THE COLLECTION AND USE OF ROAD AND TRAFFIC INFORMATION FOR ROAD ACCIDENT INVESTIGATION AND PREVENTION

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SUMMARY

The prevention of traffic accidents by selective improvements of roads is the responsibility, in the West Midlands Metropolitan County, of the County Council. It is important that the best use is made of the limited resources available for advancing the aims of the County Council, with regard to reducing the occurrance of road accidents. This research project was carried out, for the West Midlands County Council, to consider the problem of determining at which locations investigations leading to remedial schemes, should be instituted.

This thesis begins by describing the major historical developments relating, primarily, to this aspect of traffic accident prevention, and explains the background to the West Midlands County Council's existing traffic accident recording system. The validity of this approach to accident prevention is established by the inclusion of results of research carried out by the Transport and Road Research Laboratory.

The West Midlands County Council's existing traffic accident recording system, which incorporates a method of identifying and ranking accident problem locations, is described in detail, and a number of shortcomings revealed. The requirements for a technique for identifying and ranking accident problem locations for investigation are then considered in depth, in conjunction with appropriate practical constraints.

A comprehensive review, incorporating a survey of other County Councils and a literature review, of alternative methods of identifying and ranking accident problem locations was carried out, and the results are included in this thesis. Upon examination it was found that none of the methods, in their existing form, satisfied all of the requirements, discussed earlier. Consequently, proposals are put forward on which the development of a satisfactory system can be based.

Index Terms - Accident : Traffic : Investigations : Road : Blackspot

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CONTENTS

T A B L E S

F I G U R E S

PREFACE

Introduction

The research described in this thesis was conducted under the auspices of the Interdisciplinary Higher Degrees Scheme. In keeping with the basic idea of the scheme the research was of a more applied nature than the traditional form of research, and dealt with a specific problem encountered in this instance by the West Midlands Metropolitan County Council.

During the course of the research the student was an employee of the County Council, although additional sponsorship was received from the Science Research Council. In this dual rôle of full-time research student and County Council employee, this project was both research and training.

Terms of Reference

When the West Midlands Metropolitan County came into being on 1st April 1974, as a result of Local Government Reorganisation, the County Council took over the responsibility for Road Safety. A decision was made to adopt and expand the computer-based traffic accident recording and analysis system developed by the City of Birmingham. The system was still in its infancy, and development of some additional facilities was still being conducted.

At the initial meeting between the student, the County Council representatives, and the University supervisors an extensive list of topics, under the general heading of traffic accident analysis, were suggested for research. It was agreed however that the starting point for the project should be a detailed study of the accident recording and analysis system. During the course of this study, a significant shortcoming in the system's technique for identifying and ranking accident problem locations was revealed. As this is one of the more important functions of the system, it was considered that this failing warranted closer investigation, and it subsequently became the subject for research.

The Structure of the Work

Because the objective of the research was not only to produce an 'in-house' report for the sponsoring organisation but also to produce an academic research document, it was important to put the work into perspective, by reviewing the pertinent historical developments. Equally it was necessary to demonstrate the validity of the approach to traffic accident prevention on which the project is based.

An examination of the County Council's traffic accident recording and analysis system revealed serious shortcomings with regard to the identification and ranking of accident problem locations for investigation. In consequence of this the requirements for a technique for identifying and ranking accident problem locations for investigation were considered in depth.

A detailed review was then carried out to determine whether a method for identifying and ranking accident problem locations already existed which would satisfy the established requirements. The review included a survey of other County Councils and a comprehensive study of relevant literature.

Because no satisfactory alternative was revealed during the course of the review certain proposals were put forward on which the development of an acceptable system could be based.

CHAPTER 1

A SELECTED HISTORY OF ROAD SAFETY INCLUDING THE BEGINNING OF THE WEST MIDLANDS COUNTY COUNCIL'S TRAFFIC ACCIDENT RECORDING SYSTEM

1.1 Introduction

This chapter contains a review of the major developments in road safety, primarily in the context of Government involvement, e.g. committees on road safety, advice to local authorities in the form of Circulars, and Acts of Parliament. Although the emphasis is on the highway engineering aspect of road safety, something of the history of road safety in general is revealed, and the roles of the organisations involved in road safety is made clear.

More specifically the setting up, in response to a Government White Paper, of the City of Birmingham's Traffic Accident Analysis System, later to be extended to cover the West Midlands Metropolitan County, is described in detail.

1.2 The London 'Safety First' Council

On December 1st 1916 a company of about 200 public-spirited people assembled at Caxton Hall at the invitation of Mr. H.E. Blain, (later Sir Herbert Blain) then Operating Manager of the London General Omnibus Company, to determine if anything could be done to reduce the dangers from traffic in the London streets.(23) The first meeting of the London 'Safety

First' Council was held on 15th January 1917.

The 'Safety First' Council resolved to widen the scope of its operations, and the Industrial 'Safety First' Committee was appointed. From this Committee the British Industrial 'Safety First' Association was formed. In 1924 the National 'Safety First' Association came into being incorporating the British Industrial 'Safety First' Association, the London 'Safety First' Council, and certain other provincial safety organisations. In 1941 the title of the Association was changed to the Royal Society for the Prevention of Accidents.

1.3 The Alness Committee

On the 8th December 1937 the Select Committee of the House of Lords on the Prevention of Road Accidents (the Alness Committee) was appointed as the result of a debate initiated in the House of Lords on a motion by the Bishop of Winchester, in which he asked that there should be laid before the House papers relating to the continued high rate of casualties on the roads. Lord Newton moved an amendment to the effect that a Select Committee should be appointed "to consider what steps should be taken to reduce the number of casualties on the roads".[1] This amendment was agreed to, and the committee was nominated accordingly.

The figures which initiated the debate came from a report[2] issued by the Ministry of Transport stating that in the year ending 31st March 1937 there were 199,062 personal injury accidents in Great Britain of which 6,337 were fatal. Although this was the third report on Road Accidents in Great Britain, the previous being for the years 1933 and 1935 respectively, it was the first report to include all injury accidents and not just fatal accidents.

An important argument occurred in the evidence which was presented to the Alness Committee[3]. This was when certain evidence presented by the Ministry of Transport was refuted most strongly by a number of people, principally the County Surveyor of Oxfordshire, Mr. G.T. Bennett. The Ministry of Transport argued that even if the condition of the roads and vehicles was unimpeachable the total of accidents would not be appreciably affected. The evidence which they used to support this point of view is explained as follows.

The first report[4] on fatal accidents, which was for the year 1933, was based on reports made by the Commissioner of Police of the Metropolis, the Commissioner of Police of the City of London, and Chief Constables throughout Great Britain. The object with which the inquiry was instituted was to obtain a detailed analysis of the principle circumstances in which fatal accidents occurred on the roads. In addition to all the factual details which the Chief Constables were requested to include in their reports, they were invited to indicate, where possible, what in their opinion were the causes which contributed to each accident, and, where there were several contributory causes, the main cause.

The number of fatal accidents attributed by the Chief Constables to each of the following causes is shown in table 1.

Out of 6,275 fatal accidents only 121 had the sole or main cause attributed to the road alone (excluding accidents involving tramways). And in only 435 cases was the road condition given as a contributory cause.

Note: The total number of fatal accidents for 1933 was in fact 6,942 which exceeds the total number shown as being the sole or main cause of such accidents by 667. This was due partly to the fact that in a number of cases the Chief Constables did not assign a sole or main cause to an accident, but reported only two or more contributory causes, and partly to the fact that in 196 cases the cause of the accident was not traceable. In the former cases

Table 1: Fatal Traffic Accidents in Great Britain - 1933 (4)

Accident cause attributed to:	As sole or main cause		As contributor cause	
	Built-up areas	Area not built-up	Built-up areas	Area not built-up
Driver (not pedal cyclist)	852	994	705	746
Pedal Cyclist	485	371	202	176
Pedestrians	2179	636	637	155
Vehicles or their equipment	106	212	97	153
Conditions of Roadway (including presence of tramway)	70	73	226	226
Weather	28	77	97	125
Passengers, etc.	46	30	5	3
Animals	35	60	8	13
Obstructions	6	15	18	16

the causes given in the reports were shown as contributory causes only.

The following words of caution accompanied this section of the report: "This section of the report must be interpreted with particular caution, partly for reasons which have already been noted or are mentioned hereafter. It was realised, when the forms were drawn up, that the police would be faced with a very difficult task in attempting an attribution of causes for the fatal accidents upon which they were called upon to report. Lack of evidence, the complexity of circumstances and the fact that the returns were the first of their kind added to the difficulty of a definite and satisfactory analysis, and the results must be regarded as in many respects tentative and such as might be open to many corrections if the full facts had been ascertained."

The 1937 report(2) included all injury accidents but only the sole or main cause of each accident was recorded. Out of 6 337 fatal accidents only 43 were attributed to the condition of the roadway, and out of 192 725 non-fatal injury accidents only 2 345 were attributed to the condition of the roadway. The cause of 135 fatal and 1 670 non-fatal accidents could not be ascertained.

The conclusions that the Ministry of Transport drew from these figures were that almost all accidents were caused by people, be they drivers, passengers, or pedestrians, and that no reduction in accidents would be achieved by improving the roads.

In opposition to the Ministry of Transport was the County Surveyor of Oxfordshire, Mr. G.T. Bennett, who based his opposition on a study which he carried out, in his position as County Surveyor of Oxfordshire, and for which a report was produced in October 1937. This study was "a complete investigation into the circumstances under which each of the 148 fatal road accidents which occurred in the county during the four years ending 31st July 1936 took place."

In evidence presented to the Alness Committee Mr. Bennett stated the conclusions of his study as follows: the first of those conclusions was that 76% of the fatal accidents which had occurred would not have taken place if the roads had been designed and constructed in accordance with the Ministry's recommendations as contained in Memorandum 483 (the Ministry of Transport Memorandum on the Layout and Construction of Roads). Of the 76% of fatal accidents so preventable - that is preventable by some form of road improvement - 36% would have been preventable by ordinary means such as improvements of bends, improvements of visibility, improvements of intersections, and so on; 17% would have been preventable by major improvements such as the construction of dual carriageways, cycle tracks and by-passes; and 23% would have been preventable by either of these two methods. That leaves only 24% for which there was no road defect as a contributory cause at all.

The next statement by Mr. Bennett shows more clearly the relevance of his evidence: "It would be quite proper, in most of these accidents, to say that the primary cause may lie in human error, but I was chiefly examining from one point of view only and for one purpose. That was to find out whether the Oxfordshire County Council, as Highway Authority, could, by their own act, have done anything which would have prevented the occurrence of these accidents."

In their report the Alness Committee gave their judgement on the argument as follows: "The Committee have already indicated that, in their opinion, the views of the Ministry of Transport in this matter are not in all cases well founded. The Committee are strongly of this opinion. If indeed it were true, as the statistics of the Ministry suggest, that only 43 fatal accidents out of the total of the 6,337 which occurred in 1936-37 ought to be attributed to road conditions, the Ministry might well curtail their road improvement programme, and reduce their personnel. A perusal, however, of Memorandum 483 leaves the Committee in doubt whether the Ministry believe in the theory advanced on their behalf. In their original evidence the representatives of the Ministry nevertheless affirmed that over 90 percent of accidents were due to human errors of judgement or thoughtlessness. They argued that if all drivers, pedestrians and cyclists used the roads with sufficient care, there would be a negligible number of accidents, whereas it was suggested by a number of witnesses that, if roads were improved by segregation of traffic, dual carriageways, etc., and if vehicles were improved, a similar result would be obtained without dependance on the far more difficult task of improving human characteristics. One witness - the County Surveyor of Oxfordshire - affirmed that in his county 76 percent of the fatal accidents might have been prevented by road improvement, and that dual carriageways alone would have reduced the accident toll by 42 percent. The Committee realises that these are two extreme points of view. The truth, as so often happens probably lies between them. A witness from the Ministry did, towards the end of the enquiry, in fact modify the point of view from which they regard the problem. It should also be remembered that the primary object of the investigation carried out by the County Surveyor of Oxfordshire was to determine the extent to which faults in the highway system should be held responsible for accident causation. Even so, the difference between the Ministry's figures of 1.2 percent and his figures of 76 percent is startling."

This argument has been dealt with at length because of its fundamental nature in that it concerns the validity of road improvement (highway engineering methods) as a method of road accident prevention, and accident prevention by highway engineering methods is the purpose behind this project. In addition the outcome of such an argument affects one's understanding of accidents, and hence the approaches one will adopt for their prevention.

This can be shown by again quoting from the report of the Alness Committee; "The Committee are of the opinion that the majority of accidents are the result of human error in conduct or in judgement. At the same time, bad and inadequate road conditions are important contributory factors in the accident problem. If these road defects were removed, there would, in the opinion of the Committee, be a substantial reduction in the number of accidents."

That is not to say that the Alness Committee considered road improvements to be the only method of accident prevention. The Committee saw three approaches to the problem of road accidents:-

1) the education of all road users so as to reduce errors of judgement and thoughtlessness to a minimum,
2) the improvement of roads and the segregation of traffic so that accidents might be reduced in number,
3) the improvement of vehicles so as to eliminate their defectiveness as a cause of accidents.

They made recommendations about all of these, but only the second has been discussed in any detail here because it is with the second that this project is primarily concerned.

After accepting that road improvement is valid as a method of accident prevention, the next obvious question is how would one go about it, and this was the question that the Alness Committee put to Mr. Bennett. His reply was that "I should approach it primarily by reference to the accident maps and to estimated costs of removing the defects where most accidents occur."

The Committee agreed with Mr. Bennett about the use of accident maps as was shown when, after a visit to the Traffic Accident Map Room at New Scotland Yard, they stated that they considered that the soundest method of deciding on road improvement and construction would be to study the density and severity of accidents as shown on these charts. The Committee recommended that every local authority should have similar maps.

The Committee also discussed who should carry out the work and what his duties should be. They commented that there were too few accident officers and that more should be appointed.

The original appointment of Accident Officers was in December 1936, and was announced by the Minister of Transport as an experimental measure. These Accident Officers were required to act under the direct instructions of the Divisional Road Engineers, one officer being appointed in each Divisional Road Engineer's office. The Accident Officers were expected to have or to acquire a knowledge of road accident problems and the general law and regulations relating to drivers and vehicles, together with a thorough knowledge of the Highway Code. The officers were required, amongst other things, to examine accident returns and reports with a view to the selection of a number of cases which appeared to offer some chance of useful action if followed up;

to maintain close touch with Chief Constables and to examine accident maps with a view to making inspections from the standpoint of an enlightened road user of the localities in which the accidents occurred; to observe road behaviour at particular points; to call the attention of the Divisional Road Engineers to cases where technical examination of the physical state of the road appeared to show the need for the introduction of safety measures; to keep themselves informed of the work of the local safety committees and similar bodies; to take such action as might be possible to stimulate local interest in safety problems; to encourage action which might lead to more general recognition of the need for consistent observation of the spirit of the Highway Code. The Accident Officers' inspections were intended to be independent of those of the Police and the Highway Engineers. The officers were warned that nothing should be done which might be taken as in any way undermining local responsibility; that care should be taken not to impose additional work upon the Police by way of asking for information requiring special research; and that they should endeavour to secure the goodwill and co-operation of Chief Constables and Highway Engineers.

The Alness Committee not only made explicit recommendations as to the duties of the Accident

Officers but also recommended that a much more positive line be taken: "The Committee recommend that they (the officers) should investigate all the contributory causes of accidents, rather than concentrate on finding out who was primarily to blame, with a view to prosecution. This should enable the authorities concerned to remove or at any rate abate contributory causes of accidents. When defects on roads other than trunk roads have contributed to accidents, the facts do not at present necessarily come under the cognisance of the Ministry. It should be the duty of these officers to report dangerous roads and black spots. If the conditions of these roads and black spots is not put right within a reasonable period, it should be within the power of the Ministry to order the offending section of the road to be closed."

1.4 The Committee on Road Safety

The formation of the Alness Committee, and the report it produced, was one of the first significant steps in the history of road safety in so far as Governmental interest and Governmental policy are concerned. The next significant development was the appointing of a Committee on Road Safety by the Minister of Transport in December 1943, to report on the matters covered by the following terms of reference:- "To consider and frame such plans as are possible for reducing accidents on the roads and for securing improvements in the conduct of road users in the interests of safety; and to review the recommendations of the Select Committee of the House of Lords on the Prevention of Road Accidents (the Alness Committee), and to advise on those which should be adopted as measures of post-war policy for the reduction of accidents." This Committee produced an interim report in December 1944[5], and a final report in May 1947.[6]

This Committee also accepted as valid the use of road improvements as a method of accident prevention, with the following comment: "We agree with the Alness Committee that the majority of road accidents are the result of human error in conduct or in judgement and for this reason we have emphasized in earlier paragraphs of this report the need for continuous training and education of road users in the provisions of the Highway Code. Nevertheless we are at one with the Alness Committee in their opinion that bad and inadequate road conditions are important contributory factors in the accident problem. We also agree with the Alness Committee that vigorous action should be taken to remedy bad and inadequate road conditions."

The Committee on Road Safety also agreed with the Alness Committee on the use of accident maps, and went on to make recommendations of its own, and included in the appendix a detailed description of how to set up and operate an accident map system. The recommendations and the detailed description in the appendix are included here in full. The recommendations:- "Accident maps will be required locally in addition to accident statistics. The accident statistics will provide generic information; the maps will provide the topographical information and will show at a glance where the accidents are occurring and their nature and causes. By means of maps, "black spots" can be readily detected and the effect of differing densities and types of traffic and of various road conditions can be studied. The effectiveness of road improvements can also be ascertained and numerous other aspects of the road accident problem investigated. In our interim report we recommended that accident maps should be maintained, in so far as this is not already done, by the Police, the Highway Authorities and the Divisional Road Engineers. We suggest, however, that in compact areas, e.g. County Boroughs, one set of up-to-date maps properly maintained and displayed is all that is required, and that the Police should maintain such maps. This will help to ensure the closest collaboration between the Highway Authorities and the Police, which is essential for the proper investigation of road accidents. In Counties, it may be desirable in addition, for the Highway Authorities to have their own accident maps, particularly where the Police maps are only maintained at the County Police Headquarters."

The detailed description:

"<u>Traffic Accident Maps</u>

<u>Scale of Maps</u>

As the Police Districts in different parts of the Country vary widely as regards density of population and the number and nature of road accidents, it is not possible to suggest a "standard" scale for the maps. Ordnance Survey maps on the scales of 1 in., 6 in., 25 in., and 60 in. to the mile are available, and the Ordnance Survey are also developing a range of sheets on the scale of $2\frac{1}{2}$ in. to the mile. For some parts of the Country, maps on the scale of 3 in. to the mile are published by Geographia Ltd. Where Local Authorities have drawn up their own maps on scales to suit themselves it may be possible for the Police to use them for accident maps.

<u>Preparation of the Maps</u>

Main Trunk Roads should be coloured in brown on the maps.

Traffic Light installations should be indicated by small posts coloured red, green, and yellow in bands.

Police Controlled Crossings should be denoted by small white posts.

Cycle Tracks, Dual Carriageways, Guard Rails and "Halt" signs should also be shown.

The maps should be marked in squares of convenient size, each square being denoted by a letter and a number for reference purposes.

<u>Method of Marking the Accidents</u>

In congested areas it is sufficient to record those accidents which involve death or personal injury, as experience has shown that these are a better indication of places at which danger to life and limb may occur than accidents which involve only damage to vehicles. In rural districts it may be desirable to record all accidents. Each accident should be marked on the map by a flag with a coloured pin-head placed at the point where the accident occurred. These flags and pin-heads should indicate the following features:-

(1) Month of occurrence

(2) Degree of injury

(3) Class of road user killed or injured

(4) Reference number of original report

Details showing how these features are indicated are given below.

1. Month of Occurrence

The maps should normally record at any given time a minimum of six months' accidents and a maximum of seven months', a separate colour being used for each month in sequence as follows:-

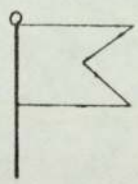
First Month ...	Orange	Fifth Month ...	Blue
Second Month ...	Green	Sixth Month ...	Pink
Third Month ...	Mauve	Seventh Month...	White
Fourth Month ...	Red		

At the end of the seventh month, the orange flags representing the first month should be taken off the maps and orange then becomes the colour for the eighth month followed by green for the ninth month and so on in rotation.

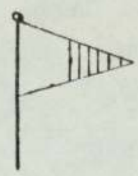
2. Degree of Injury

This should be indicated by the use of the following types of flag:-

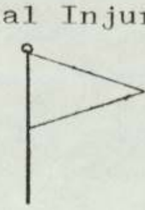
Fatal accidents



Accidents involving Serious Personal Injury



Accidents involving Slight Personal Injury



3. Class of Road User Killed or Injured

This is shown by the colour of the pin-head. (At a spot where accidents are numerous, only the colour of the pin-head can easily be distinguished). The code should be as follows:-

Red pin-head	...	Pedestrian
Blue pin-head	...	Pedal cyclist
Black pin-head	...	Motor vehicle driver or occupant
Pink pin-head	...	Motor cycle rider or passenger
Orange pin-head	...	Horse-drawn and hand propelled vehicles (drivers, occupants, etc.)
White pin-head	...	Person killed or injured while boarding or alighting from a vehicle (no collision).

(Note:- If, in a collision between a pedal cyclist and a pedestrian, the former is slightly injured while the latter suffers serious injury, the colour of the pin-head would be red).

4. Reference Number of Original Report

Police reports of accidents should bear a reference number denoting the station of origin. This reference number should be written on the front of each flag, and when the flag is due for removal at the end of the seventh month, the number should be recorded on an Index Card corresponding to the lettered and numbered square from which it was removed, thus establishing a permanent record from which accident maps for any past period could be reconstructed.

5. Time, Day of Week and Causes of Accident

If desired, the time to the nearest hour, the day of the week and the Code Numbers of the causes of each accident may be written on the back of each flag.

Note:- Modifications of this system may be necessary in some areas owing to limitation of space for housing numerous large scale maps, but the principle of providing the information in other forms should be maintained, so that quick decisions can be taken as to the type of Police action that is required to deal with varying situations from day to day."

On the point of who should carry out the work, however, the Committee on Road Safety disagreed with the Alness Committee.
"We think that the object of accident investigation and review is threefold:-

(i) to expose any dangerous or careless behaviour contrary to the law;

(ii) to ascertain and establish the broad generic causes of road accidents with a view to further control by law or other measures.

(iii) to ascertain particular causes such as bad road lay-out, vehicular failure, etc.

In our view this threefold object can best be attained by a close liaison between the Police and those responsible for the construction and maintenance of roads and for the construction and use of vehicles. Investigation immediately following an accident is the duty of the Police: subsequent review to ascertain whether road and/or vehicle conditions were the cause or contributory cause should be, and is in fact, undertaken by the engineers of the Department and the Highway Authorities. We understand that the Police report to the Department's Certifying Officers accidents alleged to be due to defective public service vehicles and goods vehicles and, where road defects are alleged to be the cause, to the Highway Authorities, or, in the case of trunk roads, to the Divisional Road Engineers. It seems to us that this procedure provides a sound basis for accident investigation and review and that what is required is intensification and proper direction of the activities of both the Police and the engineers rather than the appointment or re-appointment of Accident Officers. We realise that one of the Department's objects in appointing Accident Officers before the War was to promote co-operation between the officers of the Department, Highway Authorities and the Police, which, indeed, is an absolute essential for the success of any road safety measures. We are of the opinion, however, that a more satisfactory measure of collaboration than has hitherto been achieved can be secured by other means."

The Committee on Road Safety then went even further: "In our view the Police and the engineers of the Department and the Highway Authorities are better fitted to carry out this work, and the introduction of Accident Officers might even detract from, rather than add to, the proper examination and consideration of the problem."

A form, F.S. 98, was devised to enable Chief Officers of the Police to inform highway authorities when road conditions were alleged to be a factor contributing to a road accident. Notification of this form, and a procedure for its' use, was set out in Circular 625, of the 10th December 1948, which was sent to the appropriate local authorities.

1.5 1949-1966

In 1954 the Minister of Transport and Civil Aviation decided that a large-scale experiment (7) should be carried out over a period of two years, in an attempt to determine the effectiveness of various new and existing measures for improving road safety.

The individual measures were not all to be experimental in the sense that each would involve new basic principles; the unique feature would be the concentration of all of these measures in a comparatively small area.

Measures were proposed under headings corresponding broadly with those of Education, Enforcement, and Engineering (the 'three E's'). Studies were to be made of the effect of the measures introduced both collectively and, so far as possible, individually on the conduct of road users, on the accident rate and on the flow of traffic, so as to provide information for use in determining future policy on road accident prevention.

In 1957, as a result of a review by the Ministry of Transport and Civil Aviation, Circular 734[8], of the 25th March 1957, was sent to the County Councils, County Borough Councils, the Common Council of the City of London, the Metropolitan Borough Councils, and the Town Councils and Urban District Councils in England and Wales recommending that the procedure laid down in Circular 625 of the 10th December 1948 should be discontinued. The review had revealed that form F.S. 98, because of a number of legal and other difficulties, was not generally being completed. However, it was stated, in Circular 734, that it was considered to be of great importance that satisfactory machinery should exist whereby the highway authorities would be fully informed about road conditions which had led, or might lead, to accidents. Such machinery should include provision for the flow of information about road defects and road accidents from the Police to the highway authorities, helping the latter to keep a close watch on road conditions, to consider measures which would be immediately practicable for reducing accidents, and to pick out black spots which might require more extensive treatment.

With respect to obvious defects, such as pot-holes or mud or oil on the road, which would be easily recognised by a police officer, perhaps during a normal patrol without any accident having happened the circular stated that they could best be dealt with by close and informed liaison between the police and the highway authority and that the way in which the police report obvious road defects to the highway authorities was essentially a matter for local arrangement.

The circular was primarily concerned with other road faults which a police officer may not be able to identify and which sometimes even a highway engineer might not recognise until a number of accidents had occurred at the same site. These would include, for example, cases where road surfaces at bends had become polished and slippery when wet, although to casual inspection the road would appear in good condition and non-skid.

It was stated, in the circular, that in order to identify types of defect producing a blackspot the highway authorities should ideally have reports from the police about every road accident. It was suggested that where adequate alternative arrangements were not in operation the co-operation of the police should be sought in reporting to highway authorities the occurrence of all accidents involving personal injury on a new form, Stats. 36.(Fig.1)

Figure 1.

Police Reference No.

Form Stats. 36

Police District ....

Police Station ....

REPORT ON ROAD ACCIDENT

(To be completed in respect of all personal injury accidents)

Name of Town or Place ....

Road or Street ....

Site of accident (See note (A) below) ....

....

Accident occurred at .... a.m./p.m. .... day, the .... 19 ....

Weather (delete as necessary) Fine Snow/Sleet Rain/Hail Fog/Mist Not Known

Number of casualties: .... Killed .... Seriously injured ...... Slightly injured

Give, if applicable, particulars of any apparent defect in the layout of the highway, or faulty conditions of road surface, or tramway tracks, or street lighting.

....

....

Note (A) Indicate as closely as possible the exact site of the accident, mentioning the name of the cross roads, or the approximate distance in yards from some feature along the road (e.g. telegraph pole No......) or the number of the house opposite which it occured. The road classification number should be given if known.

It was considered that these arrangements should provide the highway authorities with the basic accident information they required, but that wherever the police were able to provide it, highway authorities should take full advantage of further information, not only about personal injury accidents but also about accidents resulting in damage only.

The Circular went on to state that to achieve the most effective results the Engineer or Surveyor should be able to refer to a cumulative permanent record of accidents. Such a system was suggested in the appendix to the Circular. It involved graphical recording and allowed for the noting of the location of each accident, the remedial measures decided upon and the date of implementation.

In the suggested system recording would be done on a special chart consisting of four parts. The bottom part would be used for recording the location of each accident and the year in which it took place. Immediately above it would be a strip map to a scale of 1 mile to 1 inch (or other appropriate scale) marked off in 1/10th mile sections. Above this could be recorded information of any existing streetlighting and speed limits and any modifications thereto. Finally the top section would be used to record a brief description of any work carried out and the date of completion. One or more charts would be prepared for each road to a convenient length.

The system would operate as follows: On receipt of accident information each accident would be indicated at the bottom of the chart by blocking in a square, to the colour chosen for the particular year, corresponding to the section of the strip map on which the accident occurred. Fatal accidents would be marked by a black dot in the square, whilst a black line drawn across a square would indicate that remedial measures had been carried out. Concentrations of blocked-in squares building up in the form of a pillar would give an indication of a black spot.

The Circular concluded with the statement that when a black spot had been located in this way it would then be necessary to refer back to the police in order to obtain fuller information about the accidents that had occurred. The known details of each accident could then be recorded on a special card which would be filed away under road classification number and mileage order, so that all cards relating to a particular site would be found together and could be quickly traced when required.

The next development, concerned directly with accident prevention by highway engineering methods which came from central government occurred in 1963 when Area Road Safety Units were set up in Hampshire and Warwickshire to study the facts about local accidents, to devise remedies, and, with the local authorities, to promote action on them. Their work was experimental at first, and their staffs remained small. But they demonstrated how accident reports could be used to diagnose and remedy local accident problems. For example on a twenty-one-mile stretch of the A45, the number of accidents in which people were hurt fell from 301 in 1964 to 252 in 1966[9]- a 16% reduction - after this treatment. The solution could be unspectacular - things like small changes in the layout of junctions, or new arrangements to shepherd children to school - but they would strike at the problems where and when they occurred.

In the nineteen-fifties and sixties a number of changes were made in the laws affecting road safety. In the Road Traffic Act of 1956 the measures for improved road safety included a compulsory annual test for vehicles over ten years old and stricter regulations on the sale of unroadworthy vehicles and the renewal of driving licences. Dangerous driving penalties were increased and extended to include pedal cyclists, and pedestrians became legally bound to obey the directions of police on traffic duties. In the Road Traffic Act of 1960 the more important legislation from earlier acts was consolidated into the one Act, containing the following seven parts:

1. General provisions relating to road traffic;
2. Minimum age for driving motor vehicles and licensing drivers;
3. Public service vehicles;
4. Regulation of carriage of goods by roads;
5. Licensing of drivers of heavy goods vehicles;
6. Third party liability;
7. Miscellaneous and general.

In the Road Traffic Act of 1962 there were increased penalties for offences including an additive penalty system, new proposals on drink and driving, and an imposition of new speed limits and the granting of more flexible powers for imposing speed limits. The new speed limits included the upper overall 70 m.p.h. limit. In the Road Safety Act of 1967 it was made an offence to drive or attempt to drive with more than 80 mg of alcohol in 100 ml of blood. Existing offences of driving or being in charge were retained. This Act also increased governmental powers with regard to roadside checks on commercial vehicles.

In the twenty years after the report, in 1947, from the Committee on Road Safety, in so far as action on road safety by the highway authorities is concerned, there seems to have been little change. The accident officers, who, as has already been said, were not engineers, concentrated their efforts more and more towards the education approach to road safety, with visits to schools, cycle training etc.

It seems to have been generally held by highway engineers that, except for a few locations requiring special attention, they were doing their part towards road safety by constructing new roads, or re-constructing old roads, to the required standards, as specified by the Ministry of Transport. It must be realised however that, to the highway authorities, road safety was just a minor matter. That is not to say that road safety was ignored but that, to the engineers, road safety was very much of a secondary consideration. Furthermore the term 'road safety' became synonymous with the only visible aspect of road safety, that is school visits, cyclist training etc., and something of a prejudice against involvement in road safety, in that it was too trivial and that there was no 'glory' in it, developed amongst engineers. Indeed some of that prejudice is still apparent amongst some engineers.

There were however some exceptions. Cornwall County Council, for example, were processing information relating to road accidents on their computer in 1964.(10) But perhaps the most notable , certainly one of the most documented, exceptions was Hertfordshire County Council whose Computer Analysis System became operational in August 1967, since when it has handled all personal injury road accidents in that county.[11]

For the majority of the highway authorities, however, no real change took place until the end of the 1960's. One of the technical reasons for this was that, until the computer, there was no real alternative to accident maps and strip maps.

1.6 <u>"Road Safety - A Fresh Approach"</u>

The next major step forward in the advancement of road safety was the Government White Paper, Command Paper 3339, entitled "Road Safety - A Fresh Approach" which was presented to Parliament by the Minister of Transport in July 1967.[9] In it were the following words: "We cannot tolerate the unnecessary pain and bereavement and human waste that road accidents make people endure. Nor can we shoulder with equanimity the heavy economic burden they impose: death and injury deprive the nation of productive output, add to the costs of medical treatment, occupy the time of the police and the courts; the costs attributable to road deaths and road injuries amount now to £250 million a year quite apart from the suffering and grief they cause. This is about the cost of 10 new hospitals. At the end of the decade, the bill could be £275 million, and by the end of the century £550 million a year. The Government intends to tackle the problem urgently but at the same time methodically and consistently. This will be done:

- by making sure that planning to deal with the problem is as clear-headed and scientific in its approach as it can be
- by strengthening the organisation to plan and co-ordinate effective action
- by educating people in the safe use of roads, by improving vehicles and by making the road-users' environment safer."

Under the heading of 'Scientific Approach' the White Paper stated that Police forces, some local authorities, and the Ministry's two Area Road Safety Units had been classifying the facts from Police Accident Reports and plotting the information on maps. Such maps would show what kind of accidents were happening and where, and unspected trouble spots would soon show up. Once the local patterns had been identified, the underlying reasons could be sought out.

Under the heading of 'Strengthening the Organisation' the White Paper announced the setting up of the Central Road Safety Unit within the Ministry of Transport. This unit would bring together a team of people of varied experience and would be the main link with the whole range of people working in road safety. Its function would be to develop and carry through the continuing programme of national road safety measures and to give fresh impetus to local efforts by guiding, stimulating and informing them. It would be the channel through which local problems could be referred for central study, research and resolution. In short it would be the "driving force in getting things done".

The proposals were summarised as follows:
"The Government's approach to the road safety problem is: first, to get the facts about accidents; second, to seek out and test remedies by scientific research; third, to evaluate the remedies; fourth, to try out on the ground and perfect them."

Following on from the White Paper, on 25th April 1969, the Circular 'Roads No 14/69' entitled "Road Safety - A Fresh Approach: The Role of the Local Authorities" was sent, by the Ministry of Transport to The Greater London Council, The Common Council of the City of London, London Borough Councils, County Councils, County Borough Councils, and Urban District Councils in England.(12) It was in this Circular that the Government set out what it expected the local authorities to be doing in terms of road safety. The positions of the Royal Society for the Prevention of Accidents and that of the Ministry of Transport's own Road Safety Organisation were also stated.

The Local Authorities' road safety task was set out in an annex to the Circular as follows: "The local authorities' task in framing and carrying out a co-ordinated local programme is:-

(a) the deep investigation of accidents in the area i.e.

(i) collecting from the police full details of all accidents within the locality, where necessary seeking further information from other sources;

(ii) setting up a record system and accident maps so that a comprehensive picture over any given time and over any part of the area can be established;

(iii) studying the pattern and trends of accidents with the object of discovering at an early date recurrent features of accidents, localized causes, and particular hazards;

(b) the study of and introduction of remedial measures related to the accident problems in the area i.e.

(i) considering the extent to which the findings of national research on road safety can be applied locally;

(ii) initiating joint consultations between those most concerned (e.g. local authority road safety officers, engineers, education officers, welfare officers, public relations officers, the police, transport undertakings, the Divisional Road Engineer) so that remedial action related to a particular length of road or part of the area can be considered;

(iii) introducing the appropriate remedial measures;

(iv) keeping "before and after" records from which the success of remedial measures can be judged;

(c) direction of road safety publicity, relating this to local needs and co-operation with the national effort i.e.

(i) obtaining public goodwill and co-operation by ensuring that those members of the public who will be most affected are kept informed, through the press, through other publicity media and by personal contact, of the need for the proposed action in any given circumstances, what it is hoped to achieve and how the public will be involved;

(ii) co-ordinating local participation in national compaigns and arranging for the display of posters and distribution of literature in libraries, schools, factories, garages, etc.;

(iii) maintaining close contact with ROSPA and with all other organisations in the area able to assist in giving advice about the correct use of the roads;

(d) direction of road user training i.e.

(i) organising, with the help of the local education authority, teachers, youth leaders, voluntary organisations etc., training schemes for pedestrians, cyclists, motorcyclists and drivers and especially for the young;

(ii) arranging for the use of suitable training grounds e.g. for cycle and motorcycle training;

(iii) persuading local teachers, youth leaders, etc. to include road safety training and education in their programmes, and offering help and guidance backed by an understanding of the particular problems of the area;

(iv) advising and assisting local education authorities in providing refresher courses for teachers and youth leaders;

(v) arranging lectures, film shows etc., for schools, clubs, local organisations, factories, etc.;

(vi) organising safe driving events, demonstrations, exhibitions, quiz programmes, etc.

Authorities may find they need to add to this list in the light of knowledge of the accident problem in their areas, traffic growth and population pattern.

But it is again emphasised that all the parts of this task need to be co-ordinated if a programme of road safety activity is to be planned and carried out effectively."

The Circular also commented on the structure of local authorities' internal management of road safety:- "At committee level there should, in the Ministry's view, be representation of all main services such as highways, police and education, backed up with sufficient resources to take effective action. If representatives from outside interests are needed, their number should be carefully regulated to prevent unwieldiness. Work at committee level should be served by a small team of officers responsible for day-to-day operations and for giving advice on road safety policy and planning."

The Circular went on to say who, in the opinion of the Ministry, should be in charge of the work of road safety: "The task outlined in Annexe A (The Local Authorities' Road Safety Task) demands an ability to organise and control an accident intelligence and road safety section, and to plan an overall attack on local road safety problems, and the personality and background knowledge to work in harmony with the people of different professions and with many other individuals and organisations which can contribute to the plan and its implementation. The central co-ordinating role does not necessarily demand specialised technical or engineering knowledge. Consequently while recognising that the duties in Annexe A, and especially the idea of accident investigation and analysis would extend the range of duties traditionally allocated to Road Safety Officers, the Ministry considers that the officer in charge of this work could best be a full time civilian Road Safety Officer.

Local action may run the risk of being dissipated if there is not an effective Road Safety Officer. A few Road Safety Officers are themselves Chief Officers, but where they are not, the Ministry's view is that, within the limits of their responsibility to their Chief Officers, they should have the status and freedom to organise the work set out in Annexe A and develop the personal contacts necessary to carry out their activities efficiently. Given the need for co-ordination and effective management the Ministry has concluded, after consultation with the Local Authority Associations, that this might well be most satisfactorily achieved where the Road Safety Officer (if not a Chief Officer himself) reports direct to the Clerk, or to a Deputy Clerk with particular responsibility for supervising an adequate and effective local road safety programme. This view does not, however, preclude the designation of road safety as the responsibility of another Chief Officer. As stated in the White Paper the pay and status of Road Safety Officers should be commensurate with the wide range of duties allotted to them.

The main weight of the local road safety problem is in towns with more than 100,000 population. It is in such towns that the Ministry considers it essential that a civilian officer with supporting staff should concentrate full time on the tasks in Annexe A."

In the Circular the Ministry made the following comments on the position of RoSPA, the Royal Society for the Prevention of Accidents, in road safety:- "Discussions are being held with the Royal Society for the Prevention of Accidents on how best to develop future co-operation between the Society and the Ministry. RoSPA has valuable experience to offer, especially in the fields of training and publicity. RoSPA's regional organisation has close contacts with local authorities in this work and can advise them on participation in national publicity campaigns, on conducting local campaigns, and in undertaking practical training schemes.

The Ministry continues to pay RoSPA for the road safety services carried out on its behalf, and in particular to pay the full cost of its regional road safety organisation. It hopes that local authorities will continue to subscribe as members of RoSPA and that they will make the fullest use of the services provided by the Society in road safety publicity, road user training, and of the training courses for, in particular, Road Safety Officers."

The Ministry also commented on the position of its own Road Safety Organisation. The setting up and the aims of the Central Road Safety Unit, as described in the White Paper, were re-stated. In addition, training courses for road safety staff were mentioned run by the Central Road Safety Unit, with the aim of bringing them up-to-date with latest developments in road safety matters at the national level and giving instructions in the techniques of accident investigation and analysis. The courses would also serve as a forum for the exchange of ideas and views. The Circular also said that in addition to the two Ministry Road Safety Units operating in Warwickshire and Hampshire, respectively, three more had been set up and were operating in Gateshead, Dewsbury and Leigh.

There are two other sections in the Circular which are relevant. They are self-explanatory and are as follows:-

(1) "The Government does not propose at present to seek fresh powers requiring local authorities to undertake road safety work. The first need is

to make the fullest use of the existing powers, which are adequate for carrying out the activities in Annexe A. The situation will be kept under review, especially in the light of the recommendations of the Royal Commission on Local Government and subsequent discussion of them."

(2) "Since the White Paper was published it has been suggested that local road safety activities would be further stimulated by more money from central funds, perhaps by direct grant for certain items of capital expenditure or to meet road safety staff salaries. But road safety activities are already taken into account when rate support grant is calculated, and the road safety element in the grant is now greater than Councils estimated for this work. In present circumstances therefore the Government is unable to give further direct financial help."

1.7 <u>The Beginning of the West Midlands County Council's Computerised Traffic Accident Recording System.</u>

In response to this Circular the City of Birmingham Highways Division began an investigation in 1970, in conjunction with the City Police to determine the feasibility of putting the City's road accident records on a computer.(13) At that time the Police, who were responsible for the production of road accident statistics, as well as collecting individual accident details, used a manual card sorter system. Any accident information that the Highways Division required had to come from the Police, who had the same operational area.

Although the Police were satisfied with their existing system, they agreed to consider joint development and analysis so that the resulting printouts of computer analyses would satisfy the requirements of both parties. It was decided that the system would use the information from each traffic accident reported to the City Police to maintain a history of accidents occurring at locations within the City. The computer accident file would not however be a substitute for the file of accident books and other information maintained by the Police Accident Office, but would hold only the accident information required to satisfy the needs of the Department of the Environment (into which the Ministry of Transport had been incorporated), the Police, and the Highways Division.

Statistics would be produced for the Police, to use in their Road Safety Work, for the Department of the Environment for the production of national accident statistics, and for public information. For the Highways Division the production of quarterly blackspot lists, together with an accident history for each blackspot, would be the main output. The Highways Division would then be able to take corrective action on any highway defects which were contributory to these unsatisfactory records. The requirements of the Highways Division were decided after discussion within the Division, and a review of the traffic accident computer systems used by other local authorities, in particular the systems used by Leicestershire County Council, Lancashire County Council, Hertfordshire County Council, Cumberland County Council, and the Greater London Council, and with reference to the report of the Traffic Accidents Statistics Study Group published in November 1968 by the Local and Public Authorities Computer Panel.

It was decided by both parties at the outset to operate a combined coding and computer analysis system, with the Police providing extraction and coding effort and the Highways Division providing systems and computer facilities. In order to achieve this combined approach the Police agreed to scrap their existing system, change their accident location method, and add supplementary information required by the Highways Division. In addition, although Police organisations in general had decided to stop coding damage-only accidents, the Birmingham Police agreed to continue coding this category of accident because the Highways Division considered the statistics to be a valuable source of supplementary information. It was also decided in order to highlight the City's blackspots, that the accidents at each location should be related to the corresponding traffic flows.

In April 1974, the Local Government Reorganisation took place with the formation of the new West Midlands Metropolitan County covering the seven Metropolitan Districts; Birmingham, Walsall, Wolverhampton, Sandwell, Dudley, Solihull, and Coventry. With the reorganisation came a re-allocation of duties, and Road Safety became the responsibility of the County Councils. In the West Midlands the decision had been taken to adopt and expand the Birmingham accident analysis system to cover the whole of the West Midlands County.

From April 1974, all accidents occurring in the West Midlands County have been recorded on the computer, but in addition it was decided to prepare information on all injury accidents in the County dating back to July 1972, for inclusion in the system so that by July 1975, there would be three years' information on injury accidents and fatalities.

1.8 The Statutory Duty of Local Authorities to Promote Road Safety.

In conjunction with the reorganisation came a piece of legislation[14] making local road safety work a statutory duty of local authorities. This came into effect when on the 1st March 1975, by Commencement No. 1 Order made on 10th December, Section 8 of the Road Traffic Act 1974 was brought into operation. Section 8 of the Road Traffic Act 1974 amends Section 38 of the Road Traffic Act 1972, so that each local authority is required to prepare and carry out a programme of measures designed to promote road safety, and is empowered to make contributions to the cost of measures for promoting road safety taken by other authorities or bodies.

Subsection (2A) of Section 38 of the Road Traffic Act 1972 as provided by Section 8 of the Road Traffic Act 1974, requires that in pursuance of the above duty local authorities -

(1) shall carry out studies into accidents arising out of the use of vehicles on roads or parts of roads, other than trunk roads, within their area;

(2) shall in the light of those studies, take such measures as appear to the authority to be appropriate to prevent such accidents, including the dissemination of information and advice relating to the use of roads, the giving of practical training to road users or any class or description of road users, the construction, improvement, maintenance or repair of roads for which they are the highway authority and other measures taken in the exercise of their powers for controlling, protecting or assisting the movement of traffic on roads;

(3) in constructing new roads, shall take such measures as appear to be appropriate to reduce the possibilities of such accidents when the roads come into use.

The Department of the Environment sent Circular ROADS 12/75[15] to those councils responsible for road safety to offer advice on the exercise of that duty. In this Circular the Department also commented on the parts that the following have to play in road safety; RoSPA (the Royal Society for the Prevention of Accidents); the Police; the public; the Department.

RoSPA

The Circular stated that, in the light of local government reorganisation and the duties imposed upon local authorities by the Road Traffic Act 1974, the Secretaries of States' present agency agreement with RoSPA was being replaced by a new agreement more suited to the new circumstances. This new agreement would provide for a reduced RoSPA territorial organisation, but a strengthened central organisation which, in consultation with the Secretaries of State, would be responsible for research and development in the fields of local publicity and road user training. In particular it would pay attention to methods of designing and evaluating local publicity and training schemes, and would suggest ways and means of improving such schemes. RoSPA would also provide, on behalf of the Secretary of State for the Environment, training facilities for local authority road safety staffs at all levels. Under the new agreement RoSPA would be available to advise the Department of the Environment and the Welsh Office and local authorities on policies and programmes for the phased reduction of road accidents.

<u>The Police</u>

The Circular stated that, as many local accident problems could only be solved by a mixture of engineering, education and enforcement measures, the police should be closely associated with the problem solving process. Given their many contacts the police could also support local authorities' efforts in the publicity and road users training fields. The Circular stated that it was essential that the road safety work of local authorities' staff and the police should be planned jointly and integrated into a single programme.

<u>Public Involvement</u>

The Circular had the following to say about public involvement:- "Proper analysis of the local accident situation and programming of remedial action greatly simplifies the process of dealing with complaints about alleged local danger spots, because most of the information required to deal with these is available without further detailed study. It is possible to inform the complainant of the facts without delay, and to give information regarding the relative priority of the problem and when action, if any, is likely to be possible. In order to ensure that proper analysis of the local accident situation as a whole is carried out and coherent programmes of remedial action prepared, while giving proper attention to complaints, many local authorities find it advantageous to separate these functions, thus ensuring that those responsible for analysis and programming are freed from day to day pressures. Given this arrangement it is important to ensure that information received from complainants is passed to those responsible for analysis.

In order to reduce to the minimum uninformed pressure for the less economically viable local schemes it is essential to ensure that there is a full opportunity for public participation in the preparation of policies and programmes for the phased reduction of road accidents. It is necessary to consult with local communities as well as district councils. Given his many contacts with the press and the public, the road safety officer, operating in close liaison with the planners and engineers is well placed to carry out this work.

It is vital to maintain the interest and enthusiasm of local communities for local safety education and training schemes. When the county council does not enter into a formal agency arrangement with its district councils, it should consider setting up area road safety committees serviced by an area road safety officer."

National Activities

The circular stated that Government publicity would be designed to change attitudes and behaviour in ways which evaluation showed to be effective. Local authorities would be kept informed of these activities and consulted whenever the need arises e.g. where the national publicity would benefit from local support. The Department of the Environment would continue to maintain close liaison with local authorities.

The Circular stated the Department of the Environment's Road Safety Units were in the process of closure. Advice, however, would continue to be available from the Department's Regional Controllers, the Welsh Office Road Safety Unit, and the RoSPA territorial offices. The Department of the Environment would continue to organise its course for local authority engineers on the Techniques of Accident Investigation and Prevention, and RoSPA, in collaboration with the Department of the Environment, would continue to organise a course on Statistical Interpretation and Evaluation. In addition a course on the Design and Evaluation of Local Publicity and Training Schemes was being prepared.

Annex 2 of the Circular was entitled "An Empirical Approach to the Promotion of Road Safety Programmes". It presented in the introduction a very brief outline of the 'mechanics' of a road accident as understood by the Department of the Environment. This is described in much greater detail in the "Accident Investigation and Prevention Manual" prepared by the Road Safety Directorate of the Department of the Environment. This Manual is used in conjunction with the course on the Techniques of Accident Investigation and Prevention organised by the Department, but copies have also been distributed to local authorities. However only the Circular is discussed here because it was the official document sent to the Chief Executives of those Councils responsible for road safety. The argument presented in the Manual is discussed in Chapter 2 of this report.

The introduction of Annex 2 of the Circular was as follows: "A road accident may be said to occur when a road user fails to cope with his environment, the latter being taken to include everything which impinges or fails to impinge upon the consciousness of the road user. Therefore there are two approaches to reducing the risk of road accidents:-

(1) The environment may be changed in such a way as to reduce the severity of the problems faced by the road user.

(2) The road user's ability to cope with these problems may be improved by the provision of information and practical training and in the ultimate by enforcement."

The Circular went on to describe practical applications of the two approaches in greater detail. However only those aspects which are related to highway engineering are discussed here.

Under the heading of "Changing the Environment" the Circular went on as follows:-

"<u>Major Road Works</u>

While major road works make a substantial contribution to reducing accident risks, they are seldom economically justified on these grounds alone. Moreover because they tend to generate additional traffic they frequently do not reduce the absolute number of accidents to the degree expected. For this reason they are not widely regarded as a cost effective means of dealing with problems solely related to the prevention of accidents.

Small Road Improvement Schemes

It is impossible to assign a single cause to a road accident. Road accidents are random multifactor events. These factors interact in a complex manner and each does not contribute a fixed element of risk to the accident situation. Reducing the risk attributable to one factor leads to a reduction in the risk attributable to the remainder. Therefore the aim is to identify one or two factors common to a substantial proportion of the accidents in a cluster and to treat these by way of small road improvements.

Small road improvements fall into two broad categories. Those which seek to raise generally the design standards at the site, and those which simply seek to reduce the risk of one or two selected accident factors occurring in the future, as explained in the previous paragraph. Raising the design standards generally is usually much more expensive than treating one or two accident factors selected as a result of detailed study. Moreover evaluation of a substantial number of small road improvement schemes has shown that the raising of design standards generally is much less likely to achieve a reduction in accidents than are less expensive schemes which seek to treat carefully selected accident factors. Therefore, the raising of design standards generally is not widely regarded as a cost effective means of dealing with sites where the problem is solely one of preventing accidents."

The Circular went on to describe different types of programmes of small road improvement schemes.

"<u>Mass Programmes</u>

It will often be found that certain factors are common to groups of accidents scattered widely throughout an area, for example, skidding, darkness, nose to tail collisions with vehicles waiting to turn right from a main road, overshooting a give-way line, misjudgement when restarting from a give-way line and so on. These are factors for which there are well tried remedies. Consequently, once the sites have been identified by analysis of the recorded accident data little or no detailed accident study is required in order to prepare programmes of treatment. Consequently, the overhead costs of such schemes are relatively small and the programmes easy to manage.

<u>Route Programmes</u>

It sometimes happens that certain routes through a county or certain radial routes into towns and cities exhibit a higher than average accident risk when compared with similar roads and conditions. In these circumstances better results can usually be achieved by a coordinated programme of small road improvements and publicity along the entire route rather than by sporadic treatment of certain sites.

<u>Neighbourhood Programmes</u>

Particularly in older towns and cities there are some neighbourhoods which have a higher than average density of accidents although the individual clusters may be quite small. Here again better results may be obtained from a co-ordinated programme of small road improvements and publicity than can be obtained from sporadic treatment of certain sites. Quite often such programmes can be related to general improvement schemes.

<u>Single Site Programmes</u>

After accounting for the sites included in the foregoing special programmes there will be a substantial number of sites requiring individual treatment. These will normally be widely scattered throughout the county, and a programme will be required to deal with these in order of priority. Quite often these sites require intensive study in order to identify common accident factors susceptible to inexpensive remedy."

The Circular also suggested programmes for the protection of pedestrians, by segregation and the provision of special crossing facilities; for improved traffic signing; and for speed limit reviews. Finally it suggested that local road user publicity programmes should be used to provide road users with essential local information related to the use of local traffic management schemes, parking facilities, places and periods of high risk, and so on.

1.9 The West Midlands County Council's Policy on Road Safety

The West Midlands County Council stated their policy on road safety in the 1975 submission[16] of the West Midlands County Council's Transport Policies and Programme, as follows:- "The County Council's basic policy in relation to road safety is to pursue a continual remedial programme towards the reduction of road accidents through the development of a county wide road accident analysis system.

In detail, the County Council will use the analysis:-

(i) to assess whether remedial measures should be physical or educational or both;

(ii) to assist in the evaluation of the criteria relating to road safety when highway improvements or traffic management measures are being considered;

(iii) to deploy resources to achieve greatest return on remedial measures.

Further, it is County Council policy that the Local Education Authorities within the county area should be encouraged to include programmes in their school curricula which contain road safety aspects in varied forms."

CHAPTER 2

REDUCING THE NUMBER AND SEVERITY OF TRAFFIC ACCIDENTS

2.1 Introduction

This Chapter commences by describing a recent investigation into the factors contributing to traffic accidents. This is followed by an estimate of the potential saving in accidents that can be achieved by selected improvements thereby establishing the overall validity and importance of this study.

The Chapter goes on to discuss the contributions of one particular agency to the task of reducing the number and severity of traffic accidents and to explain the affects on their approach of the constraint of limited resources.

2.2 The Concept of a Traffic Accident as a System Breakdown

A traffic accident can be considered as a breakdown in a system containing three components:-

(i) road users - human element

(ii) vehicles

(iii) the road-users environment - includes such features as road layout, visibility at junctions, adequacy of road signs and markings, weather conditions, and road surface.

To reduce the number and severity of accidents, i.e.

to improve the system, improvements, to that end, must be made to one or more of the system components, assuming that such improvements are possible. From research carried out by the T.R.R.L. indications are available of the relationships of the individual system components to traffic accidents. This research and its results are briefly described below.

2.3 Contributory Factors in Traffic Accidents

Between March 1970 and February 1974 a research team from the T.R.R.L. investigated 2130 traffic accidents "on the spot" in the local East Berkshire area.(17) Arrangements were made with the appropriate Police forces to inform the Accident Investigation Team, who were on call 24 hours a day, of road accidents as they happened within the specified area. The team went immediately to the scene, took photographs, made extensive notes on each vehicle including its damage and position, features of the road scene, signs of debris, tyre marks and any other environmental factors; in addition a scale plan of the site was drawn up. At a later date, with the agreement of the persons concerned, the drivers (including riders of two-wheeled vehicles) and pedestrians involved were interviewed. After all the data were collated the team discussed each accident in detail to assess the contributory factors.

