

**Road Safety Engineering. The National Roads.
The Low Cost Remedial Measures Programme.**

Evaluation of Programme 1.

RS. 456

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Foreword

In July 1998 the Government published “*The Road to Safety*”, its strategy for Road Safety over the period 1998 – 2002. The primary target of the strategy is to reduce road fatalities by the year 2002 by a minimum of 20 per cent on their 1997 level (472) and to achieve a similar reduction of at least 20 per cent in the number of serious injuries from road accidents (2182 in 1997).

Under the terms of the Strategy, the Authority is required to undertake a number of specific tasks, including the implementation of an engineering countermeasures programme on the National Roads. Under this programme, the Authority was undertaken to complete low cost remedial measures at 400 locations on the network over five years.

The first group of low cost schemes on the network were completed during 1994/1995 and sufficient time has now elapsed to allow these schemes to be evaluated in terms of accident reductions. The results of this evaluation are presented in this report. It is fair to say that the results have not only exceeded targets but also expectations. They provide a confident platform for continuation and expansion of the programme.

I wish to express my thanks to all concerned and particularly to Harry Cullen and Finbarr Crowley.

Eugene O’Connor
Head of Project Management and Engineering
January 2001.

Executive Summary

- Programme 1, 1994/1995, is the first in a series which has its origin in a decision by NRA in 1994 to provide dedicated funding to a low cost road accident remedial measures programme with an initial target spend of one million pounds per annum.
- Thirty road authorities submitted 128 schemes which were inspected, amended, approved and constructed during the period at a total cost of £1,344,000.
- Eighty-seven schemes (68%), of total cost £995,000 (74% of funding), were on National Primary Routes. Forty-one schemes (32%), of total cost £349,000 (26% of funding), were on National Secondary Routes.
- Elementary statistical analysis shows that a reduction of 25 fatal and 41 serious injury accidents was achieved relative to expected numbers. Part of this saving may be accounted for by a “regression to mean” effect (discussed on page 10) and therefore the calculated reduction should be taken as an upper band limit on the number of accidents saved.
- A statistical test shows that the reductions between the before and after periods in fatal and serious injury accident categories are statistically significant.

Of the 73 schemes listed,

- 42 (58%) are successful schemes.
- 23 (32%) are moderately successful.
- 8 (11%) are unsuccessful.
- For a once off expenditure of a little more than one million pounds, an average annual rate of return of 595% was achieved, compared with a target of 100%.
- The implication in annual accident costs of Programme 1 is a reduction from £12m. to £6m., arising from a reduction of approximately six fatal accidents and nine serious injury accidents per annum during the after period.

Chapter 1. Background.

1.1 THE NATURE OF ROAD ACCIDENTS.

While road accidents occur at random, their frequency is influenced by many deterministic factors. When accidents are looked at as statistical entities, the random aspect is clear – nobody can predict just where or when the next road accident will occur. When an accident is looked at as an outcome of a chain of events, the deterministic influences become clear – the accident is the outcome of the coincidence of a series of contributory factors. These contributory factors may be grouped conveniently under the headings Road, Vehicle and Road User. Contributory factors from these groups very often occur in combinations. The combinations which are the focus of interest in this report are those in the road and road user groups, and range from cases where a road defect precipitated an accident directly, through those where some element of the road environment misled a road user and induced a mistake, to cases where even though no defect in the road or specific human error could be identified, some practical physical alteration to the road would have made the accident less likely or less severe. This group of accidents will be referred to here as *road factor accidents*.

1.2 THE IDENTIFICATION OF ROAD FACTOR ACCIDENTS.

Before remedial measures can be applied, it is necessary to identify and classify the locations where road factor accidents are occurring. The most convenient way of doing this is to plot the location of accidents on a map or map overlay, either manually or by computer. The time period selected should be long enough for detectable patterns to build up, but not so long that changes in the road network might invalidate results. For most applications, a three year to five year period has proved useful and the accidents to be plotted include all fatal and injury accidents recorded by the police.

When the accidents are plotted, it will be noticed that clusters have formed. Subsequent investigation of the pattern of accidents will generally show that the accidents which cluster tend to include a higher proportion of road factor accidents than accidents on the network generally. Mapping therefore provides a very convenient first step towards identifying road factor accidents by identifying the locations where they occur.

Considerable work was done in the Road Safety Section of An Foras Forbartha in identifying high risk sections of the Irish road network. This included a plotting programme for map overlays (Fuller and Holland, 1974), a method for identifying urban accident locations (Curran and Newell, 1973), and a method for identifying accident locations on an interurban network (Hall, Hearne and Holland, 1971).

This last report uses a statistical rate quality control method to identify sections of road with a higher than expected accident rate per unit of travel. It was applied to the National Road network on eight separate occasions during the twenty-year period 1970 to 1990 and these volumes constituted the principal source of information about accidents on the network.

1.3 ACCIDENT INVESTIGATION AND THE DESIGN OF COUNTERMEASURES.

Considerable expertise was built up during the two decades 1970 to 1990 in accident investigation and the design of countermeasures. Model studies were published showing how to design countermeasures for typical Irish towns on the National Roads (Crowley 1983, 1984, 1986.) Two complete programmes of low cost remedial measures on the National Roads were undertaken during the same period. These were reported in summary format (Crowley 1988) and at the Local Government Spring Show Conference in 1990. An overall assessment of the scope for accident reduction through engineering methods was presented (Crowley 1992).

1.4 ORIGIN OF THE PRESENT PROGRAMME.

The present programme has its origin in a decision by NRA in 1994 to provide dedicated funding to a low cost remedial measures programme with an initial target spend of one million pounds per annum.

Chapter 2. Rationale.

