HIGH ACCIDENT LOCATIONS, 1996-2000

The Inter-urban National Route Network

SUMMARY

This paper has two main objectives:

1 to identify High Accident Locations on the inter-urban National Route Network; and
2 to find out what accident contributory risk factors, if any, are present at these locations.

It is hoped that the findings of the report will be of use to road safety engineers in locating accident black spots.

For the purposes of this report, the National Route Network was broken up into 1,922 discrete segments / sections / locations, each with similar carriageway type, traffic volumes and speed limits [sections with speed limit less than or equal to 40 mph are designated Urban sections and omitted from the analysis]. Using the National Road Needs Database, accidents were 'projected' onto national routes and the number of fatal and injury accidents in each section were counted.

A statistical model, linking the accident rate to the Average Annual Daily Traffic (AADT) of a given road section, was formulated. Using this model, 'fitted values' for the expected number of a) fatal accidents and b) all fatal and injury accidents were derived. These fitted values were then compared to the actual number of accidents and if it could be said to a reasonable degree of confidence that the difference between the actual and expected number of accidents was statistically significant, and the actual number was greater than the expected number, the section was deemed to be a High Accident Location (HAL).

This report identifies 109 inter-urban sections where the accident rate (1996-2000) proved to be higher than expected and any risk factors that can be determined to be present at these sections.

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CHAPTER 1 OBJECTIVES, SCOPE AND LIMITATIONS OF STUDY

1.1 OBJECTIVES

The general and ultimate aims of this study are to:-

1 identify High Accident Locations (HALs) on the inter-urban national road network, and

2 investigate whether at each of these individual sites there were any risk factors, such as skidding etc, that may have influenced the number of accidents occurring at that section.

A core aspect of this study is the creation of a statistical model which, for inter-urban national roads, calculates the expected number of accidents in a section given its traffic volume and section length. This is then compared with the actual outcome for the years 1996 through 2000 and in circumstances where the number of recorded accidents significantly exceeds the expected number then that section is designated a HAL.

Each HAL is further examined to determine if there appear to be any risk factors, such as skidding, road defects etc, that may have, at least in part, 'caused' the higher than expected number of accidents in the section concerned.

1.2 SCOPE

The problems involved with, and indeed techniques used in, the identification of HALs, differ quite dramatically for inter-urban and urban road networks[1].

In the former, it is thought that the dominant factor in determining the level of accidents is the length of the section and the traffic volume. In inter-urban areas few 'vulnerable road users', i.e. pedestrians and cyclists, are typically involved in accidents. In urban areas accident rates are to a much larger degree determined by the presence, or lack thereof, of these 'vulnerable' road user groups.

This study focuses exclusively on inter-urban stretches of road, i.e. sections with a speed limit in excess of 40 mph. Examination of fatal accidents on national routes suggests that approximately 80 per cent of fatal accidents on national routes occur on inter-urban sections[2].

The study deals only with the situation on national roads. There are two main reasons for limiting the study to national roads, namely: the lack of adequate time series data in relation to both traffic volumes and route number in respect of non-national road accidents; and the extent of the non-national network, which would have rendered the task in hand much more difficult.

[1] see High Accident Locations, Vol. 1. The Principal Interurban Roads, An Foras Forbartha,
[2] see Road Accident Facts, Ireland 2000.

1.3 LIMITATIONS

The results of any study are only as good as the data that they are based on.

All accident information used in the study is derived from An Garda Siochana accident report forms, known as C(T)68s. While the accident reporting system in Ireland is thought to compare favorably with many, if not most, of EU member states, it must be said that despite a legal requirement on persons involved to report all injury accidents to the Gardai, not all such accidents are reported. The absence of a complete data set, or even definitive information as to the extent of the 'under-reporting / recording problem' places limitations on what can reasonably be inferred from both this report and road accident information in general.

The second major limitation of the data set used in the report is that some of the traffic volume figures are based on sample counts conducted over relatively short periods. Obviously, there are sizeable 'margins of error' attached to such counts.

Given the aforementioned limitations of the data used in the survey, it is necessary to be cautious in the interpretation of the results. It is entirely possible that some sections, which are determined to be High Accident Locations are not actually such, and that it is data deficiencies which cause incorrect identification. It is also possible that there are some sections which are in fact High Accident Locations which, due to data deficiencies have not been identified as such.

CHAPTER 2: MODELLING ROAD TRAFFIC ACCIDENT OCCURRENCE

Road Traffic Accidents (RTAs) are generally thought of as rare, random, multi-factor events in which a road user/s fails to cope with the surrounding traffic environment (see Fridstrom and Ingebritsen, 1991 or Crowley, 1992). The occurrence of the event, i.e. the RTA, is by its very nature unpredictable. After all, if people could predict when and where they would be involved in accidents surely they would take steps to ensure that the accident wouldn't happen? However, while each individual accident is fundamentally unpredictable by its nature, the number of accidents in given locations over given time periods may display notable patterns and can be influenced by a range of factors (see, for instance, Maher and Mountain, 1988).

While road users and vehicle factors may influence individual road accidents, in road safety work it is generally assumed that human and vehicular factors play a constant role over the entire network. In essence, it is assumed that, for example, the west of Ireland drivers are not fundamentally different from the drivers on the east coast and that the condition of vehicles is roughly similar on all parts of the network (see High Accident Locations (7), 1984).

The sections of the network are not of equal length nor do they experience the same traffic flow. The number of accidents will, obviously, be influenced by both. The purpose of HAL reports is to identify sections of the road network that have a high risk factor *because* of the *physical* or *environmental* characteristics of the section. In sites where the *physical* or *environmental* characteristics lead to accidents, all else being equal a disproportionate number of accidents - i.e. a higher level of accidents than expected given the length and traffic volume of the road - should be found.

This report firstly attempts to model the expected number of accidents in a section over a period given the Average Annual Daily Traffic (AADT), a measure of traffic volume, and the length of the section in question. The report then examines whether to a reasonable degree of confidence, the difference between the actual number of accidents on the network and the expected number is statistically significant. If it can be said to a, say, 95 per cent degree of certainty that the actual number of accidents is higher than the expected number on a given stretch of road, then that stretch is designated as a HAL.

2.1 BASIC STATISTICS AND DATA PREPARATION

There are approximately 5,420 kilometers of national roads. In the 5-year period 1996-2000, there were a total of 830 fatal and a further 9,983 reported injury only accidents on these roads.

The 65 national routes were divided into a total of 1,922 sections of average length 2.82 kilometers using the National Road Needs Database. 939 of these sections were inter-urban. The program to compute road sections started at the beginning of each national road with each section lasting until a parameter relating to the road changed (i.e. carriageway type, traffic volumes or urban / inter-urban).

Information relating to the number of fatal, serious injury and minor injury accidents was available from the National Roads Authority's Road Accident Database. All of the fatal / injury accidents on national roads have rough grid co-ordinates attached to them. These accidents were then projected onto the National Roads network using the National Road Needs Database – provided that the accidents were located within a specified distance of the exact co-ordinates of the national road in question. A computer algorithm counted the number of each type of accident in each section. A number of accidents - a total of 875, or 8 per cent of total - were either located too far off the national road in question or did not contain enough detail to process and were excluded.

