	Lae City
Roundabouts - Projected				
•	NCD	Hubert Murray Hwy/Scratchley Rd		NCDIC/DoT
•	NCD	Ela Beach Rd/Lawes Rd		NCDIC/Dot
•	Lae	Milford Haven Rd/Huon Road		Lae City
•	(NCD	Waigani Drive/John Guise Drive - under consideration		NCDIC/DoT)
Traffic Lights - Projected Re-timing				
•	NCD	Hubert Murray Hwy/Taurama Rd/Wards Rd		NCDIC/DoT
•	NCD	Hubert Murray Hwy/Boroko Drive (NBC)		NCDIC/DoT
•	NCD	Hubert Murray Hwy/Waigani Drive		NCDIC/DoT
Junction Improvements - implemented				
•	Lae	Butibum Rd/Orion St	1985	Lae City
•	Lae	Central Av/7th St	1985	Lae City
•	Lae	Huon Rd/7th St	1988	Lae City
Link Improvements - projected				
•	NCD	Hubert Murrray Hwy: Scratchley Rd-Gorobe St		NCDIC/DoT
•	NCD	Waigani Drive: John Guise Drive-Koura Way		NCDIC/DoT
•	Goroko	Highlands Hwy: Mack St- Brechin St		EHDoW/DoT
Pedestrian Footbridge - installed				
•	NCD	Hubert Murray Hwy (Turumu St)	1986	NCDIC
Pedestrian Footpaths - installed				
•	Goroko	Highlands Highway	1988/1989	EHDoW/DoT
Pedestrian Barrier - projected				
•	NCD	Hubert Murray Hwy:Taurama Rd-Lahara Av		NCDIC/DoT

FIGURE 11

Chevron Boards - installed			
• GorokoHighlands Hwy (GKO-Kamaliki Ck)	Jan 88	EHDoW/DoT	
• NCD Baruni Coastal Rd	Sept 89	NCDIC/DoT	
• Gusap Bridge, Ramu Highway	Sept 89	Morobe DoW/DoT	
Speed Reduction - projected rumble strips			
• NCD Waigani Drive/John Guise Drive		NCDIC/DoT	
• NCD Diho Avenue		NCDIC/DoT	
Lane Dividers - implemented			
• GorokoHighlands Highway	Jan 88	EHDoW/DoT	
Central Reservations - implemented			
• NCD Hub Murray Hwy:Taurama Rd-Okari St	1987	NCDIC	
• NCD Waigani Drive: Tomu Place-Koani St	1988	NCDIC	
Climbing Lane			
• NCD Gavamani Rd		NCDIC	
Single Lane Bridge - bar pattern			
• Umi River, Highlands Highway	1988	MorobeDoW	
• Gusap & Boro Rivers, Ramu Highway	Aug 89	MorobeDoW/DoT	
Bus Bays - implemented			
• NCD and Lae	1984-1989	NCDIC/Lae City	

FIGURE 11 (Continued)

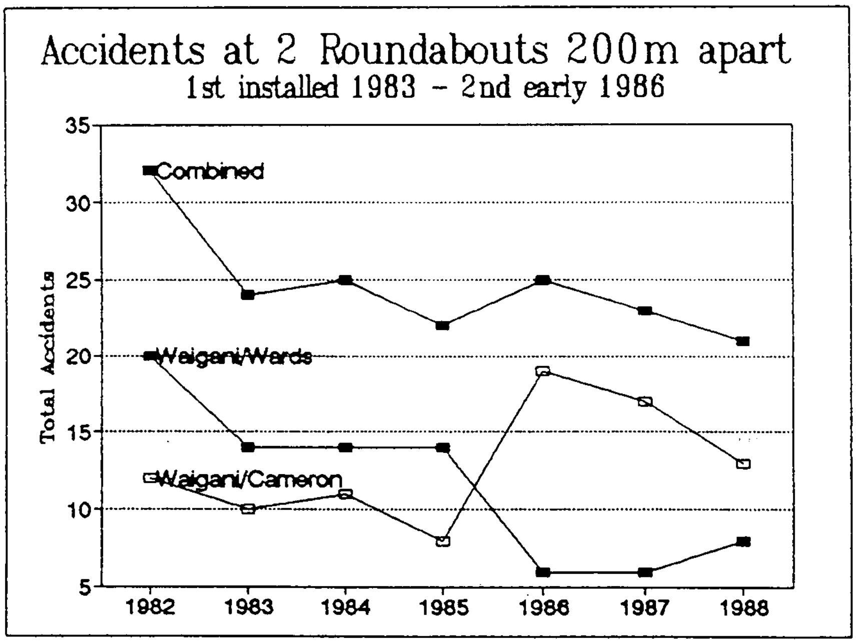


FIGURE 12 Analysis of accidents at two adjacent roundabouts in Port Moresby