Each year approximately 200 fatal and 2,000 injury accidents occur on National Roads. The annual cost of these accidents is of the order of £200m. Research suggests that the road is a contributory factor in one in four of these accidents (Sabey and Staughton, 1975), and that a low cost remedial measures programme is a very cost effective way of dealing with the problem.

The road can contribute to the occurrence of an accident in many different ways.

- A road defect, such as incorrect superelevation, precipitates an accident directly.
- Some visual element of the road environment misleads a road user and induces a mistake, leading to an accident.
- Road signs and markings fail to reinforce or interpret the road layout, leading to driver error and accident.
- The road design encourages inappropriate behaviour leading to accident.

The relationship between design and accident occurrence is still at an evolutionary stage. In particular cases reliance on road design standards may not be sufficient; the touchstone of a safe section of road is its accident record.

The objective of the programme is to reduce accident levels on the network. To achieve this, the sites selected must have an accident warrant and a contributory road factor. The following have been identified as prior requirements for a successful programme:

- Dedicated funding;
- Institutional support;
- Technical expertise at NRA and Local Authority level; and
- A good traffic accident data system.

The NRA provides the first two requirements. Since 1994 great strides have been made in developing the two technical requirements. These include the provision of a manual (DOE 1996), the provision of computer packages (Local Government Computer Services Board, 1999) and training courses.

Chapter 3. Mode of operation.

3.1 SCOPE

There are 36 road authorities eligible for funding. The programme is operated on a two-year rolling cycle. Every two years, a group of schemes is inspected, approved and agreed with each authority and funding is provided. A road authority may expect to get funding approximately every two years under the programme.

Programme 1 commenced in 1994 and continued through 1995. Thirty authorities submitted 128 schemes which were inspected, amended, approved and constructed during the period at a total cost of £1,344,000.

Programme 2 began in 1996 and was completed in 1997.

Programme 3 began in 1998 and was completed in 1999.

This report is the first of a series and deals solely with Programme 1. Some descriptive statistics and an evaluation of effectiveness are presented.

3.2 TARGETS.

The target for the programme is that a minimum annual rate of return of 100% should be achieved.

Guideline parameters for individual schemes within the programme are as follows:

- each scheme should have at least one reported injury accident per annum during the before period;
- scheme cost should be in the range £100 - £30,000; and
- each scheme should have the potential to produce a 30 to 40 per cent reduction in accidents at the location.

Chapter 4. Criteria for Approval.

Traffic volumes on National Routes lie mostly within a range of 1,500 AADT to 50,000 AADT (Annual Average Daily Traffic). At any location on the network, the number of accidents over a given time period would be proportional to the traffic volume, and might be expected to range from zero to one at a low volume location to 15 to 20 at a high volume location.

If a set of criteria is adopted based only on numbers of accident, all the locations treated would tend to be on busier routes. This would have the advantage that the absolute numbers of accidents saved would tend to be higher but locations of equal risk on less busy routes would tend to be neglected.

A set of criteria based on accident rate per unit of travel has the advantage of treating locations of similar risk equally.

A set of criteria based on visual assessment of accidents plotted on a map overlay has the advantage of flexibility – isolated accident locations and heavy clusters can be detected with equal ease.

The situation is further complicated by the fact that an adequate set of criteria needs to take account not only of the numbers of accidents influenced but also of the cost and likely success of the countermeasures proposed.

Keeping these constraints in mind, the following criteria are applied by NRA under the present programme.

1. A crude target spend from the fund is made out for each local authority, based on its mileage of National Road and the extent of its accident problem.
2. Locations submitted by each local authority are then ranked by accident numbers at the location and due weight given to the effect of traffic volume within the authority.
3. Accident reports are then scrutinised and in respect of each scheme an estimate is made of the number of accidents in which the road was a contributory factor and of the number of accidents which might be prevented by the works proposed.
4. The benefits accruing under 3 above are then compared with the cost of the schemes.
5. A new ranking within the local authority is then produced and the number of schemes which can be accommodated within the outline spend in 1 above is determined.

The remaining locations, if any, for that local authority are held over for funding until later programmes.

Chapter 5. Programme 1.

One hundred and twenty-eight approvals were issued during 1994 and 1995 in respect of Programme 1 at a total approved cost of £1,344,000. Eighty-seven schemes (68%), of total cost £995,000 (74% of funding), were on National Primary Routes. Forty-one schemes (32%), of total cost £349,000 (26% of funding), were on National Secondary Routes.

A proposal form was submitted to NRA in respect of each scheme. This form is shown in Appendix A. In 1994, only one in six authorities had a data system geared towards the identification of accident locations. Some schemes were submitted in respect of locations perceived to be hazardous but lacking a substantial accident record. In order to get the Programme established in each local authority, the best schemes were selected, even though some of these were not up to a standard that would be acceptable today. The 126 schemes approved are listed in Appendix B.

In a few instances, (e.g. the provision of “Drive on the Left” signs in tourist areas near Killarney), an approved scheme was not amenable to evaluation. The 123 remaining schemes were divided into two categories.

- Schemes where the total accident experience before and after could be taken as an index of success. These schemes are identified in the column headed “Mainstream Schemes”. There are 104 schemes in this category.
- Schemes where a subset of the accident experience would be a more appropriate index. These schemes, which include junctions in major urban areas where partial improvements were carried out, are identified in the column headed “Schemes - partial treatment”. There are 19 schemes in this category.

A subset of Category 1 schemes was identified at approval stage as being of high quality with a very good chance of success. These schemes are identified in the column headed “Best Schemes”. There are 44 schemes in this category.

Of the 104 Mainstream schemes

- 32% were inside built up areas, and 68% outside;
- of those outside, 46% were on “improved” sections and 54% on “unimproved”;
- of those outside, 41 schemes were at junctions, 7 schemes at bends, and 28 schemes were on road lengths; and
- for the whole group, the predominant accident types were 17% pedestrian, 10% single vehicle, and 12.5% head on.