Factors contributory to the accident were considered in three main groups: those concerning the road design and environment; those concerning the vehicle, its design and condition; thirdly, human factors concerning the driver or pedestrian.

The investigation found[18] that of 2042 accidents road/environment factors were judged to be contributory in 28%, vehicle design or maintenance contributed to $8\frac{1}{2}$%, and human factors in 95%. The interaction of the factors is shown below.

Contributory Factor	Percentage Contribution		
	Road & Environment	Road User	Vehicle
Single Factor	$2\frac{1}{2}$	65	$2\frac{1}{2}$
Double Factor	24	$\frac{1}{4}$	$4\frac{1}{2}$
Treble Factor		$1\frac{1}{4}$	

TABLE 2 THE INTERACTION OF CONTRIBUTORY FACTORS IN ACCIDENTS[20]

The three groups are considered in more detail below:-

(i) Road/Environment Factors:[18] This group contains such features as road layout, visibility at junctions, adequacy of road signs and markings, weather conditions and road surface. Features of the road/environment factors were grouped together to show similarity in the difficulties they present to the drivers:-

(a) Adverse Road Design - 316 Factors in 264 accidents.

Vertical, Horizontal Curvature	56
Unsuitable Layout, Junction Design	152
Poor Visibility due to Layout	108
	316

The features of "Adverse Road Design" are derived mainly from accidents, prior to which a driver did not appreciate a misleading visual situation.

(b) Inadequate Street Furniture, Road Markings - 157 Factors in 134 accidents

Inadequate Road Signs, Markings	120
Street Furniture Position Poor	11
Inadequate Street-Lighting	26
	157

Features of "Inadequate Street Furniture , Road Markings" represent insufficient and sometimes unclear information being presented to the driver, who is pre-occupied with manoeuvring his vehicle.

(c) Adverse Environment - 281 Factors in 231 Accidents.

Lack of Maintenance	70
Slippery Road, Flooded Surface	91
Weather Conditions, Sun Dazzle	78
Dazzle from Headlights	30
Fast Traffic Making Manoeuvre Hazardous	12
	281

"Adverse Environment" features are those which contributed to accidents by increasing the difficulty of manoeuvring a vehicle safely.

(d) Obstructions in the Carriageway - 129 Factors in 124 Accidents.

Animal, Object in Carriageway	33
Road Works	54
Parked Vehicles	42
	129

(ii) Vehicle Factors:[19] Vehicle factors contributing to road accidents are either design faults or defects which develop in use from wear, lack of maintenance, poor design of components or misuse.

It was concluded that vehicle defects played a major part in 8% of all accidents, and unsuitable design characteristics in a further small proportion of the order of ½%. A summary of the vehicle defects is given in the table below.

TABLE 3

Vehicle Defects and their Contribution to Accidents[19]

Total Accidents : 2130

Vehicles Involved : 3903

Type of Defect		Defects Noted in Vehicle	Defects as main contributory Factors in accidents		
		Total	Sub Total	Total	% of accidents
Tyres					
Deflation before impact		28	27	67	2.7
Illegal tread or combination		221	18		
Wrong Pressure		100	22		
Brake	Defects	387		65	2.7
Steering	Defects	10		7	0.3
Lights	Defects	12	4	10	0.4
	Inadequate	75	6		
Mechanical	Failure	38		22	0.9
Electrical	Failure	4		4	0.2
Load	Defective	17		10	0.4
Windscreen	Defective	4		4	0.2
Poor Visibility		31		4	0.2
Overall Poor Condition		12		5	0.2
		939		198	
Total Accidents in which vehicle defects were main Factor.				173	8.1%

(iii) Human Factors:[20] This is where the road user was regarded as primarily or partially to blame. The instances of specific features are listed below.

<u>Driver Error</u>	
Lack of care	905
Too fast	450
Inexperience	215
Lack of skill	33
Lack of education or roadcraft	48
Bad habit	12
Wrong position for manoeuvre	7
Distraction	337
Lack of attention	152
Lack of judgement	116
Wrong decision or action	125
Following too close	75
Improper overtaking	146
Irresponsible or reckless	61
Aggressive	6
Faulty signalling	47
Difficult manoeuvre	70
Frustration	15
Failed to look	183
Looked, but failed to see	367
Misjudged speed and distance	109
Wrong path	175
Braked and lost control	185
<u>Pedestrian Error</u>	
In dangerous position	38
Failed to look	68
Looked, but failed to see	23
Misjudged speed and distance	10

Lack of care	116
Wrong decision	1
<u>Driver Impairment</u>	
Alcohol present	463
Drugs present	87
Fatigue	159
Illness	33
Emotional Distress	26

2.4 The Potential for Reducing the Number and Severity of Traffic Accidents

The above results show the relationship between the system components and accidents. In a recently published paper[21] from the T.R.R.L. the potential for accident and injury reduction in road accidents by improvements to the system components was discussed.

The paper contains an estimate of the overall potential savings, allowing for interactions between the measures that can be applied to improve the three system components and on the basis of present knowledge, of three-fifths of the total injury accident toll. The potential savings in each area separately were estimated to be:-

	Potential savings in injury accidents (on the basis of present knowledge)
Road Environment	$\frac{1}{5}$
Vehicle	$\frac{1}{4}$
Road User	$\frac{1}{3}$

Each area was discussed separately.

(i) Road Environment

The paper stated that the aim of improvements in road environment should be not only to remove obvious deficiencies in the environment but also to influence, aid and protect the road user, and to identify general principles which can be applied across the whole road network to produce large-scale benefits. The major options for improving road safety in the area of road environment and their individual estimated benefits related to the total accident situation were:-

- geometrical design, especially junction design and control	: 11½%
- road surfaces in relation to inclement weather and poor visibility	: 5½%
- road lighting installation	: 1½%
- changes in land use, road design, and traffic management in urban areas (excluding junctions 7½%)	: 16½%

Because some of the measures interact the benefits are not mutually exclusive and not additive.

(ii) Vehicle Safety Measures

The options for improvements in vehicle design were divided into two groups - those related to primary safety (accident prevention) and those related to secondary safety (road user protection):-

Primary:	- vehicle maintenance	: 2%
	- anti lock brakes and safety tyres	: 6%
	- conspicuity of motor cycles	: 3%

Secondary: - seat belt wearing : 10%

- other vehicle occupant protection measures : 5-10%

(iii) Road User and Road Usage

The estimates of benefits from various measures to influence the road user and road usage are not so reliably based as those in the road environment and vehicle safety. It was more difficult to quantify the potential application of effective measures. The main options were:

- restriction on drinking and driving : 10%
- more appropriate use of speed limits : 5%
- propaganda and information : up to 5%
- enforcement and police presence : up to 5%
- education and training : up to 5%
- other legislation (e.g. restriction on parking) : up to 5%

This work by the T.R.R.L. clearly indicates that improvements resulting in a reduction in accidents are possible and furthermore that there is considerable room for improvement.

2.5 Agencies and Approaches

A number of agencies are involved, directly and indirectly, in the task of reducing the number and severity of traffic accidents, e.g. Police,[22] R o.S.P.A.,[23] local authorities, T.R.R.L., Road

Safety Officers, vehicle designers and manufacturers. Their contributions fall into three categories - enforcement, education, and engineering. This study is concerned with one type of agency - a County Council - and primarily with one approach - engineering. It is not intended to describe the contributions of the different agencies or discuss their relative merits as these are subsidiary to the primary purpose of this study.

2.6 County Councils - Their Role and Aim

County Councils have a statutory duty to prepare and carry out a programme of measures designed to promote road safety. The statutory requirements were described in detail in Chapter 1. To recap briefly, the County Councils are responsible for:-
"the dissemination of information and advice relating to the use of roads, the giving of practical training to road users or any class or description of road users, the construction, improvement, maintenance or repair of roads for which they are highway authority...".

It can be seen that some of the responsibilities fall into the education category and the rest into the engineering category, and it is with the latter that this study is primarily concerned.

Fulfilment of the statutory duty, with respect to the engineering responsibilities, by a County Council would only be completely achieved when all of the features which are potentially capable of causing accidents are eradicated from all of the roads for which the County Council is responsible. In order to comprehend the magnitude of the effort required to achieve that state it is helpful to consider that one of the measures would have to be almost total pedestrian/vehicle segregation. At the present time even if a County Council had sufficient resources to attempt to achieve this state there would be no chance of that Council using the resources for that purpose.

In practise the approach that has been adopted is to attempt to eradicate those features which have been responsible for and will continue to cause accidents, at the places where they occur.

2.7 Methods for Reducing the Number and Severity of Traffic Accidents

There are a number of methods whose aim is to eradicate these features. They are described below.

2.7.1 Analysis of Recorded Accident Information

The most common method, in Great Britain and abroad, is to use the accident information recorded by the police firstly to identify possible problem locations and then to determine an appropriate remedial measure.

This is based on the following reasoning:-

> When more than one accident occurs at a location it is possible that some of the accidents will be, to some degree, similar. If the points of similarity can be identified then measures can be specifically designed to prevent those accidents which are subject to the points of similarity, i.e. to prevent a particular type of accident from occurring.

The police enter the details of each traffic accident involving personal injury or involving major damage to a vehicle into an Accident Report Book. Details of accidents involving minor damage to a vehicle and accidents in which a dog is injured or killed are recorded on Accident Report Cards. (Examples of the Accident Report Book and Accident Report Cards can be found at the end of this report). In the middle of the Accident Report Book is a detachable centre page which is in a tabular format. This is the 'Stats.' 19 Form.(Fig. 2) The details of each injury accident are recorded on a Stats. 19 Form and must be submitted to the Department of Transport for the compilation of national statistics. Instructions for the completion of the Stats. 19 Form are contained in Stats. 20.[24]

Figure 2.

WELSH OFFICE

Form Stats. 19 (Rev. 1968)

REPORT OF ROAD ACCIDENT RESULTING IN PERSONAL INJURY

POLICE REFERENCE No. ____________

CASUALTIES

CASUALTY CLASS (1st 2nd 3rd 4th 5th 6th) 1

- Driver or rider 12
- Passenger 11
- Pedestrian 0

Of—

- Pedal cycle 1
- Moped solo 2
- Motor scooter solo 3
- Motor cycle solo 4
- Combination (m/p, m/s, or m/c) 5
- Car or taxi 6
- Public service vehicle 7
- Goods vehicle 8
- Other vehicle 9

SEVERITY OF INJURY 2

- Killed * 1
- Seriously injured 2
- Slightly injured 3

SEX OF CASUALTY 3-4

- Male 12
- Female 11

AGE in years †

CAR PASSENGER *

- In front seat 12
- In rear seat 11

PEDESTRIAN ACTION 5

- Crossing road at pedestrian crossing 12
- Crossing road within 50 yds. of ped. crossing 11
- Crossing road elsewhere 0
- In road, not crossing 1
- Masked by stationary vehicle 2
- On footpath or verge 3
- On refuge or centre strip 4

PSV PASSENGER

- Boarding or alighting 5

CAR OR VAN OCCUPANT *

- Safety belt in use 1
- Safety belt fitted but not in use 2
- Safety belt not fitted 3

VEHICLE OCCUPIED 6

- First vehicle 1
- Second vehicle 2
- Third vehicle 3
- Fourth vehicle 4
- Fifth or subsequent vehicle 5

VEHICLES INVOLVED

REGISTRATION NUMBERS

1st ________ 2nd ________

3rd ________ 4th ________

(1st 2nd 3rd 4th: 7 8 9 10; (7) (7) (7))

TYPE

MAKE 11-12

MODEL OR SIZE 13

SKIDDING 14

- Skidded 12
- Jackknifed 11

TOWING & ARTICULATION

- Articulated vehicle 1
- Caravan 2
- Other tow 3

VEHICLE DEFECTS 15

- Load 12
- Tyres—report for process 11
- Brakes 0
- Lights, front 1
- Lights, rear 2
- Brake lights 3
- Trafficators 4
- Vision—glass wipers, washers 5
- V.E. report requested 6

(16, 17; 12—0, 1—4)

AGE (entered by Ministry) (1st 2nd 3rd 4th) 20

MANOEUVRES 21

- Entering or leaving layby 12
- Entering or leaving hard shoulder 11
- Reversing 0
- Parked 1
- Stopping 2
- Starting 3
- Turning round 4
- Turning left or waiting to 5
- Turning right or waiting to 6
- Going ahead but held up 7
- Going ahead overtaking moving or held up vehicle 8
- Going ahead, other 9

OVERTURNING 22

- Overturned 11

PART DAMAGED 23

- Front 1
- Back 2
- Left 3
- Right 4
- All four sides 5
- None 6

24

SEATS OCCUPIED (CARS ONLY) * 25

- Front Passenger 11
- Rear: One passenger 1
- Rear: Two passengers 2
- Rear: 3 or more passengers 3

DRIVERS AND RIDERS

Vehicle: 1st 2nd 3rd 4th 18

SEX

- Male 12
- Female 11

BREATH TEST

- Positive 1
- Negative 2
- Not required 3
- Failed to provide 4

LEARNER-DRIVER 19

- "L" driver 11

DRIVER'S ACTIONS

- Disobeyed junction control 1
- Disobeyed double centre or offset line 2
- Failed to give precedence at pedestrian crossing 3

DRIVER'S OR PASSENGER'S ACTION

- Opened door negligently 4

Vehicle: 1st 2nd 3rd 4th 26

AGE GROUP (estimated)

- Under 17 years 12
- 17 years 11
- 18 years 0
- 19 years 1
- 20 years 2
- 21 years 3
- 22—24 4
- 25—28 5
- 29—34 6
- 35—54 7
- 55—64 8
- 65 or over 9

*Report these items until 31.12.70, at which date a review becomes operative.

ATTENDANT CIRCUMSTANCES

POLICE FORCE 27 28

LOCAL AUTHORITY 29 30 31

DAY OF WEEK

DATE 32 33 34 (Day Mth)

TIME (24-hour clock) 35 36 37 (Hour 5Min)

ROAD CLASS 38

- M
- A, motorway standard 1
- A 2
- B 3
- C or unclassified 4, 5

ROAD NUMBER 39 40 41 42

SPEED LIMIT 43

- 30 mph or less 3
- 40 mph 4
- 50 mph 5
- 60 mph 6
- 70 mph 7

ROAD TYPE 44

- Clearway in force 11
- One-way street 1
- Dual carriageway 2
- Other road 3

LANE MARKINGS 45

- No lane markings 1
- Two lanes 2
- Three lanes with offset double lines 3
- Normal three lanes 4
- Four lanes 5
- Lane markings unknown 6

LIGHT 46

- Daylight 1
- Dark, with street lights over 20 feet high, lit 2
- Dark, with street lights under 20 feet hight, lit 3
- Dark, street lights unlit 4
- Dark, no street lighting 5

WEATHER 47

- Raining 1
- Snowing 2
- Fog 3
- Other 4

ROAD SURFACE CONDITION 48

- Dry 1
- Wet 2
- Snow or ice 3

JUNCTION DETAIL 49

- Roundabout 1
- "T" or staggered junction 2
- "Y" junction 3
- Crossroads 4
- Multiple junction 5
- Other junction 6
- Using private drive or entrance 7
- Not at or within 20 yards of junction 8

JUNCTION CONTROL 50

- Authorized person 1
- Automatic traffic signal 2
- Stop sign 3
- 'Give Way' sign or marking 4
- Uncontrolled 5

PEDESTRIAN CROSSING (If on or within 50 yds.) 51

- Manually controlled 1
- Light-controlled at junction 2
- Light-controlled not at junction 3
- Uncontrolled 4

MOVEMENTS BEFORE ACCIDENT 52

- Stationary vehicle involved 11
- One moving vehicle 1
- Two moving vehicles, same direction 2
- Two moving vehicles, opposite directions 3
- Two moving vehicles, different roads 4
- More than two moving, all same direction 5
- More than two moving, same road, not all same direction 6
- More than two moving, not all same road 7

CARD CLASS (entered by Ministry) 53

SPECIAL CONDITIONS AT SITE 54 55 56

- Dog in carriageway 12
- Other animal in carriageway 11
- Object in carriageway 0
- Parked vehicle(s) (contributory) 1
- Automatic level crossing involved 2
- Lamp post hit 3
- Telegraph pole hit 4

CLASS OF ACCIDENT 57

- Fatal 1
- Serious 2
- Slight 3

LOCATION 58 59 60 61 62 63

† If a person over 15 is killed, report or write below a brief account of the accident.

SL.5967 8/68 TS&Co.Ltd.

The details recorded on the Stats. 19 Form and in the Accident Report Books by the police constitute the available information on accidents which can be used to identify possible problem locations and to determine an appropriate remedial measure.

The Department of Transport Road Safety Directorate run a course intended to explain and demonstrate techniques for studying accident details in order to identify those features which are responsible for causing accidents. To supplement these techniques an extensive 'check list' is introduced which contains questions about the location and the accidents aimed at revealing the problem and the possible solution. Details of all of the techniques used on the course are contained in an "Accident Investigation and Prevention Manual" which is produced by the Department of Transport.[25]

There are two additional techniques which can be used to help identify those features at a location which are responsible for causing accidents:-

(1) Conflict Studies

This is a technique developed by the Transport and Road Research Laboratory.[26,27,28,29] It was felt that analysis of the police accident records has the disadvantage that "there are rarely enough accidents at a specific site to give a clear picture of what is happening; data usually has to be collected over a long period of time while conditions change and the data is collected some time after the event has occurred." Accidents result from conflict situations in which evasive action is unsuccessful. The basis of the technique is to directly observe these conflicts, whether or not they are successfully resolved, so that factors present in the situation from which they develop can be assessed.

(2) Location Sampling

This method(29,30) also attempts to increase the amount of data that can be used to help identify adverse features at a location. The method is based on concentrating the available data from actual accidents, which are thinly spread throughout the road system, by pooling accident reports from groups of similar locations. Thus the data available in one year from, for example, 20 locations which are almost identical in character should give as much insight into the basic accident situations as the data which would accumulate over 20 years at one location.

2.7.2. General Highway Improvements

One alternative to this approach is to carry out a general improvement at those locations at which accidents have occurred. However Circular 12/75, described in detail in Chapter I, advises against this alternative on the grounds that :-

> "raising the design standards generally is usually more expensive than treating one or two accident factors selected as a result of detailed study" and "moreover evaluation of a substantial number of small road improvement schemes has shown that the raising of design standards generally is much less likely to achieve a reduction in accidents than are less expensive schemes which seek to treat carefully selected accident factors".

2.7.3. <u>"Safety Coefficient" and "Accident Coefficient" Methods</u>

In the U.S.S.R. the "safety coefficient" and "accident coefficient" methods suggested by Prof. V.F. Babkov are used for the detection of dangerous locations.[31]

The "safety coefficient" method is established on the following preconditions. The degree of the motorist's nervo-psychical tension at the beginning of a dangerous road section grows with an increase in the ratio between the speed, V, on a subsequent road section and the speed V_{en}, that can be attained on the preceding one.

"The safety coefficient is the ratio $K_s = \frac{V}{V_{en}}$

A safety coefficient diagram for the whole length of a road is plotted with the help of data from the theoretical speeds for new roads and the actual speeds for reconstructed roads.

The larger the speed change at the beginning of a dangerous road section the more intensive is the braking process. The study of the driver's nervo-physical stress changes showed that such changes appear at deceleration/acceleration above 0.6 m/sec^2.

On the basis of traffic accident data for many roads and traffic speed change data, limit figures of "safety coefficients" were established.

Safety Coefficient, K_s	The degree of danger
more than 0.8	safe
0.6 - 0.8	comparatively safe
0.4 - 0.6	dangerous
less than 0.4	very dangerous

Certain measures are recommended for road sections having a "safety coefficient" less than 0.8. The types of measures recommended are linked to the safety coefficient value.

The "Accident Coefficient" method is established on the basis of traffic accident statistics.

The degree of danger is estimated by using "total" accident coefficient, K_{acc}, which is the product of partial accident coefficients, $K_{1....14}$, taking into account the influence of separate horizontal and vertical elements, thus $K_{acc} = K_1, K_2, K_3 ... K_{14}$.

The partial coefficients are the ratio of the number of accidents for a given horizontal or vertical element and that for a standard straight road stretch with a carriageway width from 7.0 to 7.5 m and with adequate hard shoulders. Values of partial accident coefficients for various road condition characteristics are shown in Table 4.

These coefficients were defined by analysing a great number of traffic accident data for roads in the U.S.S.R. and other countries.

A road section is considered dangerous if the total accident coefficient exceeds 25 - 40 in road reconstruction or 15 - 20 in new road projects.

2.7.4 A Comprehensive Approach to Urban Road Safety Planning

The final method to be described here is still undergoing investigation. As part of its research

TABLE 4 - PARTIAL ACCIDENT COEFFICIENTS[31]

Factor considered	Values of partial accident coefficients for various road condition characteristics							
Traffic volume, vpd	500	1000	2000	3000	5000	7000	9000	
K_1	0.4	0.5	0.6	0.75	1.0	1.4	1.7	
Carriageway width, m	4.5	5.5	6.0	7.5			8.5	
K_2 with hard shoulders	2.2	1.5	1.35	1			0.8	
with soft shoulders	4	2.75	2.5	1.5			1	
Shoulder width, m	0.5	1.0	1.5	2.0			3	
K_3	2.2	1.7	1.4	1.2			1.0	
Longitudinal grade, per cent	2	3	5	7	8			
K_4 the road without median	1.0	1.25	2.5	2.8	3			
the road with median	1.0	1.0	1.25	1.4	1.5			
Radius of horizontal curves, m	50	100	150	200-300	400-600	600-1000	1000-2000	2000
K_5	10	5.4	4.0	2.25	1.6	1.4	1.25	1
Sight distance, m	100	200	300	400	500			
K_6 on horizontal curves	3	2.3	1.7	1.2	1			
on vertical curves	4	2.5	2.0	1.4	1			
Width of bridge carriageway in relation to that of approach road	Smaller by 1m		Equal		Wider by 1m		Wider by 2m	
K_7	6.0		3.0		1.5		1.0	
Length of straights, km	3	5	10	15	20	25	and above	
K_8	1.0	1.1	1.4	1.6	1.9	2		
At-grade intersection with traffic volume on main road, vpd	under 1.600		1600-3500		3500-5000		5000-7000	
K_9	1.5		2.0		3.0		4.0	

TABLE 4 - PARTIAL ACCIDENT COEFFICIENTS continued

Type of intersection		At-grade intersection with traffic volume on minor road in per cent of total on both roads			
	Grade-separated	under 10	10-20	over 20	
K_{10}	0.35	1.5	3.0	4.0	
Sight distance at at-grade intersection, m	over 60	60-40	40-30	30-20	under 20
K_{11}	1	1.1	1.65	2.5	5
Number of lanes	2	3	4 without median	4 with median	
K_{12}	1	1.5	0.8	0.65	
Distance from buildings to road, m	15-20	5-10	5 with sidewalk	5 without sidewalk	
K_{13}	2.5	5.0	7.5	10.0	
Description of road surface	very slippery	slippery	clean, dry	rough	very rough
Value of coefficient of cohesion	0.2-0.3	0.4	0.6	0.7	0.75
K_{14}	2.5	2.0	1.3	1.0	0.75

activities the Transport and Road Research Laboratory[32] is considering the possibility of adopting a comprehensive approach to the allocation of road safety resources within an urban framework, in order that the safety needs of both the arterial road system and the residential area streets can be met in a planned fashion and the accident prevention activities of the different branches of the public used more efficiently.

The basis of the technique is to assume implementation of various countermeasures in turn. To do this each countermeasure will be applied to all the accidents in the statistical record in order to identify those that it could have prevented had it been in place beforehand. The initial output of this examination will be a list of "theoretically preventable" accidents associated with each possible remedy, against which may be set the cost of implementation. The ultimate output will be a list of accident prevention measures, their nature and location, for each of which economic returns have been assessed.

The T.R.R.L. suggest that the main benefit of such a technique would be that it could offer the chance of evaluating different types of strategy in resource allocation, e.g. considering low-cost or area-wide measures first.

2.8 The Selected Method

This study is concerned only with the method described in 'A' for the following reasons:-

(i) The safety coefficient method is concerned with only one feature that might be responsible for accidents - the speed change required at the beginning of a road section. Hence it is concerned with only one type of accident which furthermore is probably more relevant to rural situations than the urban situation in the West Midlands County.

(ii) The main criticism of the accident coefficient method is that it is concerned only with road condition characteristics. It does not take into account the effects of pedestrian movement, and with 35% of the injury accidents reported in the West Midlands County in 1976 involving injury to pedestrians this is an important omission.

(iii) The comprehensive approach to urban road safety planning being developed by the T.R.R.L. was first announced in June 1977, towards the end of this study and is only mentioned here but is not discussed because there are, as yet, insufficient details available on which to base a valid criticism.

There are four stages in the method described in 'A' for eradicating features which have been responsible for and will continue to cause accidents.

These are:-

(1) identify the locations at which the features exist

(2) determine what each feature is

(3) prepare a remedial scheme for each location

(4) implement each scheme.

Before this method can be put into operation, however, there are certain practical problems to be considered.

2.9 Financial Constraint

The allocation of financial resources, by County Councils, to be used for road safety purposes, is invariably insufficient to allow implementation of all of the remedial schemes, that would be required to eradicate all of the 'accident causing features' in an acceptably short time period. (An acceptably short time period would be one in which the length of time between the implementation of the first and last schemes would not arouse the 'dissatisfaction' of the County Councillors and ratepayers affected by the last scheme).

To justify the above remark there follows an estimate of the 'time period' for the West Midlands County.

2.9.1 The Cost of Traffic Accidents in the West Midlands County

The following table shows the number of injury accidents recorded in the West Midlands County in 1975, 1976, and 1977.

Table 5

Injury Accidents in the West Midlands: 1975-77

Accident Severity	1975	1976	1977	Average
Fatal	223	227	233	228
Serious	2746	2677	2777	2733
Slight	7460	7791	7931	7727
Total	10429	10695	10941	10688

The cost of traffic accidents in the West Midlands County per annum based on the average number of accidents is £43,326,300 at June 1976 prices. This figure is calculated using the following values from the Department of Transport's Highway Economics Note 1 (February 1978) entitled Road Accident Costs 1976, 1977;(33)

For All Roads

Fatal Accident	£54900
Serious Accident	£4030
Slight Accident	£570
Damage-Only Accident	£240

Included in the total cost of accidents in the West Midlands County is a cost attributed to damage-only accidents. The number of damage-only accidents used to calculate this portion of the cost is based on the statement in Highway Economics Note 1 that it may be assumed that over all roads there are, on average, six damage-only accidents for every injury accident. (On this basis only, approximately, one third of the damage-only accidents are reported in the West Midlands each year).

2.9.2 The Components of the Cost of a Traffic Accident

The values used for costing road accidents are calculated by the Department of Transport by adding up the costs attributed to the following components.(33)

- loss of output due to death or injury. This is calculated as the present value of expected loss of earnings plus any non-wage payments (national insurance contributions, etc.) paid by the employer.
- ambulance costs and the costs of hospital treatment, etc.
- the costs of pain, grief and suffering to the casualty, relatives, and friends. These are very real costs to society but are by their nature not directly quantifiable in monetary terms. In recognition of the relevance of these losses, however, it has been the practise to include in the estimated cost values of fatal, serious and slight casualties what can only be regarded as a

notional and minimum allowance for subjective costs. Following their examination of the Department's approach to accident costing, the Advisory Committee on Trunk Road Assessment, the Leitch Committee, in their report published in October 1977, concluded that it is appropriate to include such an element in casualty cost values and recommended that the notional allowance for pain, grief and suffering used in accident evaluation should be a matter of further inter-departmental study and of public consultation.

- costs of damage to vehicles and property.
- costs of police and the administrative costs of accident insurance.

2.9.3 The Potential Financial Savings and the Expenditure Required to Achieve it.

In Circular 12/75,(15) which discusses the duty of local authorities to promote road safety, there is a section, Annexe 3, on the preparation of policies and programmes for the promotion of road safety. In the sub-section 'Small Road Improvement Based On Detailed Accident Study' the then Department of the Environment indicated that the potential monetary accident savings due to small road improvements alone is of the order of one-ninth. Hence in the West Midlands County, on this basis, the potential accident savings are £4,814,000 per annum.

In the same section it was also suggested that a first year rate of return of approximately 50% may be expected on average. On this basis the required expenditure to achieve the total potential accident savings due to small road improvements alone in the West Midlands County is £9,628,000 at June 1976 prices.

2.9.4 Financial Allocation in the West Midlands County

In the West Midlands County Council's Transport Policies and Programme submission containing the programme for 1978-79 no specific amount was allocated to engineering remedial measures for road safety problems. Instead it stated that the amount of money allocated to remedial measures would depend on improvements in staffing and would be allocated as appropriate from the allowance for minor improvements. Hence there is no definite amount that can be related to the required investment calculated above. However, the sum of £236,000, at November 1976 prices, was allocated as the road safety education and training budget. If the same amount were allocated for engineering remedial measures then it would take over 40 years to achieve the required level of investment. Although this is by no means accurate it serves to give an indication of the time period involved.

2.10 Establishing Priorities

On the basis of limited financial resources being available for accident problem location remedial measures, a decision is required on how these resources are to be allocated. In the West Midlands County this decision would be taken by the Highways Committee, to whom the powers of Highway Authority have been delegated by the County Council.

It can be seen that once the third stage of the method (the preparation of a remedial scheme) for any location has been carried out it would be possible to produce a realistic estimate of the 'performance' of that scheme, e.g. cost of scheme, number and type of accidents likely to be prevented. If this were done for all locations the Highways Committee could then compare scheme 'performances' before deciding which schemes were to be carried out and in which order.

2.10.1 Operational Constraints

There are, however, practical complications to using this method in the form that has just been suggested. Even if the manpower resources were available to investigate and prepare a remedial scheme for each location it would be extremely inefficient. It has been shown that with the financial resources allocated to the implementation of road safety remedial schemes it will be a period of years before some schemes can be implemented. It would be unrealistic to expect the conditions at those locations to remain constant. Therefore it is possible that not only might there be a change in the type of scheme required but also in its position in the order in which schemes should be implemented. Hence to employ this method correctly those schemes which have yet to be implemented must be reviewed at regular intervals.

To help put this into perspective, the following is a rough estimate of the manpower required to investigate and prepare a remedial scheme for each location in the West Midlands County. It has already been said that the potential accident savings due to small road improvements is one ninth - that is equal to 1188 injury accidents. In work done by the Greater London Council Road Safety Section[34] it was found from a survey of 85 sites that the average saving in injury accidents was 3.5 per site per year. If this value is applied to the situation in the West Midlands it can be deduced that there are 339 locations (1188 ÷ 3.5). If an estimate of 4 'man-weeks' is taken as the time required to investigate and prepare a remedial scheme for a location then 1356 man-weeks would be required to investigate and prepare a remedial scheme for every location. If a working year is considered to be 46 weeks (the other six being made up from annual leave and bank holidays) then 29.5 'man-years' would be required to investigate and prepare remedial schemes at all of the locations where accidents can be prevented by small road improvements.

2.10.2 In practice the following situations will probably exist. The Highways Committee will determine a policy which the officers of the County Council will attempt to interpret with the resources available to them, whilst still leaving the final choice of whether or not schemes are to be implemented, and in what order, to the Highways Committee. The job of the officers will be, with efficient use of the available resources, to prepare and put to the Highways Committee sufficient remedial schemes, which have been determined from the whole County and which must satisfy the Committee's policy, to exhaust the financial resources that have been allocated to remedial schemes as the resources become available (including an allowance for the possible rejection of some schemes by the Committee).

2.11 Conclusion

As it will be neither possible nor desirable to prepare a scheme for every accident problem location, a technique is required which will produce a list of locations, for which schemes will be prepared. Locations should appear in this list as near as is possible in the same order in which they would have appeared had every location been investigated and a remedial scheme prepared, and the schemes ranked for implementation by the Highways Committee according to it's policy. This technique must make efficient use of available resources, and must be capable of being repeated at regular intervals.

The next Chapter looks at the West Midlands County Council's existing accident analysis system and the part it could be expected to play in the above problem.

CHAPTER 3

THE WEST MIDLANDS COUNTY COUNCIL'S COMPUTERISED TRAFFIC ACCIDENT RECORDING SYSTEM

3.1 Introduction

Chapter 1 contained an outline of the background to the setting up of the existing West Midlands County Council's Computerised Traffic Accident Recording System. This Chapter contains a description of that system and discusses, in detail, the technique used in the system for identifying and ranking accident problem locations.

A number of faults in and problems with the system are described at appropriate places. As well as affecting the day-to-day running of the system, some of the problems have impeded the experimental work carried out in this study - this is more fully described in Chapter 6. No attempt has been made to identify all of the faults and problems that exist within the system as this was not the purpose of this study, although a number of faults and problems have been identified. The identification of any other faults and problems can best be carried out in the day-to-day running of the system. Those areas of the system which are directly concerned with the task of identifying and ranking accident problem locations have, however, been closely scrutinized. The faults and problems that are mentioned in this Chapter are, therefore, those of particular relevance to this study; as such there may be instances where the reader is able to identify certain aspects which give cause for concern but against which no critical comment has been made.

3.2 Input to the System

Traffic accident information is recorded, usually at the scene of the accident,either in an accident report book or on an accident card, depending on the severity of the accident (in the case of some damage-only accidents details are reported to the police at a police station by one of the participants). These documents are passed to the Police Statistics Office, and the major accidents are noted in the daily report book.

Details of each accident are coded onto an Accident Coding Sheet, of which there are two types. The first type, Figure 3, is for injury and major damage accidents - one accident per sheet (for major damage accidents only part of the coding sheet is completed - the top line, i.e. from "Grid Reference" to "Road Surface", and the first five fields(i) of "Vehicle

[(i) A field is a variable for which there is a fixed range of possible coded options. Examples of fields are ROAD NUMBER, SPEED LIMIT, VEHICLE DIRECTION, DRIVERS AGE, CASUALTY SEVERITY. There are two VEHICLE MANOUVRE fields. Components of some fields can be fields in their own right, e.g. YEAR, MONTH and DAY, in the field DATE.]

Details" for as many lines as there are vehicles involved). The second type, Figure 4, is for minor damage and 'dog' accidents which have less information - 20 accidents can be recorded on one sheet.

In addition to the information contained on the Stats. 19 form, the accident coding sheet contains information which is used mainly by the County Surveyor's Department and which is determined, by the coding clerks, by reading the accident reports. The additional details are:-

(a) the main location - and the presence of any pedestrian crossings

(b) the accident reference number

(c) the total number of vehicles and the total number of casualties involved - for checking input validity

(d) any damage to property

(e) the collision type

(f) the causation

(g) the vehicle direction - for each vehicle a coded direction is given to orientate it to the network.

Three of these are of particular significance; the main location, the collision type, and the causation, and are described in detail below.

3.2.1 <u>Location</u>

Up to the time when this system was first established by the City of Birmingham Highways Division for the

	NO	NUMBER		HRS	MINS	N T	S	L L S	L Y	G A E Y	TYPE		T	C E
1														

SPEED LIMIT	ROAD TYPE	LANE MARKING	WEATHER	JUNCTN TYPE	JUNCTN CONTROL	PED X TYPE	SPECIAL CONDITIONS		
								#	₦

	VEHICLE DETAILS					VEHICLE DETAILS (INJURY ONLY)							DRIVER DETAILS						CASUALTY DETAILS							
	DIRECTION	SKID/ JACKNIFE	MANOEUVRES	VEHICLE TYPE		VEHICLE MAKE	VEHICLE MODEL	TOWING	VEHICLE DEFECTS	VEHICLE AGE	OVERTURNING	DAMAGED PARTS	SEX	BREATH TEST	'L' DRIVER	DRIVERS ACTION	DRIVERS AGE		CASUALTY CLASS	SEVERITY	SEX	AGE	PEDESTRIAN ACTION / PASSENGER POSITION	VEHICLE OCCUPIED		
2					#													#							#	₦
2					#													#							#	₦
2					#													#							#	₦
2					#													#							#	₦
2					#													#							#	₦
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2					#													#							#	₦
2					#													#							#	₦

	REFERENCE	NUMBER	KMEAGE	NO	NUMBER	DATE	NUMBER	TIME HRS MINS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	TYPE	ATION	
1																	#N
1																	#N
1																	#N
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City of Birmingham, the location of individual accidents by Ordnance Survey grid reference was generally held[35] to be more practical for urban areas; the road mileage system, where accidents are located by the mileage along the road on which they occur from a fixed origin, being preferred for the more sparsely covered rural situation. However, it was decided that as Birmingham has a strongly defined radial/ring road system it would be possible to have a main road network operating on a kilometreage basis, with accidents on minor roads being located by a truncated six figure Ordnance Survey grid reference.

A specifically modified 6 inch to 1 mile map of the City was prepared showing the main road network. All the radial routes were given zero kilometreage at the inner ring road, with increasing kilometreage outwards. Check marks were made at 100 metre intervals, to enable coding clerks to interpolate an accident location to the nearest 10 metres. Ring roads and cross city routes were marked up in a similar manner with the ring roads having an increasing kilometreage in an anti-clockwise direction, and for cross city routes generally from north-west to south-east. Major junctions were given a sequential number along each route; junction accidents include those occurring up to 20 metres back along each approach. In order to reduce the possibility of double coding of junction accidents where two network roads intersect, a hierarchical colour coded system was introduced whereby the particular junction accident would be coded onto the road higher in the hierarchy, as follows:-

Position	Category	Colour	Notes
1st	Motorways	Blue	
2nd	Radial Roads	Red	Normally Principle Routes
3rd	Ring Roads	Green	Inner, Middle and Outer Ring Roads
4th	Major Cross City Routes	Brown	
5th	Minor Cross City Routes	Yellow	

Hierarchy of Main Road Network

The minor of two routes is effectively broken at the junction, but the kilometreage is carried through; no accidents are attributed to this portion of the minor route.

The accidents on the main road network were also located by a six figure grid reference as this information was required by the Department of the Environment. This had the disadvantage of double coding but it enabled a computer cross-check between the details to be included.

Hence an accident occurring on the A38 on the southern side of the City at junction 9, which is kilometre 5.55 and grid reference 042 824 (truncated), was coded as:-

042 824	ASO 38	05 55	09

In the case of accidents off the main road network location was less precise, being limited to internal road number plus six figure (0.1 km) grid reference. The road numbers used for non-network roads were assigned to them from an internal system used by the Highways Division.

The 6 inch location map also showed pedestrian crossings on and off the network. These crossings were all numbered and any accidents occurring on one of them were also located by this number.

With the advent of local government re-organisation in April 1974 the system was expanded to incorporate the whole of the West Midlands Metropolitan County area. The West Midlands Metropolitan County is made up as follows:

(a) Area

Birmingham District	-	264.3 sq. km.
Coventry "	-	96.5 sq. km.
Dudley "	-	97.9 " "
Sandwell "	-	85.6 " "
Solihull "	-	180.1 " "
Walsall "	-	106.1 " "
Wolverhampton "	-	68.9 " "
West Midlands County	-	899.4 " "

(b) Number of Network Junctions

Birmingham District	-	336
Coventry "	-	136
Dudley "	-	199
Sandwell "	-	129
Solihull "	-	55
Walsall "	-	119
Wolverhampton "	-	89
West Midlands County	-	1063

(c) Length of Road in West Midlands County

Length of Network Road 1764.9 km

Total Length of Road in County - 6200 km

There are two problems, related to the location of individual accidents, which must be mentioned here. The first is a fault, which has been known for some time and which, it is hoped, will soon be corrected, in the computer system itself. During the process of new accident records entering the system the junction numbers, see Figure 3, on the records of accidents occurring at network junctions, are being erased. The effects of this are three-fold:-

(i) it is not possible to request the details of all of the accidents occurring at a particular network junction by specifying just the road and junction numbers (see 3.12),

(ii) the blackspot listing for network junctions (see 3.9) is producing completely erroneous results, because the number of accidents accredited to each junction is determined using the junction number,

(iii) the blackspot listing for network stretches (see 3.9), which is concerned with problem locations on network stretches away from network junctions, has included locations which are actually network junctions. This is caused by the absence of the junction numbers, by which the network-junction accidents and network non-network-junction accidents are distinguished.

The second problem is concerned with the coding of the individual accident positions. Despite the hierarchical colour coding system on the maps from which the road number, kilometreage, and grid reference of each accident are determined there are still instances, at junctions where network roads of the same 'colour' cross, at which coding errors have been made. In these cases it has been found that some of the accidents have been coded as having occurred on one of the roads and the remainder as having occurred on the other road. This error is occurring because it is not always immediately clear as to which of the two, or more, roads, of the same colour, passing through the junction is considered, within the system, as the major route. In some instances the coding error has been made at the junctions of roads of different 'colours'. The extent to which this coding error is occurring is such that in any request for accident information at a network junction, all of the network roads passing through the junction are checked to ascertain whether accidents have been recorded as having occurred on them at that position (see 3.12).

The combined effect of these two faults has precluded any possibility of experiment work for this study being carried out on the computer using the accident records directly.

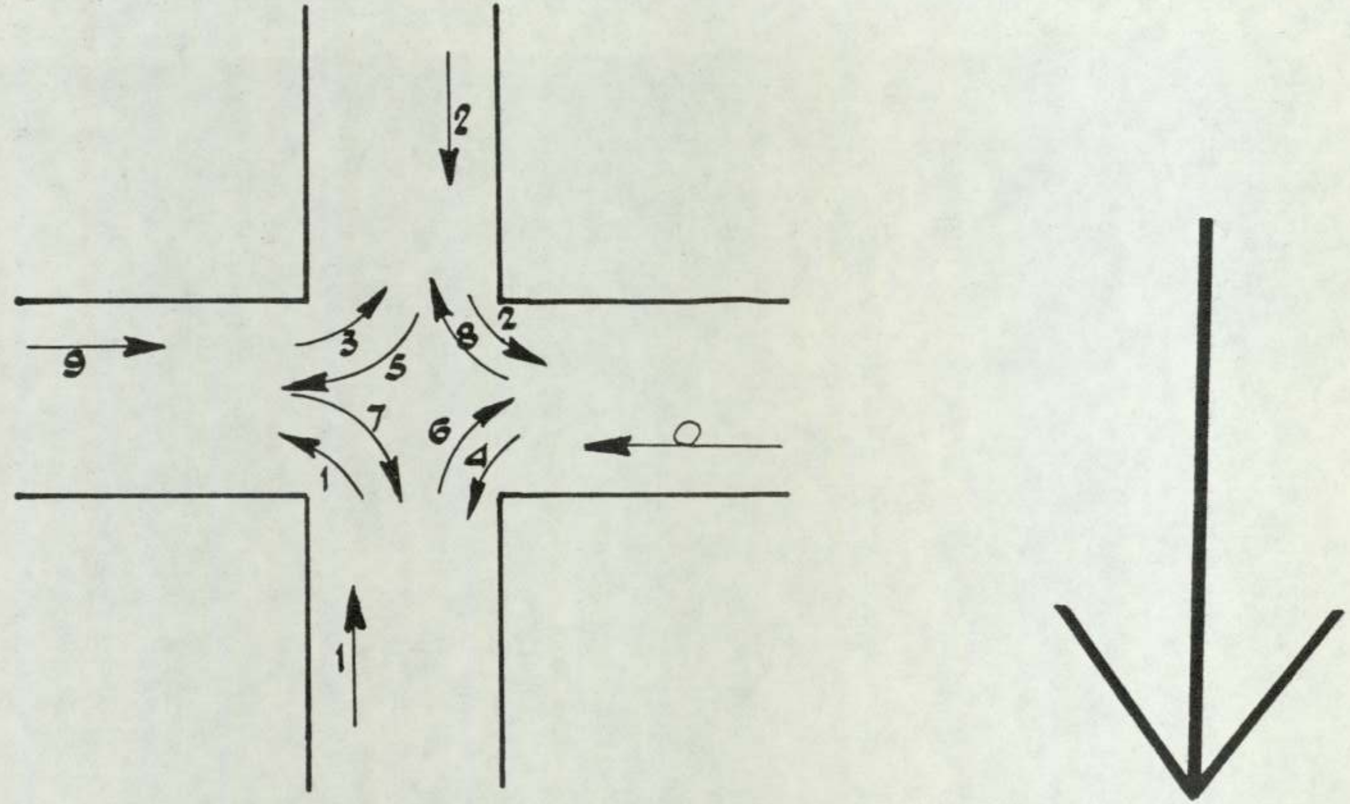
3.2.2 Collision Type

The collision type code, comprised of 1 or 2 alpha/numerical characters, assigned to an accident is selected as appropriate from those contained in Figures 5, 6, 7, 8, and 9, to indicate the type of collision that occurred in the accident. These collision type codes are based on the ones developed for Cumberland County Council's traffic accident recording system.[36] In the case of accidents involving more than two vehicles the collision type code for what is considered to be the primary collision is selected.

3.2.3 Causation

The causation description assigned to an accident is selected from those contained in the following table. Only one causation description is assigned to each accident.

Figure 5. - Collision Type Codes for Vehicle Accidents at Junctions

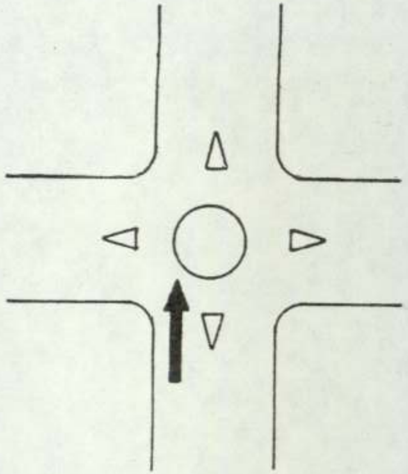


All types represented by one or two digits.
If main road vehicle is involved, first digit must be 1 or 2
(Main road vehicle is a vehicle intending to travel on
the main road before & after the junction.

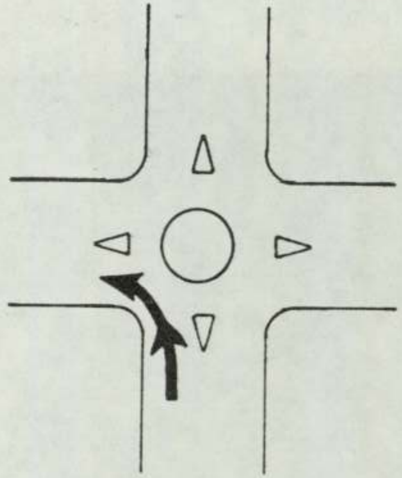
Network roads:
Increasing kilometereage

Non-network roads:
To South.

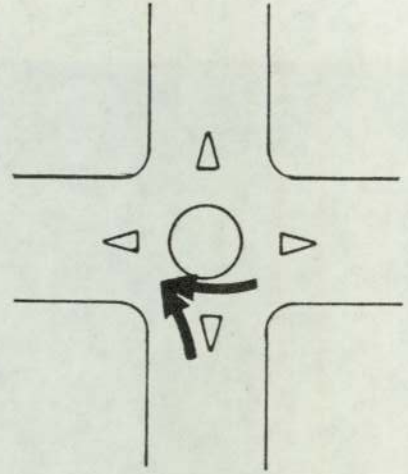
ENTERING ROUNDABOUT :-



R.I.

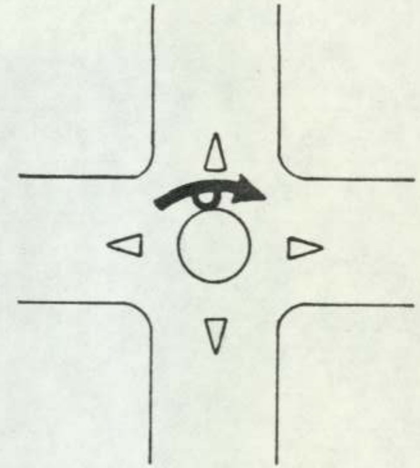


R.2.



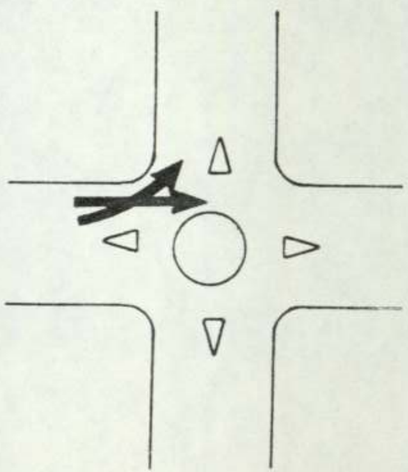
R.3.

WITHIN ROUNDABOUT :-

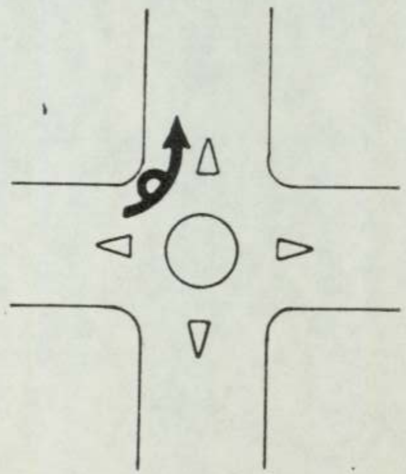


R.7.

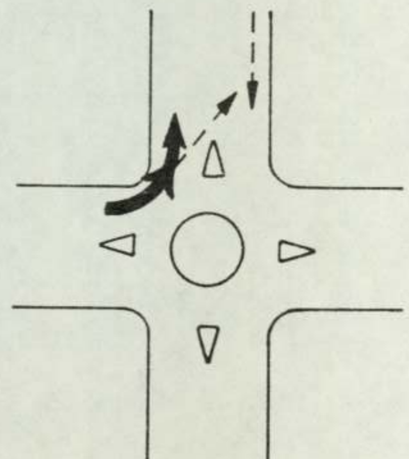
LEAVING ROUNDABOUT :-



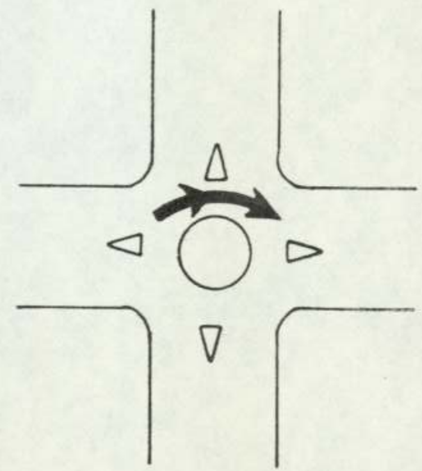
R.4.



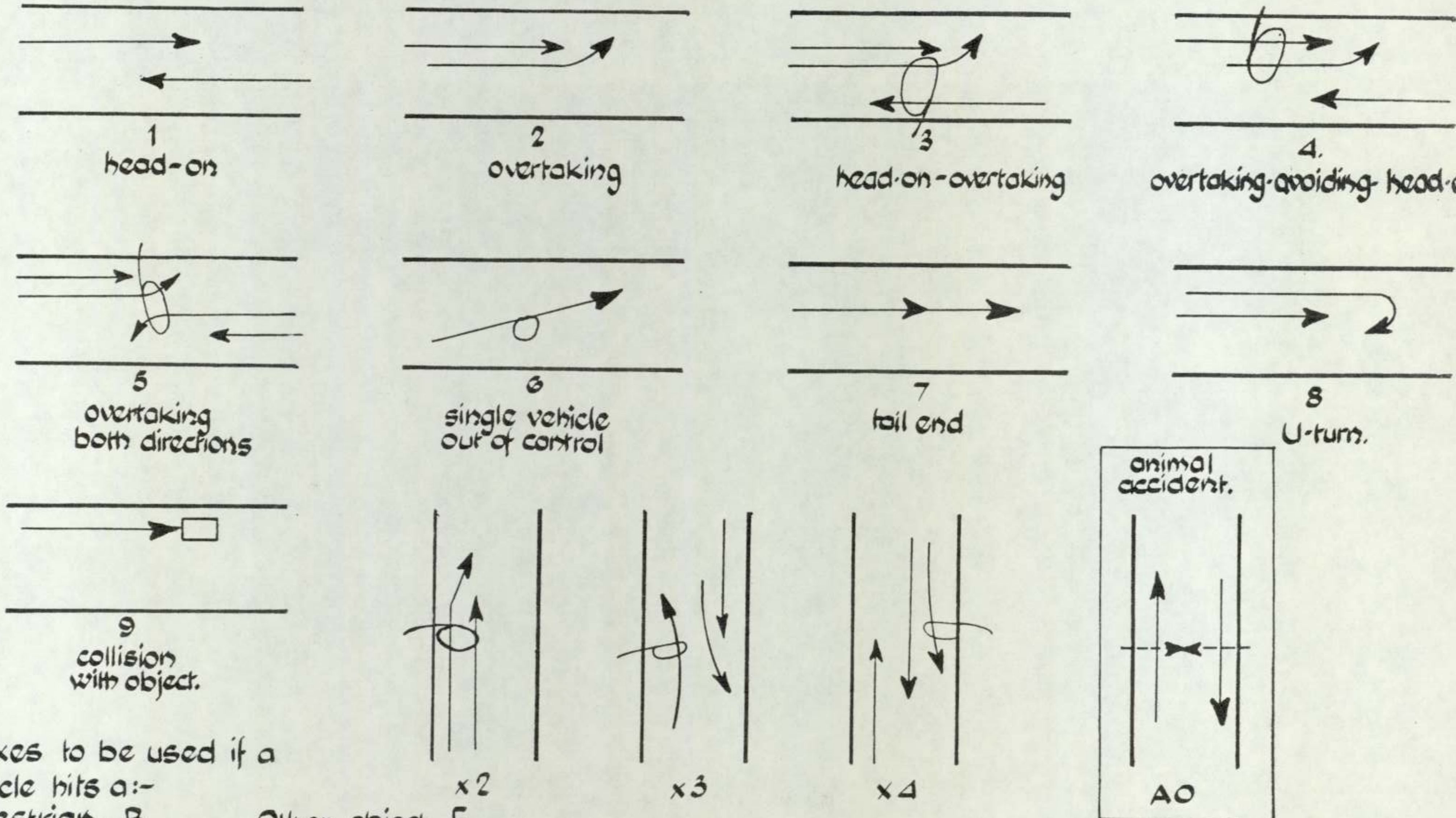
R.5.



R.6.



R.8.



Prefixes to be used if a
vehicle hits a:-
Pedestrian - B
Lamp column - C
Road signs etc - D
Telegraph pole - E
Other object F
Pedestrian on a crossing G
Parked vehicle H

Any other non-junction vehicle accident code as O.