There are approximately 4,616 kilometers of inter-urban – defined as having a speed limit greater than 40 miles per hour - national roads. After excluding the aforementioned accidents, in the five-year period 1996-2000, there were a total of 640 fatal accidents and 6,138 reported injury only accidents. In these accidents, a total of 769 persons were killed while 2,539 suffered serious injuries and 9,167 suffered minor injuries.

2.2 STATISTICAL METHODOLOGY

There are several basic types of statistical models commonly used to relate accidents to explanatory factors such as traffic flow; including: Multiple Linear Regression Models, Poisson Models, Negative Binomial Models and Accident Rate Models. Researchers have, however, gradually moved away from the use of Multiple Linear Regression Models as a result of well-documented statistical difficulties (see, for instance, Jovanis and Chang, 1986). In particular, while the actual number of accidents on a given stretch of road is constrained to be a positive whole number greater than or equal to zero, it is possible using unrestricted Multiple Linear Regression Analysis to estimate a negative number of accidents. Moreover, in the words of Bauer and Harwood (1997), "…normalizing accident frequencies with exposure estimates, such as million vehicle-miles of travel….to make accident rates appear to be a continuous random variable does not change the fundamentally discrete nature of accident data".

The Poisson distribution is a discrete distribution with the variable in question taking on whole number values greater than or equal to 0, i.e. values of 0, 1, 2, 3 etc. It is often used to model the number of events occurring within a given period – which intuitively makes it sensible to use here. In our basic Poisson model:

Let Ui be the number of accidents in a given period on road section i. We assume that U_i is a Poisson variable such that:

$$E(U_i) = a_i * V_i^{Pi} * L_i = a_i * Y_i \quad (1)$$

where

$$Y_i = V_i^{Pi} * L_i \quad (2)$$

and $E(U_i)$ is the expected number of accidents on road section i in a given period and V_i is the Average Annual Daily Traffic (AADT) on that section, L_i is the length of road of that section.

Abdel-Aty and Radwan (2000) noted, however, that proper use of the Poisson model is conditional on the mean and variance of the accident frequency variable being equal.

In the event that the mean and variance are not equal Negative Binomial Models are typically used (see Shankar et. al., 1995). The Negative Binomial is essentially similar to the Poisson model except that it permits the variance to differ from the mean value of the dependent variable. Compared with the Poisson model the Negative Binomial Model has an additional parameter such that

$$\text{Variance } (U_i) = E(U_i)*(1 + \alpha\, E(U_i)) \qquad (3)$$

where α is an over dispersal parameter (see Abdel-Aty and Radwan, 2000). The choice between the Poisson Model and the Negative Binomial model depends essentially on the α parameter. If the co-efficient is statistically significantly different from zero the Negative Binomial is appropriate, if not the Poisson model will suffice (if the α value equals 0 the Negative Binomial Model effectively reduces to the Poisson model – see Equation 3).

The last type of model commonly used in predicting the number of accidents on a given stretch of road is the Accident Rate Model where the relationship between the accident rate (the number of accidents per unit length) and traffic volume is deemed to be a power function such as:

$Y = \alpha X^{\beta}$

Where Y = accident rate, X = Average Annual Daily Traffic (AADT) and α, β are constants.

Having estimated the expected number of accidents in each given section using one of the aforementioned techniques, the remaining variability, as measured by the sum of squares (see National Roads Authority 1984), is essentially made up of:

(i) variability due to the geometric / environmental characteristics of the section, and

(ii) a residual random variability which arises because of the chance nature of accident occurrences.

The basic or null hypothesis is that sections of road of equal length with equal vehicle miles traveled should have similar levels of accidents over a given time period; and that the number of accidents in a given period should be similar to that estimated using the statistical techniques outlined above.

The null hypothesis was rejected if the difference between the actual and estimated number was so large as to have arisen in less than one in twenty times were the hypothesis valid. In other words, if we can say to a ninety-five per cent confidence level that there is a difference between the actual and expected number of accidents then we reject the null hypothesis in favor of the alternate hypothesis – there is a difference. In the case of the actual number of accidents also being greater than the expected level, the section was designated a HAL.

The next, crucial, step is to examine accident, traffic, geometric and environmental aspects of those high accident locations with a view to identifying site-specific characteristics, which,

if modified, could help reduce the accident rate on a given stretch of road to the median level.

2.3 EXAMINATION OF ACCIDENT PATTERNS

Between the years 1996 and 2000, there were a total of 10,813 accidents on national roads[3], 830 of which involved at least one fatality and 2,286 of which involved at least one serious injury but no fatality (see Table 2.3.1.).

Table 2.3.1. Accidents on National Roads classified by accident severity and year.

	1996	1997	1998	1999	2000	Total
Fatal	172	164	174	165	155	830
Serious	515	520	437	420	394	2,286
Minor	1,594	1,542	1,601	1,468	1,492	7,697
Total	2,281	2,226	2,212	2,053	2,041	10,813

A total of 7,033 (see table 2.3.2 below) of the 10,813 accidents on national roads occurred on inter-urban sections – defined as those sections with speed limits in excess of 40 mph. 82 per cent of all fatal accidents on national roads were on inter-urban sections while the figure for minor injury accidents was much lower (61 per cent). Thus the average severity of accidents on inter-urban national roads is greater than that on urban national roads.

Table 2.3.2. Accidents on Inter-urban sections of National Roads classified by accident severity and year.

	1996	1997	1998	1999	2000	Total
Fatal	142	131	149	137	125	684
Serious	367	373	311	324	313	1,688
Minor	933	899	965	924	940	4,661
Total	1,442	1,403	1,425	1,385	1,378	7,033

Of the 7,033 accidents occurring on inter-urban sections of national roads, 6,778 were used in the analysis (a total of 255 were omitted due to either a lack of data or imprecision in grid co-ordinates). So, a total of 640 fatal accidents, 1,600 serious and 4,538 minor injury accidents were studied.

Table 2.3.3. Accidents on inter-urban sections of National Roads classified by accident severity and year.

	1996	1997	1998	1999	2000	Total
Fatal	128	120	144	128	120	640
Serious	327	363	296	317	297	1,600
Minor	912	881	909	889	947	4,538
Total	1,367	1,364	1,349	1,334	1,364	6,778

[3] Excluding accidents where route number is not specified.

Analysis of the 6,778 fatal and injury accidents on inter-urban sections of national roads yielded the following results (see Appendix 3.4):

(i) 5.9 per cent involved pedestrians;
(ii) 23.4 per cent were single vehicle accidents;
(iii) 34.8 per cent occurred in the dark;
(iv) 41.7 per cent occurred in wet conditions;
(v) 33.0 per cent involved skidding;
(vi) 15.2 per cent involved goods vehicles, and
(vii) 4.3 per cent involved road defects being specified.

On any of the identified HAL it is possible to check if the proportions of these different accident types / classes were a great deal higher than those expected (see above). The procedure used was as follows (methodology similar to that used in High Accident Locations, 1984): -

(i) if there were less than four recorded accidents on the section over the period 1996-2000, no test procedure was used on the grounds that there were insufficient numbers to draw any meaningful conclusions;

(ii) the expected proportion of accidents on the section was calculated;

(iii) the reported proportion of each type of accident was compared with the expected, using a standard technique (the chi-square test); and

(iv) in cases where the actual proportion was (a) higher than expected, and (b) so high as to occur in only one in forty times or less were the expected proportion the one characterizing the section, then that accident type / class was designated a high-risk class for that section - thus facilitating to some extent the examination of accident patterns on the section.