Table 1 below shows the distribution of schemes by Authority, and Table 2 schemes approved by Route. Table 3 and Fig 1 show the distribution of schemes by cost.

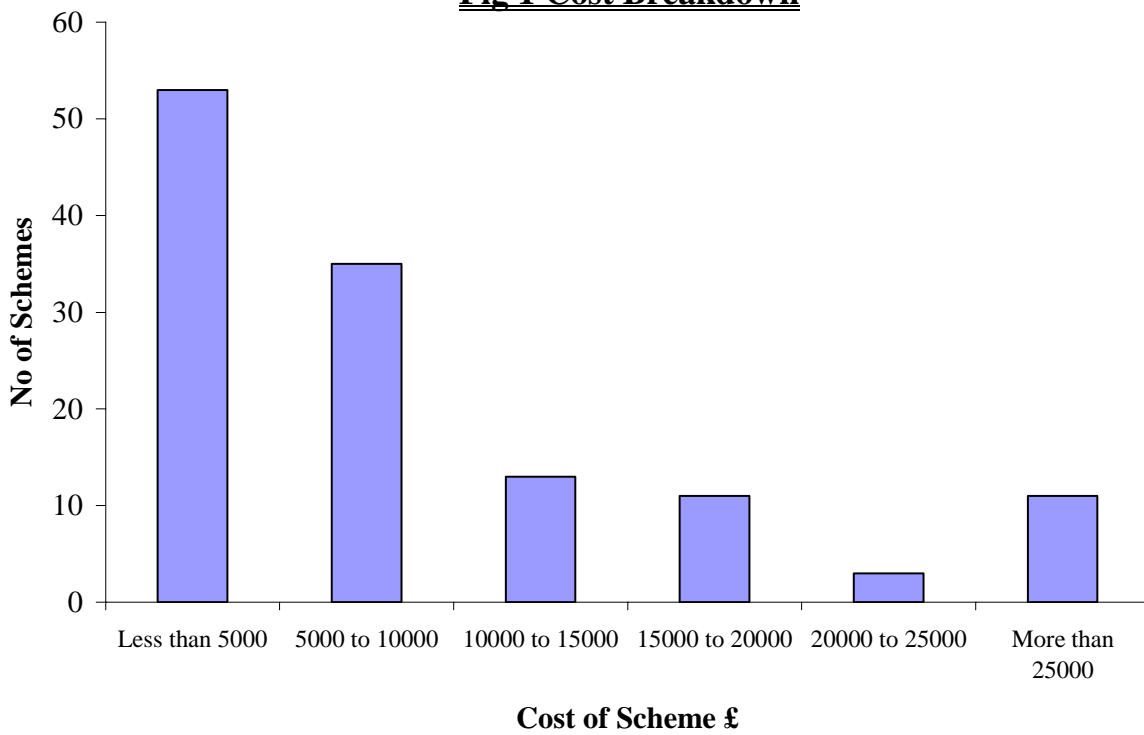
Table 2 shows that there are twice as many schemes on National Primary Routes as on the Secondaries (N51 to N85). It is expected that in the later programmes the emphasis will shift towards the Secondaries. From Table 3, there was an emphasis in Programme 1 on the merit of low cost remedial measures in the first instance. In later programmes, the cost profile will tend towards more expensive measures.

County	No of Schemes	Percentage
Carlow	5	4%
Cavan	10	8%
Clare	1	1%
Cork Borough	1	1%
Donegal	7	6%
Dublin Borough	5	4%
Dundalk UDC	1	1%
Fingal	1	1%
Galway	2	4%
Galway Boro	3	3%
Kerry	4	3%
Kildare	4	1%
Kilkenny	3	2%
Laois	8	6%
Leitrim	1	1%
Limerick	1	1%
Limerick Boro	4	3%
Louth	8	6%
Mayo	6	5%
Meath	1	1%
Monaghan	4	3%
Offaly	5	4%
Roscommon	9	7%
Sligo	3	2%
South Dublin	6	5%
Tipperary (S.R.)	2	2%
Waterford	4	3%
Waterford Boro	1	1%
Westmeath	12	10%
Wexford	1	1%
Wicklow	3	2%
Total	126	102%

Route No.	No of Schemes	Percentage
N1	6	5%
N2	6	5%
N3	9	7%
N4	6	5%
N5	3	2%
N6	6	5%
N7	12	10%
N8	2	2%
N9	5	4%
N10	1	1%
N11	4	3%
N14	3	2%
N15	5	4%
N17	3	2%
N18	3	2%
N20	2	2%
N22	2	2%
N25	6	5%
N26	3	2%
N51	1	1%
N52	2	2%
N53	3	2%
N55	4	3%
N59	2	2%
N60	1	1%
N61	1	1%
N62	6	5%
N63	3	2%
N72	3	2%
N76	1	1%
N78	5	4%
N80	2	2%
N81	4	3%
N85	1	1%
Total	126	102%

Scheme Cost £	No of Schemes	Percentage
Less than 5000	53	42%
5000 to 10000	35	28%
10000 to 15000	13	10%
15000 to 20000	11	9%
20000 to 25000	3	2%
More than 25000	11	9%
Total	126	100%

Fig 1 Cost Breakdown



Chapter 6. Evaluation of Programme 1.

6.1 STATISTICAL EVALUATION.

Appendix C shows the before and after accident details for “mainstream schemes”, and Appendix D the details for “best schemes”.

Table 4 below shows numbers of accidents before and after treatment for Programme 1, as well as an estimate of the number of accidents that would have occurred in the “after” period had the same accident rate continued (the “status quo” scenario).

Table 4. Accidents by category on mainstream schemes before and after treatment.