Junction:-

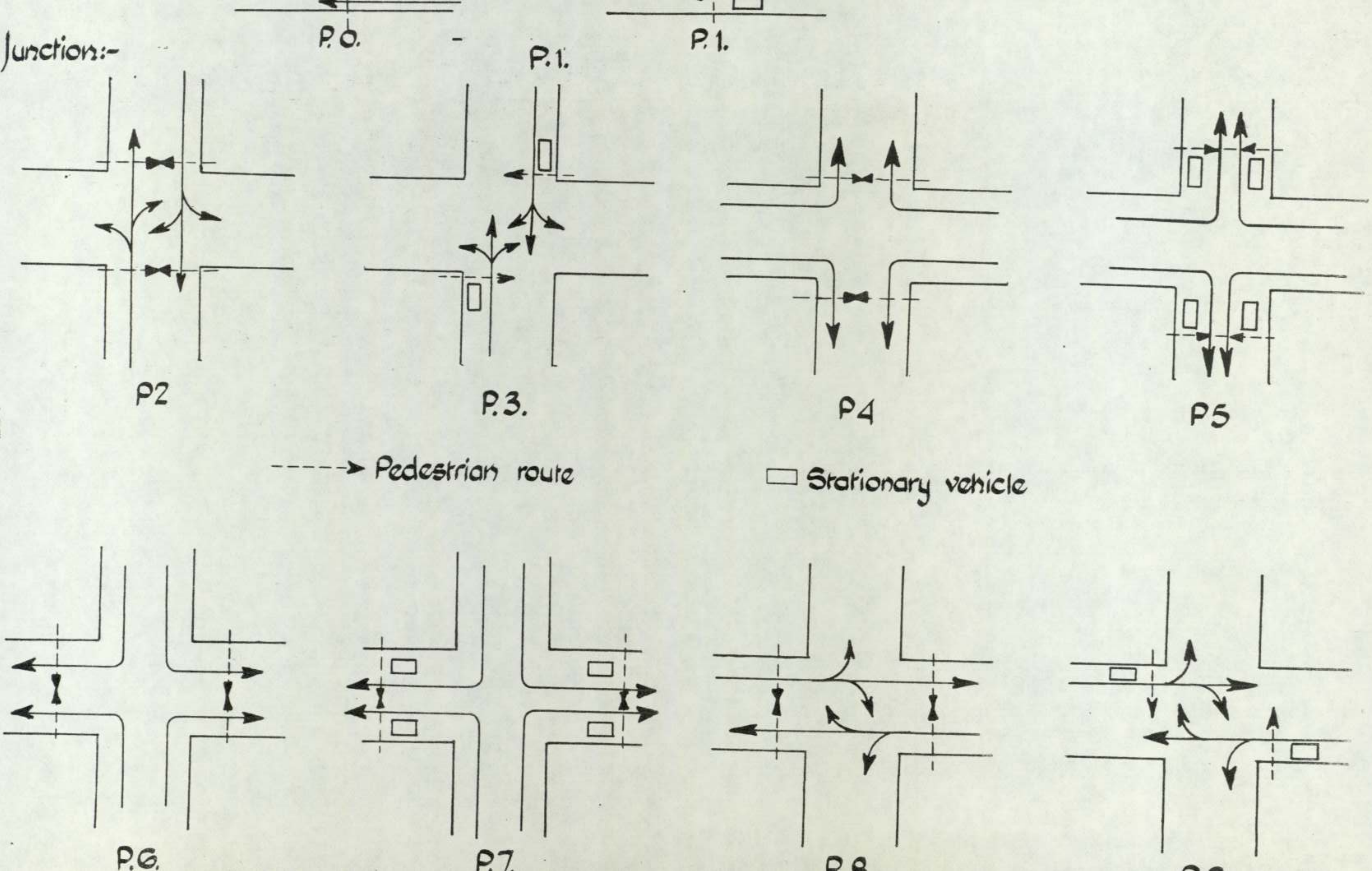

P.O.
P.1.
P.1.
P2
P.3.
P4
P5
Pedestrian route
Stationary vehicle
P.6.
P.7.
P.8

Figure 9.

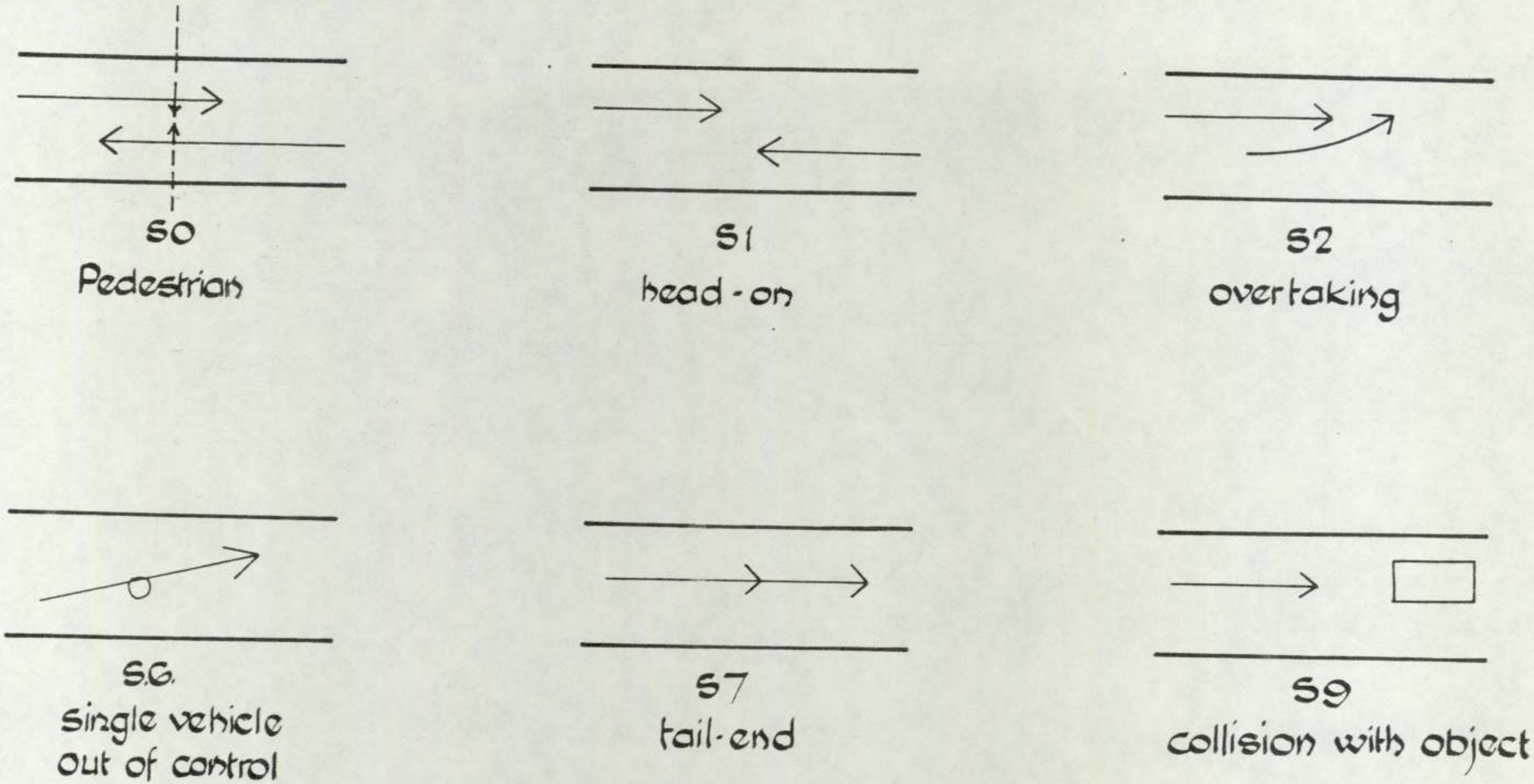

SO
Pedestrian
S1
head - on
S2
overtaking
S.6.
single vehicle
out of control
S7
tail-end
S9
collision with object

Table 6 - Accident Causation Codes

Causn. No.	Causation Description
1	Fatigued or asleep
2	Ill
3	Under influence of drink or drug
4	Physical defect of driver
5	Learner driver
6	Inexperienced with type of vehicle
7	Excessive speed for conditions
8	Failure to keep to nearside
9	Cutting in
10	Overtaking improperly on nearside
11	Overtaking improperly on offside
12	Swerving
13	Forced way through persons boarding a bus
14	Failure to accord precedence at predestrian crossing
15	Turning in road negligently
16	Reversing negligently
17	Failure to conform to traffic sign/signal
18	Failure to signal or incorrect signal
19	Pull out from nearside
20	Pull out from offside
21	Changing traffic lane without due care
22	Cyclists more than two abreast
23	Cyclist riding head down
24	Inattentive

25	Hampered by passenger/animal
26	Turning left without due care
27	Turning right without due care
28	Negligently opening side door
29	Negligently opening rear door
30	Door not properly fastened
31	Crossing junction without due care
32	Cyclist holding onto other vehicle
33	Losing control
34	Dazzled by lights of vehicle
35	Moving off whithout proper care
36	Stopping suddenly
37	Misjudged clearance
38	Following too closely behind other vehicle
39	Other error or negligence
46	Crossing masked by stationary vehicles
47	Crossing masked by moving vehicle
48	Crossing heedless (pedestrian)
49	Walking or standing in road
50	Playing in road
51	Step, walk, or run from footpath
52	Slipping or falling
53	Pedestrian - ill or physical defect
54	Pedestrian under influence of drink or drug
55	Pedestrian holding onto a vehicle
56	Pedestrian - other error or negligence
57	Board/alight p.s.v. without due care

58	Board/alight other vehicle without due care
59	Fall into or from a vehicle
60	Passenger opening door carelessly
61	Other negligence of passengers
62	Stealing a ride
63	Negligence of conductor
64	Passenger under influence of drink or drug
65	Dog in road
66	Other animal in road
67	Vehicle dangerously parked
68	Collision with vehicle in previous collision
69	Other obstruction in road
70	Defective brakes
71	Defective tyres or wheels
72	Defective steering
73	Defective chain
74	Defective frame
75	No front light
76	Inadequate front light
77	No rear light
78	Inadequate rear light
79	Unattended vehicle running away
80	Driver's view obstructed by load
81	Vehicle overloaded or shifted load
82	Other feature of vehicle or equipment
83	Rail track in bad repair
84	Wheel in tram or rail track
85	Pot-hole in road

86	Defective manhole cover
87	Other road surface condition
88	Road works in progress
89	View obstructed by layout of road
90	Slippery road surface - not due to weather conditions
91	Other road condition
92	Fog or mist
93	Ice, frost or snow
94	Strong wind
95	Heavy rain
96	Glaring sun
97	Other factors
98	Not traced

3.3 Weekly Procedure

Each week batches of completed accident coding sheets are sent from the Police coding office to the Computer Centre where they are punched onto paper tape and run through Program TA01, which is a vetting program. Firstly the validity of the value and format of each field is checked, and then the individual accident records are checked for inconsistencies by a number of cross-checks, e.g. does the accident class correspond to the severity of the worst casualty? The cross-checks are in two groups - those for which, if they are failed, the record cannot go any further and must be corrected and re-input; and those which, if they are failed, cause warnings to be printed, but allow the record to be written to the valid-records tape, to be amended at the discretion of the Police coding staff. There are two further cross-checks to check that the values in the 'number of vehicles' and 'number of casualties' fields agree with the number of vehicle and casualty records which follow.

The only other checks in TA01 are made on the fields in the batch header, which is the information on the accident batch control sheet which accompanies each batch. The batch header record gives the number of records in the batch, and the total number of accidents and these are checked at the end of the batch. These error messages are again simply warnings.

Program TA01 produces an error listing and prints the valid data onto a magnetic tape file. The corrections are input with the next run.

3.4 Monthly Procedure

At the end of each calendar month the last batch is dealt with as above except that major corrections are made as quickly as possible and re-input through TA01. This is in order that Program TA02 can be run as soon as possible. Program TA02 produces output TA.L.1 which contains the information that is required by the Department of Transport for the national statistics as soon after the end of the calendar month as possible.

The valid record tape produced by TA01 is sorted by Program TA03. TA03 sorts the complete file of accidents for the month on the basis of accident number within date within location. This is the basis on which accident records are held on the Main Accident File (see below) which contains the accident records that have been input in the previous 3 years. The sorted file is read in conjunction with the Main Accident File to check for location errors. The Main Accident File is then updated, adding the valid records and deleting all the accident records over 3 years old. (Accident records to be deleted from the Main Accident File will have already been re-recorded in a History File.) This update is carried out by Program TA04 which also prints out the records containing location errors for correction by the Police Statistics Office. These errors can be re-entered with the next month's batch of accidents, since further processing is not dependent on their immediate correction.

3.5 Main Accident File

This is a file, held on computer disc, containing all the accidents reported in the preceding three years. There are four types of records held on it:-

(i) Road records - one for each network road, containing the following information:

Road Number	Internal Road Number
Record Type	Grid Reference Bounds
Road Name	

The 'Grid Reference Bounds' are the extreme grid co-ordinates, North, East, West, South, which would form the smallest possible rectangle in which the complete road would be contained.

(ii) Junction records - one for each major junction on each network road, containing the following information:

Road Number	H.S.D. Reference Number
Record Type	Link Length
Kilometreage	Junction Flow
Junction Number	Link Flow
Dummy Indicator	Latest Blackspot Position
Junction Name	Blackspot Kilometreage
Old Indicator	Blackspot Position

'Kilometreage' - this is the distance of the junction from the starting point of the road.

'Dummy Indicator' - if there are two or more network roads passing through the same network junction, one of them will have priority over the others and the junction is considered as being along that road so far as the location of accidents is concerned. But at that point along the other network road a network junction record is also entered with a number and kilometreage along that road but with the dummy indicator marked.

'Old Indicator' - if a junction is improved or altered to such an extent that it is to be considered a different junction from the original, a junction record is input with the same road number and kilometreage as the original but with a new number greater than the largest on that road so far and a new name bearing a resemblance to the original and the same H.S.D. reference number. This will create a second junction record, next to the other and will cause the 'old indicator' on the original junction record to register the change.

'H.S.D. Reference Number' - this is the number used by the Highways Division to identify the corresponding traffic flow count location.

'Link Length' - a 'Link' is the section of road between two adjacent network junctions. The link length is added to the record when the following record is read and it is the difference between the junction kilometreages minus 0.05 kilometres.

'Junction Flow' and 'Link Flow' - see Section 3.7 on 'Flow File'.

'Blackspot Kilometreage' and 'Blackspot Position' - are fields for the recording of any blackspot stretches (see section on blackspots) in the link following this junction record and are updated every time the blackspot tables are updated.

(iii) Accident records for non-network accidents - containing all the information on the Accident Coding Form. However the six-figure grid reference on the input is converted to 8 figures. The following sequence of operations is carried out:-

> Split the six-figure grid reference into its two parts, GRID-EAST and GRID-NORTH. If GRID-EAST is greater than 200 add 3000 to GRID-EAST; otherwise add 4000. Add 2000 to GRID-NORTH. If GRID-EAST is odd subtract 1 and set a field EAST = 1. If GRID-NORTH is odd subract 1 from it and set field NORTH = 1.

Thus 2/10 km. cells are formed and the records are stored in this order. The original grid reference can be re-created, if required, by use of fields East and North.

In addition the date and accident number are moved to the front of the record and the date is reversed, to be year-month-date. This is done for the purpose of sorting the records into sequence by date.

(iv) Accident Records for network accidents. In the case of the network accident record the same conversion of grid reference to 8 figures is used but without making GRID-EAST and GRID-NORTH both even and therefore not creating the fields EAST and NORTH. The date and accident number are treated as in the non-network record and the rest of the record is a straight transcription of the input.

The non-network records are held in the Main Accident File in the sequence of accident number within date within grid reference.

The road records are in road number order, with each road followed by the junction records for the junctions along that road in kilometreage sequence. The accident records for network roads are inserted between the junction records according to their kilometreage. Accidents with the same kilometreage are in accident number order within date.

The road and junctions were put onto the Main Accident File in the same way that the accident records are input i.e. using Programs TA07, TA03, and TA04.

3.6 Monthly Procedure (contd.)

Once the Master Accident File has been updated the monthly outputs TA.L. 2-5, Figures 10 , 11 , 12 and 13 , are printed by means of Program TA05. The printouts contain the number of accidents in the current month, compared with those of the corresponding month in the preceding year, in the following tables:

TA.L.2 - Time of day by class of accident and casualty.

TA.L.3 - Type of vehicle by casualty class.

TA.L.4 - Age group by class and severity of casualty.

TA.L.5 - Causation by accident class.

If the month is December, annual outputs are printed. They are identical to TA.L. 2-5 except that they cover the whole year's data and compare the current year with the preceding year. In addition the annual output TA.L.20 is produced. TA.L.20 contains a list of the number of causations for the year's child casualties. TA05 is the program for all of these outputs.

Figure 10.

WEST MIDLANDS

TRAFFIC ACCIDENT ANALYSIS

TIME OF DAY BY CLASS OF ACCIDENT AND CASUALTY

MONTH: SEPTEMBER 1977

	INJURY									
	FATAL		SERIOUS		SLIGHT		DAMAGE	DOG	TOTAL	
HOUR	ACC	CAS	ACC	CAS	ACC	CAS	ACC	ACC	ACC	CAS
00.00 - 00.59	1	1	3	4	15	27	0	0	19	32
	(1)	(1)	(5)	(12)	(10)	(14)	(48)	(1)	(65)	(27)
01.00 - 01.59	0	0	5	5	6	8	0	0	11	13
	(1)	(1)	(6)	(9)	(16)	(25)	(31)	(0)	(54)	(35)
02.00 - 02.59	0	0	7	7	8	16	0	0	15	23
	(1)	(1)	(7)	(9)	(6)	(13)	(24)	(2)	(40)	(23)
03.00 - 03.59	1	1	0	0	5	5	0	0	6	6
	(0)	(0)	(3)	(4)	(5)	(5)	(8)	(0)	(16)	(9)
04.00 - 04.59	0	0	1	1	0	1	0	0	1	2
	(0)	(0)	(2)	(2)	(4)	(8)	(4)	(0)	(10)	(10)
05.00 - 05.59	0	0	0	0	2	2	0	0	2	2
	(0)	(0)	(2)	(2)	(2)	(3)	(6)	(1)	(11)	(5)
06.00 - 06.59	0	0	1	1	6	7	0	0	7	8
	(0)	(0)	(2)	(2)	(6)	(6)	(11)	(1)	(20)	(8)
07.00 - 07.59	0	0	5	5	21	24	0	0	26	29
	(0)	(0)	(7)	(8)	(23)	(28)	(37)	(12)	(79)	(36)
08.00 - 08.59	1	1	10	11	47	51	0	0	58	63
	(0)	(0)	(9)	(10)	(49)	(58)	(85)	(16)	(159)	(68)
09.00 - 09.59	0	0	4	4	11	13	0	0	15	17
	(1)	(1)	(7)	(8)	(25)	(27)	(49)	(8)	(90)	(36)
10.00 - 10.59	3	3	5	5	17	22	0	0	25	30
	(1)	(1)	(11)	(11)	(24)	(36)	(42)	(14)	(92)	(48)
11.00 - 11.59	0	0	6	7	29	43	0	0	35	50
	(0)	(0)	(7)	(7)	(26)	(36)	(82)	(22)	(137)	(43)

TIME OF DAY BY CLASS OF ACCIDENT AND CASUALTY

MONTH: SEPTEMBER 1977

HOUR	INJURY: FATAL ACC	INJURY: FATAL CAS	INJURY: SERIOUS ACC	INJURY: SERIOUS CAS	INJURY: SLIGHT ACC	INJURY: SLIGHT CAS	DAMAGE ACC	DOG ACC	TOTAL ACC	TOTAL CAS
12.00 - 12.59	2 (1)	2 (1)	10 (11)	10 (11)	38 (29)	47 (31)	0 (74)	0 (14)	50 (129)	59 (43)
13.00 - 13.59	0 (0)	0 (0)	8 (13)	8 (14)	41 (40)	46 (48)	0 (69)	0 (15)	49 (137)	54 (62)
14.00 - 14.59	1 (0)	1 (0)	9 (11)	13 (12)	28 (38)	48 (50)	1 (82)	0 (15)	39 (146)	62 (62)
15.00 - 15.59	2 (0)	2 (0)	14 (6)	18 (6)	46 (54)	55 (67)	0 (107)	0 (9)	62 (176)	75 (73)
16.00 - 16.59	1 (1)	1 (1)	13 (24)	13 (25)	80 (64)	99 (72)	0 (126)	0 (16)	94 (231)	113 (98)
17.00 - 17.59	1 (1)	1 (1)	12 (8)	12 (9)	75 (60)	81 (69)	0 (106)	0 (19)	88 (194)	94 (79)
18.00 - 18.59	0 (0)	0 (0)	10 (15)	11 (15)	36 (38)	41 (47)	0 (70)	0 (12)	46 (135)	52 (62)
19.00 - 19.59	1 (0)	1 (0)	13 (12)	14 (13)	30 (34)	35 (44)	0 (51)	0 (17)	44 (114)	50 (57)
20.00 - 20.59	0 (0)	0 (0)	7 (10)	7 (11)	17 (32)	22 (41)	0 (71)	0 (14)	24 (127)	29 (52)
21.00 - 21.59	1 (4)	2 (5)	7 (7)	8 (8)	22 (22)	31 (34)	0 (51)	0 (13)	30 (97)	41 (47)
22.00 - 22.59	0 (3)	0 (3)	16 (16)	18 (19)	21 (31)	31 (52)	0 (84)	0 (7)	37 (141)	49 (74)
23.00 - 23.59	4 (3)	5 (3)	27 (19)	35 (31)	40 (48)	69 (68)	0 (141)	0 (9)	71 (220)	109 (102)
TOTAL	19 (18)	21 (19)	193 (220)	217 (258)	641 (686)	824 (882)	1 (1459)	0 (237)	854 (2620)	1062 (1159)

NO OF DOGS KILLED 0 (69)
NO OF DOGS INJURED 0 (168)

NB. COMPARISON FIGURES FOR THE SAME MONTH OF THE PREVIOUS YEAR ARE ENCLOSED IN ( )

Figure 11.

WEST MIDLANDS

TRAFFIC ACCIDENT ANALYSIS

TYPE OF VEHICLE BY CASUALTY CLASS MONTH: SEPTEMBER 1977

VEHICLE TYPE

	CASUALTY	PRIVATE CAR	MOTOR CYCLE -SOLO	MOTOR CYCLE -COMB	MOPED	P S V	TAXI	VAN OR LORRY	ELEC VEH	ICE CREAM VAN	OTHERS	TOTAL MECH	PEDAL CYCLE	NO TRACE	GRAND TOTAL
FATAL	PED	11 (7)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	12 (8)	0 (1)	0 (0)	12 (9)
	DRI	1 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	2 (4)	0 (0)	0 (0)	2 (4)
	M/C	0 (0)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (1)	0 (0)	0 (0)	2 (1)
	MOP	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	P/P	0 (0)	3 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (1)	0 (0)	0 (0)	3 (1)
	P/C	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	. PAS	2 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (4)	0 (0)	0 (0)	2 (4)
SERIOUS	PED	39 (59)	12 (7)	0 (0)	1 (1)	1 (1)	0 (0)	8 (8)	0 (0)	0 (0)	1 (0)	62 (76)	0 (0)	6 (0)	68 (76)
	DRI	31 (56)	1 (0)	0 (0)	0 (0)	1 (0)	0 (0)	7 (8)	0 (0)	0 (0)	1 (0)	41 (64)	0 (0)	0 (0)	41 (64)
	M/C	10 (4)	32 (25)	0 (0)	0 (0)	0 (1)	0 (0)	7 (6)	0 (0)	0 (0)	0 (0)	49 (36)	1 (0)	0 (0)	50 (36)
	MOP	1 (3)	0 (0)	0 (0)	7 (6)	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	9 (10)	0 (0)	0 (1)	9 (11)
	P/P	3 (0)	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	6 (0)	0 (1)	0 (0)	6 (1)

TRAFFIC ACCIDENT ANALYSIS

Figure 11. (Cont)

TYPE OF VEHICLE BY CASUALTY CLASS

MONTH: SEPTEMBER 1977

VEHICLE TYPE

CASUALTY		PRIVATE CAR	MOTOR CYCLE -SOLO	MOTOR CYCLE -COMB	MOPED	P S V	TAXI	VAN OR LORRY	ELEC VEH	ICE CREAM VAN	OTHERS	TOTAL MECH	PEDAL CYCLE	NO TRACE	GRAND TOTAL
S	P/C	1 (2)	1 (0)	0 (0)	0 (0)	1 (0)	0 (0)	1 (1)	0 (0)	0 (0)	0 (0)	4 (3)	7 (7)	0 (0)	11 (10)
	PAS	26 (51)	0 (0)	0 (0)	0 (0)	5 (4)	0 (0)	1 (1)	0 (2)	0 (0)	0 (1)	32 (59)	0 (0)	0 (1)	32 (60)
	PED	159 (157)	16 (11)	0 (0)	2 (1)	8 (7)	0 (1)	29 (17)	0 (0)	1 (0)	0 (1)	215 (195)	2 (2)	10 (13)	227 (210)
	DRI	136 (161)	2 (0)	0 (0)	0 (0)	1 (3)	0 (1)	30 (31)	0 (0)	0 (0)	4 (2)	173 (198)	1 (0)	1 (3)	175 (201)
S L	M/C	36 (32)	70 (70)	0 (0)	1 (0)	1 (1)	0 (0)	8 (6)	0 (0)	0 (0)	0 (0)	116 (109)	0 (2)	1 (7)	117 (118)
I G	MOP	11 (13)	0 (1)	0 (0)	21 (17)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	32 (31)	0 (0)	1 (1)	33 (32)
H	P/P	7 (5)	10 (6)	0 (0)	1 (0)	0 (0)	0 (0)	2 (0)	0 (0)	0 (0)	0 (0)	20 (11)	1 (0)	0 (0)	21 (11)
T	P/C	15 (18)	0 (0)	0 (0)	0 (0)	0 (1)	0 (0)	1 (3)	0 (0)	0 (0)	0 (0)	16 (22)	36 (39)	1 (6)	53 (67)
	PAS	146 (182)	0 (1)	0 (0)	0 (0)	21 (35)	0 (3)	28 (20)	0 (0)	0 (0)	1 (1)	196 (242)	0 (1)	2 (0)	198 (243)
ACCIDENT															
FATAL		13 (14)	4 (2)	0 (0)	0 (0)	0 (0)	0 (0)	2 (1)	0 (0)	0 (0)	0 (0)	19 (17)	0 (1)	0 (0)	19 (18)
SERIOUS		95 (139)	42 (31)	0 (0)	8 (7)	7 (6)	0 (0)	25 (24)	0 (2)	0 (0)	2 (1)	179 (210)	8 (8)	6 (2)	193 (220)
SLIGHT		377 (419)	79 (71)	0 (0)	22 (18)	30 (43)	0 (2)	73 (60)	0 (0)	1 (0)	5 (4)	587 (617)	39 (39)	15 (30)	641 (686)
TOTAL		485 (572)	125 (104)	0 (0)	30 (25)	37 (49)	0 (2)	100 (85)	0 (2)	1 (0)	7 (5)	785 (844)	47 (48)	21 (32)	853 (924)

NB. COMPARISON FIGURES FOR THE SAME MONTH OF THE PREVIOUS YEAR ARE ENCLOSED IN ( )

AGE	FATAL							SERIOUS							SLIGHT							TOTAL
GROUP	PED	DRI	M/C	MOP	P/P	P/C	PAS	PED	DRI	M/C	MOP	P/P	P/C	PAS	PED	DRI	M/C	MOP	P/P	P/C	PAS	
0- 4	1	0	0	0	0	0	0	3	0	0	0	0	0	1	12	0	0	0	0	0	8	25
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(8)	(0)	(0)	(0)	(0)	(0)	(1)	(13)	(0)	(0)	(0)	(0)	(0)	(12)	(34)
				1 (0)							4 (9)							20 (25)				
5- 9	2	0	0	0	0	0	0	21	0	0	0	0	1	2	67	0	0	0	1	9	13	116
	(1)	(0)	(0)	(0)	(0)	(0)	(0)	(13)	(0)	(0)	(0)	(0)	(2)	(1)	(58)	(0)	(0)	(0)	(0)	(6)	(11)	(92)
				2 (1)							24 (16)							90 (75)				
10-15	1	0	0	0	0	0	1	11	0	1	0	0	4	4	63	0	0	0	2	21	16	124
	(0)	(0)	(0)	(0)	(1)	(0)	(1)	(15)	(0)	(0)	(0)	(1)	(2)	(6)	(41)	(0)	(0)	(0)	(0)	(38)	(13)	(118)
				2 (2)							20 (24)							102 (92)				
16-19	0	0	0	0	1	0	1	4	2	24	6	3	1	7	20	13	67	24	12	6	30	221
	(0)	(1)	(0)	(0)	(0)	(0)	(1)	(7)	(6)	(22)	(8)	(0)	(1)	(10)	(18)	(21)	(65)	(24)	(9)	(12)	(40)	(245)
				2 (2)							47 (54)							172 (189)				
20-24	0	0	2	0	2	0	0	3	9	16	0	1	2	6	12	40	23	0	2	5	32	155
	(0)	(1)	(1)	(0)	(0)	(0)	(0)	(1)	(19)	(5)	(1)	(0)	(0)	(12)	(9)	(53)	(25)	(1)	(2)	(0)	(42)	(172)
				4 (2)							37 (38)							114 (132)				
25-29	0	2	0	0	0	0	0	4	5	2	2	2	0	2	1	26	9	1	4	2	10	72
	(0)	(1)	(0)	(0)	(0)	(0)	(0)	(1)	(14)	(3)	(1)	(0)	(1)	(7)	(7)	(27)	(12)	(1)	(0)	(1)	(19)	(95)
				2 (1)							17 (27)							53 (67)				
30-34	0	0	0	0	0	0	0	1	9	4	0	0	0	1	9	22	6	2	0	0	12	66
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(4)	(7)	(4)	(1)	(0)	(0)	(3)	(6)	(29)	(4)	(2)	(0)	(1)	(17)	(78)
				0 (0)							15 (19)							51 (59)				
35-39	0	0	0	0	0	0	0	2	2	0	1	0	0	1	3	14	3	0	0	1	14	41
	(3)	(0)	(0)	(0)	(0)	(0)	(1)	(1)	(7)	(0)	(0)	(0)	(1)	(5)	(5)	(18)	(1)	(2)	(0)	(0)	(7)	(51)
				0 (4)							6 (14)							35 (33)				
40-44	0	0	0	0	0	0	0	3	4	3	0	0	0	2	7	11	4	0	0	1	8	43
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(3)	(5)	(0)	(0)	(0)	(0)	(2)	(11)	(13)	(2)	(0)	(0)	(3)	(17)	(56)
				0 (0)							12 (10)							31 (46)				
45-49	2	0	0	0	0	0	0	2	1	0	0	0	0	2	6	16	0	2	0	2	5	38
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(3)	(2)	(1)	(0)	(0)	(1)	(5)	(9)	(10)	(4)	(1)	(0)	(0)	(11)	(47)
				2 (0)							5 (12)							31 (35)				

AGE	FATAL							SERIOUS							SLIGHT							TOTAL
GROUP	PED	DRI	M/C	MOP	P/P	P/C	PAS	PED	DRI	M/C	MOP	P/P	P/C	PAS	PED	DRI	M/C	MOP	P/P	P/C	PAS	
50-54	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (1)	2 (1)	3 (2)	0 (0)	0 (0)	0 (0)	2 (0)	1 (3)	4 (4)	8 (12)	2 (1)	2 (0)	0 (0)	1 (2)	11 (18)	36 (44)
				0 (1)							8 (6)							28 (37)				
55-59	0 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (1)	3 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	5 (5)	9 (6)	0 (3)	2 (1)	0 (0)	2 (1)	6 (7)	31 (28)
				0 (2)							7 (3)							24 (23)				
60-64	1 (0)	0 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (7)	1 (0)	0 (1)	0 (0)	0 (0)	0 (1)	1 (1)	7 (10)	9 (4)	2 (0)	0 (0)	0 (0)	1 (2)	10 (8)	33 (35)
				1 (1)							3 (10)							29 (24)				
65-69	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (2)	1 (2)	0 (0)	0 (0)	0 (0)	0 (1)	1 (2)	7 (5)	5 (5)	1 (1)	0 (0)	0 (0)	0 (0)	11 (3)	28 (21)
				2 (0)							2 (7)							24 (14)				
70-74	2 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	4 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	4 (5)	1 (1)	0 (0)	0 (0)	0 (0)	0 (1)	5 (8)	16 (21)
				2 (2)							4 (4)							10 (15)				
75-79	1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (3)	1 (0)	0 (0)	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	2 (0)	4 (6)	11 (12)
				1 (1)							3 (3)							7 (8)				
80+	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (4)	6 (10)
				0 (0)							3 (2)							3 (8)				
TOTAL	12 (9)	2 (4)	2 (1)	0 (0)	3 (1)	0 (0)	2 (4)	68 (76)	41 (64)	50 (36)	9 (11)	6 (1)	11 (10)	32 (60)	227 (210)	175 (201)	117 (118)	33 (32)	21 (11)	53 (67)	198 (243)	1062 (1159)
				21 (19)							217 (258)							824 (882)				
NIGHT FIGS	2 (4)	1 (4)	2 (1)	0 (0)	3 (1)	0 (0)	2 (4)	22 (17)	20 (41)	25 (19)	5 (1)	5 (0)	3 (0)	15 (39)	25 (37)	66 (86)	41 (39)	9 (7)	11 (6)	6 (11)	78 (105)	341 (422)
DAY FIGS	10 (5)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	46 (59)	21 (23)	25 (17)	4 (10)	1 (1)	8 (10)	17 (21)	202 (173)	109 (115)	76 (79)	24 (25)	10 (5)	47 (56)	120 (138)	721 (737)

NB. COMPARISON FIGURES FOR THE SAME MONTH OF THE PREVIOUS YEAR ARE ENCLOSED IN ( )

TRAFFIC ACCIDENT ANALYSIS

CAUSATION BY ACCIDENT CLASS

MONTH: - SEPTEMBER 1977

CAUSATION NO	DESCRIPTION	FATAL	SERIOUS	SLIGHT	DAMAGE	DOGS	TOTAL
1	FATIGUED OR ASLEEP	0	0	1	0	0	1
		(0)	(1)	(3)	(0)	(0)	(4)
2	ILL	0	0	0	0	0	0
		(0)	(0)	(2)	(1)	(0)	(3)
3	UNDER INFLUENCE OF DRINK OR DRUG	2	10	16	0	0	28
		(0)	(8)	(18)	(10)	(0)	(36)
4	PHYSICAL DEFECT OF DRIVER	0	0	0	0	0	0
		(0)	(0)	(0)	(0)	(0)	(0)
5	LEARNER DRIVER	0	4	5	0	0	9
		(0)	(0)	(2)	(0)	(0)	(2)
6	INEXPER. WITH TYPE OF VEHICLE	0	0	3	0	0	3
		(0)	(0)	(1)	(0)	(0)	(1)
7	EXCESSIVE SPEED FOR CONDITIONS	0	0	3	0	0	3
		(0)	(1)	(2)	(0)	(0)	(3)
8	FAIL TO KEEP TO NEARSIDE	1	4	9	0	0	14
		(1)	(2)	(5)	(0)	(0)	(8)
9	CUTTING IN	0	0	3	0	0	3
		(0)	(0)	(1)	(0)	(0)	(1)
10	OVERTAKING IMPROPERLY ON N/SIDE	0	1	2	0	0	3
		(0)	(1)	(3)	(0)	(0)	(4)
11	OVERTAKING IMPROPERLY ON OFFSIDE	1	10	17	0	0	28
		(0)	(4)	(11)	(1)	(0)	(16)
12	SWERVING	1	8	18	0	0	27
		(0)	(5)	(20)	(1)	(0)	(26)
13	FORCED WAY THRO' PERSONS BOARD BUS	0	0	0	0	0	0
		(0)	(0)	(0)	(0)	(0)	(0)

Figure 13. (Cont)

WEST MIDLANDS

TRAFFIC ACCIDENT ANALYSIS

CAUSATION BY ACCIDENT CLASS — MONTH: SEPTEMBER 1977

CAUSATION

NO	DESCRIPTION	FATAL	SERIOUS	SLIGHT	DAMAGE	DOGS	TOTAL
14	FAIL ACCORD PRECEDENCE AT PED XING	0 (0)	3 (3)	16 (11)	0 (0)	0 (0)	19 (14)
15	TURN IN ROAD NEGLIGENTLY	0 (0)	2 (0)	0 (4)	0 (0)	0 (0)	2 (4)
16	REVERSING NEGLIGENTLY	0 (0)	1 (0)	3 (9)	0 (4)	0 (0)	4 (13)
17	FAIL CONFORM TRAFFIC SIGN/SIGNAL	0 (0)	15 (27)	78 (88)	0 (0)	0 (0)	93 (115)
18	FAIL TO SIGNAL OR INCORRECT SIGNAL	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	1 (1)
19	PULL OUT FROM NEARSIDE	0 (0)	1 (3)	9 (10)	0 (0)	0 (0)	10 (13)
20	PULL OUT FROM OFFSIDE	0 (0)	0 (1)	2 (2)	0 (0)	0 (0)	2 (3)
21	CHANGE TRAFF LANE WITHOUT DUE CARE	0 (0)	0 (0)	2 (3)	0 (0)	0 (0)	2 (3)
22	CYCLISTS MORE THAN TWO ABREAST	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
23	CYCLIST RIDING HEAD DOWN	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	1 (1)
24	INATTENTIVE	0 (1)	10 (12)	42 (60)	0 (0)	0 (0)	52 (73)
25	HAMPERED BY PASSENGER/ANIMAL	0 (0)	1 (0)	1 (1)	0 (0)	0 (0)	2 (1)
26	TURN LEFT WITHOUT DUE CARE	0 (0)	3 (3)	9 (9)	0 (0)	0 (0)	12 (12)

WEST MIDLANDS

Figure 13. (Cont)

TRAFFIC ACCIDENT ANALYSIS

CAUSATION BY ACCIDENT CLASS

MONTH: SEPTEMBER 1977

CAUSATION

NO	DESCRIPTION	FATAL	SERIOUS	SLIGHT	DAMAGE	DOGS	TOTAL
27	TURN RIGHT WITHOUT DUE CARE	2 (0)	18 (19)	52 (56)	0 (2)	0 (0)	72 (77)
28	NEGLIGENTLY OPEN SIDE DOOR	0 (0)	0 (0)	2 (3)	0 (0)	0 (0)	2 (3)
29	NEGLIGENTLY OPEN REAR DOOR	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
30	DOOR NOT PROPERLY FASTENED	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
31	CROSS JUNCTION WITHOUT DUE CARE	0 (1)	1 (6)	6 (10)	0 (0)	0 (0)	7 (17)
32	CYCLIST HOLDING ON OTHER VEHICLE	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
33	LOSING CONTROL	1 (6)	19 (31)	37 (62)	0 (7)	0 (0)	57 (106)
34	DAZZLED BY LIGHTS OF VEHICLE	0 (0)	1 (0)	3 (0)	0 (0)	0 (0)	4 (0)
35	MOVING OFF WITHOUT PROPER CARE	0 (0)	0 (0)	0 (2)	0 (0)	0 (0)	0 (2)
36	STOPPING SUDDENLY	0 (0)	2 (0)	10 (13)	0 (1)	0 (0)	12 (14)
37	MISJUDGE CLEARANCE	0 (0)	2 (1)	5 (7)	0 (3)	0 (0)	7 (11)
38	FOLLOWING TOO CLOSELY OTHER VEH.	1 (0)	4 (3)	29 (11)	0 (0)	0 (0)	34 (14)
39	OTHER ERROR OR NEGLIGENCE	0 (1)	2 (0)	9 (3)	0 (0)	0 (0)	11 (4)

WEST MIDLANDS

Figure 13. (Cont)

TRAFFIC ACCIDENT ANALYSIS

CAUSATION BY ACCIDENT CLASS

MONTH: SEPTEMBER 1977

CAUSATION NO	DESCRIPTION	FATAL	SERIOUS	SLIGHT	DAMAGE	DOGS	TOTAL
40		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
41		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
42		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
43		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
44		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
45		0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
46	CROSSING MASKED BY STATIONARY VEHS	2 (0)	17 (18)	69 (59)	0 (0)	0 (0)	88 (77)
47	CROSSING MASKED BY MOVING VEH.	0 (0)	0 (2)	0 (3)	0 (0)	0 (0)	0 (5)
48	CROSSING HEEDLESS	2 (2)	9 (13)	13 (21)	0 (0)	0 (0)	24 (36)
49	WALKING OR STANDING IN ROAD	0 (0)	1 (1)	5 (8)	0 (0)	0 (0)	6 (9)
50	PLAYING IN ROAD	1 (0)	0 (0)	2 (0)	0 (0)	0 (0)	3 (0)
51	STEP,WALK OR RUN FROM FOOTPATH	5 (6)	24 (32)	93 (78)	0 (1)	0 (0)	122 (117)
52	SLIPPING OR FALLING	0 (0)	2 (2)	3 (1)	0 (0)	0 (0)	5 (3)

Figure 13. (Cont)

WEST MIDLANDS

TRAFFIC ACCIDENT ANALYSIS

CAUSATION BY ACCIDENT CLASS

MONTH: SEPTEMBER 1977

CAUSATION NO	DESCRIPTION	FATAL	SERIOUS	SLIGHT	DAMAGE	DOGS	TOTAL
53	PEDESTRIAN-ILL OR PHYSICAL DEFECT	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
54	PEDN. UNDER INFLUENCE OF DRINK ETC	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	1 (1)
55	PEDN. HOLDING ONTO VEHICLE	0 (0)	0 (0)	2 (0)	0 (0)	0 (0)	2 (0)
56	PEDN.-OTHER ERROR OR NEGLIGENCE	0 (0)	1 (0)	1 (0)	0 (0)	0 (0)	2 (0)
57	BOARD/ALIGHT PSV WITHOUT DUE CARE	0 (0)	2 (1)	5 (6)	0 (1)	0 (0)	7 (8)
58	BOARD/ALIGHT OTHER VEH.-DUE CARE	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
59	FALL IN OR FROM VEHICLE	0 (0)	1 (5)	9 (14)	0 (0)	0 (0)	10 (19)
60	PASSENGER OPENING DOOR CARELESSLY	0 (0)	0 (0)	1 (1)	0 (0)	0 (0)	1 (1)
61	OTHER NEGLIGENCE OF PASSENGERS	0 (0)	0 (1)	0 (0)	0 (0)	0 (0)	0 (1)
62	STEALING A RIDE	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
63	NEGLIGENCE OF CONDUCTOR	0 (0)	0 (0)	2 (1)	0 (0)	0 (0)	2 (1)
64	PASS. UNDER INFLUENCE OF DRINK ETC	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	1 (0)
65	DOG IN ROAD	0 (0)	1 (0)	4 (1)	0 (3)	0 (0)	5 (4)

Figure 13. (Cont)

TRAFFIC ACCIDENT ANALYSIS

CAUSATION BY ACCIDENT CLASS

MONTH: SEPTEMBER 1977

CAUSATION NO	DESCRIPTION	FATAL	SERIOUS	SLIGHT	DAMAGE	DOGS	TOTAL
66	OTHER ANIMAL IN ROAD	0 (0)	0 (0)	2 (0)	0 (6)	0 (0)	2 (6)
67	VEHICLE DANGEROUSLY PARKED	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
68	COLLIDE WITH VEH. IN PREVIOUS COLL	0 (0)	0 (0)	0 (1)	0 (0)	0 (0)	0 (1)
69	OTHER OBSTRUCTION	0 (0)	1 (0)	0 (4)	0 (1)	0 (1)	1 (6)
70	DEFECTIVE BRAKES	0 (0)	2 (0)	2 (0)	0 (0)	0 (0)	4 (0)
71	DEFECTIVE TYRES OR WHEELS	0 (0)	1 (0)	3 (3)	0 (0)	0 (0)	4 (3)
72	DEFECTIVE STEERING	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
73	DEFECTIVE CHAIN	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
74	DEFECTIVE FRAME	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
75	NO FRONT LIGHT	0 (0)	0 (0)	0 (3)	0 (0)	0 (0)	0 (3)
76	INADEQUATE FRONT LIGHT	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
77	NO REAR LIGHT	0 (0)	2 (0)	0 (0)	0 (0)	0 (0)	2 (0)
78	INADEQUATE REAR LIGHT	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

Figure 13. (Cont)

WEST MIDLANDS

TRAFFIC ACCIDENT ANALYSIS

CAUSATION BY ACCIDENT CLASS

MONTH: SEPTEMBER 1977

CAUSATION NO	DESCRIPTION	FATAL	SERIOUS	SLIGHT	DAMAGE	DOGS	TOTAL
79	UNATTENDED VEHICLE RUNNING AWAY	0 (0)	0 (0)	0 (0)	0 (3)	0 (0)	0 (3)
80	DRIVERS VIEW OBSTRUCTED BY LOAD	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
81	VEHICLE OVERLOADED OR SHIFTED	0 (0)	1 (1)	2 (2)	0 (1)	0 (0)	3 (4)
82	OTHER FEATURE OF VEHICLE OR EQUIP.	0 (0)	0 (2)	2 (3)	0 (0)	0 (0)	2 (5)
83	RAIL TRACK IN BAD REPAIR	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
84	WHEEL IN TRAM OR RAIL TRACK	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
85	POT HOLE IN ROAD	0 (0)	0 (0)	0 (2)	0 (1)	0 (0)	0 (3)
86	DEFECTIVE MANHOLE COVER	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
87	OTHER ROAD SURFACE CONDITION	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
88	ROAD WORKS IN PROGRESS	0 (0)	0 (0)	0 (1)	0 (0)	0 (0)	0 (1)
89	VIEW OBSTRUCTED BY LAYOUT OF ROAD	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
90	SLIPPERY ROAD SURFACE-NOT WEATHER	0 (0)	1 (0)	8 (1)	0 (0)	0 (0)	9 (1)
91	OTHER ROAD CONDITION	0 (0)	3 (7)	13 (33)	0 (1)	0 (0)	16 (41)

Figure 13. (Cont)

WEST MIDLANDS

TRAFFIC ACCIDENT ANALYSIS

CAUSATION BY ACCIDENT CLASS

MONTH: SEPTEMBER 1977

CAUSATION NO	DESCRIPTION	FATAL	SERIOUS	SLIGHT	DAMAGE	DOGS	TOTAL
92	FOG OR MIST	0 (0)	0 (2)	0 (0)	0 (0)	0 (0)	0 (2)
93	ICE,FROST OR SNOW	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
94	STRONG WIND	0 (0)	1 (0)	1 (1)	0 (0)	0 (0)	2 (1)
95	HEAVY RAIN	0 (0)	0 (2)	0 (4)	0 (1)	0 (0)	0 (7)
96	GLARING SUN	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
97	OTHER FACTORS	0 (0)	1 (0)	2 (0)	0 (1)	0 (0)	3 (1)
98	NOT TRACED	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	1 (0)
99	ACCIDENTS WITH NO CAUSATION NO.	0 (0)	0 (0)	0 (0)	1 (1409)	0 (236)	1 (1645)

NB. COMPARISON FIGURES FOR THE SAME MONTH OF THE PREVIOUS YEAR ARE ENCLOSED IN ( )

3.7 Flow File

When the idea of having a traffic accident computer system was first considered by the City of Birmingham Highways Division it was felt that, for the system to effectively highlight the City's blackspots, the accidents at each location would have to be related to the corresponding traffic flows. In consequence of this it was decided to create a separate Flow File which would be run in conjunction with the Main Accident File when accident rates were required. The Flow File contained details of manual counts carried out at each network junction and some additional junctions. At the time that the flow file was introduced it was taking approximately 3 years to carry out counts at all of the junctions.

When the accident system was expanded to cover the whole of the West Midlands County, it was decided that, because there were insufficient resources to carry out the number of counts required to cover the now increased number of network junctions in a reasonable length of time, the facility to produce accident rates based on traffic flows would have to be discontinued - for the time being, anyway.

However the Flow File is described here to demonstrate how the system was intended to operate. The processing of the accident data, both with and without traffic flow, to identify accident blackspots is described later.

3.7.1 Traffic Counts

The Flow File is made up from manual counts taken at the network junctions. The counting is carried out by a team of counters as follows:-

> One counter stands on one arm of the junction and he is concerned only with traffic entering the junction on this one arm. He counts the traffic by type of vehicle and by which direction they leave the junction. The counts are usually taken over a $10\frac{1}{2}$ hour period, from 8.00 a.m. to 18.30 p.m., on one day.
>
> On completion of the count the counter fills in a 'Manual Traffic and Pedestrian Count Summary' sheet, Figure 14. Firstly the reference number of the junction is entered, followed by the day of the week and the date. The counter then enters the reference number of the first network junction along the arm on which he was counting. In the "DIRECTION TOWARDS" fields the reference numbers are entered of the junctions along the arms towards which the traffic leaves the junction. Finally the counts for each hour are entered. Thus one sheet is

TIME		TOTAL TRAFFIC	LEFT TURNING						STRAIGHT ON						RIGHT TURNING						PEDESTRIANS		
FROM	TO		MOTOR CYCLES	CARS & LIGHT VANS	30 cwt TO 3 tons	3 tons AND OVER	BUSES	TOTALS	MOTOR CYCLES	CARS & LIGHT VANS	30 cwt TO 3 tons	3 tons AND OVER	BUSES	TOTALS	MOTOR CYCLES	CARS & LIGHT VANS	30 cwt TO 3 tons	3 tons AND OVER	BUSES	TOTALS	ADULTS	CHILD-REN	TOTA
7·00	7·30																						
7·30	8·00																						
8·00	8·30																						
8·30	9·00																						
9·00	9·30																						
9·30	10·00																						
10·00	10·30																						
10·30	11·00																						
11·00	11·30																						
11·30	12·00																						
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15·30	16·00																						
16·00	16·30																						
16·30	17·00																						
17·00	17·30																						
17·30	18·00																						
18·00	18·30																						
18·30	19·00																						
TOTALS								₦						₦						₦			

produced for each arm of the junction and these are input together.

If there are only three arms to the junction, or there is a 'NO RIGHT TURN' or one-way system which eliminates one turning movement then only the relevant turning movements are completed. In the case of more than four arms to the junction a second sheet is used to accommodate the "DIRECTION TOWARDS" for the other arms.

3.7.2 The 'Standard Hour' Flow

The new counts are run through Program TA06 which checks the data and writes error messages. TA06 also converts the flows into standard hour, peak a.m., and peak p.m. flows and writes them to the Flow File. The flow conversion is as follows:- the total of the $10\frac{1}{2}$ hours count is converted to an average hour by multiplying by the factor $\frac{1.52}{24}$; the peak a.m. flow is taken as the total flow between 8.00 a.m. and 9.00 a.m.; the peak p.m. flow is taken as the total flow between 5.00 p.m. and 6.00 p.m. These three flows are converted to the standard hour, standard peak a.m., and standard peak p.m. flows for a standard day of a standard month by multiplying by the DAY FACTOR, which is dependent on the day of the week of the count, and the MONTH FACTOR, which is dependent on the month of the count.

The factor $\frac{1.52}{24}$, the DAY FACTORS, and the MONTH FACTORS were determined from a study carried out in 1966-68. Three sites were selected and traffic flows were counted at the sites for a twelve month period in order to observe the seasonal variations. The DAY and MONTH FACTORS so determined are:-

DAY FACTORS

DAY	FACTOR
MONDAY	1.017
TUESDAY	1.026
WEDNESDAY	1.007
THURSDAY	0.990
FRIDAY	0.962
SATURDAY	-
SUNDAY	-

MONTH FACTORS

MONTH	FACTOR
JANUARY	1.034
FEBRUARY	1.006
MARCH	0.991
APRIL	1.005
MAY	0.964
JUNE	0.978
JULY	1.011
AUGUST	1.075

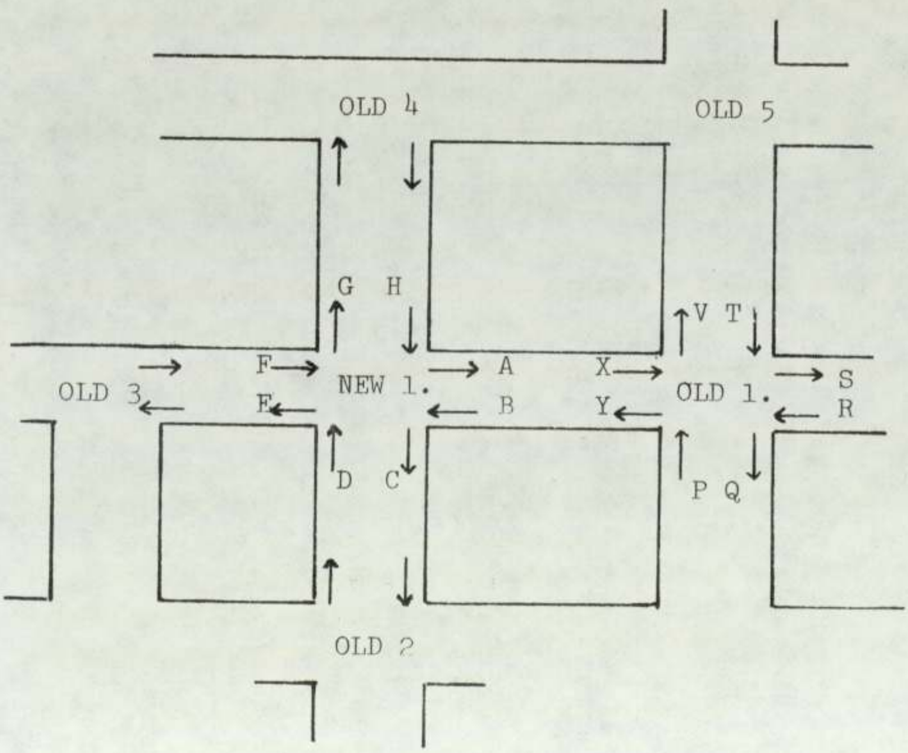
SEPTEMBER	1.015
OCTOBER	0.974
NOVEMBER	0.979
DECEMBER	0.978

There appears to be an error in the DAY FACTORS, although there is insufficient available documentation on the original preparation of these factors to ascertain whether the error was intentional or not. The sum of the DAY FACTORS for Monday to Friday is 5.002 i.e. Saturdays and Sundays are not taken into account. Later in the process the annual flows are produced by multiplying the standard hour by 24 x 365: in so doing it is implying that the flows on Saturdays and on Sundays are equal to the arithmetic mean of the flows on Monday, Tuesday, Wednesday, Thursday and Friday, and this, it was found during the course of the experimental work (see Chapter 6), was not the case. Traffic flows on Sundays were often less than one half of the corresponding average week-day flows.

3.7.3 Balancing the Flows

Each quarter, once all of the errors have been dealt with, the new counts are balanced with those already on the Flow File by Program TA08. When a new count at a junction is entered onto the Flow File it is almost certain that the flows in and out of each of the arms of the junction will be out of balance with the old flows in and out of the other end of the arm at the adjacent junction. Hence a balancing procedure is required. Rather than attempting to balance the whole of the network a simplified balancing procedure has been adopted in which the balancing is limited to the immediately adjacent links and junctions. The procedure is as follows:-

> Consider junction NEW1, see diagram below, at which a new count has been taken. The first stage of the balancing procedure is to check the balance of the links between NEW1 and the adjacent junctions, OLD 1, OLD 2, OLD 3, and OLD 4.



Consider the link NEW 1 - OLD 1. A and B are the standard-hour-out and standard-hour-in respectively for NEW 1 and Y and X are the corresponding flows for OLD 1. The imbalance, I, if one exists, on the link is

$$I = (A + B) - (X + Y)$$

If $|I| \leqslant 5\% (X + Y)$ then the link is considered to be sufficiently in balance and no alteration is made to the flows.