CHAPTER 3 RESULTS

The National Road Network comprises a total of 31 Primary Routes (numbered N/M [4] 1 – N/M 50) and 33 Secondary Routes (Numbered N 51 – N 87). Appendix 3.3 presents summary data on the accident / casualty history on inter-urban sections of these routes. Appendix 3.4 provides summary data on both the risk factors on each route and the accident rate. The key guides for Appendices 3.3 and 3.4 are provided in Appendices 3.1 and 3.2.

The inter-urban National Road Network was divided into 939 sections. Four sections were omitted as they were recently constructed and therefore lacked a sufficient accident history upon which to perform the analysis. The distribution of accidents is shown in the Table 3.1 below.

Table 3.1: Distribution of Fatal and Injury Accidents, 1996-2000, on all selected Inter-urban Sections of the National Road Network.

Number of Accidents	Frequency	Percent	Cumulative Percent
0	140	15.0	15.0
1	105	11.2	26.2
2	79	8.4	34.7
3	90	9.6	44.3
4	49	5.2	49.5
5	59	6.3	55.8
6	42	4.5	60.3
7	42	4.5	64.8
8+	329	35.2	100.0
Total	935	100.0	100.0

The expected Number of Accidents in a given section was derived from an accident rate model[5]. The expected Accident Rate was hypothesized to be a quadratic function of the AADT. Using the model estimated, the expected accident rate declines until the AADT exceeds approximately 43,000 after which point it edges up slightly. The relationship between the expected accident rate and AADT as estimated is shown in Figure 3.1 below.

Figure 3.2 (also below) shows the actual and predicted number of accidents in each given section. If the model 'fitted' perfectly all points would lie on the diagonal line [i.e. the expected number of accidents would exactly equal the actual number of accidents in all cases occurring over the period in question]. While there are many sections for which the actual number of accidents differs markedly from the expected number, the correlation between the two (=.76) is relatively strong and the model appears to 'fit' the data relatively well.

[4] N denotes a National Road that is not a Motorway, M denotes a National Road that is a Motorway.

[5] Significant over-dispersion was found in the Poisson Model ruling it unusable; while the fitted Negative Binomial Regression Model performed poorly when forecasting the number of accidents in sections which were relatively long and had a high AADT.

Figure 3.1 Injury Accident and Fatal Accident Rates - derived from accident rate model - on Inter-urban stretches of National Roads classified by AADT, average 1996-2000.

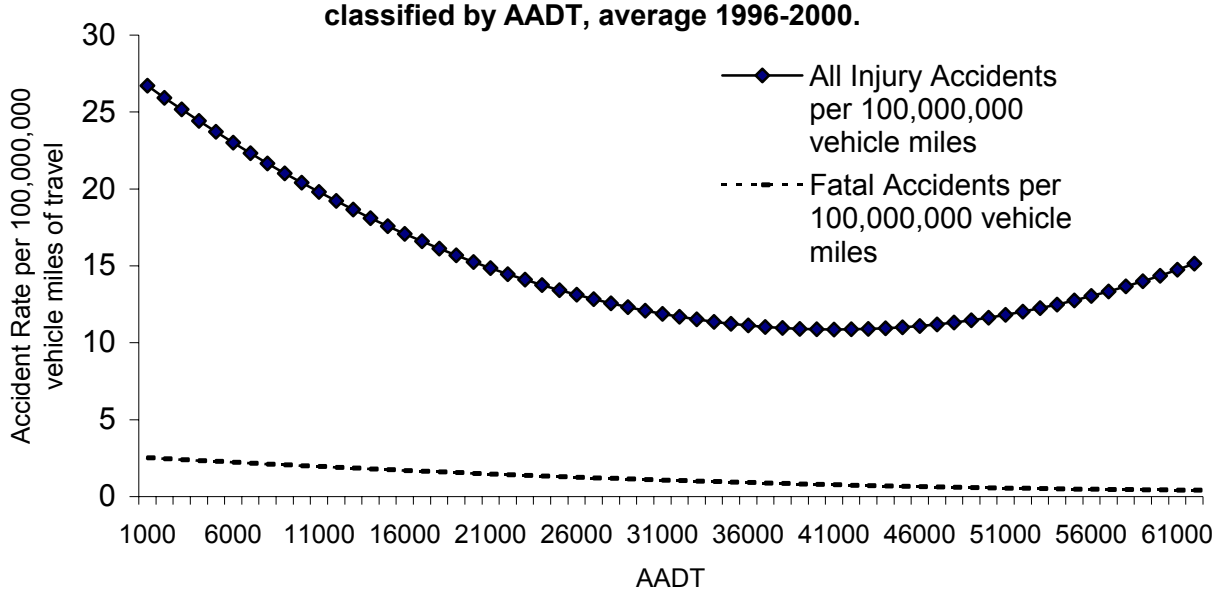
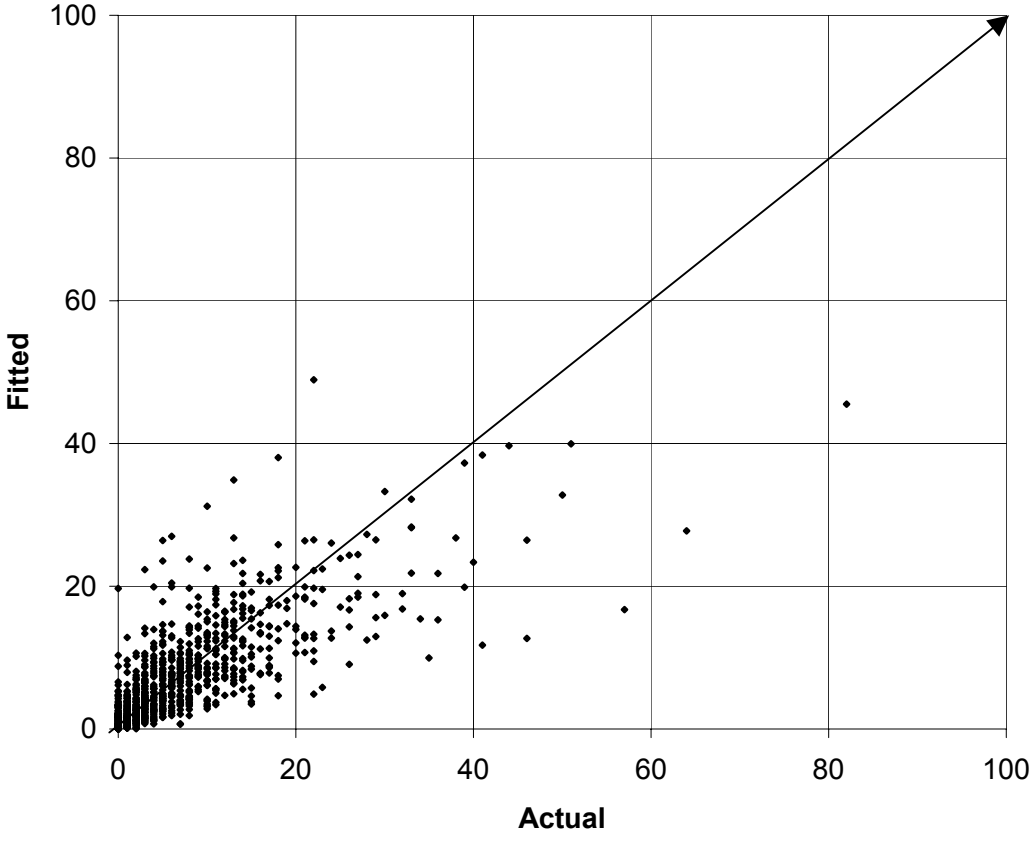


Figure 3.2 Actual Number and Predicted Number of Accidents in each section



Comparing the expected number of accidents, calculated using the accident rate model, to the actual, a total of 109 sections were shown to have a, statistically significant, greater than expected number of accidents (see Table 3.2); owing to the imprecision of both the grid co-ordinate data and the system that projects them onto National Routes, sections that had a higher than expected number of accidents but less than 4 accidents were not classified as High Accident Locations.