	Fatal	Serious Injury	Minor Injury	Total
“Before Period” (6.87 yrs.)	62	196	298	556
“Status Quo” scenario (4.57 yrs.)	41	130	198	370
Actual “After Period” (4.57 yrs.)	15	86	201	302
Reduction	26	44	-3	68

“Before Period”. This represents the average numbers in years in the period before treatment, and the sum of the numbers of accidents recorded during this period.

“Status Quo” scenario. This represents the average number in years in the period after treatment, and the sum of the numbers of accidents which would have been expected to happen during this period if treatment had not been undertaken.

Actual “After Period”. This represents the average number in years in the period after treatment, and the sum of the numbers of accidents which actually happened during this period.

Reduction. This represents a simple estimate of the numbers of accidents prevented by the treatment during the 4.57 year “After Period”.

On the face of it, there has been substantial reduction in accidents, particularly in fatal and serious injury accidents. As is usual in road safety work, the problem is to determine, (a) how much of the reduction is due to “Regression to Mean” effects and, (b) whether these reductions are statistically significant or not.

With the coming on-line of the National Roads Authority Needs Study Database, the intention is to derive mean accident rates for a variety of road types. When these rates are available, it will be possible to do meaningful calculations of regression to mean effects. For purposes of this evaluation, a simple test of significance is carried out on the before and after accident figures.

In a separate analysis fatal, serious and minor injury accidents from Table 4 above, occurring before and after the intervention, were expressed as proportions of the network totals and the proportions tested using the normal approximation to the binomial distribution. Details of the test are shown in Appendix D. The results show a significant reduction in the proportion of accidents occurring on the treated sections of the National Roads in the after period compared to the before period.

6.2 ECONOMIC EVALUATION.

Table 5 below shows the average annual rate of return on mainstream schemes, using the two methods discussed in the Guide to Road Safety Engineering in Ireland (DOE, 1996).

Table 6 below shows the annual average rate of return on “best schemes”, again using the methods discussed in the manual (DOE, 1996).

Method	"Willingness to Pay"		"Avg Cost Per Injury Accident"	
	Before	After	Before	After
No. of fatal acc. per annum.	9.4	3.5	9.4	3.5
No. of serious injury acc. per annum.	29.5	19.9	29.5	19.9
No. of minor injury acc. per annum.	44.9	45.6	44.9	45.6
No. of total acc. per annum.	83.8	69.1	83.8	69.1
Annual Cost Of Accidents	IR£12,224,000	IR£5,807,000	IR£9,936,000	IR£8,226,000
Total Cost of Schemes	IR£1,078,000.00		IR£1,078,000.00	
Avg Annual Rate of Return	595%		159%	

Table 6. "Best Schemes", Average Annual Rate of Return				
Method	"Willingness to Pay"		"Avg Cost Per Injury Accident"	
	Before	After	Before	After
No. of fatal acc. per annum.	5.9	1.0	5.9	1.0
No. of serious injury acc. per annum.	13.9	9.0	13.9	9.0
No. of minor injury acc. per annum.	20.5	18.9	20.5	18.9
No. of total acc. per annum.	40.3	28.8	40.3	28.8
Annual Cost Of Accidents	IR£7,132,000	IR£2,081,000	IR£4,774,000	IR£3,415,000
Total Cost of Schemes	IR£616,000.00		IR£616,000.00	
Avg Annual Rate of Return	820%		221%	

The “average cost per injury accident” method simply counts the number of accidents involving death or injury without taking account of severity. The “willingness to pay” method costs fatal, serious injury and minor injury accidents separately. It is proposed in this evaluation to assess the success of Programme 1 on the following bases:

- it is assumed that the 104 mainstream schemes are representative of Programme 1 (126 schemes were approved.); and
- the “willingness to pay” method is taken to be the most appropriate economic evaluation tool, since it takes into account benefits arising from reductions in accident severity as well as reductions in frequency.

Table 5 above shows that for a once off expenditure of a little more than one million pounds, an Average Annual Rate of return of 595% was achieved. (The “best schemes” achieved an even higher rate of return of 820%.) The implication in annual accident costs is a reduction from £12m. to £6m. arising from an annual reduction during the after period of approximately six fatal and nine serious injury accidents.

This is well in excess of the target first year rate of return of 100%.

6.3 SOME DETAILED RESULTS.

It is of interest to consider why some schemes have performed better than others. Table E1 Appendix E lists schemes with three or more accidents in the before period and ranked by Average Annual Rate of Return. Table E2 shows the same data for “best schemes”. Table E3 shows the same basic list as Table E1, but with fatal, serious injury and minor injury returns separate. Likewise, Table E4 shows the same basic list as Table E2.

From these tables, three basic categories of schemes are identified namely:

- successful schemes (in excess of 100% Annual Rate of Return, and which show reductions in serious injury as well as fatal accidents);
- moderately successful schemes (schemes which have high rates of return, but based on fatal accidents only, schemes which have negative rates of return but useful reductions in injury accidents and schemes which have rates of return between 0 and 100%); and
- unsuccessful schemes (negative rates of return and increases in accident numbers).

From Table E1 and Table E3,

Of the 73 schemes listed:

- 42 schemes (58%) are successful schemes;
- 23 schemes (32%) are moderately successful; and
- 8 schemes (11%) are unsuccessful.

When the similar data for “Best schemes” are considered (Table E2 and Table E4);

of the 35 schemes listed:

- 24 schemes (69%) are successful schemes;
- 10 schemes (29%) are moderately successful schemes; and
- 1 scheme (3%) was unsuccessful.