If $|I| > 5\% (X + Y)$ then the imbalance is distributed proportionately between the flows

i.e. A becomes $A' = A - \left(\frac{A}{A+B+X+Y}\right) I$

B becomes $B' = B - \left(\frac{B}{A+B+X+Y}\right) I$

X becomes $X' = X + \left(\frac{X}{A+B+X+Y}\right) I$

Y becomes $Y' = Y + \left(\frac{Y}{A+B+X+Y}\right) I$

where A', B', X', Y', are to the nearest whole number.

This procedure is repeated for each of the links. If no balancing is required on any of the links then nothing else need be done. If any of the links had to be balanced i.e. the flows altered, then the effect on the junctions must be considered.

Consider firstly junction NEW 1. Any imbalance J, on the junction is

$$J = (B' + D' + F' + H') - (A' + C' + E' + G')$$

If $|J| \leqslant 5\% (B + D + F + H)$, - these are the original flows into the junction, then the junction is sufficiently balanced and no changes are made to A', B', etc.

If $|J| > 5\% (B + D + F + H)$ then the junction is considered to be unbalanced and is balanced by setting

$$A'' = A' + \left(\frac{A'}{B'+D'+F'+H'+A'+C'+E'+G'}\right) J$$

and similarly for C", E", and G",

and $$B'' = B' - \left(\frac{B'}{B'+D'+F'+H'+A'+C'+E'+G'}\right) J$$

and similarly for D", F", and H".

Next the adjacent junctions must be considered. Consider junction OLD 1. The imbalance, L, caused by the link balancing is

$$L = (X' + T + R + P) - (Y' + V + S + Q)$$

If $|L| \leqslant 5\% (X + T + R + P)$ the junction is considered to be sufficiently balanced.

If $|L| > 5\% (X + T + R + P)$ the junction is considered to be unbalanced and is balanced by setting

$$X'' = X' \left(\frac{X'}{X'+Y'}\right) L$$

and $$Y'' = Y' \left(\frac{Y'}{X'+Y'}\right) L$$

X and Y are the only flows to be altered at the junction since the alteration of any of the other flows would mean the links on the other arms of the junction may be affected.

This procedure is repeated for OLD 2, OLD 3, and OLD 4.

If all the junctions NEW 1, OLD 1 - 4, were balanced without any need for adjustment then the system is balanced. If any of the junctions had to be balanced by adjustment of flows then the links must be re-examined and the procedure starts again. If the system is not balanced after the procedure has been repeated 5 times in all then the latest values are retained and the state of imbalance reported.

3.8 Monthly Procedure (cont.)

The old, new, and balanced flows are printed by Program TA09 which also pulls off the newly balanced flows from the Flow File along with their locations and in the form maintained on the Master Accident File. The new 'junction flow' is taken as the sum of all the new flows into the junction. The new 'link flow' is taken as the average of the sum of the flows in and out of each junction on either end of the link; the flow for each link is given the location of the junction as the lower kilometreage end of that link.

Program TA10 sorts these flows by location so that they are in the same sequence as the Master Accident File.

3.9 Quarterly Procedure

The system is now ready to produce the blackspot output, which is done by Program TA11 at 3-monthly intervals. Before this is described, however, the reasoning behind the selection of the original ranking criteria is outlined below.

3.10 "Examination of Priority Weighting for Accidents"

A short internal paper with the above title was prepared at the time the system was developed (November 1971). It is reproduced here in full:

"When examining accident statistics it is necessary to establish a priority weighting for determining which accidents should be dealt with first. The priority weighting can be used to establish an action list for treatment according to the severity of accidents at particular road junctions or stretches of road. The priority type chosen could be one of the following:-

1) Priority by number of child accidents occurring.
2) Priority by number of old person accidents occurring.
3) Priority by number of total pedestrian accidents occurring.
4) Priority by number of total accidents occurring (including damage only).
5) Priority by number of total injury accidents.
6) Priority by number of fatalities.
7) Priority by total cost of accidents.
8) Any one of alternatives 1 - 7 weighted by the number of vehicles passing through.

1) In order to establish an overall pattern for priorities, however, it is necessary to use a weighting system which considers the community as a whole and not an isolated sector. Thus whilst it might be politic to consider isolated classes, these can be selected out as required. For overall comparitive purposes throughout the City a common base must be used.

2) The common base used by the Road Research Laboratory is an economic one. They have costed out the various facets of road accidents, i.e. police and ambulance costs, damage to road and vehicles, loss of productive life of injured, loss to community of a death, etc. and on this basis the current costs are as follows:-

FATAL INJURY	£19,000
SERIOUS INJURY	£ 1,400
MINOR INJURY	£ 250
DAMAGE ONLY	£ 100
AVERAGE	£ 1,600

There are several anomalies to this approach however, for instance the community benefits when an old age pensioner is killed because it does not have to continue to pay his pension and his future productive life or economic contribution would have normally been zero because he no longer works. By the same token it costs the community more when a graduate is killed than when a school child is killed because more money has been invested in the graduate's education than on the school child, who is very unlikely to become a graduate in any case (about 10% probability). Thus concern with child injuries is based on emotion rather than logic (which is not to say necessarily that it is wrong to use an emotion based weighting, but it colours subjective assessment).

3) A further disadvantage of the economic method is that it can produce very distorted results due to the disproportionately large contribution made by one fatal accident. For instance an isolated chance accident due, say, to a drunk

falling off the pavement, getting hit and killed would have the same weighting as about 13 serious accidents occurring at a bad junction in one year.

4) The inclusion of "damage only" accidents into any system will produce large errors because it is not mandatory to report them and hence an unknown number occur.

5) It, therefore, seems reasonable to use as a basis all injury accidents, including fatalities, as the number occurring at each site. The Birmingham system uses this as a basis. In order to compare lightly trafficked routes with heavily trafficked routes a flow weighted system is used whereby the accident rate for a route section is calculated as:

$$\frac{\text{accidents/unit time}}{\text{number of vehicle per unit time x miles travelled on section}}$$

For junctions, this is modified to:

$$\frac{\text{accidents per unit time}}{\text{total traffic flow entering junction (major road flow + minor road flow)}}$$

Information on traffic flows is held on computer file and updated by HTD.

6) The normal system uses a "black spot" listing whereby the worst 100 junctions and 100 road stretches calculated by the above method are listed in descending severity order for both injury accidents and damage only accidents. In

this way it is possible to establish immediate priorities.

7) Should investigations of specific accident categories be required it will be possible to make special interrogations of the computer held files. Once on-line interrogation is possible with the next City computer this information will be available at short notice."

3.11 Quarterly Procedure (Continued)

The process of producing the blackspot output is now described, firstly when traffic flows are used, and secondly when traffic flows are not used - the latter being the current situation.

3.11.1 Blackspot Output - With Traffic Flows

TA11 firstly reads sequentially through the Master Accident File updating with the new flows where necessary and at the same time calculating an accident rate for each non-network cell, network junction, and 0.1 km stretch of network road:

(a) cells - the accident rate for each mutually exclusive 0.2 x 0.2 km cell is simply the number of injury accidents, excluding any network accidents, that have occurred in the cell in the previous 12 months.

(b) network junctions - the accident rate at a network junction is the number of injury accidents that have occurred at the junction in the previous 12 months multiplied by 10^6 and divided by the product of the standard hour junction flow, 24 and 365 i.e. the number of injury accidents per million vehicles entering the junction.

(c) network stretches - the accident rate for each mutually exclusive 0.1 km stretch of network road, excluding network junctions, is the number of injury accidents that have occurred on the stretch in the previous 12 months multiplied by 10^6 and divided by the product of the standard hour link flow, 10, 24, and 365, i.e. the number of injury accidents per million vehicle - kilometres. Where the stretch length is less than 0.1 km, as may occur with the last stretch on a link, an extra factor is included in the divisor to compensate.

Each time an accident rate is calculated it is compared with a table of the top 100 accident rates of its kind and if it is greater than the 100th rate it is slotted into the table in its appropriate position. There are three "top 100" table types - one for cells, one for network junctions, and one for 0.1 km network stretches.

When the complete file has been read and the final "top 100" tables determined, detailed statistics about the blackspots are compiled and the details are printed by Program TA12. In addition, for each table type, a blackspot is printed using the number of child pedestrian accidents in the preceding 12 months as the accident rate.

3.11.2 Blackspot Output - Without Traffic Flows

The process by which the blackspot output is produced when traffic flows are not available is almost the same as the process when traffic flows are available. The accident rate for cells is the same in both cases. The differences are:-

(a) network junctions - the accident rate at a network junction is simply the number of injury accidents that have occurred at the junction in the previous 12 months.

(b) network stretches - the accident rate for each mutually exclusive 0.1 km stretch of network road is the number of injury accidents that have occurred on the stretch in the previous 12 months.

The statistical details still appear in the output and the child pedestrian blackspot listings are still produced.

3.11.3 Blackspot Tables

Figures 15, 16, and 17 contain examples of the blackspot output.

Figure 15: Top 100 Blackspots - Network Junctions (page 1

The details shown for each of the top 100 junctions are as follows:-

(a) The road name of the major network road on which the junction is situated e.g. COTTERILLS LANE

(b) The kilometreage measurement along that road at the start of the junction e.g. 0.63

(c) The junction number

(d) The junction type, where the codes are as follows:-

1 = roundabout

2 = 'T' or staggered junction

3 = 'Y' junction

4 = Crossroads

5 = Multiple junction

6 = Other junction

(e) The junction control, where the codes are as follows:-

1 = Authorized person controlling traffic

2 = Automatic traffic signals

3 = Stop sign

4 = "Give Way" sign or marking

5 = Uncontrolled

(f) Any pedestrian crossing numbers which occur at the junction concerned

(g) The numbers of accidents concerned - Fatal and Injury on the first line and major damage on the second. Total casualties and accidents on the top line only for injury accidents.

(h) The accident rates - on the top line the accident rate for injury accidents only (this is the rate on which the order in the top 100 is based). On the second line the accident rate for major damage accidents only is just included for information. In this example the output was produced without traffic flows and the value under accident rate is simply the number of accidents divided by 100.

(i) A significant collision type - if among the injury accidents one specific collision type occurs more frequently than any other then it is printed here.

(j) A significant causation number - as for collision types above.

(k) The percentage of injury accidents at the junction involving stationary vehicles.

(l) The percentage of injury accidents at the junction in which at least one of the vehicles was reported to have skidded on a dry road surface.

(m) The percentage of injury accidents at the junction in which at least one of the vehicles was reported to have skidded on a wet road surface.

(n) The percentage of injury accidents at the junction with at least one of the casualties being aged less than 16.

(o) The percentage of injury accidents at the junction with at least one of the casualties being a pedestrian.

(p) The percentage of injury accidents at the junction occurring in the dark.

(q) The end column of the printout is used to show movements up and down the top 100 table and this is achieved by using + signs to indicate a rise and - signs to indicate a fall (more symbols indicate a greater rise or fall).

<u>Figure 16</u>: Top 100 Blackspots - Network Stretches (page 1)
This table is almost the same as the one for network junctions - the differences are

(a) The road number of the network road on which the stretch occurs.

(b) the kilometreage bounds of the stretch are given.

						CON NOS	MAJOR		DAMAGE	CAS	ACC	ACC RATE	COLL TYPE	SIG CAUS	VEH ACCS	%DRY SKID ACCS	%WET SKID ACCS	% CHILD ACCS	% PED ACCS	% DARK ACCS
1	COTTERILLS LANE	0.63	1	4	5	403 433	0	1	6	6	6	0.06 0.01	10				33			16 *
2	BRISTOL ROADETC	2.64	4	4	2		0	7	5	9	5	0.05 0.07	19					20		60 *
3	COVENTRY ROAD	3.30	6	2	4	420	0	0	4	4	4	0.04	P2				25	25	100	50 *
4	COVENTRY ROAD	7.24	9	4	2		0	4	4	4	4	0.04 0.04						50	25	*
5	INNER RING ROAD	1.08	3	5	5		0	2	4	4	4	0.04 0.02					25			**
6	WARWICK ROAD	0.30	1	4	4	0	0	5	4	4	4	0.04 0.05				25		25	25	25 **
7	WARWICK ROAD	5.91	10	2	4	867	0	2	4	5	4	0.04 0.02	P2						50	50 **
8	KINGSTANDING RD	1.28	1	4	2	217 230	0	4	4	5	4	0.04 0.04						50	25	***
9	KENLWRTH BY-PSS	5.65	10	1	4	M47	0	3	3	3	3	0.03 0.03					66			66 **
10	PERSHORE RD ETC	2.56	5	4	2		0	1	3	3	3	0.03 0.01					66		33	*
11	PERSHORE RD ETC	7.48	12	5	4	635 640	0	4	3	4	3	0.03 0.04	P2						66	33 *
12	HAGLEY R/MNR WY	1.10	1	2	4		0	11	3	4	3	0.03 0.11	R6			33		33		33 *
13	GRANGE ROAD	18.74	37	4	2		0	2	3	4	3	0.03 0.02						66		*
14	HGH ST WSTN ETC	26.65	47	2	4		0	0	3	4	3	0.03								66 *
15	SPON LANE ETC	1.53	3	4	2		0	2	3	3	3	0.03 0.02	P2						66	33 *

Figure 15.

	ROAD NAME	ROAD NO	KMEAGE	PED CROSS NOS	FATAL	MAJOR	INJURY	TOTAL CAS	ACC (DAMAGE)	ACC RATE	SIG COLL TYPE	SIG CAUS	%STAT VEH ACCS	%DRY SKID ACCS	%WET SKID ACCS	% CHILD ACCS	% PED ACCS	% DARK ACCS
1	CORPORATION ST	B4434	1.35- 1.50	M05 M5	0	6	10	15	10	0.10 0.06				10	10	10	40	30 *
2	KENLWRTH BY-PSS	A0046	4.60- 4.70	M46	0	2	9	10	9	0.09 0.02	X2				22	33	55	33
3	PERSHORE RD ETC	A0441	10.90-11.00		0	3	9	13	9	0.09 0.03	P0					33	11	44 *
4	WOLVERHAMPTON R	A4123	11.36-11.50		0	6	9	17	9	0.09 0.06	X6		11			22	11	33
5	BRISTOL ROADETC	A5038	8.66- 8.80	0	0	10	9	12	9	0.09 0.10	X2			33			44	44
6	BRISTOL ROADETC	A5038	10.50-10.60	607	1	6	8	9	9	0.09 0.06					11	11	11	44
7	BRISTOL ROADETC	A5038	11.08-11.20	605	0	8	9	13	9	0.09 0.08				11	11		22	66 **
8	COVENTRY ROAD	A0045	0.19- 0.30	1	0	13	8	11	8	0.08 0.13	P0				12	25	37	37 ***
9	COVENTRY ROAD	A0045	1.90- 2.00		0	7	8	10	8	0.08 0.07	X9					12	37	25
10	ALCESTER RD ETC	A0435	2.65- 2.80		0	7	8	12	8	0.08 0.07	09		12	12			37	25 *
11	COLLEGE ROADETC	A0453	3.04- 3.10		1	7	7	8	8	0.08 0.07	X2				25		75	37
12	GRANGE ROAD	A0459	18.74-18.80		0	7	8	12	8	0.03 0.07					12	12	12	50 ***
13	STRATFORD ROAD	A5034	5.65- 5.80	0 L06	0	4	8	9	8	0.08 0.04			25				75	25 *
14	COVENTRY ROAD	A0045	2.50- 2.60	423 417	0	7	7	8	7	0.07 0.07	X2					37	85	37
15	COVENTRY ROAD	A0045	5.35- 5.50		0	1	7	10	7	0.07 0.01	X7			14	14	28	16	28 ***

Figure 16

<u>Figure 17</u>: Top 100 Blackspots - Cells Excluding Network Accidents (page 1).

This table is similar to the other two tables but the accident rate, significant collision type, and significant causation columns are omitted. The other differences are

(a) The location is an 8 - figure grid reference of the bottom left-hand corner (South-West) of the 0.2 km square cell. The first four figures are the easting and the next four are the northing.

(b) The ROAD NUMBERS are the internal road numbers of the roads passing through the cell, on which at least one accident has occurred - up to 4 such roads can be given.

3.12 Six-Monthly Procedure

Every six months the Master Accident File is read and three histogram - style outputs are produced:-

(1) Injury Accidents - Histogram of Collisions
This histogram contains a 3 character indicator for each injury accident occurring on each network road in the preceding three years. The roads are shown in alphabetical road name order. For each road each 0.1 km stretch is listed with one stretch per line. If there are any junctions within a stretch and at least one accident has occurred at the junction then the junction number is also given against the appropriate

ACCIDENTS

	LOCATION REF	ROAD NUMBERS	PED CROSS NOS	FATAL	MAJOR DAMAGE	INJURY	TOTAL CAS	ACC	%STAT VEH ACCS	%DRY SKID ACCS	%WET SKID ACCS	% CHILD ACCS	% PED ACCS	% DARK ACCS
1	4122296003320	03321 07510 07618	313	0	11	16	26	16				6		43
2	4072285800203	00292 01772	55	0	3	11	23	11	9			18		54
3	4100285800517	00518 02607 02714		0	7	10	16	10		10		70	70	30
4	4132287600173	00970		1	2	7	9	8			12	62	62	50
5	3946290200900	12700 36110		0	1	7	15	7		14		28	57	42
6	4070286400816	00865 01352 01406		0	6	7	7	7		14			42	28
7	4096280200708	01328 01348 02244		0	7	7	8	7				42	28	42
8	3956301405072	05123		0	1	6	10	6				33		50
9	4060295602148	02151 23230	H04	0	1	6	7	6		16		33	33	16
10	4076286200334	00371 00528 01472	66	0	7	6	7	6					50	83
11	4080285800334	00380 00528 01909	10	0	11	6	10	6	16			16		83
12	4150284200554	00735 04037 04307		0	3	6	7	6	16					83
13	3902299400383	00384 00767 01082		0	4	5	7	5		20	20	20	20	40
14	4044290000024	00387		0	1	5	5	5				80	100	20
15	4072286400816	00865 01506 01507		0	3	5	5	5				20	80	40

stretch or stretches. An example of this output is contained in Figure 18.

The histogram line for any particular stretch starts with a / in the first character position. Thereafter a / marks the end of one year and the beginning of the next. In between the /'s every accident in the appropriate year is indicated by 3 characters. The first 2 characters are the collision type allocated to the accident on input to the system. The third character is used for the following symbols:-

* - if the accident was fatal

- - if the accident was serious

D - if the accident involved a dry skid

W - if the accident involved a wet skid

If none of these apply the third character is a space. If more than one of these applies then only one is printed and that is the one highest up on the list.

(2) Damage Accidents - Histogram of Collisions

This is the same as the output of injury accidents except that in some cases there is no collision type entered on the accident record. For these accidents the code DA is used to indicate a damage accident of some sort.

KMEAGE	JUNCTIONS	COLLISION TYPES
0.0- 0.1		////
0.1- 0.2		////
0.2- 0.3		///R2 R3 /
0.3- 0.4		/H9-/P0 P2 /R1W 6W 0 /
0.4- 0.5		/C6-/H9 P0- 1-/ 6 11 /
0.5- 0.6	2	/P2-///
0.6- 0.7		/P0-P2-//H9 P2-P4-/
0.7- 0.8		/P0-//S6 /
0.8- 0.9		//X2 /P1-/
0.9- 1.0		/ 6-//P9 /
1.0- 1.1		/P0-P1 /P1-C6* 7 / 6WP0-/
1.1- 1.2	3	/11 15-29 29 20-P2 11WP2- 2W/ 2W 2 7 10W21- 2-26 /P6W19-29-11W29-26 26 11 /
1.2- 1.3		/P0 P0 /P2 /P0 0 21 /
1.3- 1.4		/ 6 /11W/ 1-/
1.4- 1.5		///P2 C6 /
1.5- 1.6		////
1.6- 1.7		//P0-P1 //
1.7- 1.8		/11- 7 /11 /P0*28 26 28 P0-/
1.8- 1.9		// 7-12 //
1.9- 2.0		/ 0 C6-//22 12-/
2.0- 2.1		//16 //
2.1- 2.2		/17 0 ///
2.2- 2.3		/P2 P0 /P2 P2 0 /P0-/
2.3- 2.4		/P0-/F6-P1-19-/ 7 /
2.4- 2.5		///F6 /
2.5- 2.6		///C6-P0 /
2.6- 2.7	4	/P2 19 19-15- 2 15 19-19 P2 15 /11 2 96 15 15 /29 19 11-26- 1 26 11 15-/
2.7- 2.8		//22W/X2 /
2.8- 2.9		/ 1*///
2.9- 3.0		//F6- 7 / 2 0 /
3.0- 3.1	5	/P2 P2-20-/11-H9 26*18- 7-26 20 /28-/
3.1- 3.2		////
3.2- 3.3		//F6-//
3.3- 3.4		////
3.4- 3.5		////
3.5- 3.6		//C6 //
3.6- 3.7		/18 22 /P2*C6-//
3.7- 3.8		///F6-/
3.8- 3.9		////
3.9- 4.0		//11 //
4.0- 4.1	6	/P2 P2-17 11 /15 P2 26 17*P1 19 7 /P2-P2 /
4.1- 4.2		/ 2- 7 //C6 26*/
4.2- 4.3		/P5W24 P2 6 28- 7 28- 6 / 7 22 46 7 28 P2W/16 20 16 /
4.3- 4.4		///D6-P2 /
4.4- 4.5		/22 P0 /21 /P2-/

Figure 18.

(3) Child Pedestrian Accidents - Histogram of Collisions

This is the same as the output for injury accidents described in (1) above except that the accidents for which a collision type is printed are only those in which there was a child pedestrian casualty (a casualty under the age of 16).

In addition to the three histograms described above, an accident summary for each link and junction on the network roads is produced. These are described below.

(4) Accidents on Links

This output contains a summary for each link (length of road between two adjacent junctions) on each network road. The roads are in the same order as for the histograms i.e. alphabetical. The links within a road are detailed in sequence along the road starting at the zero kilometreage point. An example of this is contained in Figure 19.

For each link the names of the junction at the start and end of the link are given followed by the start and end kilometreages, given to the nearest 10 metres.

The following details about the accidents are then given:-

(a) the total number of casualties involved in the injury accidents on the stretch of road concerned.

(b) the total number of injury accidents.

(c) the accident rate based on injury accidents.

(d) the percentage of injury accidents which were either fatal or serious.

(e) the fatal and serious accident rate - this is similar to the accident rate but is based only on the fatal and serious accidents.

(f) the percentage of injury accidents which involved at least one pedestrian casualty.

(g) the pedestrian accident rate - as (c) above but using only pedestrian accidents.

(h) the percentage of injury accidents in which at least one of the vehicles involved was recorded as skidding on a wet road surface.

(i) the ratio of the number of dark accidents to daylight accidents (injury accidents only).

There are a further 4 details which relate only to the damage only accidents, but which are absent if their values are zero. These are:-

(j) the number of damage-only accidents.

(k) the accident rate based on damage-only accidents.

(l) the percentage of damage-only accidents in which at least one of the vehicles involved was recorded as skidding on a wet road surface.

(m) the ratio of the number of dark accidents to daylight accidents (damage-only accidents).

(5) Accidents at Junctions

This output contains a summary for each numbered junction on the network roads. The roads are in alphabetical order as for the other outputs. The junctions within a road are shown in kilometreage sequence. An example of the output is contained in Figure 20.

For each junction the junction name within the road is given and its kilometreage along the road. Additionally the junction traffic flow is given, when available, which is used to calculate the accident rate - the unit of flow is the

LINK		KMEAGES	NO CAS	NO ACC	ACC RATE	% FATAL SER	F&S RATE	% PED ACC	PED ACC RATE	% WET SKID	DARK /DAY	DAMAGE NO ACC	DAMAGE ACC RATE	DAMAGE % WET SKID	DAMAGE DARK /DAY
BESCOT ROAD	HILLARY STREET	0.00- 0.11	0	0	0.00							2	1.83		99.99
HILLARY STREET	WESTON STREET	0.11- 1.52	23	15	0.61	20	0.12	40	0.24	7	0.67	32	1.29	3	0.35
WESTON STREET	DELVES GREEN RD	1.52- 2.23	6	3	0.25	100	0.25				2.00	2	0.17		
DELVES GREEN RD	BIRMINGHAM ROAD	2.23- 3.01	7	6	0.45	50	0.23	17	0.08	17	0.50	6	0.45		0.67
BIRMINGHAM ROAD	SUTTON ROAD	3.01- 3.60	3	3	0.31						2.00	4	0.41		1.00
SUTTON ROAD	LICHFIELD ROAD	3.60- 5.34	24	18	0.59	16	0.09	6	0.04	6	0.38	22	0.72	5	0.44
LICHFIELD ROAD	HATHERTON ST	5.34- 5.61	3	3	0.75			33	0.25		0.50	6	1.50		0.67
HATHERTON ST	STAFFORD STREET	5.61- 5.99	5	4	0.67			25	0.17			4	0.67		0.33
GREEN LANE	WOLVERHAMPTN ST	6.19- 6.52	6	5	0.98			60	0.59	20	0.25	4	0.79		
WOLVERHAMPTN RD	BRIDGEMAN ST	6.60- 6.87	3	3	0.75	33	0.25	33	0.25		0.50	8	2.00	13	0.25
BRIDGEMAN ST	IDA ROAD	6.87- 7.29	7	7	1.04	57	0.59	43	0.45	14	0.75	7	1.04		0.67
IDA ROAD	WEDNESBURY ROAD	7.29- 8.16	17	13	0.87	23	0.20	31	0.27		0.44	12	0.80		0.20
WEDNESBURY ROAD		8.16- 0.00	1	1	0.00	100		100			99.99	0	0.00		

Figure 19.

number of vehicles entering the junction in one standard hour.

The rest of the details of the injury and damage accidents are just the same as the details (a) to (m) in the links output described above.

3.13 Annual Procedure

At the end of the calendar year, in addition to other outputs, a further 12 top 100 black-spot tables are created and output. There are 4 tables each for network junctions, network stretches, and non-network cells. The tables are formed on the following 4 bases:-

(i) using the number of damage-only accidents over the past year.

(ii) using the number of injury accidents over the past 3 years.

(iii) using the number of damage-only accidents over the past 3 years.

(iv) using the number of child pedestrian accidents over the past 3 years.

3.14 Interrogation System

The disc-stored Master Accident File can be interrogated either on line, using a Termi-printer

JUNCTION	KMEAGE	JUNCTION FLOW	INJURY NO CAS	NO ACC	ACC RATE	% FATAL SER	F&S RATE	% PED ACC	PED ACC RATE	% WET SKID	DARK /DAY	DAMAGE NO ACC	ACC RATE	% WET SKID	DARK /DAY
BESCOT ROAD	0.00	1019	0	0	0.00	0		0		0		1	0.04	0	99.99
WESTON STREET	1.52	1019	2	2	0.07	0		50	0.04	0	1.00	1	0.04	0	99.99
BIRMINGHAM ROAD	3.01	1019	4	1	0.04	100	0.04	0		0	99.99	0	0.00	0	
SUTTON ROAD	3.60	1019	1	1	0.04	100	0.04	100	0.04	0		2	0.07	0	
LICHFIELD ROAD	5.34	1019	1	1	0.04	0		0		0		2	0.07	0	
HATHERTON ST	5.61	1019	2	2	0.07	0		0		0	1.00	4	0.15	25	99.99
STAFFORD STREET	5.99	1019	1	1	0.04	100	0.04	100	0.04	0		1	0.04	0	99.99
GREEN LANE	6.19	1019	2	2	0.07	0		0		0		3	0.11	0	
WOLVERHAMPTN RD	6.60	1019	0	0	0.00	0		0		0		2	0.07	0	
BRIDGEMAN ST	6.87	1019	0	0	0.00	0		0		0		1	0.04	100	
IDA ROAD	7.29	1019	5	5	0.19	20	0.04	20	0.04	0	0.67	0	0.00	0	

Figure 20.

or visual display unit, V.D.U., or in background using software developed for the accident system. This was a staged development in the creation of the accident system, interrogation originally being carried out using F.I.N.D. (File Interrogation of Nineteen-Hundred Data) which is a standard I.C.L. package, but which was found not to be sufficiently flexible or responsive for the work it was required to do.

The purpose of the interrogation system is to enable the Police and the County Surveyors Department to make more use of the information stored in the Master Accident File. There are two bases on which accident details can be requested:-

(a) details of accidents occurring at a specified location(s) - the location being expressed as a road number and kilometreage (for network roads) or road number and grid reference (for non-network roads).

(b) details of accidents occurring at or between specified dates.

In the former case only, additional specifications can be imposed if required e.g. only fatal injury accidents, or accidents in which skidding was reported.

Up to a maximum of 14 fields (particular details of an accident) can be specified along with the individual or range of values that each field is to take. Any of the details recorded for each accident can be used.

The details of the accidents satisfying the enquiry conditions can be reported in one of six forms:-

(i) a one line English summary, for each accident, containing the following information:-
- Police Division where accident occurred
- Date of accident
- Time of accident
- Location of accident : road number and kilometreage (for network roads) or road number and grid reference (for non-network roads)
- Number of casualties
- Number of vehicles involved
- Classification of accident (Fatal, serious, etc.)
- Accident reference number.

(ii) an expanded English summary for each accident. This contains more information than the one line summary.

(iii) a detailed summary of each accident in a coded format. This contains all of the information recorded about each accident.

(iv) an analysis of the accidents satisfying the enquiry conditions. The analyses contained in this output have been pre-determined and cannot be added to or reduced. Figure 21 contains an example of the output which is self explanatory except for the columns headed

SIGNIFICANT

CAUSN COLL

Under each of these headings a particular causation or collision code will appear if a particular causation or collision type is found to occur in significantly more accidents than any other.

(v) a one-line summary of each accident containing particular details of the accident, with the fields specified by the user. Only a limited number of fields can be specified.

(vi) a tabular presentation containing the number of accidents satisfying two conditions specified by the user. An example of this is contained in Figure 22; the letters under DIVN are codes representing the Police Divisions;

WEST MIDLANDS METROPOLITAN COUNTY COUNCIL

TRAFFIC ACCIDENT ANALYSIS

ANALYSIS OF ACCIDENTS SATISFYING THE GIVEN CONDITIONS

ACCIDENT CLASS	ACCIDENTS	SIGNIFICANT CAUSN	COLL	%PED ACCS	%WSKID ACCS	%DSKID ACCS	%CHILD ACCS	%DARK ACCS	%CHILD PEDS
FATAL	0	00	00	0	0	0	0	0	0
SERIOUS	3	00	R1	0	0	0	0	33	0
SLIGHT	18	00	00	0	33	0	0	50	0
TOTAL INJURY	21	00	00	0	29	0	0	48	0
MAJOR DAMAGE	23								
MINOR DAMAGE	26								
DOGS	C								
GRAND TOTAL	70								

SUMMARY OF CASUALTIES INVOLVED IN THESE ACCIDENTS

FATAL 0 SERIOUS 5 SLIGHT 19

TRANSACTION 001 COMPLETED
****
PLEASE INPUT TRANSACTION CODE REF 002

TA020

ENTER ACTION CODES ACCIDENT NUMBERS

Figure 21.

ACCIDENT MATRIX

DIVN	ACCLASS 1	2	3
A	0	0	0
B	3	26	74
C	1	10	39
D	1	35	54
E	3	22	70
F	0	10	36
G	2	25	71
H	0	16	68
J	0	29	71
K	0	21	62
L	1	14	50
M	2	35	72
TOTAL	13	243	667

TRANSACTION 001 COMPLETED
****
PLEASE INPUT TRANSACTION CODE REF 002

Figure 22.

ACCLASS 1 is fatal accidents, ACCLASS 2 is serious accidents, and ACCLASS 3 is slight injury accidents.

More than one type of output can be requested for one set of enquiry conditions without repeating the enquiry.

This interrogation facility is used to provide accident details at sites under investigation, for answering day-to-day enquiries e.g. from councillors or the general public, and for compiling additional statistical information.

3.15 Conclusion

Chapter 2 finished with the conclusion that a technique is required which will produce a list of locations, for which schemes will be prepared. Locations should appear in the list as near as is possible in the same order in which they would have appeared had every location been investigated and a remedial scheme prepared, and the schemes ranked for implementation by the Highways Committee according to it's policy. This technique must make efficient use of available resources, and must be capable of being repeated at regular intervals.

Although such a procedure does not at present operate in the West Midlands County Council, it is reasonable to assume that the Blackspot outputs, as described in this Chapter, were intended to provide the list from which locations would be selected for further analysis, leading, where appropriate, to the preparation and implementation of remedial schemes. The following criticism is based on this assumption.

There are two ways in which the Blackspot Output fails to satisfy the 'specification' for a technique as described above.

3.15.1 1) Identification of Locations

The first requirement of a technique, which will fulfil the above specification, is to be able to identify all of the accident problem locations. The West Midlands County Council's system fails in this respect in that it presumes not only the maximum size that a problem location can take but also that the accident problem locations will fall neatly into pre-defined sections on network roads, and squares in non-network areas. It is not difficult to demonstrate that this is not the case.

i) Consider firstly the position of the accident problem locations, assuming that the location size is equal to or less than the pre-defined sections and squares. If such an accident problem location falls on a line separating one section, or cell, from another, it is quite likely that some of the accidents will be recorded as occurring in one section and the remainder in the other section. When the blackspot output is subsequently produced the sections will be considered separately despite the fact the accidents are part of the same problem. Furthermore, although the number of accidents at the problem location might be high enough to warrant a place in the blackspot listing, the number of accidents in the sections separately may be too low to produce an appearance in the blackspot listing. An example of this might be a pedestrian crossing, at which there is an accident problem, falling on a 100 metre boundary line on a network road and half of the accidents being coded as occurring in one section and half in the other section.

In non-network areas the situation could be even worse - if a problem location coincided with the corner of a non-network cell the accidents could be divided into four non-network cells.

ii) It is unlikely that accident problem locations will be precisely 100 metres long on network roads or 200 metres by 200 metres square in non-network areas - some will be smaller and some considerably larger. The following are examples of larger problem location problems:-

- a length or road where accidents are occurring at night over the full length of the road and where the solution would be improved streetlighting facilities.

- a length of road on which a number of pedestrian accidents are occurring as in a length of road bordered on both sides by shops

- a residential area in which a number of child pedestrian or child cyclist accidents are occurring where the focal point is the local school.

3.15.2 2) <u>Ranking of Locations</u>

Once the locations have been identified the 'technique' must rank them "in the order in which they would have appeared had every location been investigated and a remedial scheme prepared, and the schemes ranked for implementation by the Highways Committee according to its policy". A number of points can be made concerning the ranking technique employed in the West Midlands County Councils Traffic Accident Recording System when considered in conjunction with the precoding statement.

3.15.2.1 It has been stated that this Traffic Accident Recording System was originally developed for the City of Birmingham, and was subsequently adopted and expanded for the West Midlands County. The existing method of ranking came with the system and the question of whether or not it forms the best possible interpretation of the Highways Committee's policies has never been answered.

3.15.2.2 It has been found in practise that implementing a change in the criteria on which locations are to be ranked is not an easy process with this system. It entails alterations to a number of computer programs, and is not within the current capabilities of the persons involved in the day-to-day operation of the system. A change in the ranking criteria may be required if there is a change in the Highways Committee's policies. Such changes may be the result of number of events, e.g. a change in the Highways Committee membership after a local authority election; a change in central government policies; local public pressure; policy reviews.

3.15.2.3 With respect to the ranking criteria, it has been found that when the blackspot listings are formed from consideration of accident rates (section 3.11.1) the locations, almost certainly, are not ranked in the same order as the Highways Committee would have ranked them. Certain locations, included in the lists, were found to have very low numbers of accidents, albeit with very low traffic flows. The potential accident savings at these locations were considered to be too low to justify any remedial works being carried out. Indeed there were instances where it was not possible, with such a low number of accidents, to identify a specific problem for which a remedial scheme could be prepared.

3.15.2.4 It was stated earlier (section 3.7) that at present traffic flows are not used in the accident recording system. The decision to discontinue the incorporation of traffic flows was made because it was considered that there were insufficient resources to carry out, in a reasonable length of time, the number of counts required. No work has been instituted by the County Council to determine the value of traffic flow information in the identification and ranking of accident problem locations, and hence the importance that should be placed on its re-introduction.

3.15.3 The next Chapter contains a detailed examination of the requirements of a 'technique' and considers the practical constraints. In the light of this examination additional failings of the West Midlands County Council's existing system may be revealed.

CHAPTER 4

THE IDENTIFICATION AND RANKING OF ACCIDENT PROBLEM LOCATIONS FOR FURTHER INVESTIGATION

4.1 Introduction

It was concluded in Chapter 2 that a technique is required which will produce a list of locations for which schemes will be prepared. Locations should appear in this list as near as is possible in the same order in which they would have appeared had every location been investigated and a remedial scheme prepared, and the schemes ranked for implementation by the Highways Committee according to its policy. This technique must make efficient use of available resources, and must be capable of being repeated at regular intervals.

In this Chapter the above statement will be considered in two parts. Firstly, under the heading of Identification, the task of identifying accident problem locations will be discussed. Secondly, under the heading of Ranking, the remainder of the process will be discussed. The reasons that they are dealt with separately is because there is a fundamental difference in the way in which they should be considered. An identification process must be capable of identifying all accident problem locations. Hence it does not require any policy decision by the Highways Committee (other than to accept or reject the Council's Officers proposals for an identification process). As such it can be considered as a technical exercise with practical constraints. The ranking process, however, is or should be very much dependant upon policy decisions made by the Highways Committee, and care must be taken to avoid pre-empting those decisions.

4.2 Identification

Before accident problem locations can be ranked for attention, they must first be identified, and in order to guarantee total impartiality in the ranking process it is necessary that all accident problem locations be identified.

In order to be able to assess a technique's ability to identify all of the accident problem locations in the area to which it will be applied, it is firstly necessary to have a clear understanding of the term 'accident problem location', or 'accident blackspot'.

In Chapter 2 the reasoning behind this approach to traffic accident prevention was given as follows:-

> "When more than one traffic accident occurs at a location it is possible that some of the accidents will be, to some degree, similar. If the points of similarity can be identified then measures can be specifically designed to prevent those accidents which are subject to the points of similarity"

Based on the above reasoning an 'accident problem location', or 'blackspot', is a location at which there are accidents which are, to some extent, of a similar type and for which a single scheme could be prepared for their prevention; and the size of the location is such that all of the accidents that have happened or could happen which are of that similar type fall within its defining boundary.

The process of identifying problem locations is complicated, to some extent, by the fact that the recorded position of any individual accident is usually where a collision occurs or where a vehicle finally comes to rest. This can confuse matters in two respects:-

a) the position so recorded is not necessarily the postion of the actual problem
b) vehicles involved in different accidents caused by the same problem can come to rest in different places and hence be recorded as occurring in different positions

These two points can be demonstrated by the following example, which is reputed to have occurred in Yorkshire. The location was a stretch of road, in a rural situation, leading around a bend and down a long hill. Vehicles rounding the bend to go down the hill were losing control on a poor road surface or the bend and subsequently being involved in accidents. None of the accidents were recorded as occurring at the bend, and the positions at which the accidents were recorded as occurring depended upon whether the vehicle that had lost control collided with a vehicle coming up the hill or whether the vehicle finally ran off the road on it's own.

It can be seen from the above that accident problem locations will vary in size though the range of possible sizes is not made clear. The size of problem locations can vary from a few metres of road up to and including the whole area over which the technique is being applied. This is made clearer below.

It is helpful to think of problem locations as falling into three groups based upon the types of problem location. Locations of a similar size tend to fall into the same group although the sizes within a group may vary quite widely, and there is a degree of overlap in sizes between the groups. The three groups are:-

i) Spot Locations: those locations at which the problem is associated with a specific 'point' on the road e.g. a pedestrian crossing, a junction, one particular approach to a roundabout, etc.

ii) Stretch Locations: those locations at which the accidents of a similar type occur over a length of road and are associated with the general 'characteristics' of the road e.g. poor street-lighting, speeding vehicles, pedestrians crossing over a length of road as in a shopping area, parked cars.

iii) Area Locations: those locations at which the accidents of a similar type occur over an area e.g. child pedestrian or child cyclist accidents in a residential area where the focal point is the local school; accidents in industrial area. A problem may exist in the whole area over which the technique is applied for which a single scheme may be produced e.g. a publicity campaign on drinking and driving, or on driving at night.

Existing methods for identifying accident problem locations are reviewed in the next Chapter, and a proposal for a method is described in Chapter 6.

4.3 Ranking

This section is concerned with the following part of the technique which was reiterated at the beginning of this Chapter:-

> "..... Locations should appear in this list as near as is possible in the same order in which they would have appeared had every location been investigated and a remedial scheme prepared, and the schemes ranked for implementation by the Highways Committee according to its policy."

This section will be approached by considering the decision making processes involved.

4.3.1 Decision Making Process

The final selection of those schemes which are to be implemented is the responsibility of the Highways Committee. Although the Highways Committee may have a policy, the rationale behind the final decisions of acceptance or rejection of individual schemes may not be predictable. Individual members of the Committee will be subject to a variety of stimuli when arriving at a decision,

e.g. local public pressures

personal idiosyncrasies

political manoeuvring

Hence the final selection of schemes may not correspond to the selection that might be expected from consideration of the policy alone.

In selecting schemes to be put to the Highways Committee, however, the officers of the Council must be attempting to comply with the policy, and not attempting to predict the attitudes that the Committee will adopt at a meeting.

Consider how the Highways Committee would decide which schemes were to be implemented if it were adhering to its policy, and had all possible schemes to consider. The order in which schemes would be selected for implementation would be based upon the ability of each scheme to satisfy the policy requirements. This would probably be assessed by employing some cost/benefit relationship. It is possible, but unlikely, that the order in which schemes were to be implemented would be independant of the costs and effects of the schemes. Such a situation could occur, for example, if the policy required that the order in which schemes be carried out be dependant upon the number of occurrances of a particular type of incident at the location for which a scheme has been prepared.

If a cost/benefit relationship were to be used then the possible components of such a relationship would be the expected values of:

Capital cost of scheme

Difference in maintenance cost

Difference in journey costs

Life of scheme

Some measure of the benefit of the scheme

It has been argued that there are insufficient resources available to determine a scheme for every possible location, and hence determine an estimate of the cost and effect of each scheme. Therefore some method is required which will produce for the officers of the Council a list of the locations as near as is possible in the same order in which they would have appeared had every location been investigated and a remedial scheme prepared and the schemes ranked according to the policy. Schemes could then be prepared for locations, starting at the top of the list and continuing until the financial allocation is exhausted. The production of such a list will now be considered.

4.3.2 A Method of Ranking

The method for producing this order of locations for further investigation must be based on some assessment of what effects, with regard to the policy, are possible at each location, and

and what are the likely associated costs. This will be approached by considering the individual components of the cost/benefit relationship described above.

4.3.2.1 Capital Cost of a Scheme

The capital cost of implementing individual schemes can vary quite widely, depending upon the type of measure required, e.g. from road markings to an underpass. Although a realistic estimate of the capital cost of a scheme can be made before the scheme is implemented, the estimation can only be carried out after the required scheme has been determined. This is particularly relevant when alterations to services are necessary e.g. G.P.O. cables, gas mains, electricity cables, water pipes, sewers, as these alterations can constitute a major part of the cost of a scheme. However at this stage of the technique locations are being selected for further investigation, and the required scheme will not yet have been determined. Hence an estimate of the capital cost cannot be made.

It may be considered possible to obtain an indication of the type of measure likely to be required, and hence some indication of the cost, by a preliminary analysis of the accidents that have occurred at the problem location for which the scheme would be required. If a high proportion of the accidents at a location have a particular common recorded feature it may indicate a particular solution e.g. accidents during the hours of darkness - improved street-lighting; skidding accidents - improved road surface. This technique, however, is not advisable. The basis of this method of accident investigation and prevention is to identify the cheapest, most effective remedial measure by a detailed examination of the accidents that have occurred at a location. The danger of using a preliminary analysis can be demonstrated by two examples:-

a) at a location at which there are a high proportion of skidding accidents, rather than improve the road surface - a relatively expensive process - it may be possible to eliminate the cause of the skidding by removing the reasons for braking hard, e.g. by advance warning and/or clearer signing.

b) at a location at which there are a high proportion of accidents occurring in the dark, the cause might have nothing to do with the streetlighting at all, but with the users of the road at that time, e.g. drivers and pedestrians emerging from a nearby public house.

It may be acceptable to use the technique of preliminary analysis to indicate to an investigator where the problem might lie, but it should not be used to indicate the likely cost of the measure that will finally be selected.

4.3.2.2 Difference in Maintenance Costs

Although a realistic estimate of the difference in the highway maintenance costs associated with the implementation of a scheme can be made before the scheme is implemented, the estimation can only be carried out after a detailed scheme has been prepared. Hence no estimate can be made at this stage of the technique.

4.3.2.3 Difference in Journey Costs

The journey costs are based on two factors:-

i) cost of the delay time - i.e. whilst a vehicle is stationary

ii) cost of running time - dependant upon the distance a vehicle must travel and the average speed at which it travels

As was the case of the difference in maintenance costs the difference in delay and running times, and hence in journey cost, can not be estimated until a detailed scheme has been prepared.

4.3.2.4 Life of the Scheme

In a cost/benefit analysis of a scheme a prediction of the life of a scheme is required because both costs and benefits will vary with time. The life of a scheme is dependant upon plans for the future of the location at which the scheme is to be implemented, or the area in which the location occurs, and may affect the final choice of scheme, e.g.:-

- a high-cost short-life scheme is unlikely to have a favourable cost/benefit relationship

- the need to carry out some scheme for traffic accident reduction may result in the bringing forward of future improvements.

Because of the uncertain nature of plans in the current financial situation, and of the unpredictable effect of such plans on the life of schemes, it is considered to be of little value to attempt to take these factors into account at this stage of the technique.

4.3.2.5 Some Measure of the Benefit of a Scheme

The policies that are being considered here are those specifically concerned with traffic accident prevention by highway and traffic engineering methods. It is reasonable to suggest that the benefit of schemes produced in response to such policies will be some change in the occurrance of incidents involving traffic accidents.

A method of measuring the occurrance of these incidents at a location will now be considered.

4.3.2.5.1 Measurement

Let

$$p = \frac{A}{X} \qquad (1)$$

where p is the incident rate at a location. It has been suggested[45] that the following categories are some of the available variables for A and X:-

Numerator (A = numbers of accidents, casualties, or involvements)

Type	Severity	Other Subdivisions
accidents	fatal	sex
casualties	serious	age, experience
vehicle or	minor	time of day, day of week
road user	damage only	type of road or road -
involvements		feature
		weather
		collision type
		(head-on, side swipe, etc.)

Denominator (X = some measure of exposure)

time, population, vehicle registered, vehicle types, vehicle-distance, vehicle-time, vehicle flow, length of road, number of movements through junction, crew or passenger distance, road user.

If p is a measure of the occurrance of incidents at a location, then a measure of the effect of a remedial scheme at the location on such incidents is

$$\text{p before} - \text{p after} = \frac{\text{A before}}{\text{X before}} - \frac{\text{A after}}{\text{X after}} \qquad (2)$$

where the units of A and the units of X remain the same.

Until a detailed remedial scheme has been determined for a location the effect onthe denominator cannot be predicted. Therefore it should be taken that

$$X\ before = X\ after \qquad (3)$$

at the stage with which this section is concerned.

Hence

$$P\ before - P\ after = \frac{A\ before - A\ after}{X\ before} \qquad (4)$$

A and X will now be considered in more detail.

4.3.2.5.1 1) A

Policies concerned with traffic accident prevention are concerned with or about the occurrance of particular incidents, e.g. injury accidents; fatal accidents; accidents involving injury to young and/or old people; accidents at traffic signal controlled junctions, or on residential roads, or on shopping centre roads. For a specific policy, A is the incidence of the particular type of accident with which the policy is concerned.

Consider now the information available for determining A for any policy. Incidents which do not result in accidents (i.e. near missess) are only occasionally reported, e.g. by a letter from a member of the public who was involved in or observed the near miss, and are not recorded. Incidents involving damage-only accidents are not always reported and only limited details are recorded. Accidents involving injury, which are reported to the Police, form the basic recorded data from which the occurrance of specific types of incidents can be noted.

Details of injury accidents are recorded in the following three categories:-

i) When an accident happened

ii) Where it happened

iii) What happened

The information collected in the West Midlands system is listed below:-

i) When an accident happened:

The following details are recorded: the minute, the hour, the day of the week, the month and the year.

ii) Where it happened:

This is recorded in two ways:-

a) the exact location of an accident -

1) accidents on network roads are located by grid reference and road number with the position on the road to the nearest 10 metre.

2) accidents off the network are located by grid reference and internal road number.

Accidents occurring on pedestrian crossings have the number of the crossing recorded in their details. The local authority area in which an accident occurs is also noted.

b) the type of location:-

Road class

Speed limit

Presence and type of pedestrian crossing

Carriageway type

Carriageway markings

Presence and height of streetlights

Junction details

Junction control

On or off network

iii) What happened:

The following details are recorded:-

Casualty details (severity, sex, age)

Manoeuvres (of vehicles and pedestrians)

If skidding and/or overturning occurred

Vehicle defects

Vehicle types

Part of vehicle damaged

Daylight or darkness

Prevailing weather

Road surface conditions

Driver and/or rider details

With regard to the quality of the recorded information, some discrepancies have been found between the recorded accident details from the computer and the original police accident books. The West Midlands County Council has undertaken a study to determine the extent and type of such errors. It is strongly recommended here that regular monitoring takes place in order to maintain as high a standard of recording as possible, with particular emphasis on the location of individual accidents. It is also suggested that the police be made aware, if this is not already the case, of the importance placed by the County Council on the accuracy and clarity of the reporting by the police of individual accidents.

4.3.2.5.1 2) X

X is, for a location, some measure of exposure at the location. It can be seen that because the data of each accident is recorded, as described above, the factor of time is available as a measure of exposure for all locations,

e.g. $$\frac{A}{X} = \frac{\text{Number of injury accidents at a location}}{\text{in a period of 12 months}}$$

This particular example is the basis upon which the blackspot listings are currently produced in the West Midlands County Council's accident recording system, described in Chapter 3.

Originally, in that system, traffic flows were used in the production of the blackspot listings. The relationship used in the case of the network junctions was:-

$$\frac{\text{Number of injury accidents at a junction}}{\text{per million vehicles entering the junction}} = \frac{A}{X}$$

In both of these examples the numerator is the same, but a different denominator is employed. The effect of using a different denominator is that a different relationship is measured. A comparison of two locations, using the relationship from the first example, would be a comparison of the number of accidents that have occurred at each location (the time period being the same for both locations). A comparison of the same two locations using the relationship from the second example would be a comparison not only of the rate of accidents per million vehicles entering the locations but also the chance, or risk, of a vehicle entering the locations being involved in an accident.

It can be seen that for a particular type of incident with which a policy is concerned there are different ways in which the concern can be expressed, and which can be introduced by the selection of an appropriate denominator. Notable examples of different ways in which concern can be expressed are:-

a) the number of incidents of a particular type that have occurred in a specific time period
b) the risk, or chance, of a particular road-user type being involved in a particular type of incident

Unlike the accident information, which is already collected and recorded, the data for alternative measures of exposure, e.g. traffic and/or pedestrian flows, will, almost certainly, not be available for all locations, but will have to be gathered specifically for this purpose.

4.3.2.5.2 Measurement of Benefit

The purpose of this section is to examine the possibility of producing some method of predicting the benefit of some, as yet unknown, scheme at a location in order to rank locations for further investigation. It has been seen that the method of measurement, described in this section, is employed as a basis for ranking locations in a blackspot list. It has not been established, however, that the method of measurement is being employed as an attempt to measure, or predict, a benefit.

Consider again the first example, in which locations are ranked in the blackspot lists, produced by the West Midlands County Council, according to the number of injury accidents, (A), that have occurred at each location in the previous 12 months, (X), - with the locations with the largest values of $\frac{A}{X}$ at the top of the list. Two possible reasons for the location with the largest value of $\frac{A}{X}$ being at the top of the list are:-

i) simply because it has the largest value, and is therefore, the 'worst' location - this is a purely emotive reasons.

ii) because it is the location at which the largest reduction in the value of $\frac{A}{X}$ is possible.

It was shown earlier that the change in the value of $\frac{A}{X}$ is a measure of the benefit of a scheme being carried out at a location. Therefore in the second reason it can be seen that an attempt is being made to bring 'benefit' into the approach, by ranking locations according to the benefit that it is possible to obtain.

Although the largest reductions in the value of $\frac{A}{X}$ will be possible at the locations with the largest values of $\frac{A}{X}$, this does not mean that the largest reductions are most probable at those locations. In attempting to produce a method for determining the locations at which the largest reductions are probable, there are two points to bear in mind.

1) It has been stated that because it is not possible to predict the effect, if any, of a scheme on the denominator, X, then the measure of the effect of a scheme is

$$= \frac{\text{A before} - \text{A after}}{\text{X before}} \qquad (4)$$

i.e. X remains constant, and A is the only variable, hence we are concerned only with attempting to predict the change in A.

2) In Chapter 2 the reasoning for this method of accident prevention was described as follows:-
" When more than one accident occurs at a location it is possible that some of the accidents will be, to

some degree, similar. If the points of similarity can be identified then measures can be specifically designed to prevent those accidents which are subject to the points of similarity."

In addition to the 'similar' accidents at a location it can be seen that there will be accidents which are not 'similar'. It is as much a part of this approach that these accidents cannot be prevented by the small highway and traffic engineering remedial measures with which this approach is concerned. Consider again the Transport and Road Research Laboratory paper (described in section 2.4) in which the potential savings in accidents due to improvements in the road environment is put at 20%.

It is concluded from these two points that the selection of locations for investigation, with the objective of maximizing the reduction in the value of $\frac{A}{X}$, could be more accurate if it is possible to determine what number of the accidents at a location are in the preventable category. (It would be fatuous to suppose that 20% of the accidents at every location can be prevented by engineering methods). This will be considered for two sets of circumstances. Firstly the situation in which a policy is concerned with all injury accidents will be considered. Secondly the situation in which a policy is concerned with a particular type of accident will be considered.

4.3.2.5.2 1) <u>All Injury Accidents</u>

Three approaches to determining the number of accidents in the preventable category at a location will be considered:-

1) <u>Identifying 'un-preventable' accidents</u> - an attempt could be made to identify the un-preventable accidents at a location, and hence the number of preventable accidents, by producing a list of factors which, if one or more appeared in an accident record, would result in the accident being classed as un-preventable. Two problems with this approach are described below:

a) Typical of the factors which might be expected to result in an accident being classed as un-preventable are 'driving under the influence of drink' and 'tyre defects'. However accidents, as has been stated, are multi-factor events, and although 'driving under the influence of drink' or 'tyre defects' might be a contributory cause to an accident it may not necessarily be the sole cause. Such accidents, apart from the invalidating factor, could be very much a part of a group of similar accidents and it would be incorrect for them to be left out.

b) Although an accident might not have an 'invalidating' factor it need not necessarily mean that it is one of a group of similar accidents.

2) <u>Identifying 'similar' accidents</u> - the basis of this approach is to establish the number of similar accidents at a location by identifying the appropriate common factors. Categories of factors which might need to be considered are:

accident causation

collision type

manoeuvre

vehicle type

road surface conditions

light/dark

road user type

skidding

However it would not be acceptable to simply assume that the total number of accidents with a particular factor at a location is the size of a group of similar accidents, or that a group exists at all. This is because those factors which distinguish actual groups of similar accidents are not exclusive to such groups. For example, it would be most unlikely that all accidents occurring in the dark at a location would be part of a single group of similar accidents.