Table 3.2: Distribution of Fatal and Injury Accidents, 1996-2000 on all selected Sections of the Inter-urban National Road Network.

Number of Accidents	Frequency	Percent	Cumulative Percent
0	0	0.0	0.0
1	0	0.0	0.0
2	0	0.0	0.0
3	0	0.0	0.0
4	3	2.8	2.8
5	4	3.7	6.4
6	3	2.8	9.2
7	4	3.7	12.8
8+	95	87.2	100.0
Total	109	100.0	100.0

The identified High Accident Locations are shown on a map in Appendix 3.5.

The map in Appendix 3.6 locates sections with accident rates higher than, lower than or roughly equal to that which was expected.

Table 3.3 shows the details regarding the 109 sections identified as being High Accident Locations. The risk factors present at each identified HAL are denoted by an asterisk. The key to the table is shown on page 15.

Table 3.3 High Accident Location details and risk factors involved, 1996-2000.

High Risk		Section details						Accidents		Risk Factors									Expected Accidents		
A	F	RTNUM	CHSTART	CHEND	LENGTH	AADT	SECTION	FATAL	TOTACC	SKID	GDSP	GDSS	GDST	RDEF	DARK	WET	SINGLE	PED	FAT	ALL	RATE
*	*	1	0	9.57	9.57	14631	1	8	64						*			*	2.7	27.7	41.0
*		1	42.513	45.692	3.179	12102	19	3	14										0.8	8.2	32.7
*		1	73.725	77.51	3.785	19418	41	1	22										1.3	12.7	26.9
*		1	77.51	78.85	1.34	31725	42	1	14										0.5	5.6	29.5
*		1	83.22	84.076	0.856	35588	46	0	15										0.3	3.8	44.2
*		1	84.076	85.977	1.901	45394	47	1	20		*								0.6	10.6	20.8
*		2	24.55	25.709	1.159	10226	73	2	7		*							*	0.3	2.7	53.0
*		2	28.993	34.354	5.361	6495	76	1	17										0.9	8.8	43.8
*		2	59.059	75.216	16.157	4600	88	4	39						*		*		1.9	19.9	47.1
	*	2	77.61	86.402	8.792	8819	93	5	26										1.8	18.3	30.1
*	*	2	128.735	133.9	5.163	18075	107	5	57				*						1.7	16.7	54.8
*		3	13.193	14.774	1.581	6374	120	1	6										0.2	2.6	53.4
*		3	20.841	30.867	10.026	6007	125	1	34										1.5	15.4	50.7
*		3	103.162	111.08	7.918	15087	149	2	40										2.3	23.4	30.0
*		3	111.08	113.24	2.155	17305	150	2	13										0.7	6.8	31.3
*		3	119.785	121.16	1.37	42160	153	1	18										0.5	7	28.0
*		4	193.332	195.25	1.921	45998	238	1	22						*			*	0.6	10.9	22.3
*		4	196.734	198.15	1.414	58879	240	2	29									*	0.4	13	31.3
*		4	198.148	198.78	0.635	45032	241	1	15		*								0.2	3.5	47.1
*		5	83.936	87.255	3.319	3535	282	1	8										0.3	3.2	61.2
*		5	110.577	113.98	3.402	3679	291	3	7										0.3	3.4	50.2
*		6	11.987	16.365	4.378	13397	311	0	20										1.2	12	30.6
*		6	35.949	36.631	0.682	9071	316	1	4										0.1	1.4	58.0
*		7	136.204	144.9	8.695	16322	407	4	38				*						2.7	26.8	24.0
*		7	169.772	172.73	2.956	42610	417	2	36										1	15.3	25.6

Table 3.3 High Accident Location details and risk factors involved, 1996-2000 (contd.).

High Risk		Section details						Accidents		Risk Factors									Expected Accidents		
A	F	RTNUM	CHSTART	CHEND	LENGTH	AADT	SECTION	FATAL	TOTACC	SKID	GDSP	GDSS	GDST	RDEF	DARK	WET	SINGLE	PED	FAT	ALL	RATE
*		7	172.728	182.07	9.346	40179	418	5	82										3.3	45.5	19.6
*		8	54.879	55.763	0.884	7984	473	1	5										0.2	1.7	63.6
*		8	110.814	114.07	3.259	6994	495	0	11										0.5	5.7	43.3
*		9	13.372	24.209	10.837	4994	525	1	26								*		1.4	14.3	43.1
*		9	94.167	97.648	3.481	9269	554	2	18										0.7	7.5	50.1
	*	11	24.513	30.215	5.702	7487	589	5	11						*				1	10.5	23.1
*		11	49.469	60.734	11.265	8037	601	1	33										2.1	21.8	32.7
*	*	11	76.483	85.52	9.037	8855	608	5	29										1.8	18.8	32.5
*		11	85.52	89.763	4.243	7787	609	3	14									*	0.8	8	38.0
*		11	90.892	92.387	1.495	16395	612	1	15										0.5	4.6	54.9
*		11	106.797	108.16	1.359	24113	618	2	11										0.5	5	30.1
*		11	120.935	122.93	1.993	41311	626	1	35										0.7	10	38.1
*		14	7.552	10.149	2.597	5380	682	0	8										0.4	3.6	51.4
*	*	14	10.149	17.623	7.474	4147	683	4	15										0.8	8.4	43.4
*		14	17.623	18.742	1.119	7435	684	0	7				*						0.2	2	75.5
*		15	39.508	48.888	9.38	2162	699	1	23										0.6	5.8	101.8
*		15	97.083	97.973	0.89	7415	723	1	5								*		0.2	1.6	68.0
*		17	100.372	115.56	15.189	9288	774	6	50							*			3.2	32.8	31.8
*		17	115.561	116.72	1.158	15796	775	1	10										0.3	3.5	49.1
*		18	16.841	23.796	6.955	7468	789	1	21										1.2	12.7	36.3
*		21	1.934	5.295	3.361	12961	879	0	26										0.9	9.1	53.6
*		21	41.855	46.283	4.428	6536	893	2	14								*		0.7	7.3	43.4
	*	21	61.724	69.047	7.323	9050	900	4	14										1.5	15.5	19.0
*		21	69.047	72.595	3.548	3824	901	0	11										0.4	3.7	72.7
*		21	74.882	77.937	3.055	4171	903	0	8										0.3	3.5	56.3
*		21	84.361	90.669	6.308	5809	906	3	22										0.9	9.4	53.9

Table 3.3 High Accident Location details and risk factors involved, 1996-2000 (contd.).