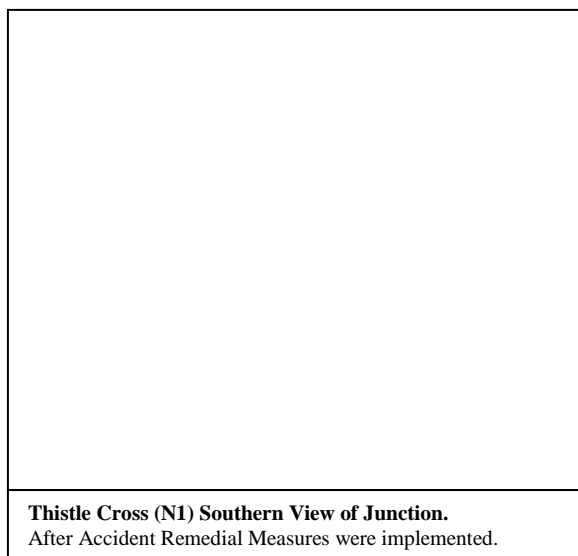
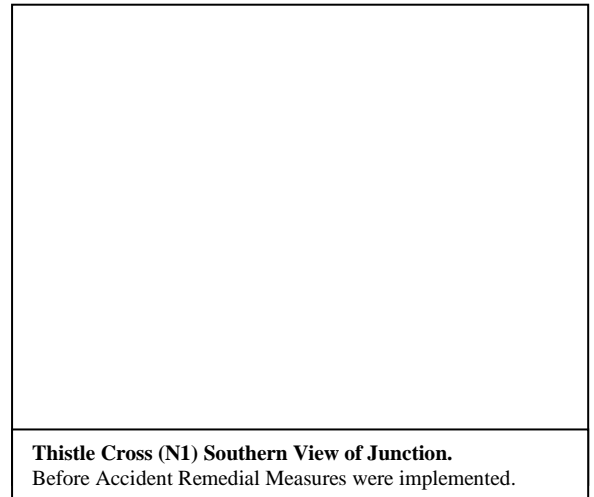
More detailed investigation of the characteristics of successful and unsuccessful schemes will be presented in the next annual report.

Thistle Cross (N1)

Problem

Vehicles travelling on the N1 were colliding with vehicles turning off the N1 or entering the N1 from the side road.

Drivers travelling on the N1 were unaware of the presence of the junction.



Measures Implemented

The warning signs on the approach to the junction were improved.

The delineation of the junction was improved, this included renewing the lining and replacing the Cats Eyes.

The Hardshoulder of the Southbound carriageway was hatched out to protect vehicles which were stopped at the junction waiting to turn onto the N1 from the side road. All vegetation interfering with the sight line was cut back, to improve sight distance.

Feede Cross (N1)

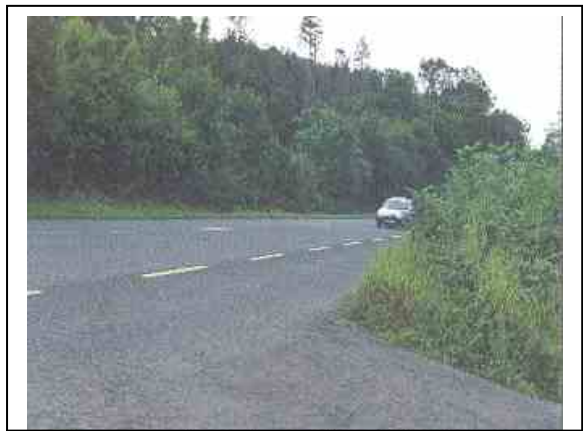
Problem

Vehicles travelling on the N1 were colliding with vehicles turning off the N1 or entering the N1 from the side road.

Drivers travelling on the N1 were unaware of the presence of the junction.



Feede Cross (N1) Southern View of Junction.
Before Accident Remedial Measures were implemented.



Feede Cross (N1) At Junction Looking North.
Before Accident Remedial Measures were implemented.



Feede Cross (N1) Southern View of Junction.
After Accident Remedial Measures were implemented.



Feede Cross (N1) At Junction looking North.
After Accident Remedial Measures were implemented.

Measures Implemented

The warning signs on the approach to the junction were improved.

The delineation of the junction was improved, this included renewing the lining and replacing the Cats Eyes.

The Hardshoulder of the Southbound carriageway was hatched out to protect vehicles which were stopped at the junction waiting to turn onto the N1 from the side road.

All vegetation interfering with the sight line was cut back, to improve sight distance.

Curly Hole (N51)

Problem

Vehicles travelling in both directions, particularly eastbound were failing to negotiate a series of bends.

A high proportion of the accidents were single vehicle accidents.

A high proportion of the accidents occurred when the road surface was wet.



Curly Hole (N51) Western Approach
Before Accident Remedial Measures were implemented.



Curly Hole (N51) Eastern Approach.
Before Accident Remedial Measures were implemented.



Curly Hole (N51) Western Approach
After Accident Remedial Measures were implemented.



Curly Hole (N51) Eastern Approach.
After Accident Remedial Measures were implemented.

Measures Implemented

Improved the warning signs on the approaches to the bends.

Chevrons were erected on the outsides of the bends.

Rumble strips were installed on the western approach.

Surface Dressing with a PSV greater than 55 was laid.

The delineation of the junction was improved.

This included replacing the intermittent centre line with a double continuous centreline with Cats Eyes. The edge line was replaced with Vibroline at the bends.

A crash barrier was erected along the road sections where vehicles tended to enter the river.

Skew Bridge at Tivoli, Lower Glanmire Road (N8) Cork

Problem

Drivers travelling from Cork were losing control of their vehicle as they negotiated the bends on the bridge. The vehicles were then crossing the carriageway and colliding with oncoming vehicles or the bridge parapet wall.



Skew Bridge at Tivoli (N8).
Before Accident Remedial Measures were implemented.



Skew Bridge at Tivoli (N8).
After Accident Remedial Measures were implemented.