To take into account the possibility of unrelated occurrances of accidents with one or more similar factors, an attempt can be made to determine whether the number of apparently similar accidents at a location is greater than might be expected - the inference being that when the number is greater a group does exist. A possible procedure for this is as follows:

> Firstly subtract the number of apparently similar accidents from the total number of accidents at a location. From the residual number and a knowledge of, for example, the incidence of accidents with the particular factor(s) in the County in one year an expected number of such accidents can be determined for the location. A statistical test can be employed to determine whether the observed number of similar accidents is significantly greater than the expected number. The number of similar accidents which would be used for ranking purposes would be the difference between the observed and expected numbers.

The selection of a different control group may produce more accurate results. Other possible control groups are:

a) accidents at similar types of locations in the County
b) national figures (if available)

Two problems with this approach are described below:

a) In the West Midlands County, it may not be possible to identify all groups of similar accidents or all accidents within each group because of the way in which accident causations are recorded.

Although accidents are multi-factor events with, in many cases, a number of contributory causes only a single cause is assigned to each accident. With the large range of options to select the causation from it is quite possible for similar accidents to be given different causations. An indication of the importance of this problem can be conveyed by the fact that in investigations of accidents at individual locations conducted by the author it has almost always been necessary to refer to the police accident books and witnesses statements in order to determine real similarities in the causes of the accidents.

b) It would be necessary to take into account the possibility that there may be more than one accident problem, and hence more than one group of similar accidents, at a location. If this is not taken into account then when one group of similar accidents is being considered, accidents in a different group(s) of similar accidents could appear as unpreventable accidents. This would have the effect of producing a greater expected number of accidents with the factor(s), than would be the case if only unpreventable accidents were considered. The result could be that the observed number of similar accident would not appear to be significantly greater than expected and/or that the difference between the observed and expected would be less.

3) <u>Predicting the Number of Un-preventable Accidents</u> - an attempt can be made to predict, at each location, the expected number of 'un-preventable' accidents, thus establishing by subtraction from the observed number of accidents, the probable number of 'preventable' accidents. This approach depends upon some function being produced from which the expected number of un-preventable accidents at a location can be calculated. Such a function would need to take into account the details of the location and some measure of the usage of the location. A statistical test can be employed to determine whether the observed number of accidents is significantly greater than the expected number of un-preventable accidents. This can be used to indicate that an accident problem does exist at a location.

Two possible advantages of this approach are:

a) the calculation of the expected number of un-preventable accidents at a location would not be directly affected by the number or size of groups of similar accidents at the location

b) the only accident details required to obtain a number of preventable accidents at a location are the date and locational details of each accident. Hence the chances of mistakes, due to recording errors, are reduced.

A possible disadvantage of this approach is that additional information may have to be collected for the calculation, e.g. location details and some measure of the usage of the location.

An attempt to produce an acceptable method for predicting the number of un-preventable accidents at a location, together with the problems encountered, is described in Chapter 7.

4.3.2.5.1 2) Particular Accident Types

Two approaches will be considered for the situation in which a policy is concerned with a particular type of accident.

1) The total number of the accidents of the particular type at each location could be taken as the number of preventable accidents. This approach would only apply if it was felt or found by experience that a remedial measure appropriate to the particular type of accident would prevent all future accidents of that type at the location e.g. total pedestrian segregation for accidents involving injury to pedestrians. This situation will be rare.

2) The second approach is to take as the number of preventable accidents the difference between the observed and expected numbers of accidents of the

particular type at each location. An expected number of accidents of the particular type at a location can be calculated, as previously described, from a knowledge of the total number of accidents at the location and, for example, the incidence of the particular type of accident in the County in one year.

It can be seen that this approach is similar to that described previously in the 'Identification of Similar Accidents'. This approach is, in the same way, subject to the complications caused by the presence of another group(s) of similar accidents at the location.

Certain aspects of the selection of the variable, A, will now be considered.

If a policy is concerned with a particular type of incident it will be necessary to select the appropriate variable or combination of variables which correspond to the type of incidents, in order to be able to determine the occurrance of such incidents in the accident records of each location. Care must be taken with the selection of the variables to ensure an accurate reflection of the aim of the policy. In some cases there will be no question as to the correct variable, but below are two examples where the obvious variable may not necessarily be the most effective in achieving the aim of the policy.

i) Accidents Involving Skidding - In order to identify those locations at which an improvement in the skid-resistant properties of the road surface should result in a reduction in such accidents the technique employed by the Greater London Council [38] is to look for locations with a preponderance of wet road accidents. This approach is held to be more effective than considering locations at which accidents involving skidding are recorded as occurring.

ii) Severity of Injury - In attempting to reduce the level of severity of injury in accidents it may be tempting to concentrate upon locations at which one or more fatal accidents have occurred. It must be realised, however, that the occurrance of a fatal accident at a location does not, on its own, necessarily provide a reliable indication of the probability of further fatal or serious injury accidents occurring at that location. The following are brief accounts of two fatal accidents that have occurred in the West Midlands County, and are described here to illustrate the above point.

a) A female pedestrian walking along the footpath adjacent to a road with a comparatively low daily traffic flow, turned to talk to a fellow pedestrian. She tripped and fell into the road into the path of a motorcycle, the only vehicle on the road at the time. She was struck on the head by the footrest of the motorcycle and sustained a fatal injury. The heel of her shoe was subsequently found to be loose.

b) A pedestrian walking to cross the road at a road junction was struck and fatally injured by a vehicle approaching the junction. The vehicle had driven up onto the footpath out of control after the driver had gone into a diabetic coma.

The importance of this is that, as it is rare for more than one fatal accident to occur at a location in a 3 year period, a more effective approach to reducing the level of severity of injury in accidents may be required, e.g. considering the number of both fatal and serious injury accidents at a location, and/or employing some form of weighting related to the severity of injury of the accidents.

Weighting of accident variables can also be employed when a policy requires that all injury accidents be included but that special emphasis be given to a particular type of incident, e.g. a fatal child pedestrian accident being twice the importance of any other fatal accident.

4.3.2.5.3 Use of Accident Data

In using A, the number of incidents that have occurred at a location, in the decision of where and what remedial schemes are to be implemented one is presuming that the number and type of incidents that have occurred in the past will occur in the future if a remedial measure is not implemented. There are certain points to be considered when deciding how the incident history should be used. These are as follows:

Random Fluctuation

The number of accidents at any one location will fluctuate from year to year. It is important therefore to use a time period of sufficient duration to nullify the effects of random fluctuation. In practise storage capacity for accident records will probably be the limiting constraint.

Alterations at a Location

In addition to the random fluctuation in the number of accidents at a location, there may be genuine increases or decreases in the number of accidents due to improvement or deterioration of the situation, e.g.

improvement - less traffic on the road due to the opening of a new bypass

deterioration - a decrease in the skid resistance of the road surface due to wearing.

Simple statistical tests can be employed to determine the probability of whether a fluctuation is random or due to some alteration in the situation.

It is also possible that the number of accidents that have occurred at a location may be 'artificially' high or low because of some temporary factor influencing the road user at the location. The factor may be of a local nature, e.g. road-works, or of a more widespread nature, e.g. petrol shortage. It may be necessary to take such factors into account when calculating the probable benefits once a remedial scheme has been prepared. They should, however, be ignored at the stage of the process concerned here.

4.3.2.6 Selection of the Benefit

At the beginning of this section it was stated that a method is required for producing, for the officers of the County Council, a list of locations for investigation as near as is possible in the same order in which they would have appeared had every location been investigated and a remedial scheme prepared and the schemes ranked according to the policy. It has been shown that it is not possible to predict, at this stage, the probable costs involved in implementing schemes. However it is possible to make some assessment of the benefit that can be obtained - with the benefit being measured in terms of the change in an incident rate. This assessment of the possible benefit can be used as a basis for ranking locations for investigation.

An approach has been suggested for predicting the number of incidents at each location that are preventable. This was discussed for two situations; firstly when a policy is concerned with all injury accidents, and secondly when a policy is concerned with a particular type of accident. It has been found that, in practise, concern with all injury accidents is more common. The latter situation is found to occur only infrequently, and usually as a part of an accident prevention programme. An example of this is the attempted identification, in the West Midlands County, of locations at which accidents involving skidding were occurring, as a consequence of the allocation of a specific sum of money in the highway maintenance budget for skid-resistant road surfacing material.

If the assessment of a possible benefit is to be used as a basis for ranking locations for investigation then, at some point, a particular benefit will have to be decided upon. The particular type or types of incident with which the method is to be concerned and the way in which the concern is to be expressed should emanate from the Highways Committee's policy. As has been shown, consideration should be given, by the officers of the County Council, to the selection of appropriate variables which will most effectively advance the aims of the policy.

If it is not possible to obtain from the policy, or from the Highways Committee direct, adequate guidance as to the benefit that is to be the objective then the following approach should be adopted. The benefit that should be taken as the objective is the reduction in accident costs, to society, per unit time. The reason for adopting this approach is that it is consistant with the aim 'to make efficient use of available resources'. This approach is discussed in more detail below.

4.3.2.6.1 Reducing the Accident Costs

The actual costs of the accidents that have occurred at each location are not readily available. The values that should be used for accident costs are those that are used by the Department of Transport, as discussed in 2.9.2, for appraising road safety projects and proposals and highway schemes.

When calculating the cost of accidents at a location there are different ways in which these costs can be applied. The costs that are attributed to accidents by the Department of Transport vary according to their severity, and hence the cost at a location could be calculated as the sum of the costs corresponding to the individual accidents. An alternative method of calculating the cost of accidents is to use the average cost per casualty, which varies according to the class of road-user. The Department of Transport [(25)] recommends that, except in special circumstances, a single cost for all injury accidents should be used in the estimation of the accident savings. One reason for this is that the occurrance of a fatal accident at a location does not, as has been shown, provide an accurate indication of the probability of additional fatal accidents occurring and hence the high costs attributed to a fatal accident could produce extreme distortion, e.g. use June 1976 values 1 fatal accident costs more than 96 slight injury accidents. Amongst the special circumstances is the situation in which a significant proportion of the injuries at a location are of a serious nature and for which the single cost would produce an undervaluing of the likely accident savings.

To calculate the benefit in terms of the possible saving in accident costs the selected method of costing could be superimposed on to a method of predicting the number of preventable accidents.

4.4 Operational Requirements

At the beginning of this Chapter it was stated that "a technique is required which ....". Three operational requirements for such a technique have been mentioned but, because of their importance, are repeated here:-

1) The technique must make efficient use of available resources
2) The technique must be capable of being repeated at regular intervals
3) The technique must be capable of being easily adapted, in operational terms, to function for different policies.

4.5 Conclusion

This Chapter has been concerned with the task of identifying and ranking accident problem locations for further investigation. The need to consider all possible locations has been stated and the variation in the size of locations has been demonstrated. It has been argued that the positional order of locations for further investigation can be based on a prediction of the possible benefit that can be achieved at each location, but that it is not possible, at the stage under consideration, to predict the likely costs involved in achieving the benefit. The decision as to what benefit is to be the objective should be made by the Highways Committee, but in practise may have to be interpreted by the officers of the Council in order that the objective be most effectively pursued. An approach to assessing the possible benefit at each location has been considered, and associated problems discussed.

The next Chapter contains a review of techniques for identifying and ranking accident problem locations for futher investigation. These techniques will be considered in terms of the requirements for such techniques as have outlined and discussed in this Chapter.

CHAPTER 5

A REVIEW OF EXISTING METHODS FOR IDENTIFYING AND RANKING ACCIDENT PROBLEM LOCATIONS

5.1 Introduction

Having discovered various inadequacies in the West Midlands County Council's system for identifying and ranking accident problem locations, a study was carried out to discover what other methods there were and to determine which, if any, would meet the requirements discussed in the previous Chapter. Two approaches were used to carry out this study:-

(1) a survey

(2) a literature review

(1) Survey: A letter was sent to all County Councils in England and Wales and to the Regional Councils in Scotland requesting details of their methods of identifying accident problem locations. Of the 61 Councils approached 47 replied, in varying degrees of detail (for full list, see Appendix B). Information on methods used by some of the Counties who did not reply was obtained from other sources, e.g. papers presented at conferences, or published in journals.

(2) Literature Review: The Transport and Road Research Laboratory provided a list of abstracts

of possible references from their computerised abstracting and information system for publications and on-going research. The Laboratory is the English-language centre for the International Road Research Documentation (IRRD) group. Additional material and references were obtained from books and Government publications in the Aston University Library and the Birmingham Central Reference Library. For a full list of references, see Appendix A.

5.2 Results of the Study

The different methods of identifying and ranking problem locations employed by the different organisations are described below. Because a number of organisations use the same, or similar, methods, individual methods are not ascribed to the individual organisations that use them, although mention of a specific organisation may be made where a method is of special interest. Individual organisations may employ more than one of the following methods.

The first two methods are not used on their own in any organisation, but are used in addition to another method. They are mentioned here for information purposes, and not as serious suggestions as a single method.

Methods

5.2.1 Political or Public Pressure

This takes the form of complaints and enquiries from Councillors and/or the general public. One Council encourages the general public to assist them by providing pre-paid postcards through parish councils to local residents who are aware of frequent accidents happening at local 'black-spots'. The cards ask for the location, the identity of vehicles involved, and brief accident details only.

5.2.2 Observation

Locations for investigation are drawn to the attention of the Council by members of staff, and by reports from the Police.

5.2.3 Visual Assessment of Accident-Position Information

The techniques described in this section all rely on visual assessment for the identification of accident problem locations. The difference in the techniques is dependant upon the form in which the accident-position information is presented.

5.2.3.1 Accident Maps

For this technique the position of each accident is marked either directly onto a map or onto a transparent sheet which will overlay a map. From an inspection of the map, accident concentrations can be identified. The accident positions can be marked manually or by a graph plotter linked to the computer containing the accident details.

Ordnance Survey maps are usually employed for this method but in some instances the County or authority concerned use their own road plans and street maps. The scale of the maps varies, usually according to the nature of the area covered; the larger scale maps being preferred for urban areas because greater distinction is required where roads are close together, and smaller scale maps for rural areas. Scales generally used are:-

Urban areas 1:1250; 1:2500

Rural areas 1:10560; 1:50,000; 1 inch : 1 mile

The time period covered by the maps varies from six months accidents recorded on one sheet to three years accidents recorded on one sheet. The frequency with which the maps are produced also varies. With a graph plotter, accident maps can be produced as required but this is impracticable if the accident maps are produced manually. If the accident maps are produced manually, one of the two approaches, described below, is usually adopted:-

(1) The accident map covers a set time interval e.g. twelve months, and at regular intervals e.g. one

month, the markings of the positions of accidents which are over twelve months old are removed and the position of the accidents that have been reported since the map was last updated, are marked onto the map.

(2) The accident map covers a set period in time e.g. a calendar year, and the accidents in that time period are marked onto the map as they are reported until the time period is complete, and then a new map is started. Usually the maps for the previous period or periods are positioned next to the current map.

There is considerable variation in the way that the positions of accidents can be displayed on the maps and in the amount of information about the individual accidents that can be included. An accident position may be drawn on the maps in the form of a dot, or a small cross, or a circle, or may be marked by a pin, or by self adhesive dots or shapes, or by a flag. When a graph plotter is employed the position of each accident is usually all that is indicated on a map. When the accident maps are produced manually, however, considerable amounts of information about each accident can be included. The following list contains some of the information which may be included:-

time, date, day, month, of accident

severity of accident

class of road user killed or injured

reference number of the original report

code number of cause attributed to the accident

dark or daylight

occurrence of skidding or overturning

This information is indicated for each accident by varying the size, shape, or colour of the pin, flag or other marker, and by markings on the marker e.g. a cross on a pin head to indicate a fatal accident, and by writing on or by the marker.

This technique of identifying accident problem locations relies on the theory that problem locations will be indicated by clusters of accidents which will be readily apparent on an accident map. The clusters of accidents identified by the inspection will then be studied in detail to determine if an accident problem really exists, and, if this is proven, what remedial measures are required.

In some cases the county or authority concerned has set specific criteria to determine whether a location should be subjected to a detailed study. The following are examples of such criteria:-

(i) 3 or more injury accidents in 12 months at any junction or feature, such as a pedestrian crossing.

(ii) 4 or more injury accidents in 12 months at any junction or in 0.3 miles of road.

(iii) 6 or more injury accidents in 36 months constitutes a cluster.

Those reports which discussed how the values were selected stated that they were set arbitrarily.

More often the selection of locations for detailed studies is dependant on the ability of the person inspecting the maps.

It is possible to aid the process of selecting locations for a detailed study, particularly if the accident maps are produced by a graph plotter. This is achieved by suppressing certain accidents from the map, e.g.

(a) suppression, from a map, of those accidents occurring at major junctions enables accident clusters on lengths of road between the major junctions and in minor road areas to be more obviously apparent.

(b) it is possible for only accidents of a particular type to be marked onto a map. Any clusters of accidents found by inspection of the map may be locations with a similar accident problem. This is the basis of a popular approach (Mass Action Plans) whereby the technique is used to identify locations with a similar problem for which a known remedial measure is available. Any of the details recorded for each accident can be the basis for selecting which accidents are to be marked onto the maps. This approach can be improved by suppressing single accidents from the maps - this makes the clusters of accidents more obvious.

5.2.3.1.1 Assessment

It is all too easy to become involved in the more usual arguments on the merits of accident maps as a technique of accident problem location detection. An example of these arguments is:-

for - accident maps are simple to use and give a clear picture of 'what is going on'.

against - accident maps are labour and time consuming to maintain and are confusing for urban areas where accidents are both numerous and close together.

It is only necessary, in this study, to comment on, or criticise, the ability of accident maps to meet the requirements, set out previously, for the identification and ranking of accident problem locations. The accident map technique fails to meet the requirements because:-

(a) it is not possible to rank locations for attention without conducting some sort of study on each of the locations identified from the maps by inspection. Any sort of study will inevitably require considerable manual involvement.

(b) it is almost certain that this method will fail to identify all of the accident problems. In a case where an accident problem is such that the accidents are spread along the length of a road e.g. street lighting problem, there may be no obvious accident cluster to indicate its presence.

Although accident maps do not meet the requirements, it does not mean that they are without use. Displaying the positions of problem locations, rather than accidents, on a map can, for example, be helpful in presenting such information to councillors and other members of staff.

5.2.3.2 Histogram - Type Presentation

The histogram-type technique is distinguished by the way in which the accident information is presented - in positional order along each road, one road at a time. There are two forms which this technique takes; strip maps, and histograms.

5.2.3.2.1 Strip Maps

In this approach, accidents are recorded manually alongside a strip map of the road on which they occurred. The strip maps, which deal with one road at a time, may be one of the following scales - 6 inches : 1 mile, $2\frac{1}{2}$ inches : 1 mile, or 1:10000. The road on the strip map is often divided into sections of equal size, usually either 100 metres or 1/10 mile in length, and accidents are recorded in the form of a bar chart, in date order, alongside the sections on which they occurred.

Strip maps are prepared for trunk and classified roads in both urban and rural areas, and in some instances for all rural roads. It is considered impractical to prepare strip maps for unclassified urban roads.

The information recorded for each accident varies from organisation to organisation from just the year of occurrence to all of the following:-

year

severity

accident type

dry, wet, or icy skids

day or night

This information is conveyed by the use of colour codes, and patterns and shapes, e.g. a circle = fatal accident; a square = serious injury accident; a triangle = slight injury accident. Other patterns were suggested in the Ministry of Transport Circular 734, of 1957, described in Chapter 1. The strip maps may contain 5 or even more, years of accident records.

In addition to the details of accidents alongside sections of roads, some of the strip maps have a section where dates and details of highway alterations, for accident remedial purposes or otherwise, can be noted. The strip maps are sometimes kept in loose folders.

It was found that the identification of accident problem locations was usually based on a visual appraisal of the completed strip maps. There were, however, instances where criteria were employed, e.g.:

3 or more accidents at a site in 3 years for rural areas,

6 or more accidents at a site in 3 years for urban areas.

In one case accident rates were used, but only on rural roads, based on the 1/10 mile sections as follows:-

5 or more accidents per million vehicle miles for rural non-junction sites,
10 or more accidents per million vehicle miles for rural junction sites.

5.2.3.2.2 Histograms

The histograms, which do not have an accompanying map, are produced by computer in one of two ways, depending on the method by which individual accidents are located:-

(i) where the individual accidents are located by road number and the distance along the road from a fixed point, the histogram is created (taking a road at a time) by presenting, on one or more lines each, the equally sized pre-defined sections, which make up the road, in the order in which they occur, and recording details of each accident on the line, or group of lines, which correspond to the section on which the accident occurred, e.g. Figure 18 (Chapter 3). The sections are usually 100 metres in length.

(ii) where the individual accidents are located by grid reference, the histogram is formed for a specified road by using either the increasing easting or northing reference line as the abscissa. Accidents are recorded on the line corresponding to the appropriate grid reference.

There is a problem with this approach in that an erroneous result may be obtained if the road doubles back on itself i.e. there will be two or more positions on the road with different easting values but the same northing value, or vice versa.

Because the histograms are produced by computer they can be produced when required, but they are usually produced at regular intervals, e.g. every 3 months.

The histograms usually contain the following information about each accident:

year of occurrence
severity
accident type
skidding

It is possible however to produce histograms which include only those accidents which satisfy certain parameters, e.g. accidents in darkness. No more than 5 years accidents are usually presented on the histograms.

It was found that the identification of problem locations from histograms was usually based on a visual appraisal. One organisation stated that a visual inspection could show:-

(i) problem sites

(ii) sites where problems are developing

(iii) the effect of remedial measures at sites where action has been taken

5.2.3.2.3 Assessment

Strip Maps and Histograms could only be used as part of a system, because they are not suitable for unclassified urban roads. It can be seen that both techniques will require manual involvement: for the visual inspection; for listing identified problem locations; and for ranking the identified locations in the order in which they are to be investigated. For the strip maps this work is in addition to the normal work of preparing and up-dating the strip maps.

This technique of identifying problem locations is suspect in that it relies on a visual inspection of limited data to determine the existence and size of the problem locations. Relating the accidents to a map of the road on which they occur probably produces better results especially if the 'inspector' has a personal knowledge of the road. The accuracy with which accidents are located, 100 metre sections, is, itself, a source for error. It is possible for all of the accidents in a section to have occurred at one end of the section, or for some of the accidents to have occurred at one end of the section and the remainder at the other end, etc. If a problem falls on a line dividing two sections it is possible that some of the accidents will be recorded on one section and the remainder on the other section, which will create a different visual effect from the effect that would be created if all of the accidents occurred on one section. Deciding whether accidents occurring in consecutive sectionsare part of a single problem or not will be, at best, a matter for inspired guess-work.

Ranking is, in most cases, dependant upon the number of accidents that have occurred at the selected locations, i.e. no attempt is made to distinguish between 'preventable' and 'un-preventable' accidents.

5.2.4 Numerical Assessment

The techniques for the identification and ranking of accident problem locations described in this section are all based on simple comparisons of readily calculable accident frequencies or rates and all are employed in, or intended for, computer based systems. The sub-sections to this section are created by the different methods by which the positions of individual accidents are recorded. Similar techniques may appear in a number of the sub-sections.

5.2.4.1 Grid Reference

In this case individual accidents are located by a grid reference, usually an Ordnance Survey grid reference, to 6, 8, or 10 figures, i.e. to the nearest 100 metres, 10 metres, or 1 metre respectively. In some cases accidents are given the grid reference of the south-west corner of the grid square in which it occurs.

The selection of sites for further investigation is based on the number of accidents that have occurred in a fixed size and, usually, pre-determined area. The process of selection is carried out by computer. In some instances this technique is applied to all of the accidents that have occurred in the county or local authority area, and in other cases just to those accidents which have occurred off the A and B roads or off a defined highway network.

In the usual selection process the computer totals the number of accidents that have occurred, in a specified time period, at each grid reference or within each grid square and prints out those references or squares with either the highest numbers of accidents or with a number of accidents greater than a pre-set level. The grid squares are usually either 100 metres x 100 metres or 1 kilometre x 1 kilometre in size. The following are examples of the pre-set levels used for selection:-

(1) 5 injury accidents in a 100 m x 100m square in a 12 month period.

(2) 40 injury accidents in a 1km x 1km square in a 12 month period.

The selection process can be adapted to identify groups of accidents of a specific type by altering the pre-set level criteria e.g. 3 injury accidents involving dry or wet skids in a 100 metres by 100 metres square in a 12 month period.

Two counties have adjusted this technique to accommodate errors in the referencing of accident positions. One method identifies 100 metres by 100 metres grid squares at which there are accident concentrations, but allows 100 metres around for referencing errors. The other method is more complicated. The black-spot search printout comprises a list of six figure grid references, each with a value. The values are derived from the number of accidents occurring in and around any six figure grid reference where there is a concentration of accidents. Each accident in the central 100 metre grid square is given a value of, usually, eight; those in the adjacent square, two; and in the diagonal squares, one.

	100m	100m	100m
100m	1	2	1
100m	2	8	2
100m	1	2	1

These values are added together to give the value appearing in the printout. It is necessary to specify the lowest accident value to be printed. The county concerned states that by covering the surrounding area, accidents that have been incorrectly referenced are taken into account.

The technique of totalling the number of accidents in individual squares has one obvious failing for the task of identifying accident 'black-spots'. If the black-spot falls on the edge of a grid square then some of the accidents will be recorded as occurring in that grid square and some in the adjacent square. Separately the grid squares might fail to be identified by the selection process, whereas the combined total, of what is a single problem, would normally have resulted in the location being identified. If a black-spot occurs at the corner of a grid square the accidents might be distributed between four squares.

There are two techniques in use which overcome this problem:-

(1) In the first technique the computer totals the number of accidents in a square 200 metres by 200 metres but moves the search square by increments of 100 metres at a time, thus causing overlapping 200 metres by 200 metres squares to be searched. Examples of the pre-set selection criteria used with this technique are:-

  (a) 4 personal injury accidents in the preceding 12 months in rural areas, and

  (b) 8 personal injury accidents in the preceding 12 months in urban areas.

(2) The county which employs this second technique locates the individual accidents to 8 figures, i.e. to 10 metres. A possible problem location is identified by the criterion of 5 or more

personal injury accidents in a 30 metres radius circle in the previous 36 months.

5.2.4.1.1 Assessment

There still remains a problem which is inherent in this approach. In reality accident problem locations vary not only in size, from less than the area of a 100 metres by 100 metres square to something much larger, but also in shape e.g. a length of road; a junction; a residential area. The pre-defined square and even the '30 metres radius circle' are incapable of identifying precisely, and sometimes even completely, the boundary of an accident problem location which does not coincide with the boundary of the square or circle. Hence the number of accidents in a square, or circle, may be more or less than the actual number of accidents occurring at the problem location. This means that in some instances the ranking of locations for attention, when based on accident numbers, will be incorrect; and in some instances problem locations will fail to be identified at all.

5.2.4.2 Road Number and Metreage

In this case the position of each accident is defined by the number of the road on which it occurs, e.g. A45, and the distance along the road from a particular point. Because of the preliminary work required - the preparation of special maps, and junction and road number codes - the roads on which accidents can be recorded in this way are usually limited to recognised routes and/or classified roads.

The identification process was found to be similar for all of the techniques employed with this method of locating accidents, and can best be understood if considered as a two part process:-

(a) firstly the number of accidents that have occurred in equally sized sections of road are noted. The sections can be either discrete contiguous sections of road, as is the case in the West Midlands County Council's existing system (Chapter 3), or can be overlapping sections formed by moving the scanning length in increments which are shorter than the scanning length, e.g. if the scanning (section) length is 500 metres and the increment length is 100 metres the first section would be 0 - 500 metres, the second 100 - 600 metres, and so on. In the cases encountered the scanning length varied from 100 metres to 2 kilometres, but the increment length was always 100 metres.

(b) the second part of the process is the selection of sections for detailed investigation. Three distinct methods were discovered for determining this:-

(i) in the first method the sections with the highest number of accidents in a specific time period are investigated first. This is the method employed in the West Midlands County Council's existing system, but it is also used by another authority to create a list of the twenty 1 - mile (black mile) lengths of road having the highest accident record in one year.

(ii) in the second method those sections which have more than a pre-set number of accidents in a specific time period are selected for investigation. Some examples of the 'threshold' levels used are:-

- 12 or more injury accidents in a section of road, 300 metres long, in the previous 3 years (blacksite).

- 4 or more injury accidents in a section of road 100 metres long in the previous 12 months.

- 2 or more injury accidents involving

skidding on a wet road surface in a section of road 300 metres long in the previous 12 months (skid-site).

(iii) in the third method a section is selected for investigation when the number of accidents within the section divided by the length of the section, is greater than the number of accidents on the whole of the route in which the section occurs, divided by length of the route, i.e. the threshold level is the arithmetic mean for the route.

5.2.4.2.1 Assessment

The techniques described in this section do not satisfy the requirements, set out in the previous Chapter, for identifying and ranking accident problem locations. The size of actual accident problem locations is unlikely to be the same as the size of the pre-defined sections described above - some will be longer and some shorter. Equally the boundaries of the problem locations and the sections are unlikely to coincide and hence the accidents at one problem location may be divided into two or even more sections. Hence some accident problem locations will not be identified and a distorted view will be obtained of others.

Ranking of the sections for investigation is dependant upon the number of accidents that have occurred i.e. no attempt is made to distinguish between 'preventable' and 'un-preventable' accidents.

5.2.4.3 Node and Link Networks

'Node and Link' networks are networks of roads, composed usually of recognised routes and/or classified roads, in which the 'nodes' are the junctions between roads included in the network, and the 'links' are the stretches of network road between the nodes. What distinguishes them from other networks is that, for the purposes of identifying accident problem locations, accidents are recorded as occurring at a particular node or on a particular link - no account is taken of the positions of individual accidents within a node or a link, although this information may have been recorded.

Individual nodes and links are specified in two different way, either

(i) by a reference number, e.g. a unique alpha/numerical code, or the road number and the number of the node or link in order of occurrence, or

(ii) by the physical boundaries of the node or link, e.g. by the road number and the start and finish kilometreages of the node or link, or by the road number and grid reference co-ordinates such as the South-West and North-East corners of a "box" drawn around the link or node.

In the techniques that are based on node and link networks the process of identifying and ranking accident problem locations becomes a matter of selecting nodes and links for investigation. This is achieved using one or more of the following criteria:-

(i) 3 or more injury accidents at a node in the preceding 6 months.

(ii) 12 or more injury accidents at a node in the preceding 3 years.

(iii) 4 or more injury accidents at a node in the preceding 12 months.

(iv) the 50 worst nodes based on numbers of accidents.

(v) the 50 worst links based on numbers of accidents.

(vi) the 100 worst nodes selected on the basis of the average annual accident total (from 3 years records).

(vii) the 100 worst links selected on the basis of the maximum moving average accident rate per annum (from 3 year records).

To help in the selection of nodes and links for investigation, additional information is printed alongside the node or link details in the black spot listings produced for some authorities. A particular example of this is in the black spot listings produced for the Greater London Council.[34,38] The following information is printed alongside the junction details of the junctions (nodes) appearing in the black spot listings:-

- the number of injury accidents
- the cost of the accidents
- % of accidents occurring on a wet road surface
- % of accidents involving 'wet skids'
- % of accidents involving injury to pedestrians
- % of accidents occurring in the hours of darkness
- % of accidents involving injury to children
- % of accidents involving parked vehicles.

Preference for investigation is given to sites with high numbers of accidents, a rising accident trend, or above average risk associated with certain contributory factors such as the proportion occurring on wet roads.

5.2.4.3.1 Assessment

The node and link techniques are assessed here separately because some authorities use the techniques described above for their nodes, or major junctions, but employ different techniques for the accidents which occur on the links, or stretches of road between the major junctions.

(i) Links

The use of links fails to satisfy the requirements for a technique, as described in the previous Chapter, because specific accident problem locations are not identified. Hence some manual work is required to find out where an accident problem lies on a link, and how many accidents have actually occurred on it. Equally there is no indication of how many problem locations there are on a link.

The ranking of the links is also unsatisfactory. A link with 3 or 4 accident problem locations with relatively small numbers of accidents and correspondingly small potential savings per location, may have enough accidents upon it to out-rank a link with only 1 accident problem location but with a larger number of accidents at it.

(ii) Nodes

In one respect the nodes do satisfy the requirements, because they can all be treated as potential accident problem locations. The nodes must be considered separately from stretches of road because it is unlikely that the types of problems that occur at major junctions will extend onto the adjacent stretches of road, and vice versa. Also, although it is possible for a problem at a junction to be associated with a specific part of the junction, e.g. one particular approach road, or with one particular manoeuvre, it requires a detailed investigation of the accidents at the junction to ascertain the fact. Hence for the purposes of identifying accident problem locations it must be assumed that, if an accident problem does exist at a major junction, then the boundary of the problem location and the boundary of the junction coincide.

The different ranking criteria that are employed are based on numbers of accidents -

no attempt is made to determine the number of 'preventable' accidents or the number of 'un-preventable' accidents.

5.2.5 3 Techniques of Special Interest

In this section three techniques for identifying and ranking accident problem locations are described in detail. The three techniques are presented here because they are of particular interest.

5.2.5.1 The Technique use by Gwent County Council

The first technique is the one used by the Accident Statistics Study Group in the County of Gwent.[39] In this system the highway network, consisting of all roads down to and including Class III roads, has been split up into sections. Each section has been given an alpha-numeric reference number which, when combined with the number of the route on which it occurs, becomes unique. A section is defined as a length of carriageway of homogeneous characteristics, its boundaries being defined by their descriptions. A junction is treated as a section, but of zero effective length. This method of sectioning has been coarsened in the case of Class III routes, and the entire length of each route is treated as one section. It was felt that because of the relatively short average length of this category of road and the few accidents reported, the quality of information obtained would be satisfactory. Accidents occurring on unclassified roads are located by a six figure grid reference, to within 100m squares. There are approximately 3200 sections in the highway system, of which 400 relate to Class III routes.

The analysis of personal injury accidents within Gwent is undertaken by the Accident Statistics Study Group. Representation on the group is provided by the following:-

(a) the Gwent Constabulary

(b) the County Surveyor's Highway Department

(c) the Chief Executive's Office

(d) the County Treasurer's Department

(e) the Welsh Office (Roads Division)

(f) the Welsh Road Safety Unit

Each month a meeting of the Group takes place, at which five tabulations are discussed. The five tabulations are produced monthly from the computerised accident records, and are as follows:-

(a) Police Tabulations giving details of accidents broken down under fourteen various types.

(b) A yearly accumulative summary of accidents on classified roads.

(c) A yearly accumulative summary of accidents on unclassified roads.

(d) A card image listing, which contains a listing of the actual data entered into the computer each month.

(e) An accident investigation tabulation which provides details of accidents which have occurred at any particular site when any combination of three conditions is satisfied, the conditions being as follows:-

   (i) 3 injury accidents in a calendar year
   (ii) 2 injury accidents in a calendar month
   (iii) 1 injury accident in each of any two consecutive months.

At the meeting a 'short list' of sites considered worthy of closer examination is drawn up, and individual Group members accept responsibility for collating all available data, which is subsequently forwarded to the Group Secretary.

The Group Secretary convenes site meetings to which all interested parties are invited, including, where appropriate, technical representation from the District involved. The site meeting provides recommendations for appropriate remedial measures and such recommendations are discussed at the next monthly Group meeting. Ratified recommendations are forwarded to the appropriate departments for action.

5.2.5.1.1 Assessment

There are a number of points which can be drawn from the description of the approach employed in Gwent.

Firstly, the concept of homogeneous sections is introduced - this is discussed later in this study. Secondly, despite the fact that it is a relatively unsophisticated technique for identifying and ranking accident problem locations, and that manual involvement is required to produce the 'short list', the technique is considered by the users to be satisfactory. This is probably because any shortcomings can be ignored or overcome by a manual involvement which is only practical in a County with a relatively small number of injury accidents in a year - approximately 1800, which is approximately 17% of the number of injury accidents that occur in the West Midlands County in one year. It can be seen, therefore, that what is suitable for one authority may not be suitable for another; also that it is not necessary to have an over sophisticated system if a simpler system will suffice.

The third point is that involving all of the interested parties at the time when the decisions on remedial measures are being made, has much to recommend it. The group so formed is likely to achieve more toward reducing the number and severity of accidents in this way than would be the case if the organisations involved in the group worked independently. The group probably has more authority, and hence is more likely to have its recommendations accepted and acted upon than might otherwise be the case.

5.2.5.2 <u>The Technique used by Strathclyde Regional Council</u>

The second technique is one which was originally developed by the former Corporation of Glasgow. It has been expanded, and is now used by the Strathclyde Regional Council. In this system every junction in the Region has been given a unique number. Individual accident positions are defined by a combination of grid reference and one of the following, as appropriate:-

(i) In urban areas, the position is defined by quoting the number of the nearest junction and the distance from that junction to the accident in the direction of a second junction, the number of which is also quoted.

(ii) In rural areas, where there is a junction in the 1 kilometre by 1 kilometre ordnance survey grid square in which the accident occurred, the position is defined by quoting the junction number and the distance from the junction to the accident in the direction of a neighbouring grid square, which is also quoted.

(iii) In rural areas, where there is no junction in the 'accident square', the position is defined by quoting the reference of the accident square and the distance to the accident from a neighbouring square, which is also quoted.

This method of locating individual accidents, by reference to the nearest junction, was chosen because of the fact that the Transport and Road Research Laboratory had estimated that two-thirds of all accidents in urban areas occur at junctions.

There are three standard tabular outputs produced by the computer which are used for identifying locations for investigation. These are described below:-

(i) Firstly, there is the Accident Blackspot Table, which is produced quarterly, which contains a "league table" of all junctions having more than four accidents within a distance of 20 metres from these junctions in the preceding twelve months. Also given on the table is the number of accidents which have occurred at each junction in the current calendar year and for up to 3 years before. A Statistical Index is calculated to measure objectively the change in risk at each junction by comparing the number of accidents in the latest 12 month period with the preceding 2 years. The formula employed for this is based on the Standard Error of the Difference and is as follows:-

$$S = \frac{\left| x - \frac{1}{2} \right|}{\sqrt{\frac{2}{3}\,(x + y)}}$$

Where S is the Statistical Index, x is the number of accidents in the latest 12 month period, and y is the number of accidents in the preceding 2 years. Additionally there is a 'comment' column which indicates the comparison of the latest 12 months with the previous years by printing INCREASE, STATIC or DECREASE. If a junction shows a 'decrease' and a Statistical Index greater than 2.0 and if remedial work has been carried out to prevent accidents, this shows that, with a 95% confidence level, some real change in risk at the junction has taken place and that the decrease is not due to random chance. Similarly when a junction shows an 'increase' and the Statistical Index is greater than 2.0, this indicates that it is 95% certain that the increase in accidents is not due to chance but that a real increase in risk has occurred at the junction.

(ii) Secondly there is the Significant Change Table. It is similar to the Blackspot Table except that only junctions with 10 or more injury accidents in 3 years are considered, and the junctions are listed in descending order of Statistical Index, with a cut off at the value of 2.0 (95% confidence level). The purpose of this table is to determine the junctions where the level of risk has changed, subsequently enabling analyses to be carried out to identify those factors which have caused the change. From this it is hoped that it will be possible to draw up guidelines on the effects of various traffic management measures on accident rates.

(iii) The third table is the Weighted Blackspot Table, which is also derived from the Blackspot Table. In this table a weighting is made for the classification of the road in which the accident occurred. Motorways, expressways and unclassified roads are given a weighting of 1.0, 'A' class roads a weighting of 0.33, and 'B' class roads a weighting of 0.5. The junctions are listed in descending order of weighted accidents.

The weighting factors were chosen subjectively and arbitrarily to reflect what was considered to be a bad accident rate in each class. It has been found, subsequently, that the weighting factors chosen do reflect the national statistics for these classes or road.

The purpose of the table is to give extra emphasis to accidents on unclassified roads, where traffic volumes are light, and on motorways, which are designed with safety in mind.

Additional output from the accident records is obtained using two data handling packages. These are described below.

(i) GEDAN

This package, supplied by Honeywell, is used for "ad hoc" enquiries. It is also used for frequency studies, e.g. number of accidents occurring versus the hour of the day, or tabulations, e.g. road classification of accident versus severity of the accident. The main use of GEDAN is to sort through accident records searching for a particular common factor and printing out all accidents of the chosen type grouped according to junction reference numbers. The results are then manually sorted to obtain sites with a high incidence. An example of a study of this type is the identification of junctions where drivers disobey traffic signs and signals.

(ii) EASYWORK

This package, supplied by Knight Consultancy Services Limited, is similar to GEDAN but is capable of more complex arithmetical processes. An example of the type of study undertaken using EASYWORK is an examination of sites with an abnormally high proportion of darkness accidents. Firstly the overall ratio of dark to daylight accidents is calculated as a control; secondly chi-squared values are calculated for each junction; finally locations with a high proportion of darkness accidents are printed out in descending order of chi-squared values, with a cut off at the 95% confidence level.

The latest addition to the system is a development from a logic flow chart which tests the accident pattern at a location for a number of features with known engineering remedies, e.g. a chi-squared test is carried out on the proportion of accidents occurring in the dark. The logic shown on the chart has been programmed for the computer and it is possible to apply the deductive reasoning process to every location on a regular basis. If a deductive statement is generated at any location, an Accident

Analysis Table, containing details of all of the accidents at the location, is printed, followed by the deductive statement(s), e.g. "it is x% certain that there is an abnormal factor present in the hours of darkness".

5.2.5.2.1 Assessment

There are a number of points about the techniques employed in Strathclyde which are worth emphasising:

(i) Firstly it can be seen that an attempt has been made to identify and quantify any changes in the number of accidents at a location, whether it is an increase indicating a worsening situation, or a decrease due to remedial measures.

(ii) Secondly an attempt has been made to bring extra emphasis to certain accidents - those on unclassified roads and motorways - by introducing an elementary system of weighting.

(iii) Thirdly the identification of sites on the basis of different criteria is possible, although it does entail a certain amount of manual involvement.

5.2.5.3 TARA

TARA[40] (Traffic and Accidents on Roads, Analysis) is a highways information system developed by a working party of the County Surveyors' Society and composed of members from the following counties: Oxfordshire, Somerset, Mid-Glamorgan, Gloucestershire, Buckinghamshire and Devon. The TARA system was originally conceived as a traffic and accident information system but has been expanded in order to fulfil the broader concepts of a highways information system. TARA consists of a central, two-dimensional network modelling system, with a series of sub-systems referenced to it for carrying out discrete functions, whilst at the same time providing integrated information. The sub-systems include the following, although more can be added: traffic flow and speed data; road accidents; highway maintenance records; and street furniture maintenance records. The central network modelling system is known as Level 1 and the sub-systems are known as Level 2 and it is with the Level 2 sub-system containing the Accident Analysis Facilities that this section is concerned.

It is not intended to discuss all of the details of the Level 2 sub-system on Accident Analysis, but to concentrate on one aspect which is of particular interest. This is the technique used for identifying and ranking accident problem locations occurring on the main highway network. The technique was presented in a paper,[40] produced by West Glamorgan County

Council in 1976, entitled TARA - Accident Analysis Facilities. However, the technique was originally developed and used jointly by the Cornwall and Devon County Councils.[10]

The object of the technique is "to provide, on the basis of a regular scan of stored accident records, identifying details of those lengths of road on which the accident rate, expressed in terms of the number of accidents per million vehicle kilometres, is approaching or surpassing certain pre-determined norms; and to present those details in such a manner that those responsible for routine accident investigation can make direct comparisons, one road with another, when assessing priorities".[40] It can be seen that the technique requires traffic flow data which is obtained from another Level 2 sub-set.

Before describing the operational sequence it is necessary to explain two terms - Rating Length and Cursor Length:-

(a) Rating Length: The network of roads is divided up into individual continuous lengths, called Rating Lengths, and each one is dealt with separately. A Rating Length is defined by the following criteria

(i) The traffic volume on the various sections of road comprising the rating length should be constant within certain small tolerances.

(ii) The traffic characteristics on the various sections of road comprising the rating length should be uniform within reason.

(iii) The physical characteristics of the various sections of road comprising the rating length should be uniform within reason.

If all of these criteria are satisfied there is no reason why the rating length should not be quite large.

(b) Cursor Length: A Cursor Length is calculated for each Rating Length and is the distance which, when multiplied by the annual traffic flow on the Rating Length, produces exactly 1 million vehicle kilometres per year, e.g. a traffic flow of 4 million vehicles a year requires a length of 0.25 kilometres to generate 1 million vehicle kilometres, whereas a flow of 0.5 million vehicles a year requires a length of 2 kilometres.

The operation of the technique is as follows. Each Rating Length is systematically scanned in the direction of increasing kilometreage. This involves the placing of the Cursor Length successively on each accident location and noting the number of accidents 'captured' within that length, which directly equals the Accident Rate. Each successive placing of the Cursor will then yield an equal, greater, or lesser number of accidents than the previous one until the last on the Rating Length has been included. The system provides for the merging of all the individual results of each Cursor position and can include accident rates within kilometreage limits of almost zero (indicating intermediate minor junctions or blackspots), to accident rates applicable to the entire Rating Length, or to any combination of both. A diagrammatical representation of the merging process is shown in Figure 25. The accident rate produced by the merging operation is then compared to the appropriate Norm for the length and any results above a specified level e.g. 75% of the Norm, are reported in absolute terms and as a percentage of the Norm.

It is suggested that although national accident rates can be used as the Norms it is better to select ones on the basis of local experience and on the basis of the yield of problem areas produced.

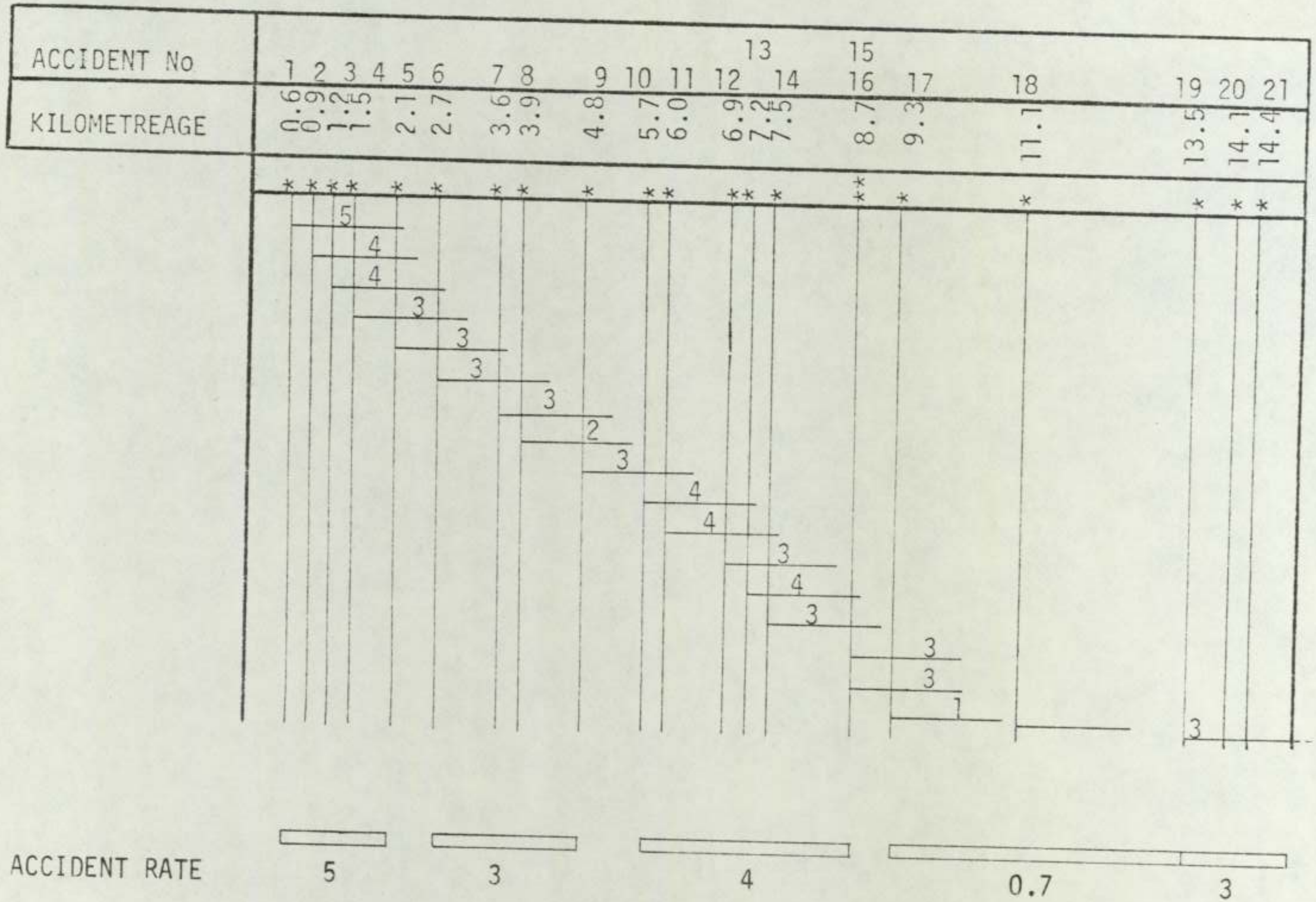


Figure 23 - A Diagrammatical Representation of the Merging Process in TARA(40)

The Norms could be adjusted to produce just enough problem areas to be studied at any one time. Alternatively the percentage of the Norm at which a 'Black Spot' or 'High Risk Length' is considered to exist can be adjusted e.g. 100%, 150%.

By presenting the results of the scan in such a way that each accident rate is quoted, together with its respective start and end kilometreage i.e. the locations of the first and last accidents responsible for that accident rate, it is hoped that some sense of perspective can be achieved, i.e. that there will be an indication as to whether the accident rate produced is due to a group of accidents tightly packed at some 'Black Spot', or to a spread of accidents over a length which may then be considered as a 'High Risk Length'.

Where the Rating Length under consideration is less in length then the derived Cursor Length, the accident rate, arrived at on the basis of the Cursor Length, is increased in the ratio of Cursor Length/ Section Length.

In the analysis a single accident occurring in isolation on a Rating Length is assumed to have no statistical significance and is ignored, with an appropriate message being displayed.