High Risk		Section details						Accidents		Risk Factors									Expected Accidents		
A	F	RTNUM	CHSTART	CHEND	LENGTH	AADT	SECTION	FATAL	TOTACC	SKID	GDSP	GDSS	GDST	RDEF	DARK	WET	SINGLE	PED	FAT	ALL	RATE
*		22	0	11.43	11.43	6380	908	3	27					*					1.8	18.5	33.2
*		22	59.015	70.98	11.965	5050	922	3	30										1.5	15.9	44.6
*		22	87.728	99.177	11.449	10241	931	3	46										2.6	26.5	35.2
	*	24	0	7.324	7.324	8740	949	5	13									*	1.5	15.1	18.2
*		24	17.342	21.288	3.946	5242	956	2	11										0.5	5.4	47.7
*	*	24	50.821	59.719	8.898	7071	971	4	29										1.5	15.6	41.4
*		24	99.837	110.68	10.842	5993	995	0	26										1.6	16.7	35.9
*		24	110.679	119.2	8.521	9705	996	2	32										1.9	19	34.7
*		25	4.558	12.104	7.546	6716	1005	2	24										1.2	12.7	42.5
*		25	49.924	51.739	1.815	7688	1023	0	11										0.3	3.4	70.7
	*	25	63.604	70.296	6.692	9273	1035	4	8										1.4	14.4	11.6
*		25	83.512	85.706	2.194	9047	1048	0	18										0.5	4.6	81.4
*		25	114.514	116.45	1.94	6753	1060	1	10								*		0.3	3.3	68.5
*		25	144.107	148.74	4.636	5749	1076	2	14										0.7	6.9	47.1
*		25	148.743	150.27	1.53	7286	1077	0	8										0.3	2.7	64.4
	*	25	156.363	163.12	6.76	7945	1082	4	17										1.3	13	28.4
*		30	29.149	29.889	0.74	5887	1130	0	4										0.1	1.1	82.4
*		52	1.004	2.34	1.336	6231	1174	0	5										0.2	2.1	53.9
*		52	89.902	99.166	9.264	2630	1210	1	14										0.7	6.9	51.6
*		52	144.153	147.59	3.44	1911	1226	0	6										0.2	1.9	81.9

Table 3.3 High Accident Location details and risk factors involved, 1996-2000 (contd.).

High Risk		Section details						Accidents		Risk Factors									Expected Accidents		
A	F	RTNUM	CHSTART	CHEND	LENGTH	AADT	SECTION	FATAL	TOTACC	SKID	GDSP	GDSS	GDST	RDEF	DARK	WET	SINGLE	PED	FAT	ALL	RATE
*		52	156.399	163.76	7.365	1764	1229	0	8										0.4	3.8	55.3
*	*	52	173.836	188.58	14.745	4221	1236	4	32										1.6	16.8	46.1
*	*	53	6.764	17.482	10.718	4023	1243	5	41					*					1.1	11.7	85.3
*		54	0.454	6.417	5.963	3873	1247	0	13				*			*			0.6	6.3	50.5
*		54	14.232	22.681	8.449	3095	1254	0	13										0.7	7.3	44.6
*		54	24.205	27.647	3.442	3425	1257	0	7										0.3	3.3	53.3
*		54	27.647	31.313	3.666	5960	1258	2	11										0.5	5.6	45.2
*		55	39.964	47.961	7.997	2515	1277	1	15								*		0.5	5.7	66.9
*		55	52.706	58.814	6.108	2317	1283	2	10								*		0.4	4.1	63.4
*		55	58.814	62.978	4.164	3638	1284	0	10										0.4	4.2	59.2
*		55	62.978	71.224	8.246	4513	1285	2	17				*	*					1	10	41.0
*		55	72.428	76.687	4.259	5822	1288	1	13										0.6	6.4	47.0
*		56	8.166	10.423	2.257	7308	1294	1	8										0.4	4.1	43.5
*		56	11.091	18.965	7.874	3514	1297	1	16										0.7	7.6	51.9
*		59	28.878	51.358	22.48	2121	1342	3	24										1.3	13.7	45.2
*		62	9.463	21.249	11.786	2629	1426	0	15										0.8	8.8	43.4
*		63	0	2.365	2.365	3452	1445	1	6										0.2	2.3	65.9
*		63	80.483	92.657	12.174	2215	1471	2	16										0.7	7.7	53.2
*		67	46.996	51.721	4.725	1353	1502	0	8										0.2	1.9	112.3
*		69	4.504	21.83	17.326	4722	1536	3	36								*		2.1	21.8	39.5
*		69	67.064	76.982	9.918	5007	1556	2	21										1.3	13.1	37.9
*		69	76.982	87.486	10.504	4418	1557	1	28										1.2	12.5	54.1

Table 3.3 High Accident Location details and risk factors involved, 1996-2000 (contd.).

High Risk		Section details						Accidents		Risk Factors									Expected Accidents		
A	F	RTNUM	CHSTART	CHEND	LENGTH	AADT	SECTION	FATAL	TOTACC	SKID	GDSP	GDSS	GDST	RDEF	DARK	WET	SINGLE	PED	FAT	ALL	RATE
*		69	88.33	90.97	2.64	4418	1559	1	10							*			0.3	3.1	76.9
*		71	79.678	82.832	3.154	4634	1619	2	10		*							*	0.4	3.9	61.4
*		71	121.833	125.58	3.747	4960	1632	0	13										0.5	4.9	62.8
*		72	0.584	14.359	13.775	3486	1672	0	22										1.3	13.3	41.1
*		72	15.898	18.453	2.555	4096	1675	0	10										0.3	2.8	85.7
*		72	152.388	160.12	7.729	3702	1709	1	17										0.8	7.9	53.3
*		76	25.964	27.302	1.338	4769	1735	0	5										0.2	1.7	70.3
*		76	33.457	42.322	8.865	5598	1738	1	21					*					1.2	12.9	38.0
*		78	22.454	31.57	9.116	1846	1757	2	22		*			*		*	*		0.5	4.9	117.3
*		80	26.763	28.092	1.329	3333	1774	0	4										0.1	1.2	81.0
*		80	85.785	91.834	6.049	5682	1796	2	17										0.9	8.9	44.4
*		81	25.888	35.767	9.879	3125	1821	3	17										0.8	8.6	49.4
*		81	35.767	45.315	9.548	2910	1822	0	16										0.7	7.8	51.7
*		81	45.315	54.73	9.415	5118	1823	3	46										1.2	12.7	85.7
*		81	62.297	64.758	2.461	7918	1827	1	12		*								0.5	4.7	55.3
*		84	3.352	10.616	7.264	5704	1872	3	21										1	10.7	45.5

High Risk	A =	Section is High Risk for All Accidents	F =	Section is High Risk for Fatal Accidents
Section Details	RTENUM =	National Route Number	CHSTART =	Chainage Start
	CHEND =	Chainage End	LENGTH =	Length (km)
	AADT =	Average Annual Daily Traffic	SECTION =	Section Number
Accidents	FATAL =	Number of Fatal Accidents	TOTACC =	Total Number of Injury Accidents
Risk Factors	SKID =	Skidding	GDSP =	Goods Vehicle plus Pedestrian
	GDSS =	Single Goods Vehicle Accident	GDST =	Accident Involving at least two vehicles (incl 1 Goods Vehicle)
	RDEF =	Road Defect Cited	DARK =	Accident Occurred in the Dark
	WET =	Accident Occurred in the Wet	SINGLE =	Single Vehicle Accident
	PED =	Pedestrian Accident		
Expected Accidents	FAT =	Expected Number of Fatal Accidents only	ALL =	Expected Number of Fatal / Injury Accidents
Rate	RATE =	Injury Accident Rate per 100,000,000 miles		

APPENDICES

Appendix 3.1 Coding for Fatal and Injury Accidents on Inter-urban Sections of National Roads Classified by Route, 1996-2000.