Measures Implemented

Improved the warning signs on the approaches to the bends.

Erect large Chevrons on the outside of the Bend

Collon Village (N2)

While this would be classified as a Traffic Calming Scheme, it was funded under the Low Cost Accident Remedial Measures Program

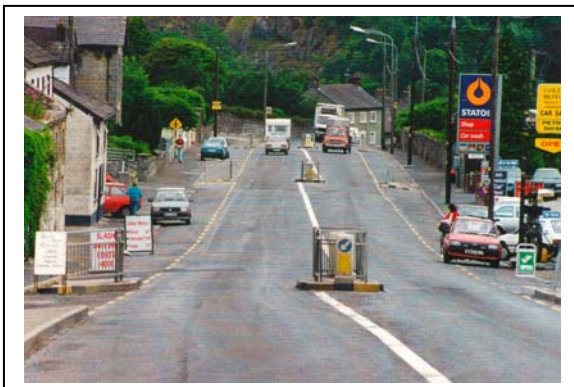
Problem

The heavy volumes and excessive speed of vehicles, was in direct conflict with the normal pedestrian and pedal cycle activity normally associated with a village.

High speed of through traffic and restricted visibility was creating difficulties for traffic on the R168 trying to merge with the traffic on the N2



Collon Village (N2) General View of the Village.
Before Accident Remedial Measures were implemented.



Collon Village (N2) General View of the Village.
After Accident Remedial Measures were implemented.

Measures Implemented

A “Gateway Entrance” was erected at both ends of the village.

A 400m transition zone leading into each “Gateway” was installed.

Rumble Strips were installed within the transition zone.

3 No. Central refuge islands were installed to aid pedestrians wishing to cross the road.

The Hardshoulder was converted into parking bays, with a number of kerbed build outs installed opposite the central islands.

Appendix A

Proposal Form For Low Cost Remedial Measures			
National Roads Authority			
Local Authority _____	Proposal Number _____	Rank _____	
Name of Location _____		Road No _____	
Location Relative to Marker Post(s) (See Guidelines)			
<i>Single Site</i>	_____ m from Marker Post	_____ in Dir	_____
<i>Road Length</i>	Start _____ m from Marker Post	_____ in Dir	_____
	End _____ m from Marker Post	_____ in Dir	_____
Location Type:			
	Improved Section <input type="checkbox"/>	Unimproved Section	<input type="checkbox"/>
	Inside Built-up area <input type="checkbox"/>	Outside Built-up area	<input type="checkbox"/>
Junction <input type="checkbox"/>	Bend <input type="checkbox"/>	Road Length	<input type="checkbox"/>
Predominant Accident Type			
Pedestrian <input type="checkbox"/>	Single Vehicle <input type="checkbox"/>	Head On	<input type="checkbox"/>
Mixed <input type="checkbox"/>	Conflict Warrant <input type="checkbox"/>		
Problem Type (Tick one or more)			
Surface <input type="checkbox"/>	Layout <input type="checkbox"/>	Definition <input type="checkbox"/>	Width <input type="checkbox"/>
Markings <input type="checkbox"/>	Sight Distance <input type="checkbox"/>	Signs <input type="checkbox"/>	
Other <input type="checkbox"/>	Specify _____		
Reported Injury Accidents, 1990 to Present. (Give year, serial no., as on top right-hand corner of C(T)68 and brief description) and classify as F(fatal), S.I. or M.I.			
Any Supporting Information _____			
Describe Proposed Scheme _____			
Estimate of Cost _____			
Describe How Proposal should Reduce Accidents _____			

Appendix B

SCHEMES APPROVED UNDER PROGRAMME 1, 1994, 1995.