The description of the technique contained in the paper(40) produced by West Glamorgan County Council proved to be too vague to enable an assessment of the technique to be made. In consequence of this, additional enquiries were made, and a copy of the flow chart of the rating operation was obtained, and is reproduced in full in Figure 26. The variables used in the flow chart are explained below:-

AR = ACCIDENT RATE within limits of:

LL = LOWER KILOMETREAGE LIMIT

HL = HIGHER KILOMETREAGE LIMIT

AC = COUNT OF TWO OR MORE CONSECUTIVE ACCIDENTS WITHIN CURSOR LENGTH

HAR = HOLDING ACCIDENT RATE FOR PREVIOUS SCANS within limits of:

HLL = HOLDING LOWER KILOMETREAGE LIMIT

HHL = HOLDING HIGHER KILOMETREAGE LIMIT

SAC = HOLDING SINGLE ACCIDENT COUNT within limits of:

LLSA = HOLDING LOWER KILOMETREAGE LIMIT

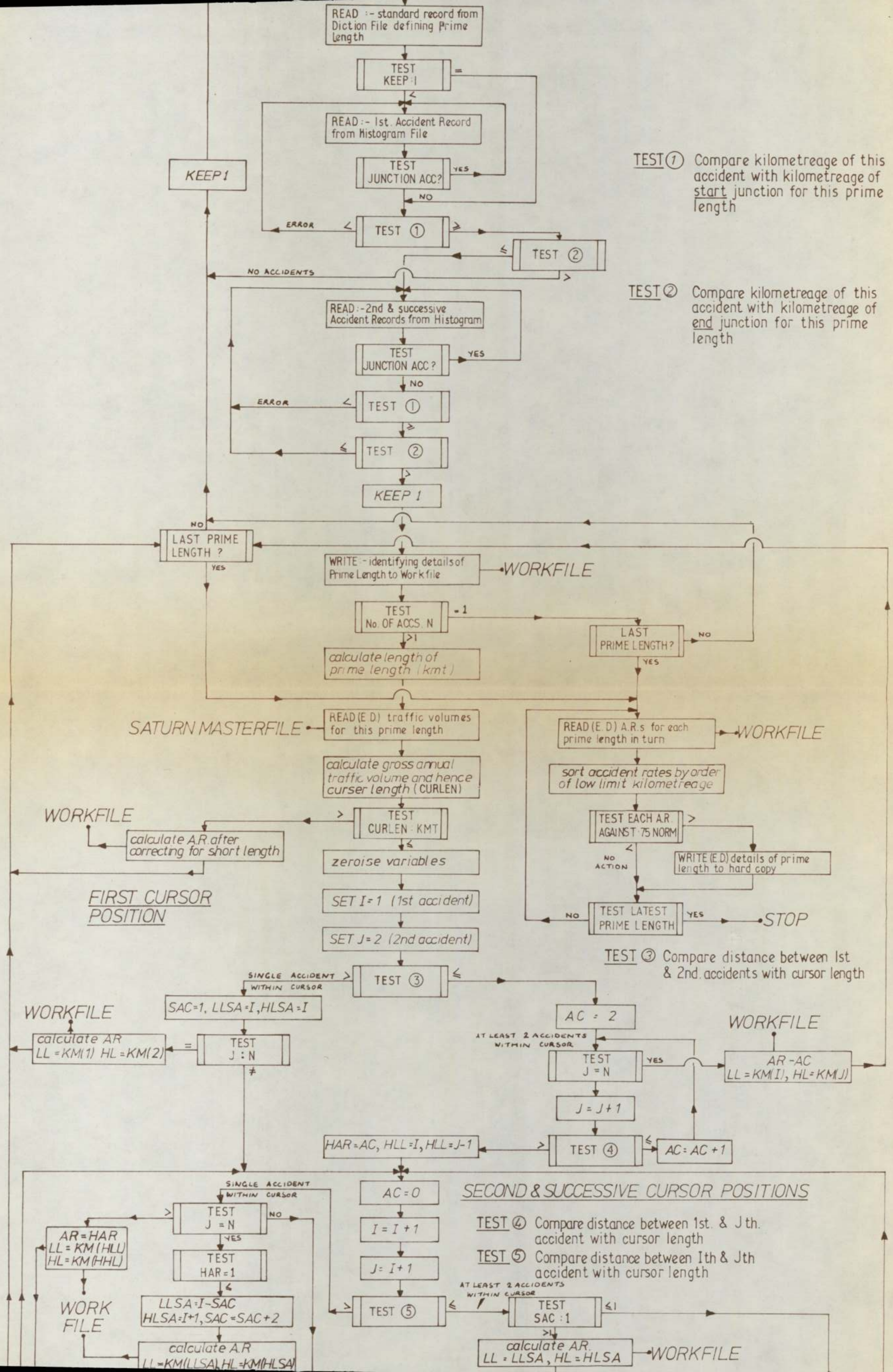
HLSA = HOLDING HIGHER KILOMETREAGE LIMIT

ECLP = COUNT OF 'END CLIPPED' ACCIDENTS within limits of:

ECLL = HOLDING LOWER KILOMETREAGE LIMIT

ECHL = HOLDING HIGHER KILOMETREAGE LIMIT

Figure 24. Flow Chart of the Moving Cursor Technique used in TARA



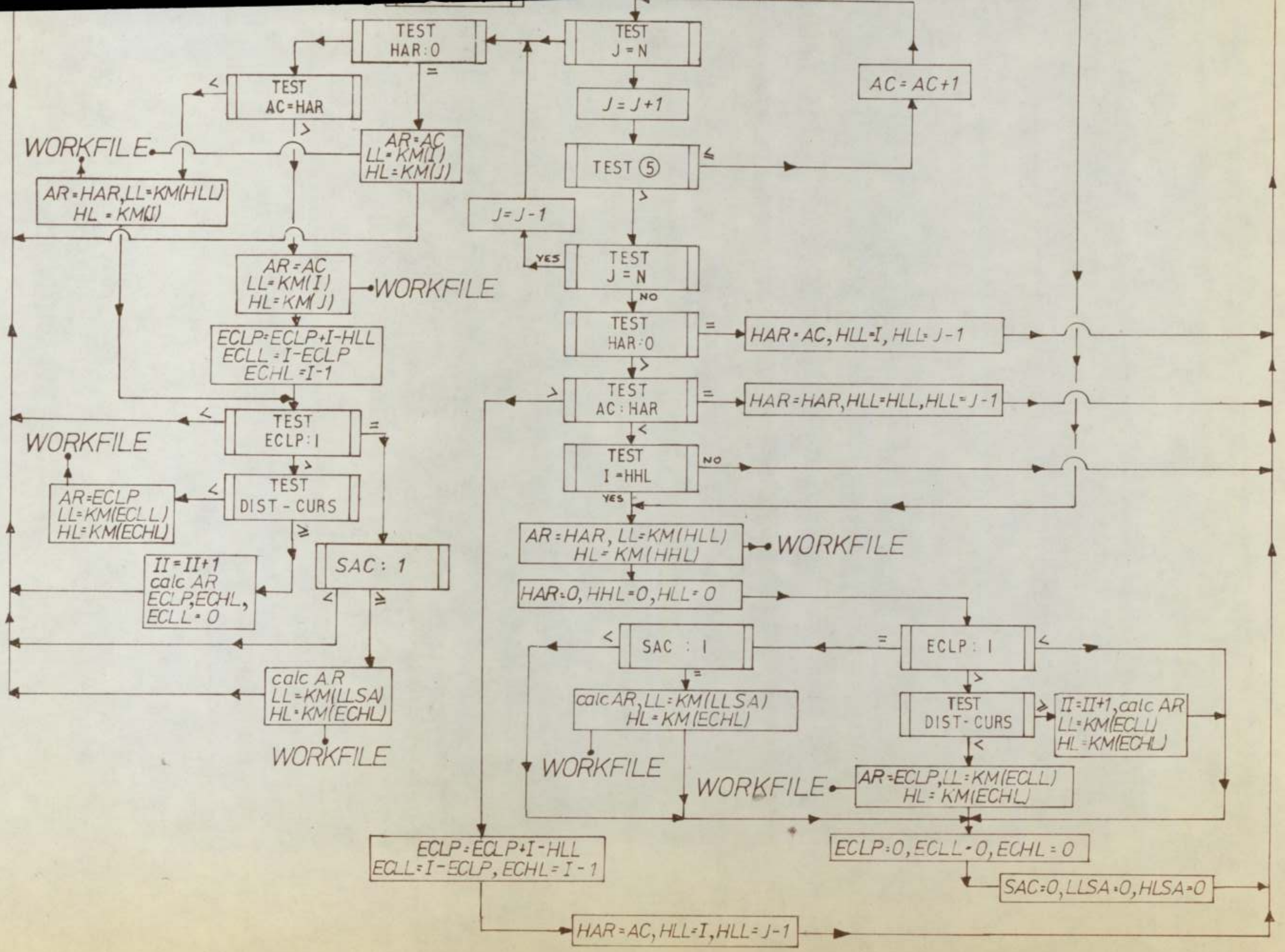
TEST ① Compare kilometreage of this accident with kilometreage of start junction for this prime length

TEST ② Compare kilometreage of this accident with kilometreage of end junction for this prime length

TEST ③ Compare distance between 1st & 2nd accidents with cursor length

TEST ④ Compare distance between 1st. & J th. accident with cursor length

TEST ⑤ Compare distance between Ith & Jth accident with cursor length



TEST HAR:0
TEST J = N
AC = AC+1
TEST AC=HAR
J = J+1
AR=AC LL=KM(I) HL=KM(J)
WORKFILE
TEST ⑤
AR=HAR,LL=KM(HLL) HL = KM(J)
J=J-1
AR=AC LL=KM(I) HL=KM(J)
WORKFILE
TEST J = N
YES
NO
TEST HAR:0
HAR=AC, HLL=I, HLL=J-1
ECLP=ECLP+I-HLL ECLL =I-ECLP ECHL =I-1
TEST AC:HAR
HAR=HAR,HLL=HLL,HLL=J-1
TEST ECLP:I
WORKFILE
TEST I =HHL
TEST DIST-CURS
AR=ECLP LL=KM(ECLL) HL=KM(ECHL)
AR=HAR, LL=KM(HLL) HL=KM(HHL)
WORKFILE
II=II+1 calc AR ECLP,ECHL, ECLL=0
SAC : 1
HAR=0, HHL=0, HLL=0
SAC : I
ECLP : I
calc A.R LL=KM(LLSA) HL=KM(ECHL)
calc AR, LL=KM(LLSA) HL=KM(ECHL)
TEST DIST-CURS
II=II+1, calc AR LL=KM(ECLL) HL=KM(ECHL)
WORKFILE
WORKFILE
WORKFILE
AR=ECLP,LL=KM(ECLL) HL=KM(ECHL)
ECLP=ECLP+I-HLL ECLL=I-ECLP, ECHL=I-1
ECLP=0, ECLL=0, ECHL=0
SAC=0, LLSA=0, HLSA=0
HAR=AC, HLL=I, HLL=J-1

I = ACCIDENT ON WHICH START OF CURSOR IS POSITIONED

J = SUCCESSIVE ACCIDENTS WITHIN CURSOR LENGTH

5.2.5.3.1 Assessment

Because the logic on which the flow chart is based is not available, assessment of this technique must be made by consideration of the results produced by the technique in operation. Therefore a test was carried out: the distribution of accidents shown in Figure 25 (which is a reproduction of a Figure used in the report[40] by the West Glamorgan County Council) was taken as the rating length, and three different hypothetical traffic flows on the rating length were considered in turn, i.e. three different cursor lengths. The flows were:-

(i) 0.5 million vehicles per annum, which is equal to a cursor length of 2 kilometres.

(ii) 2.0 million vehicles per annum, which is equal to a cursor length of 0.5 kilometres.

(iii) 5.0 million vehicles per annum, which is equal to a cursor length of 0.2 kilometres.

The results of applying the technique to the three situations are shown in Figure 27. The results for (i), where the cursor length was 2 kilometres were

(a) LL = 0.6 km; HL = 2.7 km; AR = 5

(b) LL = 3.6 km; HL = 4.8 km; AR = 3

(c) LL = 5.7 km; HL = 8.7 km; AR = 5

(d) LL = 9.3 km; HL =11.1 km; AR = 2

(e) LL =13.5 km; HL =14.4 km; AR = 3

The results for (ii), where the cursor length was 0.5 kilometres, were

(a) LL = 0.6 km; HL = 1.5 km; AR = 2

(b) LL = 2.1 km; HL = 2.7 km; AR = 0.67

(c) LL = 3.6 km; HL = 3.9 km; AR = 2

(d) LL = 5.7 km; HL = 6.0 km; AR = 2

(e) LL = 6.9 km; HL = 7.5 km; AR = 2

(f) LL = 8.7 km; HL = 9.3 km; AR = 3

(g) LL = 11.1 km; HL = 13.5 km; AR = 0.33

(h) LL = 14.1 km; HL = 14.4 km; AR = 2

The results for (iii), where the cursor length was 0.2 kilometres, were

(a) LL = 0.6 km; HL = 7.5 km; AR = 0.35

(b) LL = 8.7 km; HL = 8.7 km; AR = 2

(c) LL = 9.3 km; HL = 14.4 km; AR = 0.23

From a visual assessment of the results, as shown in Figure 27, there appears to be a number of anomalies in the grouping of the accidents, e.g.

- in the first case, where the cursor length was 2.0

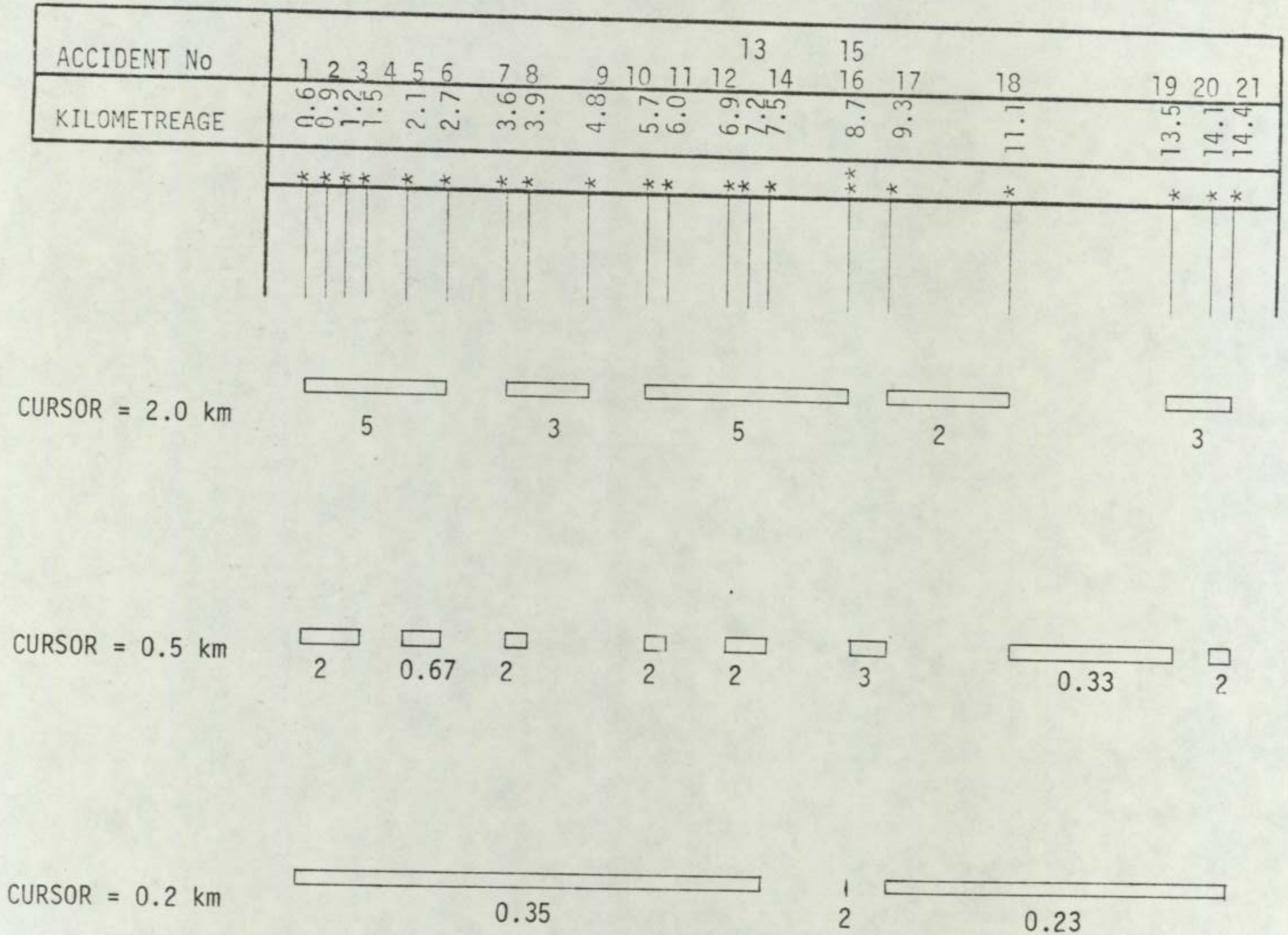


Figure 25. - TARA : Results for Three Different Flows

kilometres, one might expect that accident number 17 should have been in the group 10 to 16; the distance between 16 and 17 is less than the distance between 14 and 15, and between 11 and 12.

- also in the first case accident number 9 could have been grouped with 10 to 16; the distance between 8 and 9 is the same as the distance between 9 and 10 and is also the same as the distances between 11 and 12, and 14 and 15.

- in the second case, where the cursor length was 0.5 kilometres, it seems more likely that accident number 19 should be grouped with 20 and 21 than with 18.

Although this technique may be producing the intended results, it can be seen, from the above, that they are not the results that are actually required.

5.2.6 Statistical Techniques

The statistical techniques consist of the application of a probabilistic model to determine the locations where the level of risk to the road user is significantly greater than can normally be expected.

The basis for the use of statistical techniques for identifying accident problem locations is as follows. Consider two road sections of equal length, geometric design, and vehicular and pedestrian characteristics (in both flow and composition). Suppose also that the number of accidents occurring on the two sections is known for some time period. Since there is no reason to expect that more accidents will occur on one section than on the other, the probability, p, that a particular accident will fall on one section is $\frac{1}{2}$. The probability that the accident will not fall on that section or that it will fall on the other is 1 - p, also equal to $\frac{1}{2}$. This is equivalent to a binomial trial.

Consider this now for a number, k, of such sections. The probability that a particular accident will occur on any section, i, is given by:

$$p_i = \frac{e_i}{\sum_{i=1}^{k} e_i} \quad \text{subject to} \quad \sum_{i=1}^{k} p_i = 1$$

where e_i is the expected number of accidents for section i. The probability that a particular accident will not occur on section i or that it will fall on any other section is $1 - p_i$. If the total number of accidents on all of the sections is n for any given time period, then the number of accidents, x_i, which will occur on section i will be described by the following binomial distribution, with parameters n and p_i:

$$f(x_i) = \binom{n}{x_i} p_i^{x_i} (1-p_i)^{n-x_i}$$

The expected number, e_i, of accidents for a section, i, is obtainable from a relationship such as:

$$e_i = a.\ Q_i^b .\ L_i$$

where - Q_i is the traffic flow on section i

- L_i is the length of section i
- 'a' and 'b' are known constants for all of the roads under consideration.

Of four methods encountered which employ a statistical technique two[41,42] assume a normal approximation to the binomial distribution, one[43] assumes a poisson approximation, and the fourth[44] assumes a poisson approximation to the binomial for expected numbers of accidents up to 15 and a normal approximation to the binomial for expected numbers of accidents over 15.

So far a method of calculating the expected number of accidents for each section has been described and theoretical distributions of accident occurrence determined. In practise however it will be found that too many sections will have too many accidents and too many sections will have too few accidents to agree with the theoretical distribution. This is because sections differ in accident risk because of factors which have not been accounted for, such as poor skid resistance, inadequate streetlighting, etc. It is the sections where there are significantly more accidents than expected which are the high risk locations.

Determining whether the actual number of accidents on a section is significantly greater than expected is carried out as follows. If the poisson approximation to the binomial has been assumed, poisson tables are used to determine the probability that the difference between the actual number of accidents and the expected number of accidents is not due to random chance. It can be seen that a two-sided test is required. If the actual number of accidents is greater than a particular upper confidence limit then it may be concluded that the number of accidents is significantly high and the location in question needs to be examined with a view to possible remedial action. If the actual number of accidents is less than a particular lower confidence limit then it may be concluded that the number of accidents is significantly low and the location in question may be studied with a view to yielding facts to aid in accident reduction elsewhere. One method[43] suggests that confidence limits equivalent to 95% degree of confidence be used.

If the normal approximation to be binomial has been assumed, an adaption of the test statistic for the normal approximation is used to determine whether the difference between the actual and expected numbers of accidents is significant or not. The test statistic for a section i is

$$Z_i = \frac{a_i - e_i}{\sqrt{e_i(1-\frac{e_i}{n})}}$$

where a_i is the actual number of accidents on section i. It is assumed that when n is large e_i/n is small in comparison to 1 and hence the following conservative approximation holds:

$$Z_i = \frac{a_i - e_i}{\sqrt{e_i}}$$

One method [42] suggests that a confidence level of 97½% be used, which is equivalent to a value of Z of 1.96.

5.2.6.1. Assessment

The use of a function for producing an expected number of accidents, as described above, is the same approach as that suggested in "Predicting the Number of Un-preventable Accidents" in Chapter 4 (section 4.3.2.5.2.1). Two points concerning the use of the function in the ranking of locations for investigation are made below:-

i) It is argued above that the expected number of accidents for a section of road is some function of the length of the section of road and the traffic flow on it. Such a function could be derived from consideration of the number of accidents and the traffic flow on each section of road with which the technique is concerned, together with the length of each section.

Consider the situation in which a policy is concerned with a particular type of accident. Although it would be possible to determine a function for the expected number of the particular type of accident on a section of road in terms of the length of the section and traffic flow on it, such a function would be inaccurate. A function for calculating the expected number of a particular type of accident should take into account the number of opportunities in which such accidents could occur, e.g. if the concern were with pedestrian accidents - that is accidents between pedestrians and vehicles - the function should involve both pedestrian and vehicular flows.

Although it may be possible to produce such functions for expected numbers of particular types of accidents, the quantity of information that will have to be collected to meet the demands of possible policies may, in practice, prove prohibitive, e.g. pedestrian flows divided into age groups and vehicular flows by class of vehicle for all locations.

ii) If such a function, as described above, is derived from consideration of the number of accidents and the traffic flow on each section of road with which the technique is concerned, together with the length of each section, then the function that is obtained will not be a function for the expected number of 'un-preventable' accidents at a location, as discussed in Chapter 4. Hence the difference between the observed and expected numbers of accidents will not be a prediction of the number of 'preventable' accidents. This is because both 'preventable' and 'un-preventable' accidents are included in the accidents from which the function is derived.

5.3 CONCLUSION

Of the methods encountered in the survey and literature review none satisfy all of the requirements for a technique, as discussed in Chapter 4, in their existing forms, although a number of methods go part way to satisfying some of the requirements. In consequence of this some of the methods described in this Chapter, together with some additional ideas, are used, in the next two Chapters, to create techniques for use in identifying and ranking of accident problem locations for investigation.

CHAPTER 6

A METHOD FOR USE IN THE IDENTIFICATION OF ACCIDENT PROBLEM LOCATIONS

6.1 Introduction

This Chapter contains a description of a technique for use in the identification of accident problem locations. It was considered that because of the shortcomings in the West Midlands County Council's existing system and because a satisfactory method was not revealed by the survey, an attempt should be made to determine a new technique.

6.2 Basis of the Method

It was stated in Chapter 4 that a technique should be capable of identifying all accident problem locations, and an accident problem location was described as:

> "a location at which there are some accidents which are, to some extent, of a similar type and for which a single scheme would be prepared for their prevention, and the size of the location is such that all of the accidents that have happened or could happen which are of that similar type fall within its defining boundary."

It was also stated in that Chapter that:

"the size of problem locations can vary from a few metres of road up to and including the whole area over which the technique is being applied."

The procedure that is generally adopted in practice is not to attempt to identify accident problem locations, as described above, but to attempt to identify possible accident problem locations. These locations are then ranked for attention according to some criteria involving the accidents that have occurred at each location. This process of identification is achieved by dividing the highway network into sections - usually discrete sections. Each section is then considered as a possible accident problem location. As has been shown, the problem with this approach is that if the boundaries of the defined sections and the boundaries of the accident problems do not coincide a distorted result is obtained.

The aim of the technique, described in this Chapter, is to divide the highway network into sections such that if an accident problem exists in a section then the boundaries of both will coincide. This is to be achieved by dividing the highway network into homogeneous sections, and is based on the following reasoning:-

When an accident problem occurs on a section of road it is reasonable to expect that the effect of the problem will be uniform over the length of the section, i.e. that the probability of an accident occurring due to the problem is the same throughout the section of road, if the characteristics of the section of road are uniform, i.e. those factors which form the road users 'environment' are uniform throughout the section, e.g. lane and carriageway widths, road surface properties, adjacent land use, vehicle speeds. It is reasonable to suggest that if there is a fundamental change in the characteristics of the road then the problem may cease to exist. Hence the boundaries of the problem and the section of road on which it occurs will coincide. Even if a problem extends across a 'characteristic' boundary, i.e. the boundary between two adjacent sections of road with different characteristics, then it is possible that the effect of the problem, and hence the remedial measures required, will differ for the two sections. If this were the case the remedial schemes for the two locations should be ranked independantly.

6.3 A Method of Dividing Roads into Sections

Lengths of road, however, are rarely, if ever, homogeneous. This method divides roads into sections which can be considered, for the purpose required here, to be homogeneous. The method is based on the idea of homogeneity together with the idea of there being three groups of accident problem locations, presented in

Chapter 4. The three groups were:-

i) Spot Locations: those locations at which the problem is associated with a specific 'point' on the road, e.g. a pedestrian crossing, a junction.

ii) Stretch Locations: those locations at which the accidents of a similar type occur over a length of road, and are associated with the general 'characteristics' of the road, e.g. poor street-lighting, speeding, pedestrians crossing over a length of road as in a shopping area, parked cars.

iii) Area Locations: those locations at which the accidents of a similar type occur over an area, e.g. child pedestrian and child cyclist accidents in a residential area where the focal point is the local school; accidents in industrial areas.

A primary consideration in developing a technique for identifying and ranking accident problem locations in the West Midlands County was to reduce any alterations to the existing system,required to produce an acceptable technique, to a minimum. In attempting to comply with this, the method of dividing roads into sections was developed on the basis of the existing method of locating individual accidents (see Chapter 3). As a result of this the method is described here separately for network junctions, network stretches, and non-network areas. Accident records for the preceding 3 year period would be used, where appropriate.

6.3.1 Network Junctions

A network junction is the junction between two or more network roads, and accidents occurring up to 20 metres back along each approach are recorded as occurring at it.

For this method each network junction has been taken to be a spot location, for which the question of homogeneity does not occur - hence each network junction is a discrete section of road.

It is possible that an accident problem may be associated with a part of a junction, e.g. one particular approach, or one particular manoeuvre. However, dividing junctions into smaller sections would involve an alteration to the existing system, and would require precise recording of individual accident positions. It is felt that little benefit would be derived and that, because of the relatively small numbers of accidents that occur, the effect could be detrimental to the overall aim.

6.3.2 Network Stretches

Network stretches are the lengths of road which form the accident highway network, excluding the network junctions.

Two of the three types of accident problem location can occur on network stretches - spot locations, and stretch locations. To identify all accident problem locations the following procedure must be adopted.

Firstly the lengths of network road between the network junctions must be divided into 'homogeneous sections', where 'homogeneity' is defined by the following:-

- the traffic volume must be constant, within certain small tolerances, throughout a section

- the traffic characteristics must be uniform, within reason, throughout a section

- the physical characteristics must be uniform, within reason, throughout a section

Determination of the actual limits for the above criteria will be part of the development process required before the technique can become operational.

With respect to the physical characteristics, a section may, in practice, be a number of kilometres in length, and have minor roads leading off it and pedestrian crossings upon it, and still be acceptable as a section. The aim is to obtain sections such that, if a stretch accident problem exists on a section then the boundaries of both will conincide. The following are typical boundary positions between sections:

- major junctions
- end/start of dual carriageways
- end/start of a shopping area
- urban/rural boundary
- etc.

6.3.2.1 Pseudo Junctions

Where the end of a 'homogeneous' section does not coincide with a network junction, e.g. where there is some change in either the traffic volume, traffic characteristics, or physical characteristics (usually the latter) on the network road not caused by the presence of a network junction, it will be necessary to create a pseudo-junction, which will have finite kilometreage limits, such that all accidents caused by the change will be recorded as occurring at the pseudo-junction. Each pseudo-junction must have a unique reference number.

6.3.2.2 'Homogeneous' Sections

Because the sections will not be truly homogeneous it is possible for spot locations, and for stretch locations which do not extend over the full length of a section, to occur on a section. In order to identify all of the problem locations the following technique is used and is applied to each homogeneous section in turn.

The basis of the technique is the identification of any clusters of accidents on a section, which are then examined to determine whether or not the accident density of a cluster is significantly greater than the accident density of the remainder of the section.

When a cluster is identified as having a greater accident density it does not automatically follow that the cluster is an accident problem location. The cluster may be due, partly or wholey, to an increase in the number of random accidents at that point as a result of an increase in the number of vehicles using that element of the road, e.g. where a minor (non-network) road crosses the major road.

Hence when a cluster is identified no assessment is made as to whether or not it is an accident problem location. This assessment is made later in the process. What has been identified is a length of road where the accident density is significantly greater than for the rest of the section and, therefore, constitutes a potential accident problem location. Such a cluster should be considered separately from the remainder of the section in which it occurs because a problem may exist at it, which does not exist on the remainder of the section.

In the technique potential spot problem locations are identified first.

6.3.2.2.1 Spot Locations

For this technique an assumption has been made, based on experience gained during the course of the reseach and from work carried out elsewhere that all accidents which have occurred at individual spot locations have occurred within a length of road not greater than 100 metres long.

The procedure is as follows:-

A cursor length of 100 metres is moved along a section in jumps of 10 metres (in the existing West Midlands County Council accident recording system accidents are only located to the nearest 10 metres - see Chapter 3). The number of injury accidents 'captured' in each cursor position is noted.

The start and finish kilometreages of the position of the cursor length in which the greatest number of accidents has occurred, is noted together with the number of accidents. Where two or more cursor positions have equal numbers of accidents the position with the lowest kilometreage values, i.e. the first one encountered, is selected.

The selected cursor position is then subjected to two tests:-

i) is the accident density (accidents per unit length) of the cursor position significantly greater than might be expected from consideration of the length of the section and the number of accidents upon it? The Chi-squared Test can be used to produce the answer, as follows:-

$$\chi^2 = \frac{\left(n - \left[\frac{100N}{L}\right]\right)^2}{\left(\frac{100N}{L}\right)} + \frac{\left(\left[N-n\right] - \left[\frac{L-100}{L}\right]\right)^2}{\left(\frac{L-100}{L}N\right)}$$

where

χ^2 = Chi-squared

n = the number of accidents in the cursor position

N = the number of accidents in the section

L = the length of the section in metres

The appropriate significance level will have to be determined during development.

ii) is the accident density of either of the two immediately adjacent 100 metre lengths significantly greater than might be expected from consideration of the length of the section and the number of accidents upon it. The Chi-squared Test can be used, as above.

If the first test proves negative, i.e. that the accident density at the cursor position is <u>not</u> significantly greater than might be expected, then that 100 metre length does not constitute a potential spot accident problem location, and it can be assumed that no further potential spot locations exist on that section.

If the first test proves positive, i.e. that the accident density in the cursor position <u>is</u> significantly greater than might be expected, and the second test proves negative, i.e. that the accident densities of neither of the adjacent 100 metre lengths are significantly greater than might be expected, then the cursor position is a potential spot accident problem location. The start and finish kilometreages of the cursor position and the number of accidents is noted. The process can now be repeated on the section, excluding where necessary the accidents that have occurred in the identified potential spot location and the length of the location, to determine if there are any more potential spot locations.

If both tests prove positive this implies that the accidents in the cursor position are part of a potential stretch accident problem location, and not a potential spot location. The process must now be repeated to determine if there are any potential spot locations on the section. Those accidents that were in the cursor position which has been identified as being a potential stretch location must be suppressed when the identification of the cursor position with the greatest number of accidents is carried out, but must be included when the tests are being carried out in order to prevent another part of the potential stretch location from being identified as a potential spot location.

6.3.2.2.2 Stretch Locations

The following procedure is used to identify potential stretch problem locations which occur within a pre-defined 'homogeneous' section.

The length of the section minus the length of any potential spot problem locations that have been identified by the previous technique, is divided by the number of accidents on the section minus the number of accidents on the spot locations, to obtain an 'average distance between accidents' - this is not the precise arithmetic mean because the distances from the start and finish of the section to the first and last accidents, respectively, are included.

Ignoring the accidents on the spot locations the 'average distance between accidents', obtained above, is compared with the actual distance between each adjacent accident (adjacent in position, not time) and those lengths where the actual distance is the shorter are retained.

The lengths which are directly adjacent are collected into groups such that a continuous, unbroken length of road is formed from each group. Where a length of road between two accidents is not adjacent to another length which is shorter than the 'average distance between accidents', then it is discarded.

Each group of accidents so formed must be subjected to the following test:-

i) is the density of accidents in the group significantly greater than might be expected from consideration of the length of the section and the number of accidents upon it (excluding where appropriate, the lengths and numbers of accidents for any identified spot location)? The Chi-squared test can be used as follows:-

$$\chi^2 = \frac{\left(n - \left[\frac{l}{L} N\right]\right)^2}{\frac{l}{L} N} + \frac{\left(\left[N - n\right] - \left[\frac{L - l}{L} N\right]\right)^2}{\frac{L - l}{L} N}$$

where

l = the length of road in metres, from the first to the last accident in the group

n = the number of accidents in the group

L = the length of the section in metres, minus the length of any spot locations

N = the number of accidents in the section minus the number of accidents in any spot locations

If the test proves positive then the group of accidents constitutes a potential stretch problem location.

6.3.2.2.3 <u>Section Locations</u>

Once the potential spot and stretch problem locations have been identified in a section by the above techniques the remainder of the section must be considered as a potential accident problem location in which the effect of a problem if one exists, extends over the whole of the section. Hence the remainder of the section must be considered as a single entity.

It is not necessarily true that, for the remainder of the section, only an accident problem which extends over all of the remainder of the section can occur. It is possible, for example, for a spot location to exist, but remain undetected because the density of accidents at the spot location is not significantly greater than for the remainder of the section. However this is unlikely, but if such a situation does occur then it is probable that either:-

a) the effect of the problem at the spot location is minor - reflected by a low accident density, or

b) the effect of the problem on the remainder of the section is major, with a high accident density, in which case the section is likely to be high in the priority listing for attention, and the spot location should be discovered in the course of a detailed investigation of the section.

6.3.3 Non-Network Areas

In this method non-network roads are tackled separately from network roads despite the possibility that a problem affecting a particular non-network area may also affect an adjacent network road. The reason for not including the network road is that, by virtue of the fact that the road has been selected to be a part of the network, the traffic characteristics of the network road will be different from those in the non-network area.

To identify the accident problem locations in non-network areas it is first necessary to divide the County area into smaller areas within which the 'environmental' conditions are reasonably constant, e.g. industrial, residential, rural, to create 'homogeneous' area. Each area, so formed, can then be considered individually, as was the case with the 'homogeneous' sections of road.

It is possible for all three types of accident problem location to occur in non-network areas - spot locations, stretch locations, and area locations. However it was decided that it was unnecessary to devise a technique for identifying stretch locations, for the following reasons:-

i) For a stretch of road to be a significant accident problem location the road would have to be a route, and most of the routes have been included in the network.

ii) The majority of accidents occur on network roads. Therefore there are unlikely to be many such locations.

iii) Such locations would be detected in the course of a detailed study of the larger area within which they occur.

In the West Midlands County Council's existing system, see Chapter 3, non-network accidents are located in the following way. All accidents occurring in the 100metre x 100metre grid square 'A' in figure 26 are given the grid reference of the bottom left-hand (south-west) corner of that square, i.e.grid reference 204 100

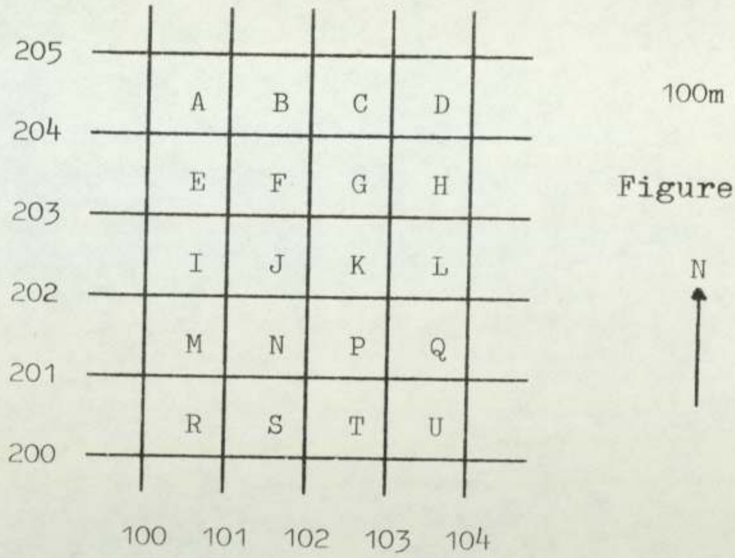


Figure 26.

6.3.3.1 <u>Spot Locations</u>

For the identification of spot locations the assumption was made that the maximum size of a spot location is 100 metres by 100 metres square.

Consider the 200 metre by 200 metre square formed by A, B, E and F in figure 26. It can be seen that a spot location could occur in A or B or E or F, or between A and B, A and E, E and F, F and B, or in the middle of A and E and B and F. This equally applies for the square formed by B, C, F, and G.

The method for identifying spot locations is as follows:-

Count the number of accidents that have occured in each 200 metre x 200 metre square that can be formed with a different 100 metre x 100 metre grid square in the bottom left-hand corner, i.e. in figure 26, if all of the lettered squares form a 'homogeneous' area, there will be twelve 200 metre x 200 metre squares formed with the following 100 metre x 100 metre squares in the bottom left-hand corner - E, F, G, I, J, K, M, N, P, R, S, T,

Pick out the 200 metre x 200 metre square which contains the highest number of accidents. Test whether the density of accidents in this 200 metre x 200 metre square exceeds the density of accidents for the whole of the area by a statistically significant amount. This can be achieved using the Chi-squared Test as follows:-

$$\chi^2 = \frac{\left(n - \left[\frac{0.04}{A} N\right]\right)^2}{\left(\frac{0.04}{A} N\right)} + \frac{\left(\left[N - n\right] - \left[\frac{A - 0.04}{A} N\right]\right)^2}{\left(\frac{A - 0.04}{A} N\right)}$$

where

χ^2 = Chi- squared

n = the number of accidents in the 200 metre x 200 metre square

N = the number of accidents in the are

A = the total area in square kilometres.

If the accident density is significantly greater, then a potential spot problem location exists in that 200 metre by 200 metre square. The process can then be repeated (excluding any part of the square already identified) to determine if any further potential spot problem locations exist.

6.3.3.2 Area Locations

Once the potential spot problem locations have been identified in an area the remainder of the area must be considered as a potential accident problem location in which the effect of a problem, if one exists, extends over the whole of the area. Hence the remainder of the area must be considered as a single entity.

6.4 Conclusion

The method, described above, would divide the highway network in the County into the following groups of locations:-

a) Network Junctions - for which the start and finish kilometreages and the accidents that have occurred at each location in the preceding three years are known,

b) Potential Spot Problem Locations (on network roads) - for which the start and finish kilometreages and the accidents that have occured at each location in the preceding three years are known,

c) Potential Stretch Problem Locations (on network roads) - for which the start and finish kilometreages and the accidents that have occurred at each location in the preceding three years are known,

d) 'Homogeneous' Sections of Network Road - for which the start and finish kilometreages of each section, the length of the section excluding the lengths of any potential spot and stretch locations that have been identified as occurring on the section, and the accidents that have occurred on the section in the preceding three years, excluding any accidents that occurred on the potential spot and stretch locations, are known,

e) Pseudo Junctions - for which the start and finish kilometreages and the accidents that have occurred in the preceding three years are known,

f) Potential Spot Problem Locations (on non-network road) - for which the grid reference boundary and the accidents that have occurred in the preceding three years are known,

g) 'Homogeneous' Areas of Non-network roads - for which the area of the 'homogeneous' area, excluding the area of any potential spot locations, identified as occurring in the 'homogeneous' area, and the accidents that have occurred in the preceding three years, excluding any accidents in any potential spot locations, are known.

The information for each location will then be used in a ranking procedure to produce a list of locations for investigation.

It can be seen that a considerable amount of work would be required to carry out the division of the highway network into homogeneous sections. It must be emphasised, however, that this task would only have to be carried out once, apart from updating due to road improvements, new highway construction, changes in the pattern of traffic movement, etc. The process of identifying potential spot and stretch problem locations on network roads and potential spot problem locations on non-network areas would, of course, be repeated each time a new list of locations is required, but this could be carried out on a computer.

CHAPTER 7

A METHOD FOR PREDICTING THE NUMBER OF 'UNPREVENTABLE' ACCIDENTS

7.1 Introduction

In Chapter 4 it was argued that locations should be ranked for investigation, at the stage with which this study is concerned, on the basis of the benefit it is possible to obtain at each location. It was proposed that in order to assess the possible benefit at locations an attempt should be made to determine at each location the number of the accidents, with which a policy is concerned, which are 'preventable'. A number of different approaches were suggested.

This chapter looks in more detail at one of these approaches - 'Predicting the Number of Unpreventable Accidents'. The basis of this approach is the production of some function by which the expected number of 'unpreventable' accidents at a location can be calculated. The difference between the expected number of 'unpreventable' accidents and the observed number of all accidents at a location is the number of 'preventable' accidents. The decision to investigate this approach was based on the following reasons:-

From the review of techniques for identifying and ranking accident problem locations, described in

Chapter 5, it appears that the situation in which the concern is with the prevention of all injury accidents, as opposed to particular types of accidents, is most common. Therefore it was felt that it was more important to consider those approaches, suggested in Chapter 4, for determining the total number of accidents in the preventable category at a location.

The first of the approaches, discussed in Chapter 4, was the suggestion that an attempt could be made to identify the 'unpreventable' accidents at a location, and hence the number of 'preventable' accidents, by producing a list of factors which, if one or more appeared in an accident record, would result in the accident being classed as 'unpreventable'. It was decided not to pursue this approach, for the reasons given in that section.

The basis of the second approach was to establish the number of similar accidents at a location by identifying the appropriate common factors. In Chapter 4 it was stated that the principal problem, as far as the West Midlands County Council's system is concerned, is that only a single causation is assigned to each accident. In practice accidents will often have a number of contributory causes, and if factor analysis is to be carried out all of these contributory casuses should be recorded. However determining all possible contributory causes for each accident will require a thorough and detailed examination of the police accident record books, and probably witnesses statements. Thus an increase in the quantity and quality of the abstracting and coding of the accident details will be required, together with increases in data input, data storage space in the computer, and processing time. A certain amount of computer program re-writing will also be required. Hence it was considered that the third approach should be examined in an attempt to avoid these alterations.

Another reason for considering this particular approach for predicting the number of 'unpreventable' accidents is that it may be of use if a policy concerning a particular type of accident is introduced. In Chapter 4 it was explained that, with the second of the two approaches suggested for determining the numbers of accidents of a particular type which are preventable, the result may be affected if there is more than one accident problem, and hence more than one group of similar accidents, at a location. This problem could be overcome if the expected number of 'unpreventable' accidents at such locations is available - calculated according to the approach to be discussed in this chapter. The expected number of accidents of the particular type could be calculated knowing the expected number of 'unpreventable' accidents, and the incidence of the particular type of accident in the County in one year. Ranking could then be based on the difference between the expected and observed numbers of the particular type of accident.

7.2 Predicting the Number of Unpreventable Accidents

The reasoning for this method of accident prevention was described in Chapter 2 as follows:-

> "When more than one accident occurs at a location it is possible that some of the accidents will be, to some degree, similar. If the points of similarity can be identified then measures can be specifically designed to prevent those accidents which are subject to the points of similarity."

In Chapter 4 the following statement was added to the above:-

> "In addition to the 'similar' accidents at a location it can be seen that there will be accidents which are not 'similar'. It is as much a part of this approach that these accidents cannot be prevented by the small highway and traffic engineering remedial measures with which this approach is concerned. Consider again the Transport and Road Research Laboratory paper (described in section 2.4) in which the potential savings in accidents due to improvements in the road environment is put at 20%."

It can be seen that the conclusion that is drawn is that there may be accidents at a location which can be prevented by small highway and traffic engineering measures and accidents which cannot be prevented by such measures.

Consider the 'unpreventable' accidents - the accident which cannot be prevented by such measures. Two assumptions can be made concerning these accidents:-

1) The number of 'unpreventable' accidents at a location will increase with increasing traffic flow because there will be more opportunity for such accidents to occur.

2) The chance of an 'unpreventable' accident occurring is not independant of location characteristics, i.e. for different types of location with identical traffic flows the number of 'unpreventable' accidents cannot be expected to be the same at each location. This is because:

   a) the chance of a particular event occurring, which may result in an unpreventable accident, will vary between different types of location, e.g. it is unlikely that the chance of a dog straying onto the carriageway will be the same for a motorway and a road in a residential area,

   b) the chance that a particular event will result in an 'unpreventable' accident will vary between different types of location, e.g. it is unlikely that the chance of a burst tyre resulting in an accident will be the same on a high speed dual carriageway as on a single carriageway with a 30 m.p.h. speed limit.

Now consider a number of identical locations, but with different traffic flows, where the traffic flow and number of 'unpreventable' accidents in a set time period are known for each location. A relationship between the traffic flow and the number of 'unpreventable' accidents can be determined by regression. Because the locations are identical the effect of location characteristics on the chance of an 'unpreventable' accident occurring will be the same for all of the locations.

Hence a function is produced with which the expected number of 'unpreventable' accidents at a location can be determined if the traffic flow at the location is known. There are three problems to be overcome before this approach can be used in practice:-

1) identical locations do not exist

2) actual numbers of 'unpreventable' accidents will not be known

3) traffic flow data will not be available for all locations

These problems are discussed, below, in relation to the proposals considered in the previous chapter.

7.2.1 'Identical' Locations

Despite the fact that identical locations do not exist, it is considered that it is possible to determine groups of locations which will be sufficiently similar to achieve the basic aim of the approach. It should be remembered that the 'unpreventable'accidents, by their definition, are not affected by minor highway variations. In practice this could be achieved as follows.

In Chapter 6 it was proposed that the highway networks be divided into 'homogeneous' locations, of which there were seven categories. When the process of dividing the highway network into the 'homogeneous' sections is carried out each network junction, homogeneous section of network road, psuedo junction, and non-network area could be further classified according to certain additional categories, e.g. roundabout, dual carriageway, residential area. In the case of potential spot and stretch problem locations they would automatically take the classification of the road or area in which they occurred.

Hence functions would be produced from and for each sub-group of locations which are in the same homogeneous group and which have the same additional classifications. Selection of the actual categories for classification will have to be carried out during development of the technique.

7.2.2 <u>Numbers of 'Unpreventable' Accidents</u>

If this approach were to be adopted, actual numbers of 'unpreventable' accidents would not, at first, be known. In time, when sufficient detailed studies of accidents at individual locations have been carried out, information would be available as to actual numbers of 'unpreventable' accidents. This information can then be used in the production of the functions.

Initially, however, only the numbers of all accidents at locations will be known. This information can be used to produce a function, but it will be a function for the expected number of all accidents at a location and not the expected number of 'unpreventable' accidents.

Consider the situation in which it is known that, for a particular type of location, it is usually possible to prevent, by a remedial scheme, a specific proportion of the accidents that occur, e.g. 40%. This can be interpreted as meaning that 40% of the accidents at a location are 'preventable' accidents, and the remaining 60% are 'unpreventable' accidents. It can be seen that, on this basis the expected number of 'unpreventable' accidents at a location where the traffic flow is known would be 60% of the expected number of all accidents obtained from a function, as described above. In other words a function for the expected number of 'unpreventable' accidents would be 0.6 times the function for the expected number of all accidents.

Initially, in practice, the relationship between the function for the expected numbers of all accidents and the function for the expected number of unpreventable accidents could be based on the estimate of the potential savings in injury accidents given by the T.R.R.L., discussed in Chapter 2. Alternatively, information may be available from work carried out by other local authorities or research organisations.

7.2.3 Traffic Flow Data

Traffic flow data would be required for this approach. At present traffic flow information is not available for the whole of the accident highway network. Therefore this information would have to be obtained before the technique could be introduced, and would have to be updated at regular intervals.

In the case of non-network roads, it could be considered to be impractical, because of the additional resources required, to attempt to collect traffic flow data. However, traffic flow data for non-network areas may not be necessary for the production of a function, for the following reasons:-

> because non-network areas do not, usually, include through-routes, the variation in traffic flow between similar types of non-network area will be relatively small.

7.3 Selection of a Function

This section discusses the selection of functions for the expected number of accidents at locations, for network and non-network locations separately.

7.3.1 Network Locations

For each sub-group of locations which occurs on network roads, and hence for which traffic flows would be available the function for the expected number of accidents has 'exposure' as the single variable, where exposure is measured by

$$Q.L$$

where Q = traffic flow per unit time,

and L = length of road

$$\therefore \quad e = f\,(Q.L)$$

where e = expected number of accidents

For network junctions no account is taken in the function, directly, of the variation in turning movements at different junctions. However this can be taken into account by an appropriate addition to the classifying categories for the determination of sub-groups. This is demonstrated in examples of regression analyses, given later.

In a similar manner, variations in pedestrian presence must be taken into account during the selection of the sub-groups.

A non-linear function is required because the chance that a driver error or loss of control will result in a collision with another vehicle increases with increased vehicle presence. The following non-linear relationship was selected

$$e = a . Q^{b} . L$$

where 'a' and 'b' are constants for a particular sub-group of locations

For network junctions, potential spot problem locations on network roads, and psuedo junctions the difference in road lengths is considered to be negligible, and 'L' is given the value of unity.

7.3.2 Non-Network Locations

For potential spot problem locations in non-network areas, the expected number of accidents for a spot location in a particular sub-group is obtained by dividing the total number of accidents from all of the locations in the sub-group by the number of locations, i.e.

$$e = \frac{\sum_{L=1}^{L=N} A_L}{N}$$

where A_L = number of accidents at location 'L'

N = number of locations in the sub-group

For 'homogeneous' areas of non-network roads the expected number of accidents per unit area is obtained by dividing the total number of accidents from all locations in a sub-group by the total area of the locations, i.e.

$$e = \frac{\sum_{L=1}^{L=N} A_L}{\sum_{L=1}^{L=N} B_L}$$

where B_L = the area of location 'L'

7.4 Regression Analyses

In order to determine a function for the expected number of accidents at a location, of a particular sub-group, for which the traffic flow is known a regression analysis is required. To demonstrate this regression analyses were carried out on a random sample of network junctions (subject only to availability of traffic flow information). The following are the four sub-groups which were selected, together with the number of junctions in each sub-group:-

i) automatic traffic signal (A.T.S.) controlled junctions - 20 junctions

ii) roundabouts - 20 junctions

iii) priority junctions at which 25% or less of the vehicles entering the junction entered on the minor road - 12 junctions

iv) priority junctions at which more than 25% of the vehicles entering the junction entered on the minor road - 11 junctions

Each junction was visited to confirm that it satisfied the classification criteria, and certain information on the physical position and layout of the junction was noted. This information, together with the traffic flow and accident record for the preceding three years was recorded and is contained in the appendix, along with plans showing the approximate position of each junction in the County. The traffic flow data for each junction was converted to an annual traffic flow for 1977, and a description of how this was carried out is also contained in the appendix.

Thus for each junction in each sub-group the following information was available:-

i) Y = the number of accidents per annum

ii) X = annual traffic flow

The selected form of the function was

$$Y = a \cdot X^b$$

where 'a' and 'b' are constants for each sub-group

The constants 'a' and 'b' were found, for each sub-group by carrying out a linear regression to form the function

$$\log_e Y = \log_e a + b \cdot \log_e X$$

The regression was carried out using a standard package for a programmable calculator. The data for each sub-group is contained in tables, 7, 8 and 9.

7.4.1 A.T.S. Junctions

From the regression analysis conducted on the data from the A.T.S. junctions the values of 'a' and 'b' were found to be

$$a = 0.105\ 432$$
$$b = 1.461\ 262$$

hence the function for the expected number of accidents is

$$e = 0.105\ 432 \times Q^{1.461\ 262}$$

This result is represented diagramatically in figure 27.

The absolute value of the correlation coefficient, r, was found to be

$$r = 0.633\ 617$$

A.T.S. Junctions - Data for Regression Analysis

Site	Traffic Flow per annum - X ($x 10^6$)	Accidents per annum - Y	Log_e X	Log_e Y
1	11.774 065	9.666 667	2.465 899	2.268 684
2	7.289 409	0.666 667	1.986 422	-0.405 465
3	11.181 723	6.000	2.414 281	1.791 760
4	19.808 614	8.333 333	2.986 117	2.120 264
5	9.581 107	4.333 333	2.259 793	1.466 337
6	5.036 395	0.333 333	1.616 690	-1.098 613
7	13.768 376	6.000	2.622 374	1.791 760
8	10.750 172	1.666 667	2.374 922	0.510 826
9	8.258 758	3.333 333	2.111 274	1.203 973
10	6.842 852	2.666 667	1.923 205	0.980 829
11	4.564 798	3.666 667	1.518 374	1.299 283
12	6.923 363	1.333 333	1.934 902	0.287 682
13	7.196 591	1.666 667	1.973 607	0.510 826
14	9.427 411	2.000	2.243 621	0.693 147
15	8.735 255	2.000	2.167 367	0.693 147
16	11.355 657	3.000	2.429 716	1.098 612
17	9.042 687	3.666 667	2.201 956	1.299 283
18	6.716 126	2.333 333	1.904 511	0.847 298
19	11.719 337	3.333 333	2.461 240	1.203 973
20	11.921 665	2.333 333	2.478 357	0.847 298

Table 7.

Roundabouts - Data for Regression Analysis

Site	Traffic Flow per annum - X ($\times 10^6$)	Accidents per annum - Y	$\log_e X$	$\log_e Y$
1	8.973 024	2.666 667	2.194 223	0.980 829
2	7.419 029	0.333 333	2.004 048	-1.098 613
3	11.234 401	2.666 667	2.418 981	0.980 829
4	4.549 730	0.666 667	1.515 068	-0.405 465
5	9.028 181	2.666 667	2.200 351	0.980 829
6	11.296 264	2.333 333	2.424 472	0.847 298
7	6.829 263	1.666 667	1.921 217	0.510 826
8	7.769 118	0.666 667	2.050 157	-0.405 465
9	10.727 601	4.000	2.372 820	1.386 294
10	5.243 217	1.000	1.656 935	0.000
11	5.741 352	0.666 667	1.747 695	-0.405 465
12	11.137 839	1.333 333	2.410 348	0.287 682
13	7.715 918	0.666 667	2.043 286	-0.405 465
14	10.069 665	1.333 333	2.309 527	0.287 682
15	12.610 593	4.333 333	2.534 537	1.466 337
16	10.705 291	2.666 667	2.370 738	0.980 829
17	8.675 320	0.666 667	2.160 482	-0.405 465
18	11.104 981	1.666 667	2.407 394	0.510 826
19	4.775 483	0.333 333	1.563 495	-1.098 613
20	3.770 741	0.333 333	1.327 271	-1.098 613

Table 8.

Priority Junctions (1) - Data for Regression Analysis

Site	Traffic Flow per annum - X ($x 10^6$)	Accidents per annum - Y	Log_e X	Log_e Y
1	5.833 325	2.666 667	1.763 588	0.980 829
2	3.801 977	0.666 667	1.335 521	-0.405 465
3	4.038 206	1.666 667	1.395 800	0.510 826
4	8.542 005	4.333 333	2.144 996	1.466 337
5	7.559 006	3.000	2.022 740	1.098 612
6	2.611 573	1 000	0.959 953	0.000
7	5.643 475	3.666 667	1.730 500	1.299 283
8	3.004 148	1.000	1.099 994	0.000
9	7.194 277	1.000	1.973 279	0.000
10	4.295 997	0.333 333	1.457 684	-1.098 613
11	5.621 357	0.333 333	1.726 573	-1.098 613
12	6.515 807	1.000	1.874 231	0.000

Priority Junctions (2) - Data for Regression Analysis

Site	Traffic Flow per annum - X ($x 10^6$)	Accidents per annum - Y	Log_e X	Log_e Y
1	4.449 168	0.666 667	1.492 717	-0.405 465
2	3.696 489	2.000	1.307 383	0.693 147
3	5.572 500	2.666 667	1.717 844	0.980 829
4	7.333 931	2.000	1.992 512	0.693 147
5	6.907 935	1.000	1.932 671	0.000
6	7.349 700	3.000	1.994 659	1.098 612
7	7.491 134	3.666 667	2.013 720	1.299 283
8	4.756 881	0.333 333	1.559 592	-1.098 613
9	1.238 413	0.333 333	0.213 831	-1.098 613
10	7.227 282	4.666 667	1.977 863	1.540 445
11	6.704 091	1.000	1.902 718	0.000

The value of r indicates the degree of correlation between the function and the data from which it was produced - the closer the value of 'r' is to unity, the higher is the degree of correlation. 'r' is obtained from the following equation:-

$$r^2 = \frac{m^2 \cdot o_x^2}{o_y^2}$$

where m = slope of the regression line

o_x^2 = variance of the 'x' data points

o_y^2 = variance of the 'y' data points

In this case a value of 'r' close to unity would indicate either that no problems exist at any of the locations, or that there are problems at each location which have a similar effect on the numbers of accidents. It can be seen in figure 27 that one of the locations has an actual number of accidents considerably in excess of the expected number.