Key

Road =	National Route Number
Km =	Length of Section in Kilometres
Miles =	Length of Section in Miles
Killed =	Number Killed in Accidents in Section
SI =	Number Seriously Injured in Accidents in Section
MI =	Number sustaining Minor Injuries in Accidents in Section
UI =	Number sustaining Injuries of Unknown Severity in Accidents in Section
TI =	Total Number Injured in Accidents in Section
TC =	Total Number of Casualties in Accidents in Section (= TI + Killed)
F =	Number of Fatal Accidents in Section
S =	Number of Serious Injury Accidents in Section
M =	Number of Minor Injury Accidents in Section
Total =	Total Number of Fatal and Injury Accidents in Section

Appendix 3.2 Coding for Accident Types and Rates on Inter-urban Sections of National Roads Classified by Route, 1996-2000.

Key

Road =	National Route Number
Total =	Total Number of Fatal and Injury Accidents in Section
Ped =	Total Number of Pedestrian Accidents in Section
SV =	Total Number of Single Vehicle Accidents in Section
TV =	Total Number of Accidents Involving Two or More Vehicles
Dark =	Total Number of Accidents Occurring in the Hours of Darkness
Wet =	Total Number of Accidents Occurring in Wet Conditions
Skyes =	Total Number of Accidents Involving Skidding
Goodsp =	Total Number of Accidents Involving a Goods Vehicle and Pedestrian
Goodss =	Total Number of Accidents Involving only a Goods Vehicle
Goodst =	Total Number of Accidents Involving a Goods Vehicle and at least one other vehicle
Rddef =	Total Number of Accidents where road defects were cited
Vkm (mn) =	Total Number of Million Vehicle Kilometres travelled in section between 1996-2000
Vm (mn) =	Total Number of Million Vehicle Miles travelled in section between 1996-2000
Rate =	Total Number of Accidents per Hundred Million Vehicle Miles of Travel

Appendix 3.3: Fatal and Injury Accidents on Inter-urban Sections of National Roads Classified by Route, 1996-2000.

	LENGTH		CASUALTIES						ACCIDENTS			
ROAD	KM	MILES	KILLED	SI	MI	UI	TI	TC	F	S	M	TOTAL
N01	72.49	44.94	29	53	372	15	440	469	21	33	197	251
N02	113.78	70.55	43	118	420	21	559	602	33	71	197	301
N03	114.01	70.69	28	105	363	31	499	527	24	59	194	277
N04	179.23	111.12	37	125	449	94	668	705	33	82	240	355
N05	114.69	71.11	19	71	177	9	257	276	18	44	88	150
N06	131.24	81.37	21	77	264	23	364	385	19	49	121	189
N07	157.96	97.93	47	123	556	64	743	790	35	86	298	419
N08	146.68	90.94	35	86	363	14	463	498	30	57	179	266
N09	97.95	60.73	23	60	223	19	302	325	19	44	109	172
N10	31.65	19.62	8	13	61	3	77	85	7	8	33	48
N11	109.76	68.05	42	109	387	38	534	576	31	62	185	278
N12	9.31	5.77	1	4	13	2	19	20	1	4	9	14
N13	44.65	27.68	6	22	73	6	101	107	4	14	33	51
N14	17.81	11.04	5	18	67	0	85	90	5	8	31	44
N15	93.29	57.84	26	70	230	19	319	345	22	40	97	159
N16	41.82	25.93	1	11	46	1	58	59	1	7	22	30
N17	110.43	68.46	23	68	233	13	314	337	20	40	107	167
N18	78.53	48.69	18	58	267	37	362	380	16	44	117	177
N19	3.98	2.47	0	6	27	1	34	34	0	4	13	17
N20	77.91	48.30	28	69	207	18	294	322	20	41	108	169
N21	78.69	48.79	19	80	205	13	298	317	19	42	114	175
N22	89.34	55.39	16	66	269	4	339	355	15	53	129	197
N23	7.64	4.74	0	4	15	1	20	20	0	3	8	11
N24	96.63	59.91	20	69	250	16	335	355	19	42	126	187
N25	173.79	107.75	52	175	428	24	627	679	39	105	201	345
N26	24.10	14.94	0	10	29	1	40	40	0	3	18	21
N27	2.63	1.63	2	4	15	0	19	21	1	2	7	10
N28	8.73	5.41	1	3	23	2	28	29	1	2	11	14
N29	2.86	1.77	0	0	0	0	0	0	0	0	0	0
N30	27.99	17.35	6	15	37	1	53	59	4	9	17	30
M50	22.34	13.85	4	7	97	26	130	134	4	5	71	80