NRA Ref	Local Authority	Description	Route	App Cost	Main Stream Schemes	Schemes Partial Treatment	"Best" Schemes
PRG1_01	Carlow	Wallsforge	N80	£ 500	√		
PRG1_02	Carlow	Carlow town - 3 locations	N9	£ 3,000	√		
PRG1_04	Carlow	Mortarstown	N9	£ 3,000	√		
PRG1_05	Carlow	Orchard to Millford Cross	N9	£ 7,500	√		
PRG1_06	Carlow	Pollerton Little	N9	£ 5,000	√		√
PRG1_07	Cavan	Ballyhaise @ Bunn	N3	£ 6,400	√		
PRG1_08	Cavan	College St./Barrick Hill	N3	£ 10,000	√		
PRG1_09	Cavan	Connolly St./College St.	N3	£ 4,800	√		
PRG1_10	Cavan	Deredis	N3	£ 4,000	√		
PRG1_11	Cavan	Derrygarra	N3	£ 500	√		
PRG1_14	Cavan	Milltown at Drumaloor	N3	£ 900	√		
PRG1_15	Cavan	Pedestrian Crossing Cavan	N3	£ 10,000	√		
PRG1_16	Cavan	Putighan @ Bunn	N3	£ 2,600	√		
PRG1_17	Cavan	Corduff Cross	N55	£ 12,700	√		
PRG1_18	Cavan	Killydoon at Gowna	N55	£ 2,000	√		
PRG1_19	Clare	Lahinch Road, Ennis	N85	£ 8,000	√		
PRG1_20	Cork Borough	Skew Bridge, Tivoli (Part Funding)	N8	£ 32,400	√		
PRG1_24	Donegal	Four Lane Rd., Letterkenny	N14	£ 10,000	√		
PRG1_25	Donegal	Manor Roundabout	N14	£ 15,000	√		
PRG1_26	Donegal	Newtowncunningham	N14	£ 3,000	√		
PRG1_27	Donegal	Ballintra/Rossnowlagh	N15	£ 5,000	√		
PRG1_28	Donegal	Finner Camp	N15	£ 29,795	√		
PRG1_30	Donegal	Laghey Village	N15	£ 5,000	√		
PRG1_31	Donegal	North of Ballybofey	N15	£ 6,000			
PRG1_32	Dublin Borough	NCR/Clonliffe Road	N1	£ 10,000		√	
PRG1_33	Dublin Borough	O'Connell St	N1	£ 13,000		√	
PRG1_34	Dublin Borough	Nutley Lane, Stillorgan	N11	£ 5,000		√	
PRG1_35	Dublin Borough	Phibsboro Rd. (Doyles Corner)	N2	£ 5,000		√	
PRG1_36	Dublin Borough	Harolds Cross Park	N81	£ 5,000		√	
PRG1_37	Dundalk UDC	Barrick St.	N1	£ 57,915		√	
PRG1_39	Fingal	Blakes Cross	N1	£ 12,000	√		
PRG1_40	Galway	Loughgeorge to Clare Galway	N17	£ 4,225	√		
PRG1_41	Galway	To Carofin	N17	£ 2,692	√		
PRG1_42	Galway	Carnmore Cross	N18	£ 18,570	√		
PRG1_43	Galway	Kilcolgan	N18	£ 2,060	√		
PRG1_44	Galway	South of Oranmore	N18	£ 2,680	√		
PRG1_46	Kerry	Killarney Bypass at Lewis Rd.	N22	£ 7,000	√		
PRG1_47	Kerry	Tourist areas around Killarney	N22	£ 15,000			
PRG1_48	Kerry	From Shrone Cross Westwards	N72	£ 11,500	√		
PRG1_49	Kerry	Gortroe outside Killarney	N72	£ 8,600	√		√
PRG1_50	Kildare	Johnstown	N7	£ 10,000		√	
PRG1_51	Kildare	Kill	N7	£ 10,000		√	
PRG1_52	Kildare	Kill - Johnstown @ Hotel	N7	£ 10,000		√	
PRG1_53	Kildare	Turf Bog Lane	N7	£ 10,000		√	
PRG1_56	Kilkenny	Flagmount	N10	£ 6,638	√		√
PRG1_57	Kilkenny	Parkmore	N76	£ 5,687	√		√
PRG1_58	Kilkenny	Dungarvan Village	N9	£ 24,725	√		√

NRA Ref	Local Authority	Description	Route	App Cost	Main Stream Schemes	Schemes - Partial Treatment	"Best" Schemes
PRG1_59	Laois	Holy Cross, Mountrath	N7	£ 8,639	√		
PRG1_60	Laois	Main St. Mountrath	N7	£ 6,985	√		√
PRG1_61	Laois	Crettyard	N78	£ 3,932	√		
PRG1_62	Laois	Newtown Cross	N78	£ 2,665	√		
PRG1_63	Laois	Pedigree Corner	N78	£ 2,874	√		
PRG1_64	Laois	The Rushes	N78	£ 17,320	√		
PRG1_65	Laois	Wandsford Bridge	N78	£ 8,206	√		
PRG1_66	Laois	Bloomfield Cross	N80	£ 1,350	√		√
PRG1_68	Leitrim	Aughamore Junction	N4	£ 43,220	√		√
PRG1_69	Limerick	Daly's Cross	N7	£ 64,805	√		√
PRG1_71	Limerick Boro	Childers Road/Ballinacurra Road	N20	£ 4,500		√	
PRG1_72	Limerick Boro	Punches Cross	N20	£ 12,000		√	
PRG1_74	Limerick Boro	Dublin Rd./Pennywell Rd.	N7	£ 6,000		√	
PRG1_75	Limerick Boro	Mallow St./Henry St.	N7	£ 18,000			
PRG1_78	Louth	Feede Cross	N1	£ 8,720	√		√
PRG1_79	Louth	Thistle Cross	N1	£ 11,250	√		√
PRG1_80	Louth	Blakestown Cross	N2	£ 10,900	√		√
PRG1_81	Louth	Collon Village	N2	£ 42,375	√		√
PRG1_82	Louth	Curly Hole, Tullyallen	N51	£ 21,300	√		√
PRG1_83	Louth	Mapastown Bridge	N52	£ 18,000	√		√
PRG1_84	Louth	Hackballs Cross	N53	£ 4,275	√		√
PRG1_85	Louth	Rathmore	N53	£ 2,700	√		√
PRG1_86	Mayo	Ballindine Village	N17	£ 10,000	√		
PRG1_87	Mayo	Cloongullane Bridge	N26	£ 5,000	√		
PRG1_88	Mayo	Foxford Town	N26	£ 10,000	√		√
PRG1_89	Mayo	Stonehall/Corragh/Rathbawn	N26	£ 10,000	√		
PRG1_90	Mayo	Kilbree/Sheeaun	N5	£ 5,000	√		
PRG1_92	Mayo	Lord Edward St.,Ballina	N59	£ 3,000	√		
PRG1_93	Meath	Dunshaughlin Village	N3	£ 41,234	√		√
PRG1_95	Monaghan	Coolshannagh, Monaghan	N2	£ 20,000	√		
PRG1_96	Monaghan	Drumillard Little, Castleblaney	N2	£ 8,000	√		√
PRG1_97	Monaghan	Highfield Estate,Carrickmacross	N2	£ 5,500	√		√
PRG1_98	Monaghan	Castleblaney to Border	N53	£ 7,500	√		
PRG1_99	Offaly	Cemetery Road, Crinkle	N62	£ 4,500	√		√
PRG1_101	Offaly	Dromakeenan (near National School)	N62	£ 1,000	√		√
PRG1_100	Offaly	Cooldery Rd. & Brosna Rd., Gloster	N62	£ 5,500	√		√
PRG1_102	Offaly	Jackies Cross, Sharavogue	N62	£ 1,500	√		√
PRG1_103	Offaly	Upgrade of Markings & Studs	N62	£ 10,000	√		√
PRG1_104	Roscommon	Croghan Road	N4	£ 3,000	√		
PRG1_105	Roscommon	Frenchpark	N5	£ 2,500	√		
PRG1_106	Roscommon	Rathcroghan School	N5	£ 3,000	√		
PRG1_107	Roscommon	Corfanulla School	N6	£ 3,000	√		
PRG1_108	Roscommon	Cloverhill School	N60	£ 3,000	√		
PRG1_109	Roscommon	Ballybay School	N61	£ 6,000	√		
PRG1_110	Roscommon	Ballyleague School	N63	£ 3,000	√		
PRG1_111	Roscommon	Ballyleague(Walshes filling Station)	N63	£ 3,500	√		
PRG1_112	Roscommon	Galway Road (Railway Bridge)	N63	£ 2,000	√		
PRG1_113	Sligo	Cashelgarran	N15	£ 5,000	√		√
PRG1_114	Sligo	Carraroe	N4	£ 5,000	√		√