7.4.2 Roundabouts

From the regression analysis conducted on the data from the roundabouts the values of 'a'and 'b' were found to be

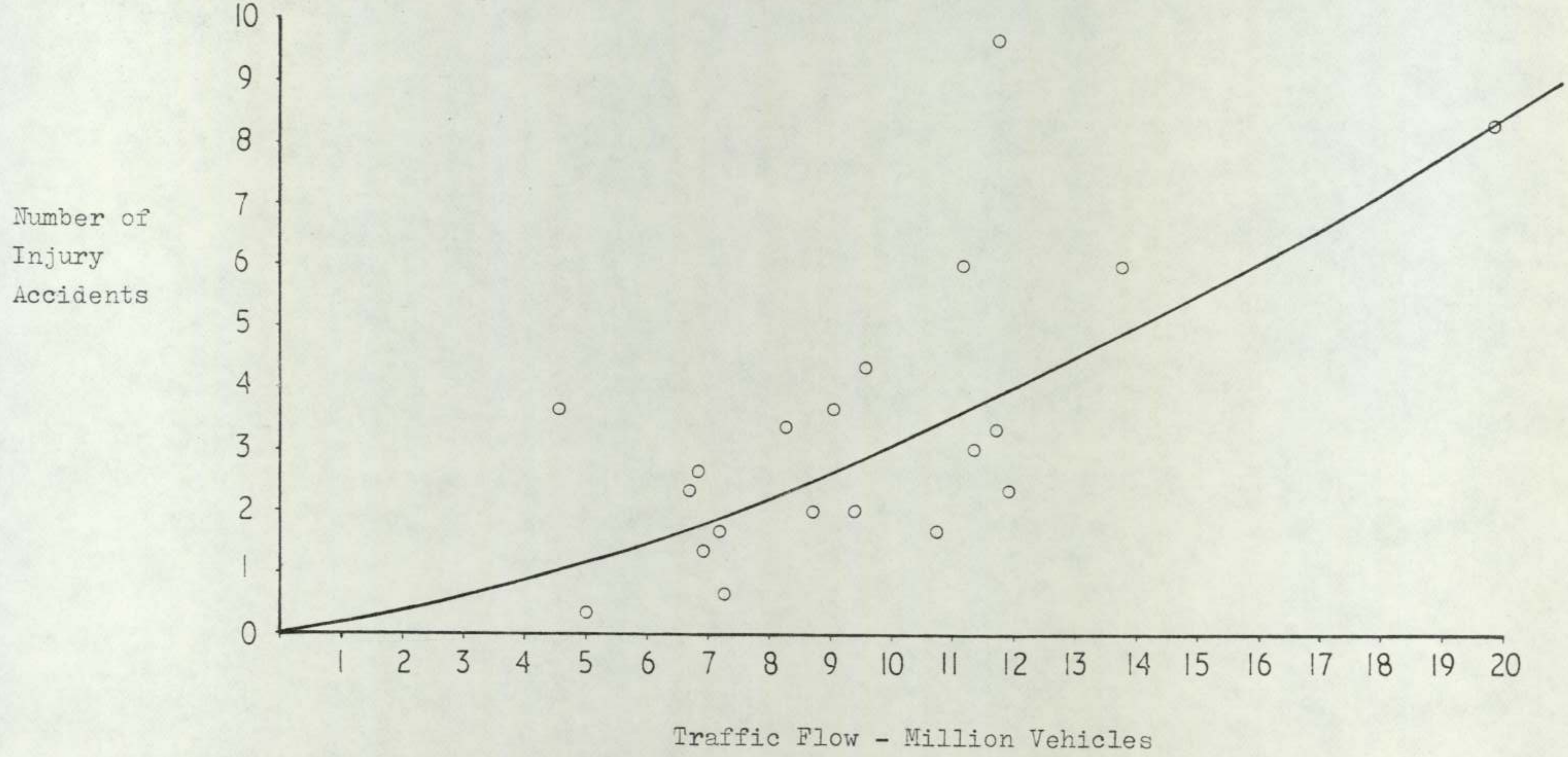
a = 0.029 442

b = 1.773 727

hence the function for the expected number of accidents is

$$e = 0.029\ 442 \times Q^{1.773\ 727}$$

FIGURE 27: A.T.S. JUNCTIONS - REGRESSION ANALYSIS



this result is represented diagramatically in figure 28.

The value of r, the absolute value of the correlation coefficient, was

$$r = 0.786\ 448$$

7.4.3 Priority Junctions (minor road traffic less than 25%)

From the regression analysis conducted on the data from the priority junctions at which 25% or less of the traffic enters on the minor roads, the values of 'a' and 'b' were found to be

$$a = 0.244\ 472$$

$$b = 1.008\ 836$$

hence the function for the expected number of accidents is

$$e = 0.244\ 472 \times Q^{1.008\ 836}$$

This result is represented diagramatically in figure 29.

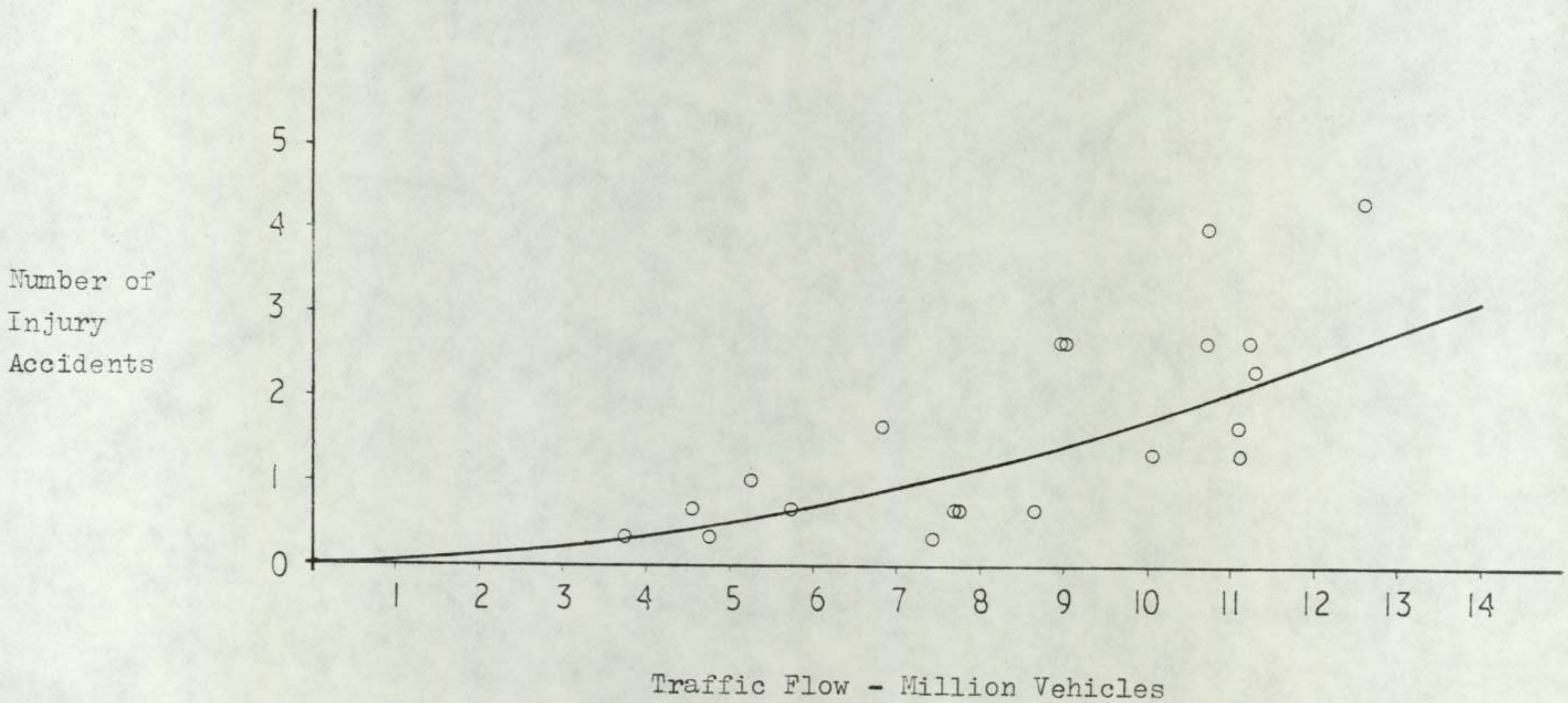
The value of r, the absolute value of the correlation coefficient, was

$$r = 0.436\ 073$$

7.4.4 Priority Junctions (minor road traffic greater than 25%)

From the regression analysis conducted on the data from the

FIGURE 28: ROUNDABOUTS - REGRESSION ANALYSIS



priority junctions at which more than 25% of the traffic enters on the minor roads, the values of 'a' and 'b' were found to be

$$a = 0.221\ 450$$

$$b = 1.120\ 428$$

hence the function for the expected number of accidents is

$$e = 0.221\ 450 \times Q^{1.120\ 428}$$

This result is represented diagramatically in figure 30.

The value of r, the absolute value of the correlation coefficient, was

$$r = 0.646\ 425$$

The regression analysis, shown above, would be applied in a similar manner to each of the sub-groups of potential spot problem locations on network roads and psuedo-junctions. For potential stretch problem locations and 'homogeneous' sections on network roads the constants 'a' and 'b' would be found using the 'annual traffic flow per unit length' from each location, i.e.

$$Y = a \cdot \left(\frac{X}{L} \right)^{b}$$

7.5 Functions for 'Unpreventable' Accidents

Having produced functions for the expected number of accidents

FIGURE 29: PRIORITY JUNCTIONS 1

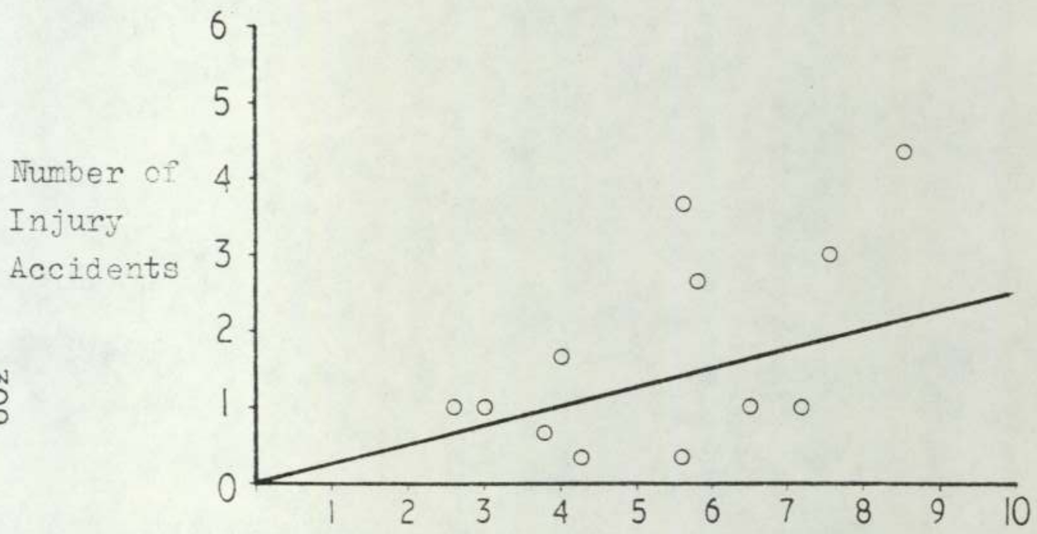
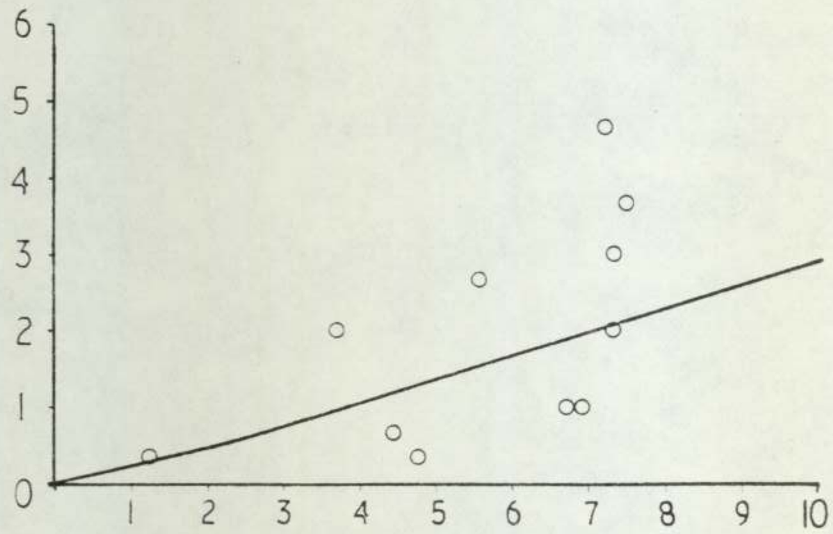


FIGURE 30: PRIORITY JUNCTIONS 2



Traffic Flow - Million Vehicles

for each sub-group of each of the seven location groups, adjustments are required to produce the final functions which are to be used to predict the expected number of 'unpreventable' accidents at locations in each sub-group. As was stated earlier the adjustments can be based initially on the estimate of the potential savings in injury accidents given by the T.R.R.L.[21], which is discussed in Chapter 2.

7.6 Conclusion

This chapter has been concerned with a proposal for the production of functions for predicting the number of unpreventable accidents. From a knowledge of the traffic flow at a location, the function appropriate to the type of location could be used to calculate an expected number of unpreventable accidents. The difference between the number and the number of observed accidents at a location is the expected number of preventable accidents for that location, and is the number to be used in the ranking of locations. Exactly how it is used will depend upon the way in which the benefit is measured, as discussed in Chapter 4, which is in turn dependant upon the Highway Committee's policy.

It can be seen that this approach would involve a certain amount of work before it could be introduced. Classification of locations is required, although this can be viewed as an extension of the work required to implement the proposals in Chapter 6 and need only be carried out once - except for occasional updating as alterations to locations occur.

Additional traffic flow data, however, will be required, and will need to be updated on a regular basis. Alterations to existing computer programs will also be required, and new programs will need to be prepared.

Conclusions and Discussion

This study has been concerned, primarily, with the task of identifying and ranking traffic accident problem locations for investigation using road and traffic information, together with individual accident records.

After reviewing the concept and history of traffic and highway engineering measures as a method for reducing the occurrance of accidents, the need for an requirements of a technique for identifying and ranking accident problem locations for investigation were explained. An examination of the West Midlands County Council's existing Traffic Accident Recording System revealed serious shortcomings with regard to the method employed in that system for identifying and ranking accident problem locations.

In view of these shortcomings the requirements for a technique, stated previously, were considered in depth, in conjunction with appropriate practical constraints. The following conclusions were reached:

- accident problem locations can vary in size from a few metres of road upto and including the whole area over which the technique is to be applied. All possible locations should be considered.

- the positional order of locations for investigation should be based upon a prediction of the benefit, as stipulated by the Highways Committee, that can be achieved at each location.

It is not possible, at the stage under consideration, to predict the costs involved in achieving the benefit.

An approach to assessing the possible benefit at each location was also discussed.

A study was conducted of existing techniques for identifying and ranking accident problem locations, the details of which were obtained by means of a survey of the County and Regional Councils and a literature review. However, no single alternative was found which would satisfy the requirements for a technique.

In consequence of this it was decided that consideration should be given to the problem. As a result the following proposals were put forward:-

- a method was proposed for dividing the highway network into sections, each of which would be considered as a potential accident problem location.

- a method was proposed, to be used with the above method, for determining the number of 'unpreventable' accidents at a location, in order to calculate the number of 'preventable' accidents for each location. This would be used in the assessment of the possible benefit at each location.

It is unfortunate that there was insufficient time to develop these proposals to a finished state. However, if the West Midlands County Council accept that their existing system is unsatisfactory, and decide that the situation is to be rectified, then this thesis in general and the proposals in particular will provide a foundation and direction for the development of an acceptable system.

With regard to the development of such a system it has been shown that alterations to the existing system will be required. There are alternative approaches, however, and the work required for implementing each approach will need to be established in detail in order that it can be considered, in conjunction with policy requirements, when the decision on the approach, or approaches, to be adopted is taken. In addition, consideration should be given where extra information would have to be collected, to the alternative uses to which such information can be put. For example, the additional traffic flow data required for the method proposed in Chapter 7 may be considered to have a wider application, and hence be of more general value, than the results of the abstracting and coding of additional accident details required for one of the alternative approaches.

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APPENDIX A

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APPENDIX B

Replies to the survey, described in Chapter 5, were received from the following:

Metropolitan Counties:

Greater Manchester	South Yorkshire
Tyne and Wear	

County Councils - England:

Avon	Bedfordshire
Buckinghamshire	Cambridgeshire
Cheshire	Cleveland
Cornwall	Derbyshire
Devon	Dorset
Durham	East Sussex
Gloucestershire	Hampshire
Hereford and Worcester	Hertfordshire
Kent	Lancashire
Leicestershire	Lincolnshire
Norfolk	Northamptonshire
Northumberland	North Yorkshire
Nottinghamshire	Oxfordshire
Salop (Shropshire)	Somerset
Staffordshire	Suffolk
Warwickshire	West Sussex
Wiltshire	

County Councils - Wales :

Clwyd	Dyfed
Gwent	Mid-Glamorgan
South-Glamorgan	

Regional Councils - Scotland:

Borders	Central
Dumfries and Galloway	Highland
Lothian	Strathclyde

A P P E N D I X   C

Calculation of Annual Traffic Flows At Junctions

The annual traffic flows at the selected junctions were calculated from the regular manual traffic counts taken by the West Midlands County Council. Each count is taken on one day and is usually of $10\frac{1}{2}$ or 12 hours duration - 8.00 a.m. to 6.30 p.m. and 7.00 a.m. to 7.00 p.m. respectively. Because of the error in the values in the existing system for calculating annual traffic flows, described in 3.7.2, the following approach has been adopoted.

This approach uses information from some automatic-count location near to the junction to predict the flow pattern at the junction. The automatic-count location must be close enough to the junction to permit the assumption that the traffic flow pattern will be the same at both locations. An automatic count is one in which a mechanical counter is used, usually a pneumatic detector is used although there are a number of permanently-sited magnetic detectors in the West Midlands County. The automatic count locations are usually stretches of road away from junctions. The pneumatic detectors are left in position for a complete and continuous 7-day period. Automatic counts are carried out at the same locations usually at intervals of one year.

Using the traffic flow data obtained from the relevant automatic count, the following procedure was adopted:-

1) The $10\frac{1}{2}$ or 12 hour flow at each junction was converted to a 24 hour flow for the junction for the same day of the week on which the count was taken, by multiplying by the value of either

$$\frac{Tot_{(same\ day)}}{10\frac{1}{2}_{(same\ day)}} \quad \text{or} \quad \frac{Tot_{(same\ day)}}{12_{(same\ day)}}$$

as appropriate, where

$Tot_{(same\ day)}$ = the total flow at the automatic-count location on the same day of the week as the count at the junction

$10\frac{1}{2}_{(same\ day)}$ = the flow at the automatic-count location on the same day of the week as the count at the junction in the same $10\frac{1}{2}$ hour period

$12_{(same\ day)}$ = the flow at the automatic-count location on the same day of the week as the count at the junction in the same 12 hour period

2) The 24 hour flow was converted to an 'average flow' by multiplying by the value of

$$\frac{Tot_{(week)}}{Tot_{(same\ day)} \times 7}$$

where

$Tot_{(week)}$ = the total flow at the automatic-count location in the complete 7-day period

3) The average flow was converted to a standard flow by multiplying by the appropriate MONTH FACTOR for the month in which the manual count was taken. The MONTH FACTORS used were those from the existing system (see section 3.7.2) and were used to correct for seasonal variation.

4) An annual flow was then obtained by multiplying by 365. The reduced flows that occur at Christmas and the variation in flow at other Bank Holidays were considered to be insignificant, in this context, and were ignored.

5) The annual flows were converted to the same base year, 1977, to counter any variation due to annual growth. The annual flow for each junction where the count was not carried out in 1977 was adjusted to a 1977 flow using the ratio of the automatic count in the same year as the junction count to the aumtomatic count in 1977.

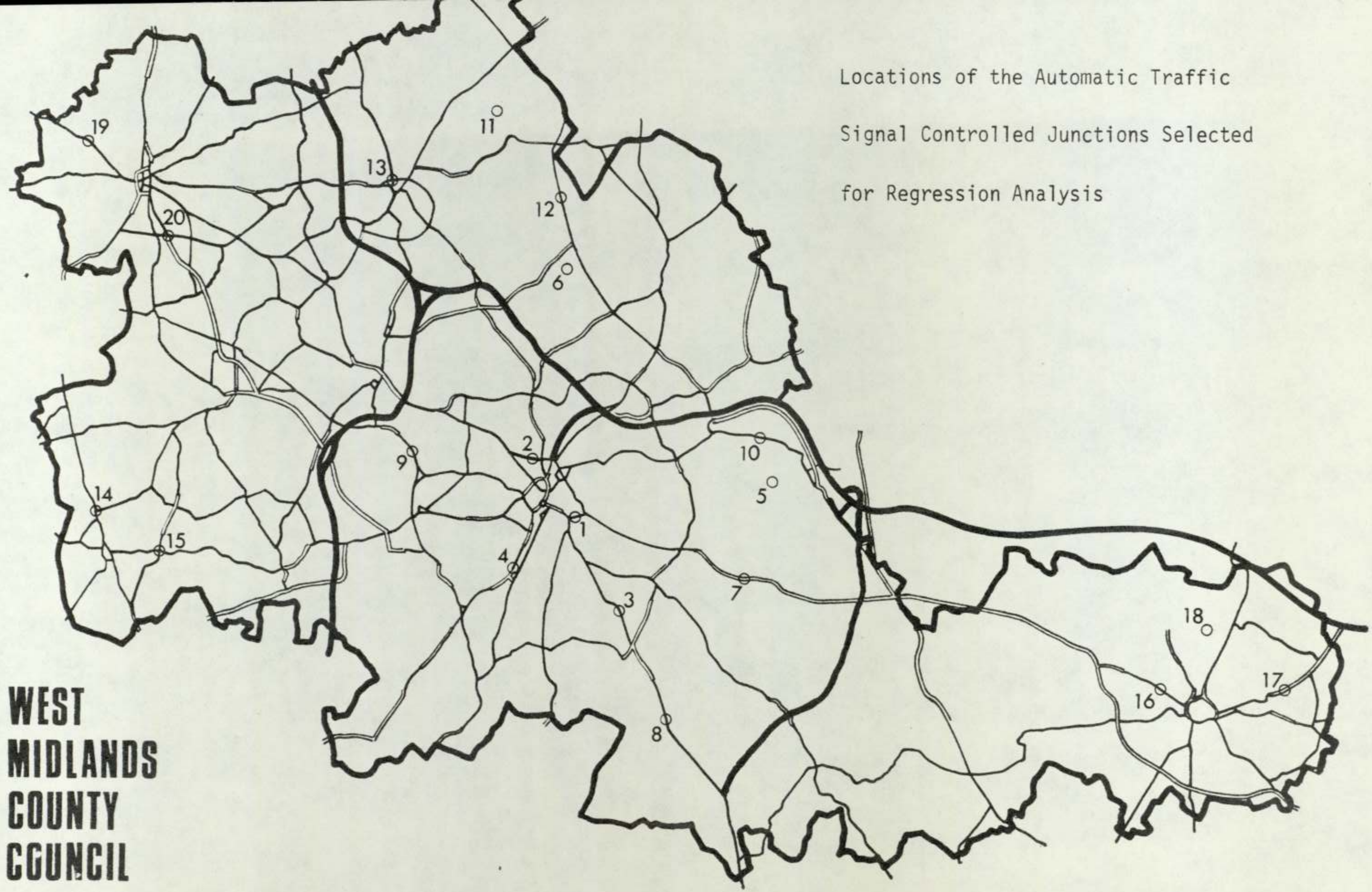
APPENDIX D

Locations and Details of the Junctions Selected for Regression Analyses

Locations of the Automatic Traffic

Signal Controlled Junctions Selected

for Regression Analysis



A.T.S. Junction Details — Location Number : 1

Road 1 : Coventry Road	Road No : A 45
Road 2 : Watery Lane	Road No : A 4540
Road 3 : –	Road No : –

Traffic Count Location Number : 70

Accident Network Location :

Road No : A0045	Kilometreage : 0019 – 0030
Road No : A4540	Kilometreage : 0048 – 0060
Road No : –	Kilometreage : –

Location Details

Junction Type : crossroads   Speed Limit : 30 mph.

Area : urban ; residential / industrial.

Road	A0045		A4540		–	
	1	2	1	2	1	2
Carriageway	single	single	single	single	–	–
Approach	2 lanes	2 lanes	1 lane	1 lane	–	–
Central Refuge	no	no	no	no	–	–
Road Studs	no	no	no	no	–	–

Pedestrian Phase : no

Bus Route : yes   Streetlighting : yes

Other Features : yellow box junction

Traffic Flow

Count Date : Tuesday 26/04/77   Duration : 12 hours

12 hour count flow : 26 992 vehicles

Annual Flow : 11 774 065 vehicles

Number of Accidents

	1975 – 76	1976 – 77	1977 – 78	Total
A0045	5	15	9	29
A4540	0	0	0	0
–	–	–	–	–
Total	5	15	9	29

Accident Rate :

0.821 014 injury accidents per million vehicles.

A.T.S. Junction Details

Location Number : 2

Road 1 : New John Street West	Road No : A 4540
Road 2 : Summer Lane	Road No : U 173
Road 3 : –	Road No : –

Traffic Count Location Number : 395

Accident Network Location :

Road No : A4540	Kilometreage : 0370 - 0383
Road No : U0173	Kilometreage : 0068 - 0078
Road No : –	Kilometreage : –

Location Details

Junction Type : crossroads

Speed Limit : 30 mph.

Area : urban ; residential / industrial ; garage on corner.

Road	A4540		U0173		–	
	1	2	1	2	1	2
Carriageway	single	single	single	single	–	–
Approach	2 lanes	2 lanes	2 lanes	2 lanes	–	–
Central Refuge	yes	yes	no	no	–	–
Road Studs	yes	yes	yes	yes	–	–

Pedestrian Phase : no

Bus Route : yes

Streetlighting : yes

Other Features : –

Traffic Flow

Count Date : Thursday 31/03/77 Duration : 12 hours

12 hour count flow : 20 708 vehicles

Annual Flow : 7 289 409 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A4540	0	1	1	2
U0173	0	0	0	0
–	–	–	–	–
Total	0	1	1	2

Accident Rate :

0.091 457 injury accidents per million vehicles.

A.T.S. Junction Details — Location Number : 3

Road 1 : Stratford Road	Road No : A 34
Road 2 : School Road	Road No : S 4040
Road 3 : -	Road No : -

Traffic Count Location Number : 93

Accident Network Location :

Road No : AS034	Kilometreage : 0309 - 0321
Road No : S4040	Kilometreage : 0605 - 0615
Road No : -	Kilometreage : -

Location Details

Junction Type : crossroads Speed Limit : 30 mph.

Area : urban ; residential ; shops on corner.

Road	AS034		S4040		-	
	1	2	1	2	1	2
Carriageway	single	single	single	single	-	-
Approach	2 lanes	2 lanes	2 lanes	2 lanes	-	-
Central Refuge	no	no	no	no	-	-
Road Studs	yes	yes	yes	yes	-	-

Pedestrian Phase : no

Bus Route : yes Streetlighting : yes

Other Features : 'shellgrip' on AS034 approaches.

Traffic Flow

Count Date : Tuesday 13/12/77 Duration : 12 hours

12 hour count flow : 26 570 vehicles

Annual Flow : 11 181 723 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
AS034	8	4	6	18
S4040	0	0	0	0
-	-	-	-	-
Total	8	4	6	18

Accident Rate :

0.536 590 injury accidents per million vehicles.

A.T.S. Junction Details — Location Number : 4

Road 1 : Bristol Road	Road No : A 38
Road 2 : Priory Road	Road No : B 4217
Road 3 : –	Road No : –

Traffic Count Location Number : 35

Accident Network Location :

Road No : AS038	Kilometreage : 0260 - 0272
Road No : B4217	Kilometreage : 0211 - 0226
Road No : –	Kilometreage : –

Location Details

Junction Type : crossroads Speed Limit : 30 mph.

Area : urban ; residential .

Road	AS038		B4217		–	
	1	2	1	2	1	2
Carriageway	single	single	single	single	–	–
Approach	3 lanes	3 lanes	3 lanes	3 lanes	–	–
Central Refuge	yes	yes	yes	yes	–	–
Road Studs	yes	yes	yes	yes	–	–

Pedestrian Phase : no

Bus Route : yes Streetlighting : yes

Other Features : yellow box junction ; central refuges extended on AS038 approaches.

Traffic Flow

Count Date : Tuesday 08/02/77 Duration : 12 hours

12 hour count flow : 44 513 vehicles

Annual Flow : 19 808 614 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
AS038	9	7	9	25
B4217	0	0	0	0
–	–	–	–	–
Total	9	7	9	25

Accident Rate :

0.420 692 injury accidents per million vehicles.

A.T.S. Junction Details

Location Number : 5

Road 1 : Meadway	Road No : B 4128
Road 2 : Mackadown Lane	Road No : Unclassified
Road 3 : Kitts Green Road	Road No : Unclassified

Traffic Count Location Number : 272

Accident Network Location :

Road No : B4128	Kilometreage : 0660 - 0680
Road No : -	Kilometreage : -
Road No : -	Kilometreage : -

Location Details

Junction Type : crossroads

Speed Limit : 30 mph.

Area : urban ; residential ; public house on one corner.

Road	B4128		Mackadown Lane		Kitts Green Rd	
	1	2	1	2	1	2
Carriageway	single	single	single	-	single	-
Approach	3 lanes	3 lanes	2 lanes	-	2 lanes	-
Central Refuge	yes	yes	yes	-	yes	-
Road Studs	yes	yes	yes	-	yes	-

Pedestrian Phase : no

Bus Route : yes

Streetlighting : yes

Other Features : -

Traffic Flow

Count Date : Monday 11/07/77

Duration : 12 hours

12 hour count flow : 19 707 vehicles

Annual Flow : 9 581 107 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
B4128	6	5	2	13
-	-	-	-	-
-	-	-	-	-
Total	6	5	2	13

Accident Rate :

0.452 279 injury accidents per million vehicles.

A.T.S. Junction Details | **Location Number : 6**

Road 1 : Sutton Oak Road	Road No : B 4138
Road 2 : Bakers Lane	Road No : U 8572
Road 3 : –	Road No : –

Traffic Count Location Number : 140

Accident Network Location :

Road No : B4138	Kilometreage : 0375 – 0385
Road No : U8572	Kilometreage : 0024 – 0036
Road No : –	Kilometreage : –

Location Details

Junction Type : crossroads   Speed Limit : 30 mph.

Area : urban ; residential ; shops on one corner .

Road	B4138		U8572		–	
	1	2	1	2	1	2
Carriageway	single	single	single	single	–	–
Approach	1 lane	1 lane	1 lane	1 lane	–	–
Central Refuge	no	no	no	no	–	–
Road Studs	no	no	no	no	–	–

Pedestrian Phase : no

Bus Route : yes   Streetlighting : yes

Other Features : –

Traffic Flow

Count Date : Tuesday 14/10/75   Duration : 10½ hours

10½ hour count flow : 9 919 vehicles

Annual Flow : 5 036 395 vehicles

Number of Accidents

	1975 – 76	1976 – 77	1977 – 78	Total
B4138	0	0	1	1
U8572	0	0	0	0
–	–	–	–	–
Total	0	0	1	1

Accident Rate :

0.066 185 injury accidents per million vehicles.

A.T.S. Junction Details — Location Number : 7

Road 1 : Coventry Road	Road No : A 45
Road 2 : Sheaf Lane	Road No : Unclassified
Road 3 : Hobs Moat Road	Road No : Unclassified

Traffic Count Location Number : 89

Accident Network Location :

Road No : A0045	Kilometreage : 0720 - 0731
Road No : –	Kilometreage : –
Road No : –	Kilometreage : –

Location Details

Junction Type : crossroads Speed Limit : 30 mph.

Area : urban ; shopping centre.

Road	A0045		Sheaf Lane		Hobs Moat Rd	
	1	2	1	2	1	2
Carriageway	dual	dual	single	–	single	–
Approach	4 lanes	4 lanes	3 lanes	–	3 lanes	–
Central Refuge	no	no	yes	–	yes	–
Road Studs	no	no	no	–	no	–

Pedestrian Phase : full pedestrian subways - full guard-railing

Bus Route : yes Streetlighting : yes

Other Features : A.T.S. on A0045 set on over-head gantries.

Traffic Flow

Count Date : Thursday 24/02/77 Duration : 12 hours

12 hour count flow : 34 474 vehicles

Annual Flow : 13 768 376 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0045	9	7	2	18
–	–	–	–	–
–	–	–	–	–
Total	9	7	2	18

Accident Rate :

0.435 781 injury accidents per million vehicles.

A.T.S. Junction Details

Location Number : 8

Road 1 : Stratford Road	Road No : A 34
Road 2 : Solihull Road	Road No : U 125
Road 3 : -	Road No : -

Traffic Count Location Number : 1401

Accident Network Location :

Road No : AS034	Kilometreage : 0620 - 0635
Road No : U0125	Kilometreage : 0000 - 0005
Road No : -	Kilometreage : -

Location Details

Junction Type : 'T'-junction

Speed Limit : 30 mph.

Area : urban ; shopping centre .

Road	AS034		U125		-	
	1	2	1	2	1	2
Carriageway	single	single	single	-	-	-
Approach	2 lanes	2 lanes	1 lane	-	-	-
Central Refuge	yes	yes	yes	-	-	-
Road Studs	no	no	no	-	-	-

Pedestrian Phase : no

Bus Route : yes

Streetlighting : yes

Other Features : -

Traffic Flow

Count Date : Monday 03/10/77

Duration : 12 hours

12 hour count flow : 26 518 vehicles

Annual Flow : 10 750 172 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
AS034	3	1	1	5
U0125	0	0	0	0
-	-	-	-	-
Total	3	1	1	5

Accident Rate :

0.155 036 injury accidents per million vehicles.

A.T.S. Junction Details — Location Number : 9

Road 1 :	Smethwick High Street	Road No : A 457
Road 2 :	Crockett's Lane	Road No : U 1
Road 3 :	Cooper's Lane	Road No :unclassified

Traffic Count Location Number : 1506

Accident Network Location :

Road No : A0457	Kilometreage : 0482 - 0491
Road No : U0001	Kilometreage : 0185 - 0190
Road No : -	Kilometreage : -

Location Details

Junction Type : crossroads   Speed Limit : 30 mph.

Area : urban ;residential ; junior school close-by.

Road	A0457		U0001		Cooper's Lane	
	1	2	1	2	1	2
Carriageway	single	single	single	-	single	-
Approach	2 lanes	2 lanes	1 lane	-	1 lane	-
Central Refuge	yes	yes	no	-	no	-
Road Studs	yes	yes	yes	-	yes	-

Pedestrian Phase : no - school crossing patrol .

Bus Route : yes   Streetlighting : yes

Other Features : partial pedestrian guard-railing

Traffic Flow

Count Date : Thursday 15/09/77   Duration : 10½ hours

10½ hour count flow : 18 297 vehicles

Annual Flow : 8 258 758 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0457	2	5	3	10
U0001	0	0	0	0
-	-	-	-	-
Total	2	5	3	10

Accident Rate :

0.403 612 injury accidents per million vehicles.

A.T.S. Junction Details — Location Number : 10

Road 1 : Chester Road	Road No : A 47
Road 2 : Hurst Lane	Road No : unclassified
Road 3 : –	Road No : –

Traffic Count Location Number : 1423

Accident Network Location :

Road No : A0047	Kilometreage : 0970 - 0990
Road No : –	Kilometreage : –
Road No : –	Kilometreage : –

Location Details

Junction Type : crossroads   Speed Limit : 40 mph.

Area : urban ; shopping centre ; public house on one corner.

Road	A0047		Hurst Lane		–	
	1	2	1	2	1	2
Carriageway	single	single	single	single	–	–
Approach	2 lanes	2 lanes	1 lane	1 lane	–	–
Central Refuge	yes	no	no	no	–	–
Road Studs	yes	no	no	no	–	–

Pedestrian Phase : no

Bus Route : yes   Streetlighting : yes

Other Features : –

Traffic Flow

Count Date : Friday 08/07/77   Duration : 10½ hours.

10½ hour count flow : 12 776 vehicles

Annual Flow : 6 842 852 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0047	3	1	4	8
–	–	–	–	–
–	–	–	–	–
Total	3	1	4	8

Accident Rate :

0.389 701 injury accidents per million vehicles.

A.T.S. Junction Details

Location Number : 11

Road 1 : Walsall Road	Road No : A 454
Road 2 : Bosty Lane	Road No : U 89
Road 3 : -	Road No : -

Traffic Count Location Number : 2039

Accident Network Location :

Road No : A0454	Kilometreage : 0910 - 0926
Road No : U0089	Kilometreage : 0218 - 0233
Road No : -	Kilometreage : -

Location Details

Junction Type : crossroads Speed Limit : 30 mph.

Area : urban ; residential/rural ; shops & pub on 2 corners.

Road	A0454		U0089		-	
	1	2	1	2	1	2
Carriageway	single	single	single	single	-	-
Approach	3 lanes	3 lanes	2 lanes	2 lanes	-	-
Central Refuge	yes	yes	yes	yes	-	-
Road Studs	yes	yes	yes	yes	-	-

Pedestrian Phase : no

Bus Route : yes Streetlighting : yes

Other Features : -

Traffic Flow

Count Date : Friday 31/12/76 Duration : 10½ hours

10½ hour count flow : 10 711 vehicles

Annual Flow : 4 564 798 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0454	3	6	2	11
U0089	0	0	0	0
-	-	-	-	-
Total	3	6	2	11

Accident Rate :

0.803 248 injury accidents per million vehicles.

A.T.S. Junction Details	Location Number :12
Road 1 : Chester Road	Road No : A 452
Road 2 : Foley Road West	Road No : B 4151
Road 3 : -	Road No : -

Traffic Count Location Number : 2032

Accident Network Location :

Road No : A0452	Kilometreage : 1010 - 1024
Road No : B4151	Kilometreage : 0625 - 0637
Road No : -	Kilometreage : -

Location Details

Junction Type : crossroads Speed Limit : 40 mph.

Area : urban ; residential ; shops on one corner.

Road	A0452		B4151		-	
	1	2	1	2	1	2
Carriageway	single	single	single	single	-	-
Approach	1 lane	1 lane	1 lane	1 lane	-	-
Central Refuge	no	no	no	no	-	-
Road Studs	yes	yes	yes	yes	-	-

Pedestrian Phase : no

Bus Route : yes Streetlighting : yes

Other Features : 'Shellgrip' on A0452 approaches.

Traffic Flow

Count Date : Friday 04/11/77 Duration : 12 hours

12 hour count flow : 16 508 vehicles

Annual Flow : 6 923 363 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0452	0	3	1	4
B4151	0	0	0	0
-	-	-	-	-
Total	0	3	1	4

Accident Rate :

0.192 585 injury accidents per million vehicles.

A.T.S. Junction Details — Location Number : 13

Road 1 : Green Lane	Road No : B 4210
Road 2 : Blue Lane West	Road No : B 4456
Road 3 : –	Road No : –

Traffic Count Location Number : 2106

Accident Network Location :

Road No : B4210	Kilometreage : 0020 – 0040
Road No : B4456	Kilometreage : 0608 – 0625
Road No : –	Kilometreage : –

Location Details

Junction Type : crossroads Speed Limit : 30 mph.

Area : urban ; residential ;police station & car-park on corners.

Road	B4210		B4456		–	
	1	2	1	2	1	2
Carriageway	dual	single	single	single	–	–
Approach	2 lanes	2 lanes	2 lanes	2 lanes	–	–
Central Refuge	yes	no	yes	yes	–	–
Road Studs	no	no	yes	yes	–	–

Pedestrian Phase : no

Bus Route : yes Streetlighting : yes

Other Features : –

Traffic Flow

Count Date : Tuesday 14/06/77 Duration : 12 hours.

12 hour count flow : 17 802 vehicles

Annual Flow : 7 196 591 vehicles

Number of Accidents

	1975 – 76	1976 – 77	1977 – 78	Total
B4210	0	1	1	2
B4456	0	1	2	3
–	–	–	–	–
Total	0	2	3	5

Accident Rate :

0.231 591 injury accidents per million vehicles.

A.T.S. Junction Details

Location Number :14

Road 1 : High Street	Road No : A 491
Road 2 : Brettall Lane	Road No : A 461
Road 3 : Platts Road	Road No :unclassified

Traffic Count Location Number : 1778

Accident Network Location :

Road No : A0491	Kilometreage : 0439 - 0450
Road No : A0461	Kilometreage : 0110 - 0115
Road No : -	Kilometreage : -

Location Details

Junction Type : crossroads

Speed Limit : 30 mph.

Area : urban ; shopping centre.

Road	A0491		A0461		Platts Road	
	1	2	1	2	1	2
Carriageway	single	single	single	-	single	-
Approach	2 lanes	1 lane	2 lanes	-	1 lane	-
Central Refuge	yes	yes	yes	-	no	-
Road Studs	no	no	no	-	no	-

Pedestrian Phase : no

Bus Route : yes

Streetlighting : yes

Other Features : Platts Road is a very minor road.

Traffic Flow

Count Date : Monday 29/11/76

Duration : 10½ hours.

10½ hour count flow : 18 215 vehicles

Annual Flow : 9 427 411 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0491	2	3	1	6
A0461	0	0	0	0
-	-	-	-	-
Total	2	3	1	6

Accident Rate :

0.212 147 injury accidents per million vehicles.

A.T.S. Junction Details   Location Number :15

Road 1 : Stourbridge Road	Road No : A 458
Road 2 : Pedmore Road	Road No : A 4036
Road 3 : -	Road No : -

Traffic Count Location Number : 1718

Accident Network Location :

Road No : A0458	Kilometreage : 0830 - 0840
Road No : A4036	Kilometreage : 0250 - 0260
Road No : -	Kilometreage : -

Location Details

Junction Type : crossroads   Speed Limit : 30 mph.

Area : urban ; shopping centre.

Road	A0458		A4036		-	
	1	2	1	2	1	2
Carriageway	single	single	single	single	-	-
Approach	2 lanes	2 lanes	2 lanes	1 lane	-	-
Central Refuge	no	no	no	no	-	-
Road Studs	yes	yes	yes	yes	-	-

Pedestrian Phase : no

Bus Route : yes   Streetlighting : yes

Other Features : -

Traffic Flow

Count Date : Tuesday 03/05/77   Duration : 12 hours.

12 hour count flow : 21 241 vehicles

Annual Flow : 8 735 255 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0458	1	0	2	3
A4036	0	2	1	3
-	-	-	-	-
Total	1	2	3	6

Accident Rate :

0.228 957 injury accidents per million vehicles.

A.T.S. Junction Details — Location Number : 16

Road 1 : Holyhead Road	Road No : A 4114
Road 2 : Moseley Avenue	Road No : B 4107
Road 3 : -	Road No : -

Traffic Count Location Number : 1378

Accident Network Location :

Road No : A4114	Kilometreage : 0260 - 0274
Road No : B4107	Kilometreage : 0255 - 0268
Road No : -	Kilometreage : -

Location Details

Junction Type : crossroads   Speed Limit : 30 mph.

Area : urban ; residential/industrial area ; pub on corner.

Road	A4114		B4107		-	
	1	2	1	2	1	2
Carriageway	single	single	single	dual	-	-
Approach	3 lanes	3 lanes	3 lanes		-	-
Central Refuge	yes	yes	yes	yes	-	-
Road Studs	no	no	no	no	-	-

Pedestrian Phase : no

Bus Route : yes   Streetlighting : yes

Other Features : -

Traffic Flow

Count Date : Wednesday 02/11/77   Duration : 12 hours.

12 hour count flow : 26 107 vehicles

Annual Flow : 11 355 657 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A4114	3	3	3	9
B4107	0	0	0	0
-	-	-	-	-
Total	3	3	3	9

Accident Rate :

0.264 186 injury accidents per million vehicles.

A.T.S. Junction Details — Location Number : 17

Road 1 : Ansty Road	Road No : A 46
Road 2 : Sewall Highway	Road No : U 155
Road 3 : -	Road No : -

Traffic Count Location Number : 1324

Accident Network Location :

Road No : A0046	Kilometreage : 0668 - 0678
Road No : U0155	Kilometreage : 0134 - 0145
Road No : -	Kilometreage : -

Location Details

Junction Type : crossroads   Speed Limit : 30 mph.

Area : urban ; residential ; shops, garage, & pub on corners.

Road	A0046		U0155		-	
	1	2	1	2	1	2
Carriageway	dual	dual	single	single	-	-
Approach	2 lanes	2 lanes	1 lane	1 lane	-	-
Central Refuge	yes	yes	yes	yes	-	-
Road Studs	no	no	no	no	-	-

Pedestrian Phase : no

Bus Route : yes   Streetlighting : yes

Other Features : close to school. A.T.S. switched on - 24/09/75

Traffic Flow

Count Date : Tuesday 29/01/76   Duration : 12 hours.

12 hour count flow : 17 803 vehicles

Annual Flow : 9 042 687 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0046	not relevant	8	3	11
U0155	not relevant	0	0	0
-	-	-	-	-
Total	-	8	3	11

Accident Rate :

0.608 226 injury accidents per million vehicles.

A.T.S. Junction Details — Location Number :18

Road 1 : Holbrook Lane	Road No : U 145
Road 2 : Burnaby Road	Road No : U 161
Road 3 : -	Road No : -

Traffic Count Location Number : 1970

Accident Network Location :

Road No : U0145	Kilometreage : 0110 - 0120
Road No : U0161	Kilometreage : 0000 - 0005
Road No : -	Kilometreage : -

Location Details

Junction Type : T' junction Speed Limit : 30 mph.

Area : urban ; residential area ; shops on corner.

Road	U0145		U0161		-	
	1	2	1	2	1	2
Carriageway	single	single	single	-	-	-
Approach	3 lanes	2 lanes	2 lanes	-	-	-
Central Refuge	no	yes	no	-	-	-
Road Studs	no	yes	yes	-	-	-

Pedestrian Phase : yes - by request on 2 approaches.

Bus Route : yes Streetlighting : yes

Other Features : school entrance close by - school crossing patrol operating at the junction.

Traffic Flow

Count Date : Wednesday 01/10/75 Duration : 12 hours

12 hour count flow : 16 716 vehicles

Annual Flow : 6 716 126 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
U0145	3	2	2	7
U0161	0	0	0	0
-	-	-	-	-
Total	3	2	2	7

Accident Rate :

0.347 42 injury accidents per million vehicles.

A.T.S. Junction Details — Location Number : 19

Road 1 : Tettenhall Road	Road No : A 41
Road 2 : Henwood Road	Road No : B 4161
Road 3 : Lower Street	Road No : U 117

Traffic Count Location Number : 2215

Accident Network Location :

Road No : AN041	Kilometreage : 2397 - 2410
Road No : B4161	Kilometreage : 0480 - 0490
Road No : U0117	Kilometreage : 0000 - 0005

Location Details

Junction Type : crossroads Speed Limit : 30 mph.

Area : urban ; residential ; garage on one corner.

Road	AN041		B4161		U0117	
	1	2	1	2	1	2
Carriageway	single	single	single	–	single	–
Approach	1 lane	1 lane	1 lane	–	1 lane	–
Central Refuge	no	no	no	–	no	–
Road Studs	no	no	no	–	no	–

Pedestrian Phase : no

Bus Route : yes Streetlighting : yes

Other Features : –

Traffic Flow

Count Date : Tuesday 13/09/77 Duration : 12 hours.

12 hour count flow : 25 817 vehicles

Annual Flow : 11 719 337 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
AN041	6	0	4	10
B4161	0	0	0	0
U0117	0	0	0	0
Total	6	0	4	10

Accident Rate :

0.284 430 injury accidents per million vehicles.

A.T.S. Junction Details   Location Number :20

Road 1 :	Birmingham New Road	Road No : A 4123
Road 2 :	Parkfield Road	Road No : A 4039
Road 3 :	–	Road No : –

Traffic Count Location Number : 2262

Accident Network Location :

Road No : A4123	Kilometreage : 1730 - 1743
Road No : A4039	Kilometreage : 0220 - 0233
Road No : –	Kilometreage : –

Location Details

Junction Type : crossroads   Speed Limit : 30 mph.

Area : urban ; residential.

Road	A4123		A4039		–	
	1	2	1	2	1	2
Carriageway	dual	single	single	single	–	–
Approach	2 lanes	2 lanes	1 lane	1 lane	–	–
Central Refuge	yes	yes	no	no	–	–
Road Studs	yes	yes	yes	yes	–	–

Pedestrian Phase : no

Bus Route : yes   Streetlighting : yes

Other Features : –

Traffic Flow

Count Date : Monday 31/01/77   Duration : 12 hours.

12 hour count flow : 27 473 vehicles

Annual Flow : 11 921 665 vehicles

Number of Accidents

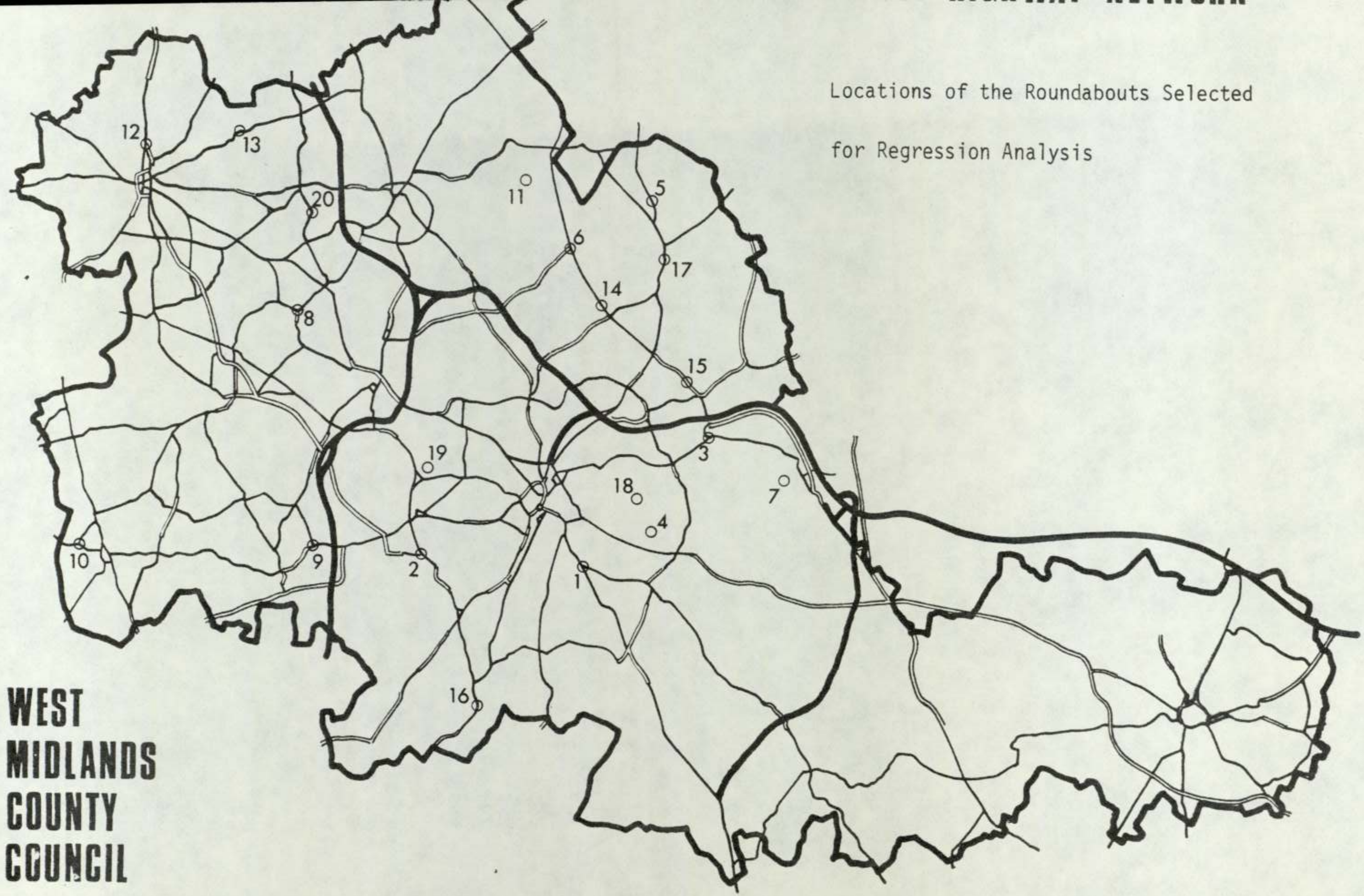
	1975 - 76	1976 - 77	1977 - 78	Total
A4123	2	0	4	6
A4039	0	0	1	1
–	–	–	–	–
Total	2	0	5	7

Accident Rate :

0.195 722 injury accidents per million vehicles.

Locations of the Roundabouts Selected

for Regression Analysis



Roundabout Junction Details — Location Number : 1

Road 1 : Warwick Road	Road No : A 41
Road 2 : Stratford Road	Road No : A 34
Road 3 : -	Road No : -

Traffic Count Location Number : 71

Accident Network Location :

Road No : AS041	Kilometreage : 0320 - 0330
Road No : AS034	Kilometreage : 0000 - 0004
Road No : -	Kilometreage : -

Location Details

Island Size : medium / small Speed limit : 30 mph.

Area : urban ; shops ; public house on corner.

Lane Width : single

Road	AS041		AS034		-	
C/way	single	single	single			
Approach	1 lane	1 lane	1 lane	-	-	-
Priority	none	none	none	-	-	-

Bus Route : yes Streetlighting : yes

Other Features : pedestrian crossing on one approach.

Traffic Flow

Count Date : Thursday 28/07/77 Duration : 12 hours

12 hour count flow : 22 984 vehicles

Annual Flow : 8 973 024 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
AS041	0	1	3	4
AS034	3	0	1	4
-	-	-	-	-
Total	3	1	4	8

Accident Rate :

0.297 187 injury accidents per million vehicles.

Roundabout Junction Details

Location Number : 2

Road 1 : Court Oak Road	Road No : W 4040
Road 2 : Lordswood Road	Road No : A 4123
Road 3 : –	Road No : –

Traffic Count Location Number : 123

Accident Network Location :

Road No : W4040	Kilometreage : 0149 – 0160
Road No : A4123	Kilometreage : 0000 – 0007
Road No : –	Kilometreage : –

Location Details

Island Size : medium / small

Speed limit : 30 mph.

Area : urban ; residential

Lane Width : single

Road	W4040		A4123		–	
C /way	single	single	single	–	–	–
Approach	1 lane	1 lane	1 lane	–	–	–
Priority	offside	offside	offside	–	–	–

Bus Route : yes

Streetlighting : yes

Other Features : –

Traffic Flow

Count Date : Friday 24/02/78

Duration : 10½ hours

10½ hour count flow : 15 804 vehicles

Annual Flow : 7 419 029 vehicles

Number of Accidents

	1975 – 76	1976 – 77	1977 – 78	Total
W4040	0	0	0	0
A4123	0	0	1	1
–	–	–	–	–
Total	0	0	1	1

Accident Rate :

0.044 92 injury accidents per million vehicles

Roundabout Junction Details

Location Number : 3

Road 1 : Bradford Road	Road No : A 47
Road 2 : Newport Road	Road No : U 148
Road 3 : –	Road No : –

Traffic Count Location Number : 161

Accident Network Location :

Road No : A0047	Kilometreage : 0746 - 0769
Road No : U0148	Kilometreage : 0090 - 0100
Road No : –	Kilometreage : –

Location Details

Island Size : large   Speed limit : 30 mph.

Area : urban ; residential : garage on corner.

Lane Width : 2 lane width, unmarked.

Road	A0047		U0148		–	
C/way	single	single	single	–	–	–
Approach	2 lanes	2 lanes	1 lane	–	–	–
Priority	offside	offside	offside	–	–	–

Bus Route : yes   Streetlighting : yes

Other Features : –

Traffic Flow

Count Date : Wednesday 08/02/78   Duration : 12 hour

12 hour count flow : 27 449 vehicles

Annual Flow : 11 234 401 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0047	2	4	2	8
U0148	0	0	0	0
–	–	–	–	–
Total	2	4	2	8

Accident Rate :

0.237 366 injury accidents per million vehicles.

Roundabout Junction Details

Location Number : 4

Road 1 : Hob Moor Road	Road No : U 1355
Road 2 : Heybarnes Road	Road No : unclassified
Road 3 : Newbridge Road	Road No : unclassified

Traffic Count Location Number : 519

Accident Network Location :

Road No : U1355	Kilometreage : 0250 - 0258
Road No : -	Kilometreage : -
Road No : -	Kilometreage : -

Location Details

Island Size : medium Speed limit : 30 mph.

Area : urban ; residential ;shops on one corner.

Lane Width : single

Road	U1355		Heybarnes		Newbridge	
C/way	single	single	single	-	single	-
Approach	1 lane	1 lane	1 lane	-	1 lane	-
Priority	offside	offside	offside	-	offside	-

Bus Route : yes Streetlighting : yes

Other Features : pedestrian crossing on one approach.