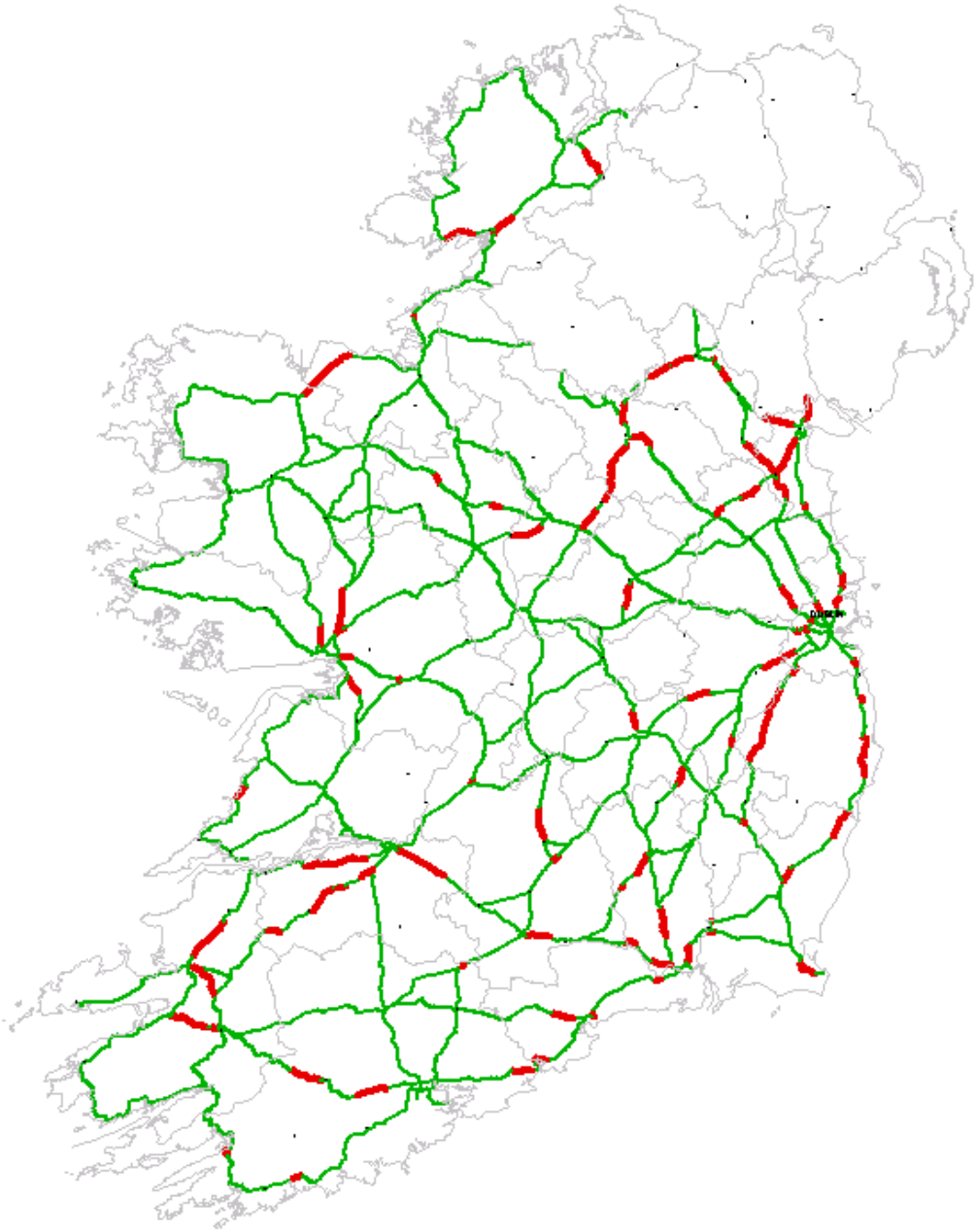
ROAD	KM	MILES	KILLED	SI	MI	UI	TI	TC	F	S	M	TOTAL
N51	46.96	29.11	4	5	33	3	41	45	3	4	20	27
N52	160.41	99.46	15	47	245	8	300	315	14	30	117	161
N53	16.46	10.21	6	11	93	4	108	114	6	8	35	49
N54	29.26	18.14	2	17	88	9	114	116	2	13	43	58
N55	69.51	43.09	9	34	136	4	174	183	8	21	69	98
N56	139.73	86.63	10	87	206	7	300	310	8	49	83	140
N58	10.61	6.58	0	2	8	0	10	10	0	2	2	4
N59	273.40	169.51	18	68	206	5	279	297	14	39	91	144
N60	81.47	50.51	4	18	113	4	135	139	4	13	60	77
N61	67.39	41.78	8	20	70	0	90	98	8	8	39	55
N62	81.94	50.80	2	32	96	1	129	131	2	24	47	73
N63	84.34	52.29	8	18	115	1	134	142	7	13	56	76
N65	37.39	23.18	1	10	29	0	39	40	1	5	17	23
N66	21.57	13.37	0	6	23	0	29	29	0	3	11	14
N67	114.94	71.26	3	18	95	1	114	117	3	10	47	60
N68	34.39	21.32	0	23	17	1	41	41	0	14	9	23
N69	82.65	51.24	14	44	192	10	246	260	11	31	94	136
N70	128.71	79.80	2	32	84	0	116	118	2	22	47	71
N71	159.66	98.99	17	86	161	11	258	275	15	59	80	154
N72	151.03	93.64	13	59	208	8	275	288	12	43	104	159
N73	27.92	17.31	6	6	26	0	32	38	3	2	14	19
N74	17.10	10.60	1	3	12	1	16	17	1	3	6	10
N75	6.77	4.20	1	3	9	0	12	13	1	1	4	6
N76	42.54	26.37	9	23	63	2	88	97	7	13	35	55
N77	21.20	13.15	1	1	43	1	45	46	1	1	18	20
N78	55.67	34.51	9	18	95	2	115	124	7	11	48	66
N80	112.16	69.54	20	40	136	9	185	205	16	27	70	113
N81	62.64	38.84	12	43	194	12	249	261	12	30	87	129
N83	42.44	26.31	0	4	13	0	17	17	0	3	10	13
N84	65.40	40.55	10	25	79	5	109	119	7	14	39	60
N85	21.99	13.64	1	3	45	2	50	51	1	2	20	23
N86	41.68	25.84	2	29	45	6	80	82	2	15	26	43
N87	25.10	15.56	1	5	23	0	28	29	1	4	10	15
Total	4,616	2,862	769	2,539	9,167	633	12,339	13,108	640	1,600	4,538	6,778

Appendix 3.4: Accident Types and Rates on Inter-urban Sections of National Roads Classified by Route, 1996-2000.

	ACCIDENTS	ACCIDENT TYPE			CONDITIONS			GOODS			ROADS			
ROAD	TOTAL	PED	SV	TV	DARK	WET	SKYES	GOODSP	GOODSS	GOODST	RDDEF	VKM (MN)	VMILES (MN)	RATE
N01	251	23	32	196	88	77	66	2	1	38	8	1,763	1,093	22.96
N02	301	22	65	214	119	124	90	2	10	52	15	1,680	1,041	28.90
N03	277	21	47	209	102	112	83	2	5	40	7	2,207	1,368	20.25
N04	355	31	64	260	140	151	117	6	6	48	10	3,464	2,148	16.53
N05	150	12	44	94	61	60	56	0	3	16	6	1,023	634	23.66
N06	189	8	42	139	66	71	72	0	3	18	6	2,252	1,396	13.53
N07	419	14	68	337	140	166	132	2	8	94	14	4,573	2,835	14.78
N08	266	11	73	182	76	109	78	4	9	40	10	2,579	1,599	16.64
N09	172	5	42	125	62	66	59	1	2	39	6	1,259	781	22.04
N10	48	3	12	33	12	20	14	0	1	9	4	319	197	24.30
N11	278	15	56	207	94	106	97	0	6	24	13	2,532	1,570	17.71
N12	14	3	4	7	6	4	7	0	0	1	0	89	55	25.34
N13	51	6	17	28	20	28	24	1	3	8	4	675	419	12.18
N14	44	3	9	32	18	27	9	0	0	7	3	201	125	35.24
N15	159	18	41	100	49	58	63	0	1	18	8	1,003	622	25.57
N16	30	0	17	13	6	22	18	0	4	2	3	203	126	23.82
N17	167	8	37	122	72	90	46	1	0	19	6	1,259	781	21.39
N18	177	9	31	137	56	74	60	2	1	20	9	1,693	1,050	16.86
N19	17	2	2	13	8	6	6	0	0	1	0	146	91	18.77
N20	169	8	44	117	61	68	37	1	4	15	8	1,422	881	19.17
N21	175	10	33	132	69	82	47	0	1	22	4	933	578	30.25
N22	197	7	36	154	71	102	60	1	2	18	15	1,144	710	27.77
N23	11	1	4	6	4	3	4	0	0	1	0	59	37	30.04
N24	187	12	46	129	69	88	46	1	1	15	5	1,136	705	26.54
N25	345	18	92	235	114	118	131	2	9	42	12	2,796	1,734	19.90
N26	21	0	5	16	8	10	5	0	0	3	0	168	104	20.19
N27	10	0	1	9	2	3	4	0	0	1	0	70	43	23.19
N28	14	0	3	11	4	4	5	0	0	0	1	172	107	13.11
N29	0	0	0	0	0	0	0	0	0	0	0	11	7	0.00
N30	30	1	9	20	6	9	7	0	2	3	0	205	127	23.59
M50	80	4	9	67	22	29	25	1	0	9	2	1,926	1,194	6.70

	ACCIDENTS	ACCIDENT TYPE			CONDITIONS			GOODS			ROADS			
ROAD	TOTAL	PED	SV	TV	DARK	WET	SKYES	GOODSP	GOODSS	GOODST	RDDEF	VKM (MN)	VMILES (MN)	RATE
N51	27	1	11	15	12	10	9	0	0	2	0	257	159	16.98
N52	161	5	40	116	46	76	69	1	2	27	11	1,013	628	25.63
N53	49	1	13	35	23	18	23	0	0	6	6	145	90	54.46
N54	58	3	18	37	18	34	23	0	1	12	5	193	120	48.44
N55	98	3	34	61	37	39	35	0	7	16	8	430	267	36.74
N56	140	12	34	94	57	62	52	0	1	10	7	938	582	24.06
N58	4	0	2	2	0	2	0	0	0	1	0	66	41	9.82
N59	144	8	39	97	49	53	52	0	3	7	5	1,497	928	15.51
N60	77	2	15	60	25	33	18	1	0	9	3	578	358	21.50
N61	55	2	11	42	18	23	19	0	0	3	2	424	263	20.94
N62	73	2	18	53	28	31	26	0	0	12	3	495	307	23.79
N63	76	7	20	49	20	23	27	0	1	7	1	500	310	24.53
N65	23	1	10	12	8	8	8	0	2	2	2	167	103	22.24
N66	14	0	5	9	6	4	4	0	1	1	0	81	50	28.00
N67	60	8	13	39	24	27	20	1	0	0	3	479	297	20.19
N68	23	0	6	17	6	8	12	0	0	4	0	243	150	15.29
N69	136	5	46	85	50	69	37	1	6	12	9	670	415	32.76
N70	71	7	23	41	17	22	19	0	0	0	2	766	475	14.96
N71	154	19	47	88	53	63	43	1	0	13	6	1,319	818	18.83
N72	159	6	43	110	54	82	47	0	0	29	4	920	571	27.87
N73	19	2	7	10	9	9	7	0	2	4	1	157	97	19.53
N74	10	0	4	6	4	5	5	0	0	3	1	91	56	17.77
N75	6	0	2	4	4	3	0	0	0	0	0	162	100	5.98
N76	55	2	13	40	12	19	26	0	2	5	5	349	216	25.45
N77	20	1	4	15	5	10	9	0	0	7	1	163	101	19.82
N78	66	6	25	35	17	34	27	1	0	4	9	356	221	29.90
N80	113	1	26	86	39	44	50	1	3	21	5	790	490	23.06
N81	129	7	33	89	40	62	57	3	2	18	5	471	292	44.14
N83	13	0	6	7	3	4	4	0	0	1	0	139	86	15.07
N84	60	8	7	45	24	29	19	0	0	8	2	445	276	21.76
N85	23	0	10	13	8	10	10	0	1	1	2	169	105	21.98
N86	43	2	12	29	11	20	8	0	1	2	2	288	178	24.10
N87	15	2	6	7	6	2	5	0	0	2	0	110	68	21.98
Total	6,778	398	1,588	4,792	2,358	2,825	2,238	39	117	872	289	53,831	33,375	20.31

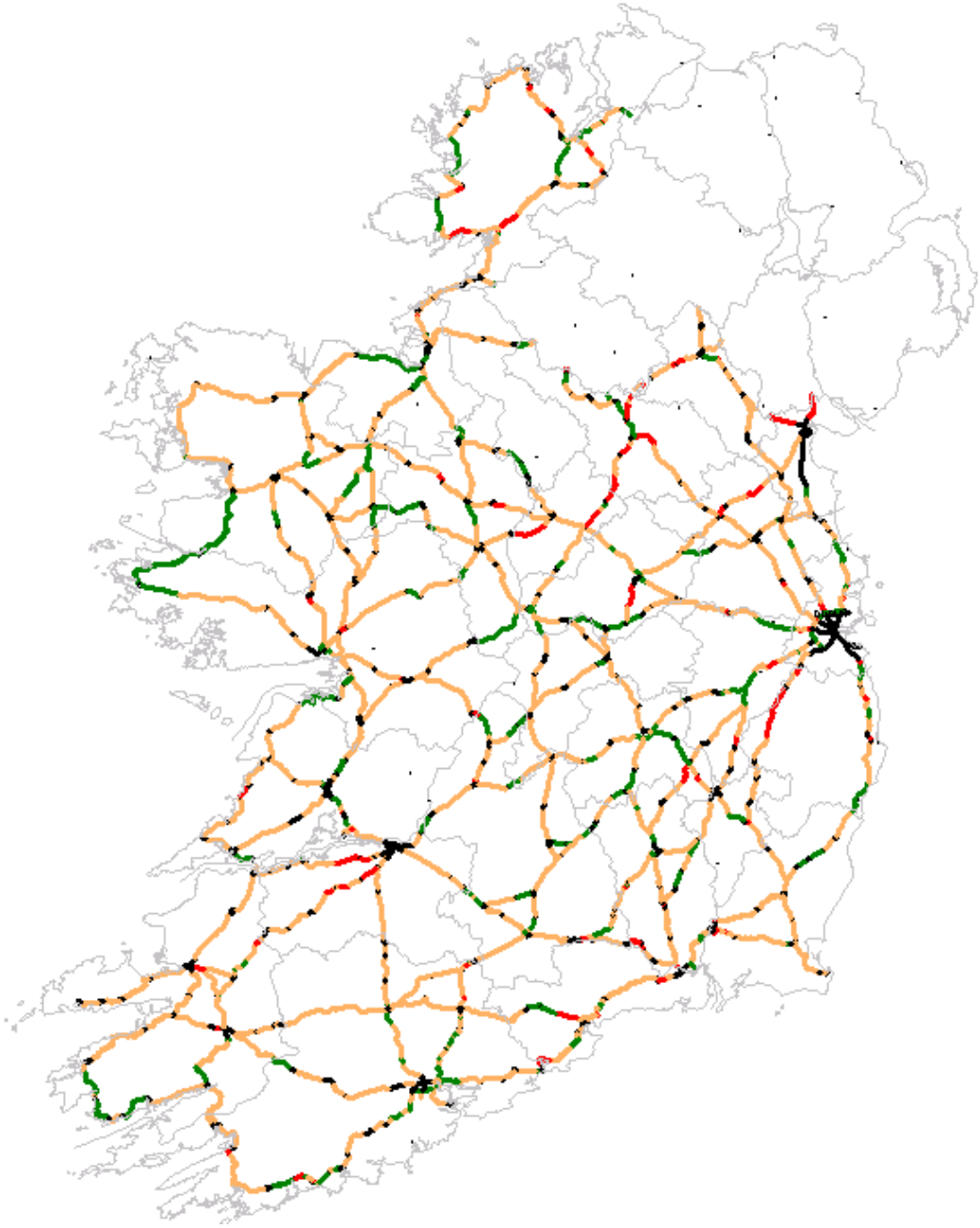
Appendix 3.5: Map of High Accident Locations on Inter-urban stretches of the National Road Network, 1996-2000.



Colour Guide

-------- **High Accident Location**
-------- **Not a High Accident Location**

Appendix 3.6: Map of Accident Rates on Inter-urban stretches of the National Road Network, 1996-2000.



Colour Guide

-------- **Accident rate two or more times larger than expected**
-------- **Accident rate between a half and twice the expected rate**
-------- **Accident rate a half or less of the expected rate**
-------- **Urban area / new road section (not analysed)**

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