Traffic Flow

Count Date : Thursday 05/05/77 Duration : 12 hours

12 hour count flow : 11 598 vehicles

Annual Flow : 4 549 730 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
U1355	0	0	2	2
-	-	-	-	-
-	-	-	-	-
Total	0	0	2	2

Accident Rate :

0.146 52 injury accidents per million vehicles

Roundabout Junction Details

Location Number : 5

Road 1 : Lichfield Road	Road No : A 5127
Road 2 : Mere Green Road	Road No : B 4151
Road 3 : Hill Village Road	Road No : Unclassified

Traffic Count Location Number : 357

Accident Network Location :

Road No : A5127	Kilometreage : 0995 - 1010
Road No : B4151	Kilometreage : 0985 - 0995
Road No : -	Kilometreage : -

Location Details

Island Size : medium

Speed limit : 30 mph.

Area : urban ; shops ; public house on one corner.

Lane Width : 2 lanes (marked) around part of island.

Road	A5127		B4151		Hill Village Rd	
C/way	single	single	single	single	single	-
Approach	2 lanes	1 lane	2 lanes	1 lane	1 lane	-
Priority	offside	offside	offside	offside	offside	-

Bus Route : yes

Streetlighting : yes

Other Features : pedestrian crossing over centre of island.

Traffic Flow

Count Date : Wednesday 02/03/77 Duration : 12 hours

12 hour count flow : 19 830 vehicles

Annual Flow : 9 028 181 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A5127	2	3	3	8
B4151	0	0	0	0
-	-	-	-	-
Total	2	3	3	8

Accident Rate :

0.295 371 injury accidents per million vehicles.

Roundabout Junction Details — Location Number : 6

Road 1 : Chester Road	Road No : A 452
Road 2 : Queslett Road	Road No : A 4041
Road 3 : Thornhill Road	Road No : B4138

Traffic Count Location Number : 125

Accident Network Location :

Road No : A0452	Kilometreage : 1180 - 1195
Road No : A4041	Kilometreage : 0000 - 0015
Road No : B4138	Kilometreage : 0405 - 0410

Location Details

Island Size : large Speed limit : 40 mph.

Area : urban ; residential ; garage on corner.

Lane Width : part single / part double lane width - no markings

Road	A0452		A4041		B4138	
C/way	dual	dual	dual	-	single	-
Approach	2 lanes	2 lanes	2 lanes	-	1 lane	-
Priority	offside	offside	offside	-	offside	-

Bus Route : yes Streetlighting : yes

Other Features : -

Traffic Flow

Count Date : Thursday 23/03/78 Duration : 12 hours

12 hour count flow : 26 608 vehicles

Annual Flow : 11 296 264 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0452	0	2	3	5
A4041	0	1	1	2
B4138	0	0	0	0
Total	0	3	4	7

Accident Rate :

0.206 55 injury accidents per million vehicles.

Roundabout Junction Details | Location Number : 7

Road 1 : Cooks Lane	Road No : B 4128
Road 2 : Chelmsley Road	Road No : Unclassified
Road 3 : -	Road No : -

Traffic Count Location Number : 1452

Accident Network Location :

Road No : B4128	Kilometreage : 0788 - 0800
Road No : -	Kilometreage : -
Road No : -	Kilometreage : -

Location Details

Island Size : medium   Speed limit : 30 mph.

Area : urban ; residential ; garage on one corner.

Lane Width : part single / part double lane width - marked.

Road	B4128		Chelmsley Road		-	
C/way	single	single	dual	-	-	-
Approach	1 lane	1 lane	2 lanes	-	-	-
Priority	nearside	offside	offside	-	-	-

Bus Route : yes   Streetlighting : yes

Other Features : -

Traffic Flow

Count Date : Thursday 14/07/77   Duration : 12 hours

12 hour count flow : 13 535 vehicles

Annual Flow : 6 829 263 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
B4128	4	0	1	5
-	-	-	-	-
-	-	-	-	-
Total	4	0	1	5

Accident Rate :

0.244 048 injury accidents per million vehicles.

Roundabout Junction Details

Location Number : 8

Road 1 : Leabrook Road	Road No : A 461
Road 2 : Gospel Oak Road	Road No : A 4037
Road 3 : Ocker Hill Road	Road No : Unclassified

Traffic Count Location Number : 1528

Accident Network Location :

Road No : A0461	Kilometreage : 1360 - 1370
Road No : A4037	Kilometreage : 0000 - 0005
Road No : -	Kilometreage : -

Location Details

Island Size : medium

Speed limit : 30 mph.

Area : urban ; residential ; shop on corner.

Lane Width : single

Road	A0461		A4037		Ocker Hill Road	
C/way	single	single	single	-	single	-
Approach	1 lane	1 lane	1 lane	-	1 lane	-
Priority	Offside	offside	offside	-	offside	-

Bus Route : yes

Streetlighting : yes

Other Features : -

Traffic Flow

Count Date : Thursday 06/01/77

Duration : 12 hours

12 hour count flow : 18 740 vehicles

Annual Flow : 7 769 118 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0461	0	0	0	0
A4037	0	0	2	2
-	-	-	-	-
Total	0	0	2	2

Accident Rate :

0.085 810 injury accidents per million vehicles.

Roundabout Junction Details — Location Number : 9

Road 1 : Halesowen Road	Road No : A 458
Road 2 : Long Lane	Road No : A 4034
Road 3 : Kent Road	Road No : U 561

Traffic Count Location Number : 1707

Accident Network Location :

Road No : A0458	Kilometreage : 0130 - 0140
Road No : A4034	Kilometreage : 0000 - 0005
Road No : U0561	Kilometreage : 0700 - 0710

Location Details

Island Size : Mini — Speed limit : 30 mph.

Area : urban ; residential ; garage on one corner ; public house and shops on another.

Lane Width : 3 lanes - marked

Road	A0458		A4034		U0561	
C/way	single	single	single	-	single	-
Approach	2 lanes	2 lanes	1 lane		1 lane	
Priority	offside	offside	offside	-	offside	-

Bus Route : yes — Streetlighting : yes

Other Features : -

Traffic Flow

Count Date : Tuesday 10/05/77 — Duration : 12 hours

12 hour count flow : 24 825 vehicles

Annual Flow : 10 727 601 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0458	5	5	2	12
A4034	0	0	0	0
U0561	0	0	0	0
Total	5	5	2	12

Accident Rate :

0.372 870 injury accidents per million vehicles.

Roundabout Junction Details — Location Number : 10

Road 1 : Bridgnorth Road	Road No : A 458
Road 2 : High Street Wollaston	Road No : A 461
Road 3 : Meriden Avenue	Road No : Unclassified

Traffic Count Location Number : 1719

Accident Network Location :

Road No : A0458	Kilometreage : 1128 - 1135
Road No : A0461	Kilometreage : 0000 - 0005
Road No : -	Kilometreage : -

Location Details

Island Size : medium Speed limit : 30 mph.

Area : urban ; shops and garage on corners.

Lane Width : single

Road	A0458		A0461		Meriden Avenue	
C/way	single	single	single	-	single	-
Approach	1 lane	1 lane	1 lane	-	1 lane	-
Priority	offside	offside	offside	-	offside	-

Bus Route : yes Streetlighting : yes

Other Features : pedestrian crossings on 3 approaches.

Traffic Flow

Count Date : Wednesday 23/11/77 Duration : 12 hours

12 hour count flow : 12 154 vehicles

Annual Flow : 5 243 217 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0458	2	1	0	3
A0461	0	0	0	0
-	-	-	-	-
Total	2	1	0	3

Accident Rate :

0.190 723 injury accidents per million vehicles.

Roundabout Junction Details

Location Number : 11

Road 1 : Aldridge Road	Road No : B 4151
Road 2 : Foley Road West	Road No : B 4152
Road 3 : –	Road No : –

Traffic Count Location Number : 2088

Accident Network Location :

Road No : B4151	Kilometreage : 0490 - 0500
Road No : B4152	Kilometreage : 0212 - 0222
Road No : –	Kilometreage : –

Location Details

Island Size : Large

Speed limit : 40 mph

Area : rural ; garage on corner.

Lane Width : single

Road	B4151		B4152		–	
C/way	single	single	single	single	–	–
Approach	1 lane	1 lane	1 lane	1 lane	–	–
Priority	offside	offside	offside	offside	–	–

Bus Route : yes

Streetlighting : yes

Other Features : –

Traffic Flow

Count Date : Wednesday 14/12/77 Duration : 12 hours

12 hour count flow : 13 937 vehicles

Annual Flow : 5 741 352 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
B4151	0	1	0	1
B4152	1	0	0	1
–	–	–	–	–
Total	1	1	0	2

Accident Rate :

0.116 117 injury accidents per million vehicles.

Roundabout Junction Details — Location Number : 12

Road 1 :	Waterloo Road	Road No : A 449
Road 2 :	Stafford Street	Road No : A 459
Road 3 :	Foxs Lane / Dunstall Road	Road No : Unclassified

Traffic Count Location Number : 2225

Accident Network Location :

Road No : A0449	Kilometreage : 0780 - 0789
Road No : A0459	Kilometreage : 1950 - 1960
Road No : -	Kilometreage : -

Location Details

Island Size : large   Speed limit : 30 mph.

Area : urban ; residential .

Lane Width : double lane width - unmarked.

Road	A0449		A0459		Foxs	Dunstall
C/way	single	single	dual	-	single	single
Approach	1 lane	1 lane	2 lanes	-	1 lane	1 lane
Priority	offside	offside	offside	-	offside	offside

Bus Route : yes   Streetlighting : yes

Other Features : -

Traffic Flow

Count Date : Monday 20/02/78   Duration : 12 hours

12 hour count flow : 25 856 vehicles

Annual Flow : 11 137 839 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0449	3	0	1	4
A0459	0	0	0	0
-	-	-	-	-
Total	3	0	1	4

Accident Rate :

0.119 712 injury accidents per million vehicles.

Roundabout Junction Details | Location Number : 13

Road 1 : Lichfield Road	Road No : A 4124
Road 2 : Wood End Lane	Road No : B 4484
Road 3 : –	Road No : –

Traffic Count Location Number : 2267

Accident Network Location :

Road No : A4124	Kilometreage : 0370 – 0380
Road No : B4484	Kilometreage : 0390 – 0395
Road No : –	Kilometreage : –

Location Details

Island Size : medium   Speed limit : 30 mph.

Area : urban ; residential : shops on one corner.

Lane Width : single

Road	A4124		B4484		–	
C/way	single	single	single	–	–	–
Approach	1 lane	1 lane	1 lane	–	–	–
Priority	offside	offside	offside	–	–	–

Bus Route : yes   Streetlighting : yes

Other Features : –

Traffic Flow

Count Date : Wednesday 15/06/77   Duration : 12 hours

12 hour count flow : 16 344 vehicles

Annual Flow : 7 715 918 vehicles

Number of Accidents

	1975 – 76	1976 – 77	1977 – 78	Total
A4124	0	2	0	2
B4484	0	0	0	0
–	–	–	–	–
Total	0	2	0	2

Accident Rate :

0.086 401 injury accidents per million vehicles.

Roundabout Junction Details — Location Number : 14

Road 1 : Chester Road	Road No : A 452
Road 2 : Kings Road	Road No : B 4149
Road 3 : Windsor Road	Road No : Unclassified

Traffic Count Location Number : 154

Accident Network Location :

Road No : A0452	Kilometreage : 1445 - 1458
Road No : B4149	Kilometreage : 0265 - 0275
Road No : -	Kilometreage : -

Location Details

Island Size : medium   Speed limit : 30 mph.

Area : urban ; shops - public house on corner

Lane Width : single

Road	A0452		B4149		Windsor Road	
C/way	single	single	single	single	single	-
Approach	2 lanes	2 lanes	1 lane	1 lane	1 lane	-
Priority	offside	offside	offside	offside	offside	-

Bus Route : yes   Streetlighting : yes

Other Features : pedestrian crossings on 2 approaches.

Traffic Flow

Count Date : Wednesday 27/08/75   Duration : 10 ½ hours

10½ hour count flow : 16 122 vehicles

Annual Flow : 10 069 665 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0452	0	2	1	3
B4149	0	0	1	1
-	-	-	-	-
Total	0	2	2	4

Accident Rate :

0.132 411 injury accidents per million vehicles.

Roundabout Junction Details

Location Number : 15

Road 1 : Chester Road	Road No :	A 452
Road 2 : Tyburn Road	Road No :	B 4148
Road 3 : -	Road No :	-

Traffic Count Location Number : 262

Accident Network Location :

Road No : A0452	Kilometreage : 1904 - 1915
Road No : B4148	Kilometreage : 0344 - 0356
Road No : -	Kilometreage : -

Location Details

Island Size : large

Speed limit : 40 mph.

Area : urban ; residential ; public house on one corner : shops on one approach.

Lane Width : 2-lane width - unmarked.

Road	A0452		B4148		-	
C/way	dual	dual	dual	dual	-	-
Approach	2 lanes	2 lanes	2 lanes	2 lanes	-	-
Priority	offside	offside	offside	offside	-	-

Bus Route : yes

Streetlighting : yes

Other Features : pedestrian crossings on 2 approaches.

Traffic Flow

Count Date : Friday 27/08/76

Duration : 10 $\frac{1}{2}$ hours

10$\frac{1}{2}$ hour count flow : 22 402 vehicles

Annual Flow : 12 610 593 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0452	5	5	3	13
B4148	0	0	0	0
-	-	-	-	-
Total	5	5	3	13

Accident Rate :

0.343 626 injury accidents per million vehicles.

Roundabout Junction Details

Location Number :16

Road 1 : Pershore Road South	Road No : A 441
Road 2 : The Green / Masshouse Lane	Road No : U 2347
Road 3 : Wharf Road	Road No : U 1891

Traffic Count Location Number : 287

Accident Network Location :

Road No : A0441	Kilometreage : 0843 - 0853
Road No : U2347	Kilometreage : 0000 - 0005
Road No : U1891	Kilometreage : 0320 - 0330

Location Details

Island Size : medium

Speed limit : 30 mph.

Area : urban ;residential ; public house and shops on one approach.

Lane Width : single

Road	A0441		U2347		U1891	
C/way	single	single	single	single	single	-
Approach	1 lane	1 lane	1 lane	1 lane	1 lane	-
Priority	offside	offside	offside	offside	offside	-

Bus Route : yes

Streetlighting : yes

Other Features : -

Traffic Flow

Count Date : Monday 14/06/76

Duration : 10½ hours

10½ hour count flow : 21 754 vehicles

Annual Flow : 10 705 291 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0441	1	2	5	8
U1891	0	0	0	0
U2347	0	0	0	0
Total	1	2	5	8

Accident Rate :

0.249 098 injury accidents per million vehicles.

Roundabout Junction Details — Location Number : 17

Road 1 : High Street	Road No : A 5127
Road 2 : Coleshill Street	Road No : U 6793
Road 3 : –	Road No : –

Traffic Count Location Number : 322

Accident Network Location :

Road No : A5127	Kilometreage : 0735 – 0745
Road No : U6793	Kilometreage : 0000 – 0005
Road No : –	Kilometreage : –

Location Details

Island Size : medium / small — Speed limit : 30 mph.

Area : urban ; shops.

Lane Width : single

Road	A5127		U6793		–	
C/way	single	single	single	–	–	–
Approach	1 lane	1 lane	1 lane	–	–	–
Priority	nearside	nearside	offside	–	–	–

Bus Route : yes — Streetlighting : yes

Other Features : –

Traffic Flow

Count Date : Monday 30/06/75 — Duration : 10½ hours

10½ hour count flow : 17 359 vehicles

Annual Flow : 8 675 320 vehicles

Number of Accidents

	1975 – 76	1976 – 77	1977 – 78	Total
A5127	0	1	1	2
U6793	0	0	0	0
–	–	–	–	–
Total	0	1	1	2

Accident Rate :

0.076 846 injury accidents per million vehicles.

Roundabout Junction Details

Location Number :18

Road 1 : Bordesley Green	Road No : B 4128
Road 2 : Belchers Lane	Road No : Unclassified
Road 3 : –	Road No : –

Traffic Count Location Number : 270

Accident Network Location :

Road No : B4128	Kilometreage : 0250 - 0258
Road No : –	Kilometreage : –
Road No : –	Kilometreage : –

Location Details

Island Size : large   Speed limit : 30 mph.

Area : urban ; residential ; shops on one approach - public house on corner.

Lane Width : single

Road	B4128		Belchers Lane		–	
C/way	single	dual	single	single		
Approach	2 lanes	2 lanes	1 lane	1 lane		
Priority	offside	offside	offside	offside		

Bus Route : yes   Streetlighting : yes

Other Features : pedestrian crossings on 2 approaches

Traffic Flow

Count Date : Thursday 17/07/75   Duration : 10½ hours

10½ hour count flow : 17 768 vehicles

Annual Flow : 11 104 981 vehicles

Number of Accidents

Road	1975 - 76	1976 - 77	1977 - 78	Total
B4128	3	1	1	5
–	–	–	–	–
–	–	–	–	–
Total	3	1	1	5

Accident Rate :

0.150 083 injury accidents per million vehicles.

Roundabout Junction Details

Location Number : 19

Road 1 :	Windmill Lane	Road No : B 4136
Road 2 :	Grove Lane	Road No : U 1
Road 3 :	Cranford Street	Road No : Unclassified

Traffic Count Location Number : 1579

Accident Network Location :

Road No : B4136	Kilometreage : 0332 - 0344
Road No : U0001	Kilometreage : 0075 - 0080
Road No : –	Kilometreage : –

Location Details

Island Size : large

Speed limit : 30 mph.

Area : urban ; residential ; public houses on 2 corners.

Lane Width : single

Road	B4136		U0001		Cranford Street	
C/way	single	dual	single	–	single	–
Approach	1 lane	2 lanes	1 lane	–	1 lane	–
Priority	offside	offside	offside	–	offside	–

Bus Route : yes

Streetlighting : yes

Other Features : –

Traffic Flow

Count Date : Thursday 27/05/76 Duration : 10½ hours

10½ hour count flow : 12 139 vehicles

Annual Flow : 4 775 483 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
B4136	0	0	1	1
U0001	0	0	0	0
–	–	–	–	–
Total	0	0	1	1

Accident Rate :

0.069 01 injury accidents per million vehicles.

Roundabout Junction Details — Location Number : 20

Road 1 : The Green	Road No : A 462
Road 2 : Midland Road	Road No : U 96
Road 3 : –	Road No : –

Traffic Count Location Number : 2066

Accident Network Location :

Road No : A0462	Kilometreage : 0270 - 0280
Road No : U0096	Kilometreage : 0000 - 0050
Road No : –	Kilometreage : –

Location Details

Island Size : large

Speed limit : 30 mph.

Area : urban ; residential .

Lane Width : single

Road	A0462		U0096		–	
C/way	single	single	single	–	–	–
Approach	1 lane	1 lane	1 lane	–	–	–
Priority	offside	offside	offside	–	–	–

Bus Route : yes

Streetlighting : yes

Other Features : –

Traffic Flow

Count Date : Thursday 30/09/76 Duration : 10 hours

10 hour count flow : 8 143 vehicles

Annual Flow : 3 700 741 vehicles

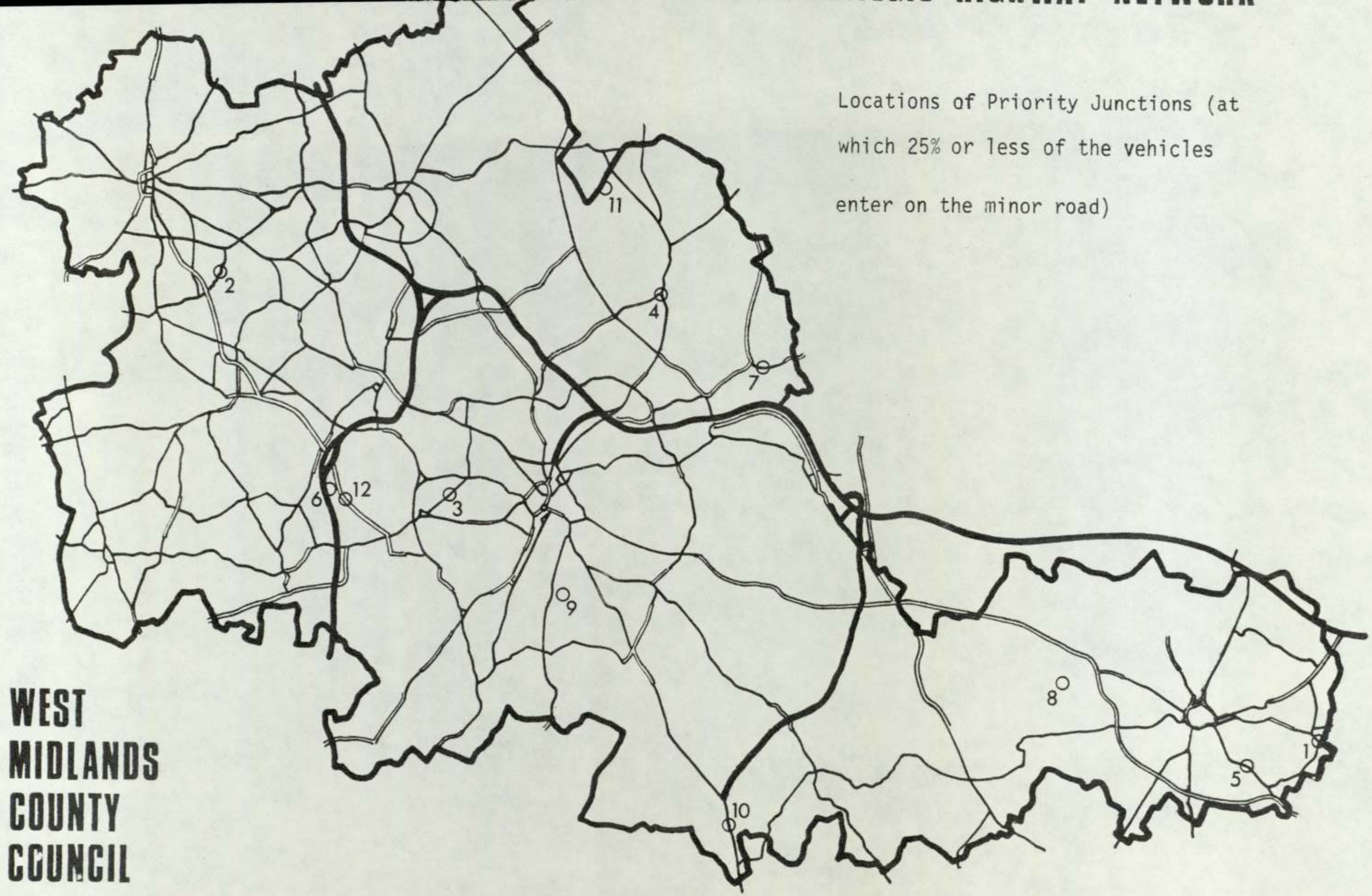
Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0462	1	0	0	1
U0096	0	0	0	0
–	–	–	–	–
Total	1	0	0	1

Accident Rate :

0.090 072 injury accidents per million vehicles.

Locations of Priority Junctions (at which 25% or less of the vehicles enter on the minor road)



Priority Junction Details | **Location Number : 1**

Road 1 : Brandon Road	Road No : A 428
Road 2 : Willenhall Lane	Road No : A 4082
Road 3 :	Road No :

Traffic Count Location Number : 1340

Accident Network Location :

Road No : A0428	Kilometreage : 066 - 077
Road No : A4082	Kilometreage : 297 - 300
Road No :	Kilometreage :

Location Details

Junction Type : T-junction Speed Limit : 30 mph

Area : urban ; residential ; school, shop, and garage on corner.

Road	A0428		A4082			
	1	2	1	2	1	2
Carriageway	single	single	single			
Lanes	1 lane	1 lane	1 lane			
Control	-	-	G/way			

Control Details : GIVE WAY lines, only, on minor road. Seperate right-turning lane on major road.

Bus Route : yes Streetlighting : yes

Other Features : 2 entrances into and 1 exit from minor road seperated by islands. Island with Keep Left bollards on both major approaches. School Crossing Patrol

Traffic Flow

Count Date : Wednesday 14/01/76 Duration : 12 hours.

Flow in Count : 12 183 vehs. % Entering on Minor : 23.37%

Annual Flow : 5 833 325 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0428	2	1	5	8
A4082	0	0	0	0
Total	2	1	5	8

Accident Rate :

0.457 144 injury accidents per million vehicles.

Priority Junction Details **Location Number : 2**

Road 1 : Ladymoor Road	Road No : A 463
Road 2 : Highfields Road	Road No : U 80
Road 3 :	Road No :

Traffic Count Location Number : 2253

Accident Network Location :

Road No : A0463	Kilometreage : 497 - 505
Road No : U0080	Kilometreage : 000 - 004
Road No :	Kilometreage :

Location Details

Junction Type : T-junction Speed Limit : 30 mph

Area : urban ; industrial ; school on corner.

Road	A0463		U0080			
	1	2	1	2	1	2
Carriageway	single	single	single			
Approach	1 lane	1 lane	1 lane			
Control	-	-	G/way			

Control Details : GIVE WAY sign and road-markings on minor road. Warning centre line on major road.

Bus Route : yes Streetlighting : yes

Other Features :

Traffic Flow

Count Date : Thursday 25/08/77 Duration : 10½ hours

Flow in Count : 8 009 vehs. % Entering on Minor : 23.01%

Annual Flow : 3 801 977 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0463	0	1	1	2
U0080	0	0	0	0
Total	0	1	1	2

Accident Rate :

0.175 347 injury accidents per million vehicles.

Priority Junction Details

Location Number : 3

Road 1 : City Road	Road No : N 4040
Road 2 : Rotton Park Road	Road No : B 4129
Road 3 :	Road No :

Traffic Count Location Number : 354

Accident Network Location :

Road No : N4040	Kilometreage : 631 - 647
Road No : B4129	Kilometreage : 055 - 068
Road No :	Kilometreage :

Location Details

Junction Type : Crossroads Speed Limit : 30 mph

Area : urban ; residential.

Road	N4040		B4129			
	1	2	1	2	1	2
Carriageway	single	single	single	single		
Approach	1 lane	1 lane	1 lane	1 lane		
Control	-	-	G/way	G/way		

Control Details : Illuminated GIVE WAY signs, and road-markings on minor road. Warning centre lines on major road.

Bus Route : yes **Streetlighting :** yes

Other Features : Parking restrictions at the junction.

Traffic Flow

Count Date : Wednesday 29/10/75 Duration : 10½ hours

Flow in Count : 8 114 vehs. **% Entering on Minor :** 21.95%

Annual Flow : 4 038 206 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
N4040	3	1	1	5
B4129	0	0	0	0
Total	3	1	1	5

Accident Rate :

0.412 725 injury accidents per million vehicles.

Priority Junction Details | **Location Number : 4**

Road 1 : Birmingham Road	Road No : A 5127
Road 2 : Jockey Road	Road No : A 453
Road 3 : Pilkington Avenue	Road No : unclassified

Traffic Count Location Number : 315

Accident Network Location :

Road No : A5127	Kilometreage : 604 - 611
Road No : A0453	Kilometreage : 070 - 080
Road No :	Kilometreage :

Location Details

Junction Type : crossroads   Speed Limit : 30 mph

Area : urban ; residential ; pub and shops on two corners.

Road	A5127		A0453		Pilkington Ave	
	1	2	1	2	1	2
Carriageway	single	single	single	-	single	-
Approach	1 lane	2 lanes	2 lanes	-	1 lane	-
Control	-	-	G/way	-	G/way	-

Control Details : Illuminated GIVE WAY sign, and road-markings on A0453 approach. Give Way road-markings only on Pilkington Ave.

Bus Route : yes   Streetlighting : yes

Other Features : Parking restrictions at the junction. Pedestrian crossing (zebra) on maor road approach (1).

Traffic Flow

Count Date : Thursday 29/07/76   Duration : 12 hours

Flow in Count : 19 563 vehs.   **% Entering on Minor :** 20.34%

Annual Flow : 8 542 005 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A5127	5	6	2	13
A453	0	0	0	0
Total	5	6	2	13

Accident Rate :

0.507 297 injury accidents per million vehicles.

Priority Junction Details Location Number : 5

Road 1 : London Road	Road No : A0423
Road 2 : Humber Road	Road No : B4110
Road 3 :	Road No :

Traffic Count Location Number : 1337

Accident Network Location :

Road No : A0423	Kilometreage : 182 - 195
Road No : B4110	Kilometreage : 000 - 003
Road No :	Kilometreage :

Location Details

Junction Type : T-junction Speed Limit : 30 mph

Area : urban ; residential .

Road	A0423		B4110			
	1	2	1	2	1	2
Carriageway	dual	dual	single			
Approach	2 lanes	2 lanes	2 lanes			
Control	-	-	G/way			

Control Details : Give Way road-markings on minor road.

Bus Route : yes Streetlighting : yes

Other Features : Central refuge on minor road approach. Gap in central reserve of dual carriageway for right-turning traffic. Parking restrictions at junction.

Traffic Flow

Count Date : Monday 12/12/77 Duration : 12 hours

Flow in Count : 19 406 vehs. **% Entering on Minor** : 20.32%

Annual Flow : 7 559 006 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0423	2	6	1	9
B4110	0	0	0	0
Total	2	6	1	9

Accident Rate :

0.396 878 injury accidents per million vehicles.

Priority Junction Details — **Location Number : 6**

Road 1 : Cakemore Road	Road No : B 4169
Road 2 : Penncricket Lane	Road No : U 12
Road 3 :	Road No :

Traffic Count Location Number : 1590

Accident Network Location :

Road No : B4169	Kilometreage : 164 - 173
Road No : U0012	Kilometreage : 000 - 003
Road No :	Kilometreage :

Location Details

Junction Type : T-junction   Speed Limit : 30 mph

Area : urban ; residential.

Road	B4169		U0012			
	1	2	1	2	1	2
Carriageway	single	single	single			
Approach	1 lane	1 lane	1 lane			
Control	-	-	G/way			

Control Details : Illuminated GIVE WAY sign, and road-markings on minor road. Warning centre markings on major road.

Bus Route : yes   Streetlighting : yes

Other Features :

Traffic Flow

Count Date : Wednesday 16/06/76   Duration : 10½ hours

Flow in Count : 5831 vehs.   % Entering on Minor : 16.17%

Annual Flow : 2 611 573 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
B4169	1	2	0	3
U0012	0	0	0	0
Total	1	2	0	3

Accident Rate :

0.382 911 injury accidents per million vehicles.

Priority Junction Details | **Location Number : 7**

Road 1 : Kingsbury Road	Road No : A0497
Road 2 : Water Orton Road	Road No : U7926
Road 3 : Cottage Lane	Road No : unclassified

Traffic Count Location Number : 239

Accident Network Location :

Road No : A0497	Kilometreage : 625 - 633
Road No : U7926	Kilometreage : 000 - 003
Road No :	Kilometreage :

Location Details

Junction Type : crossroads **Speed Limit :** 40 mph

Area : Urban ; residential ; pub and shops on 2 corners.

Road	A0497		U7926		Cottage Lane	
	1	2	1	2	1	2
Carriageway	single	single	single	-	single	-
Approach	1 lane	2 lanes	1 lane	-	1 lane	-
Control	-	-	G/way	-	G/way	-

Control Details : Illuminated GIVE WAY signs, and road-markings on minor roads. Right-turning lane on one major road approach (2).

Bus Route : yes **Streetlighting :** yes

Other Features : Pedestrian crossing (zebra) on one major road approach (1) - with central refuge. Shellgrip on approach to pedestrian crossing.

Traffic Flow

Count Date : Friday 02/07/76 **Duration :** 10½ hours

Flow in Count : 9698 vehs. **% Entering on Minor :** 15.93%

Annual Flow : 5 643 475 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0497	4	4	3	11
U7926	0	0	0	0
Total	4	4	3	11

Accident Rate :

0.649 718 injury accidents per million vehicles.

Priority Junction Details | **Location Number : 8**

Road 1 : Broad Lane	Road No : U 131
Road 2 : Banner Lane	Road No : unclassified
Road 3 :	Road No :

Traffic Count Location Number : 1959

Accident Network Location :

Road No : U0131	Kilometreage : 468 - 474
Road No :	Kilometreage :
Road No :	Kilometreage :

Location Details

Junction Type : T-junction   Speed Limit : 30 mph

Area : urban ; residential/industrial : garage on corner.

Road	U0131		Banner Lane			
	1	2	1	2	1	2
Carriageway	single	single	single			
Approach	1 lane	1 lane	1 lane			
Control	-	-	G/way			

Control Details : Give Way road markings on minor road.
Warning centre markings on major road.

Bus Route : yes   **Streetlighting :** yes

Other Features : Keep Left bollards on minor road approach.

Traffic Flow

Count Date : Tuesday 24/05/77   Duration : 12 hours

Flow in Count : 7754 vehs.   % Entering on Minor : 15.08%

Annual Flow : 3 004 148 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
U0131	1	0	2	3
Total	1	0	2	3

Accident Rate :

0.332 873 injury accidents per million vehicles.

Priority Junction Details | **Location Number : 9**

Road 1 : Wake Green Road	Road No : B 4217
Road 2 : Church Road	Road No : U 179
Road 3 :	Road No :

Traffic Count Location Number : 600

Accident Network Location :

Road No : B4217	Kilometreage : 481 - 489
Road No : U0179	Kilometreage : 150 - 159
Road No :	Kilometreage :

Location Details

Junction Type : T-junction   Speed Limit : 30 mph

Area : urban ; residential : shops on corner.

Road	B4217		U0179			
	1	2	1	2	1	2
Carriageway	single	single	single			
Approach	1 lane	1 lane	1 lane			
Control	-	-	G/way			

Control Details : Give Way road-markings on minor road.

Bus Route : yes   Streetlighting : yes

Other Features : Keep Left bollards on minor road.

Traffic Flow

Count Date : Thursday 06/11/75   Duration : 10½ hours

Flow in Count : 14 132 vehs.   % Entering on Minor : 13.02%

Annual Flow : 7 194 277 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
B4217	2	0	1	3
U0179	0	0	0	0
Total	2	0	1	3

Accident Rate :

0.138 999 injury accidents per million vehicles.

Priority Junction Details **Location Number : 10**

Road 1 : Stratford Road	Road No : A 34
Road 2 : Boxtrees Road	Road No : U 130
Road 3 :	Road No :

Traffic Count Location Number : 1404

Accident Network Location :

Road No : AS034	Kilometreage : 1225 - 1235
Road No : U0130	Kilometreage : 000 - 003
Road No :	Kilometreage :

Location Details

Junction Type : T-junction Speed Limit : 50 mph

Area : rural ; garage on corner.

Road	AS034		U0130			
	1	2	1	2	1	2
Carriageway	single	single	single			
Approach	1 lane	1 lane	1 lane			
Control	-	-	G/way			

Control Details : Illuminated GIVE WAY sign, and road-markings on minor road. Right-turning refuge with hatching on major road.

Bus Route : yes **Streetlighting :** yes

Other Features : Keep Left bollards on minor road.

Traffic Flow

Count Date : Monday 09/08/76 Duration : 10½ hours

Flow in Count : 7148 vehs. **% Entering on Minor :** 12.62%

Annual Flow : 4 295 997 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
AS034	0	0	1	0
U0130	0	0	0	0
Total	0	0	1	1

Accident Rate :

0.077 592 injury accidents per million vehicles.

Priority Junction Details — **Location Number : 11**

Road 1 :	Thornhill Road	Road No : B4138
Road 2 :	Foley Road East	Road No : B4151
Road 3 :		Road No :

Traffic Count Location Number : 2122

Accident Network Location :

Road No : B4138	Kilometreage : 570 - 580
Road No : B4151	Kilometreage : 725 - 732
Road No :	Kilometreage :

Location Details

Junction Type : T-junction   Speed Limit : 30 mph

Area : urban ; residential.

Road	B4138		B4151			
	1	2	1	2	1	2
Carriageway	single	single	single			
Approach	1 lane	1 lane	1 lane			
Control	-	-	G/way			

Control Details : Illuminated GIVE WAY sign, and road-markings on minor road. Warning centre line on major road.

Bus Route : yes   Streetlighting : yes

Other Features : 3-TON limit on one approach of major road.

Traffic Flow

Count Date : Thursday 12/05/77   Duration : 12 hours

Flow in Count : 13 543 vehs.   % Entering on Minor : 12.55%

Annual Flow : 5 621 357 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
B4138	0	0	0	0
B4151	0	1	0	1
Total	0	1	0	1

Accident Rate :

0.059 298 injury accidents per million vehicles.

Priority Junction Details | **Location Number : 12**

Road 1 : Wolverhampton Road	Road No : A 4123
Road 2 : Brandhall Lane	Road No : U 5
Road 3 :	Road No :

Traffic Count Location Number : 1561

Accident Network Location :

Road No : A4123	Kilometreage : 404 - 413
Road No : U0005	Kilometreage : 000 - 003
Road No :	Kilometreage :

Location Details

Junction Type : T-junction

Speed Limit : 40 mph

Area : urban ; residential.

Road	A4123		U0005			
	1	2	1	2	1	2
Carriageway	dual	dual	single			
Approach	2 lanes	2 lanes	1 lane			
Control	-	-	G/way			

Control Details : Illuminated GIVE WAY sign, and road-markings on minor road.

Bus Route : yes

Streetlighting : yes

Other Features : Gap in central reserve of dual carriageway for right-turning traffic. Parking restrictions at junction. Keep Left bollards on minor road.

Traffic Flow

Count Date : Friday 10/06/77

Duration : 10½ hours

Flow in Count : 14 567

% Entering on Minor : 8.16%

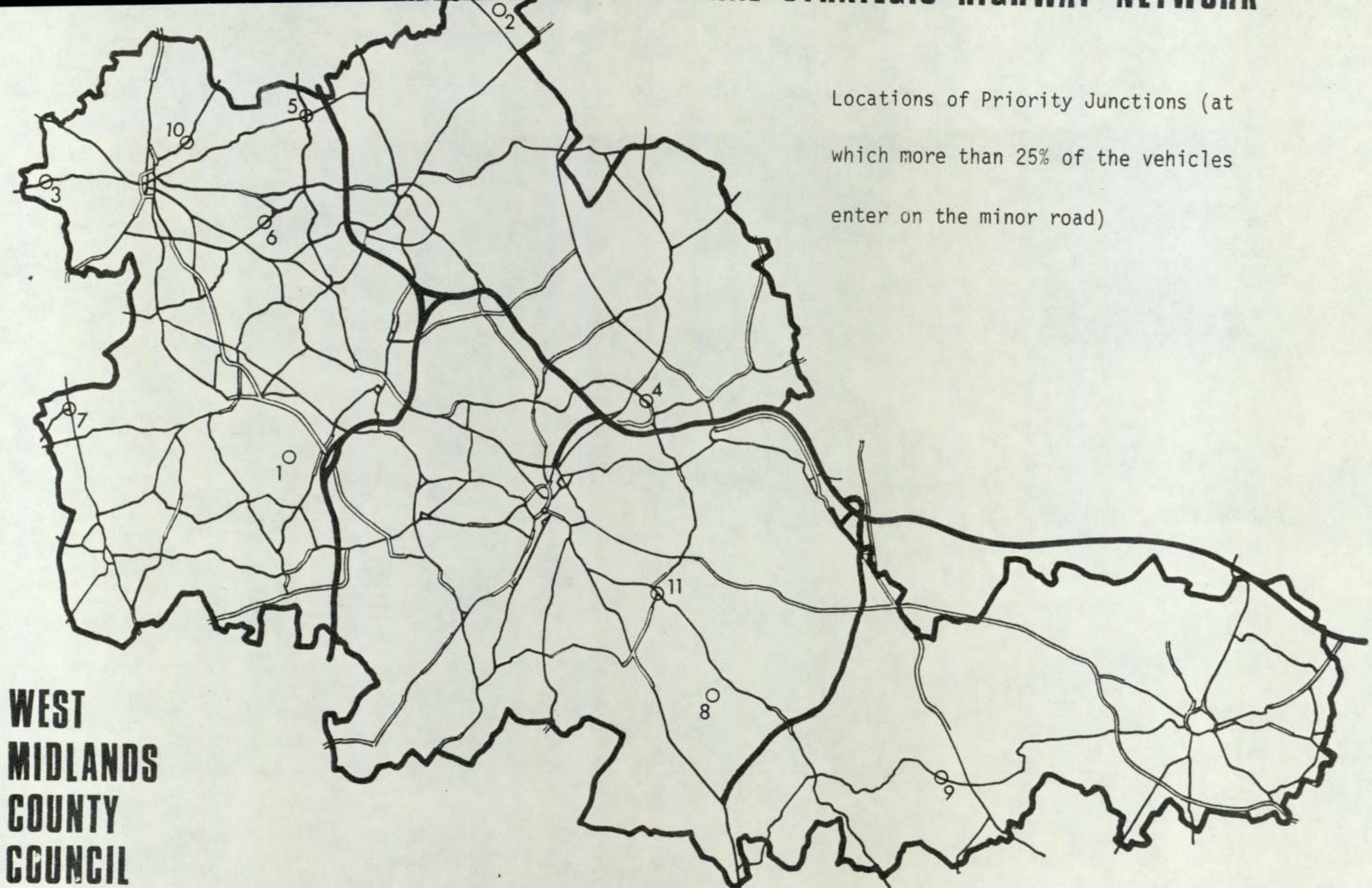
Annual Flow : 6 515 807 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A4123	1	1	1	3
U0005	0	0	0	0
Total	1	1	1	3

Accident Rate :

0.153 473 injury accidents per million vehicles.



Locations of Priority Junctions (at which more than 25% of the vehicles enter on the minor road)

Priority Junction Details | **Location Number : 1**

Road 1 : Newbury Lane	Road No : U 9
Road 2 : Portaway Hill	Road No : U 7
Road 3 :	Road No :

Traffic Count Location Number : 1607

Accident Network Location :

Road No : U0009	Kilometreage : 225 - 233
Road No : U0007	Kilometreage : 240 - 250
Road No :	Kilometreage :

Location Details

Junction Type : Staggered Crossroads   Speed Limit : 30 mph

Area : Urban ; residential ; pub on corner

Road	U0009		U0007			
	1	2	1	2	1	2
Carriageway	single	single	single	single		
Approach	1 lane	1 lane	1 lane	1 lane		
Control	-	-	G/way	G/way		

Control Details : Illuminated GIVE WAY sign, and road-markings on minor. Warning markings on major road.

Bus Route : yes   Streetlighting : yes

Other Features :

Traffic Flow

Count Date : Thursday 20/05/76   Duration : 10½ hours

Flow in Count : 7 940 vehicles   % Entering on Minor : 47.66%

Annual Flow : 4 449 168 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
U0009	0	0	1	1
U0007	1	0	0	1
Total	1	0	1	2

Accident Rate :

0.149 841 injury accidents per million vehicles.

Priority Junction Details **Location Number : 2**

Road 1 : Lichfield Road	Road No : B4155
Road 2 : Ogley Road	Road No : U 105
Road 3 :	Road No :

Traffic Count Location Number : 2098

Accident Network Location :

Road No : B4155	Kilometreage : 658 - 666
Road No : U0105	Kilometreage : 054 - 065
Road No :	Kilometreage :

Location Details

Junction Type : Staggered crossroads Speed Limit : 30 mph

Area : Urban ; residential ; garage and shops on 2 corners.

Road	B4155		U0105			
	1	2	1	2	1	2
Carriageway	single	single	single	single		
Approach	1 lane	1 lane	1 lane	1 lane		
Control	-	-	G/way	G/way		

Control Details : Illuminated GIVE WAY signs, and road-markings on minor. Warning markings on major road.

Bus Route : yes Streetlighting : yes

Other Features :

Traffic Flow

Count Date : Wednesday 20/07/77 **Duration** : 12 hours

Flow in Count : 9 826 vehicles. **% Entering on Minor** : 44.86%

Annual Flow : 3 696 489 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
B4155	2	1	3	6
U0105	0	0	0	0
Total	2	1	3	6

Accident Rate :

0.541 054 injury accidents per million vehicles.

Priority Junction Details | **Location Number : 3**

Road 1 :	Bridgenorth Road	Road No :	A 454
Road 2 :	Windmill Lane	Road No :	U 114
Road 3 :		Road No :	

Traffic Count Location Number : 2238

Accident Network Location :

Road No :	A0454	Kilometreage :	2630 - 2635
Road No :	U0114	Kilometreage :	509 - 524
Road No :		Kilometreage :	

Location Details

Junction Type : Crossroads   Speed Limit : 30 mph

Area : Urban ; non-residential : pub on corner.

Road	A0454		U0114			
	1	2	1	2	1	2
Carriageway	single	single	single	single		
Approach	1 lane	1 lane	1 lane	1 lane		
Control	-	-	G/way	G/way		

Control Details : Illuminated GIVE WAY signs, and road markings on minor road. Warning markings on major road.

Bus Route : yes   Streetlighting : yes

Other Features : Keep Left bollards on 1 minor approach.

Traffic Flow

Count Date : Thursday 11/11/76   Duration : 11 hours

Flow in Count : 11 227 vehicles. % Entering on Minor : 39.19 %

Annual Flow : 5 572 500 vehicles.

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0454	2	3	3	8
U0114	0	0	0	0
Total	2	3	3	8

Accident Rate :

0.478 540 injury accidents per million vehicles.

Priority Junction Details **Location Number : 4**

Road 1 : Bromford Lane	Road No : E 4040
Road 2 : Kingsbury Road	Road No : B 4148
Road 3 :	Road No :

Traffic Count Location Number : 342

Accident Network Location :

Road No : E4040	Kilometreage : 664 - 674
Road No : B4148	Kilometreage : 108 - 118
Road No :	Kilometreage :

Location Details

Junction Type : Crossroads Speed Limit : 30 mph

Area : Urban ; residential .

Road	E4040		B4148			
	1	2	1	2	1	2
Carriageway	dual	single	single	single		
Approach	2 lanes	1 lane	1 lane	1 lane		
Control	-	-	G/way	G/way		

Control Details : Illuminated GIVE WAY signs, and road-markings on minor road. Keep Left bollards on 1 minor approach. Warning markings on major road.

Bus Route : yes Streetlighting : yes

Other Features : Double Yellow lines on corners. Pedestrian crossing on single c/way major road approach. Pedestrian guard railing on 1 corner.

Traffic Flow

Count Date : Tuesday 03/01/78 Duration : 10½ hours

Flow in Count : 13 947 vehs. % Entering on Minor : 38.73 %

Annual Flow : 7 333 931 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
E4040	1	4	1	6
B4148	0	0	0	0
Total	1	4	1	0

Accident Rate :

0.272 705 injury accidents per million vehicles.

Priority Junction Details **Location Number : 5**

Road 1 : Lichfield Road	Road No : A 4124
Road 2 : Cannock Road	Road No : A 462
Road 3 :	Road No :

Traffic Count Location Number : 2073

Accident Network Location :

Road No : A4124	Kilometreage : 652 - 661
Road No : A0462	Kilometreage : 730 - 744
Road No :	Kilometreage :

Location Details

Junction Type : Staggered crossroads Speed Limit : 30 mph

Area : Urban ; residential ; shop on 1 corner.

Road	A4124		A0462			
	1	2	1	2	1	2
Carriageway	single	single	single	single		
Approach	1 lane	1 lane	1 lane	1 lane		
Control	-	-	G/way	G/way		

Control Details : Illuminated GIVE WAY signs, and road-markings on minor roads. Warning markings on major road.

Bus Route : yes Streetlighting : yes

Other Features : Directional signing on approaches. Keep Left bollards on minor approaches.

Traffic Flow

Count Date : Wednesday 10/08/77 Duration : 12 hours

Flow in Count : 13 668 vehs % Entering on Minor : 31.74 %

Annual Flow : 6 907 935 vehicles.

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A4124	0	1	2	3
A0462	0	0	0	0
Total	0	1	2	3

Accident Rate :

0.144 761 injury accidents per million vehicles.

Priority Junction Details Location Number : 6

Road 1 : Willenhall Road	Road No : A 463
Road 2 : Moseley Road	Road No : U 99
Road 3 :	Road No :

Traffic Count Location Number : 2251

Accident Network Location :

Road No : A0463	Kilometreage : 194 - 206
Road No : U0099	Kilometreage : 259 - 270
Road No :	Kilometreage :

Location Details

Junction Type : staggered crossroads **Speed Limit :** 30 mph

Area : urban ; residential ; pub & 2 garages on 3 corners.

Road	A0463		U0099			
	1	2	1	2	1	2
Carriageway	single	single	single	single		
Approach	1 lane	1 lane	1 lane	1 lane		
Control	-	-	G/way	G/way		

Control Details : Illuminated GIVE WAY signs, and road-markings on minor roads.

Bus Route : yes **Streetlighting :** yes

Other Features : Keep Left bollards on minor approaches.

Traffic Flow

Count Date : Wednesday 22/02/78 **Duration :** 10½ hours

Flow in Count : 15 018 vehs. **% Entering on Minor :** 30.44%

Annual Flow : 7 349 700 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0463	3	2	4	9
U0099	0	0	0	0
Total	3	2	4	9

Accident Rate :

0.408 180 injury accidents per million vehicles.

Priority Junction Details | **Location Number : 7**

Road 1 : Holbeache Road	Road No : A 449
Road 2 : Wolverhampton Road	Road No : A 491
Road 3 :	Road No :

Traffic Count Location Number : 1721

Accident Network Location :

Road No : A0449	Kilometreage : 149 - 158
Road No : A0491	Kilometreage : 000 - 004
Road No :	Kilometreage :

Location Details

Junction Type : T-junction **Speed Limit :** 30 mph

Area : urban ; residential

Road	A0449		A0491			
	1	2	1	2	1	2
Carriageway	single	single	single	-		
Approach	1 lane	1 lane	2 lanes			
Control	-	-	G/way			

Control Details : Illuminated GIVE WAY signs, and road-markings on minor. Hatching on major road (gap for turn). Hatching on minor road seperating lanes.

Bus Route : yes **Streetlighting :** yes

Other Features : directional signing on approaches.

Traffic Flow

Count Date : Tuesday 24/05/77 **Duration :** 12 hours

Flow in Count : 18 247 vehs. **% Entering on Minor :** 26.71%

Annual Flow : 7 491 134 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0449	3	5	1	9
A0491	1	0	1	2
Total	4	5	2	11

Accident Rate :

0.489 468 injury accidents per million vehicles.

Priority Junction Details | **Location Number : 8**

Road 1 : High Street (Solihull)	Road No : B 4102
Road 2 : Church Hill Road	Road No : U 129
Road 3 :	Road No :

Traffic Count Location Number : 1447

Accident Network Location :

Road No : B4102	Kilometreage : 741 - 749
Road No : U0129	Kilometreage : 569 - 605
Road No :	Kilometreage :

Location Details

Junction Type : T-junction   Speed Limit : 30 mph

Area : urban ; offices, pubs, and church on corners.

Road	B4102		U0129			
	1	2	1	2	1	2
Carriageway	single	single	single			
Approach	1 lane	1 lane	2 lanes			
Control	-	-	G/way			

Control Details : Illuminated GIVE WAY signs, and road-markings on minor.

Bus Route : yes   Streetlighting : yes

Other Features : The minor road approach splits into two just before the junction i.e. 2 entrances/exits seperated by an island. Ped-crossing just before split on minor.

Traffic Flow

Count Date : Friday 17/06/77   Duration : 12 hours

Flow in Count : 12 113 vehs.   % Entering on Minor : 26.65%

Annual Flow : 4 756 881 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
B4102	0	1	0	1
U0129	0	0	0	0
Total	0	1	0	1

Accident Rate :

0.070 074 injury accidents per million vehicles.

Priority Junction Details | **Location Number : 9**

Road 1 : Balsall Street	Road No : A 4023
Road 2 : Station Road	Road No : B 4105
Road 3 :	Road No :

Traffic Count Location Number : 1438

Accident Network Location :

Road No : A4023	Kilometreage : 1124 - 1135
Road No : B4105	Kilometreage : 000 - 003
Road No :	Kilometreage :

Location Details

Junction Type : T-junction | Speed Limit : 40 mph

Area : urban ; residential ; shop on one corner.

Road	A4023		B4105			
	1	2	1	2	1	2
Carriageway	single	single	single			
Approach	1 lane	1 lane	1 lane			
Control	-	-	G/way			

Control Details : Illuminated GIVE WAY sign, and road-markings on minor road.

Bus Route : yes | **Streetlighting :** yes

Other Features :

Traffic Flow

Count Date : Wednesday 11/02/76 | **Duration :** 12 hours

Flow in Count : 2967 vehs. | **% Entering on Minor :** 26.49%

Annual Flow : 1 238 413 vehicles.

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A4023	1	0	0	1
B4105	0	0	0	0
Total	1	0	0	1

Accident Rate :

0.269 162 injury accidents per million vehicles.

Priority Junction Details **Location Number : 10**

Road 1 : Cannock Road	**Road No :** A 460
Road 2 : Raynor Road / Bushbury Road	**Road No :** U 120
Road 3 :	**Road No :**

Traffic Count Location Number : 2248

Accident Network Location :

Road No : A0460	**Kilometreage :** 196 - 210
Road No : U0120	**Kilometreage :** 509 - 524
Road No :	**Kilometreage :**

Location Details

Junction Type : Staggered crossroads. **Speed Limit :** 30 mph
Area : urban ; garage, pub, shops and carpark on corners.

Road	A0460		U0120			
	1	2	1	2	1	2
Carriageway	single	single	single	single		
Approach	1 lane	1 lane	1 lane	2 lanes		
Control	-	-	G/way	G/way		

Control Details : Illuminated GIVE WAY signs, and road-markings on minor. Warning centre lines on major road.

Bus Route : yes **Streetlighting :** yes

Other Features : Keep Left bollards on one minor approach (1). Centre island on other minor approach (2). Local directional signposts.

Traffic Flow

Count Date : Wednesday 16/03/77 **Duration :** 12 hours.
Flow in Count : 15 230 vehs. **% Entering on Minor :** 25.80%
Annual Flow : 7 227 282 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
A0460	5	4	5	14
U0120	0	0	0	0
Total	5	4	5	14

Accident Rate :

0.645 701 injury accidents per million vehicles.

Priority Junction Details Location Number : 11

Road 1 : Warick Road	Road No : A 41
Road 2 : Fox Hollies Road	Road No : U 995
Road 3 :	Road No :

Traffic Count Location Number : 604

Accident Network Location :

Road No : AS041	Kilometreage : 602 - 615
Road No : U0995	Kilometreage : 050 - 057
Road No :	Kilometreage :

Location Details

Junction Type : T-junction Speed Limit : 30 mph

Area : urban ; residential.

Road	AS041		U0995			
	1	2	1	2	1	2
Carriageway	single	single	single			
Approach	2 lanes	2lanes	1 lane			
Control	-	-				

Control Details : Illuminated GIVE WAY signs, and road markings on minor road.

Bus Route : yes Streetlighting : yes

Other Features : Parking restrictions on major road.

Traffic Flow

Count Date : Tuesday 27/07/76 Duration : 10½ hours.

Flow in Count : 14 540 vehs. % Entering on Minor : 25.19%

Annual Flow : 6 704 091 vehicles

Number of Accidents

	1975 - 76	1976 - 77	1977 - 78	Total
AS041	2	1	0	3
U0995	0	0	0	0
Total	2	1	0	3

Accident Rate :

0.149 163 injury accidents per million vehicles.