NRA Ref	Local Authority	Description	Route	App Cost	Main Stream Schemes	Schemes - Partial Treatment	"Best" Schemes
PRG1_115	Sligo	Bunnafeida (Complete Funding)	N59	£ 40,000	√		
PRG1_119	South Dublin	Athgoe Road	N7	£ 5,000		√	
PRG1_121	South Dublin	Longmile Road	N7	£ 3,000		√	
PRG1_122	South Dublin	Monastery Road	N7	£ 5,000		√	
PRG1_124	South Dublin	Embankment Bend Sth west.	N81	£ 20,000		√	
PRG1_125	South Dublin	Fortunestown / Cheeverstown	N81	£ 20,000		√	
PRG1_126	South Dublin	Killinarden Rd / Cheeverstown	N81	£ 10,000		√	
PRG1_130	Tipperary (S.R.)	Pill Road, Carrick-on-Suir	N25	£ 20,000	√		√
PRG1_131	Tipperary (S.R.)	Biggslet outside Cashel	N8	£ 32,190	√		√
PRG1_132	Waterford	Carrolls Cross	N25	£ 5,518	√		
PRG1_133	Waterford	Ring Canal Road	N25	£ 3,536	√		
PRG1_134	Waterford	Tarr's Bridge	N25	£ 10,875	√		
PRG1_135	Waterford	Master McGrath Junction	N72	£ 14,797	√		
PRG1_136	Waterford Boro	Ferrybank Dual Carriageway	N25	£ 33,000	√		√
PRG1_137	Westmeath	Ballinafid	N4	£ 19,000	√		√
PRG1_138	Westmeath	Corkhill, Kinegad	N4	£ 19,000	√		√
PRG1_139	Westmeath	Heathstown	N4	£ 3,400	√		√
PRG1_140	Westmeath	Lynn Road, Mullingar	N52	£ 11,000	√		√
PRG1_141	Westmeath	Ballymahon Road, Mullingar	N55	£ 22,500	√		√
PRG1_142	Westmeath	Tubberclair	N55	£ 1,000	√		√
PRG1_143	Westmeath	Creggan Roundabout	N6	£ 19,700	√		√
PRG1_144	Westmeath	Kinnegad	N6	£ 5,800	√		√
PRG1_145	Westmeath	Moate East-Killeenboylegan	N6	£ 27,000	√		√
PRG1_146	Westmeath	Oldtown	N6	£ 1,000	√		√
PRG1_147	Westmeath	Pass of Kilbride	N6	£ 2,800	√		√
PRG1_148	Westmeath	Kilgarvan Bridge	N62	£ 2,900	√		√
PRG1_149	Wexford	Marshmeadows, New Ross	N25	£ 10,000	√		
PRG1_151	Wicklow	Cullenmore Bends	N11	£ 11,000	√		√
PRG1_152	Wicklow	Johnstown Lane, Nth of Rugby Club	N11	£ 1,600	√		
PRG1_153	Wicklow	Milltown Lane / Rosanna, Ashford	N11	£ 6,000	√		

Appendix C

MAINSTREAM SCHEMES. BEFORE AND AFTER ACCIDENT DETAILS

L.A.	Description	RT	Cost £	Before Period					After Period				
				Yrs	F	S.I.	M.I.	Tot	Yrs	F	S.I.	M.I.	Tot
Carlow	Wallsforge	N80	500	7			5	5	4			3	3
Carlow	Carlow town - 3 locations	N9	3000	7	2	4	10	16	4		1	12	13
Carlow	Mortarstown	N9	3000	7		1	2	3	4			3	3
Carlow	Orchard to Millford Cross	N9	7500	7	1	3	8	12	4	1	4	5	10
Carlow	Pollerton Little	N9	5000	7	1	2	1	4	4		1	2	3
Cavan	Ballyhaise @ Bunn	N3	6400	6	1		1	2	5				
Cavan	College St./Barrick Hill	N3	10000	7		3	4	7	4		1	9	10
Cavan	Connolly St./College St.	N3	4800	7		2	1	3	4		2	1	3
Cavan	Deredis	N3	4000	6					5		1		1
Cavan	Derrygarra	N3	500	6		1	1	2	5			1	1
Cavan	Milltown at Drumaloor	N3	900	6			1	1	5				
Cavan	Pedestrian Crossing Cavan	N3	10000	6					5		1		1
Cavan	Putighan @ Bunn	N3	2600	7			1	1	4			1	1
Cavan	Corduff Cross	N55	12700	7		2	3	5	4		2	3	5
Cavan	Killydoon at Gowna	N55	2000	6		1		1	5		1	2	3
Clare	Lahinch Road, Ennis	N85	8000	6		6	5	11	5	1	1	3	5
Cork Boro	Skew Bridge, Tivoli (Part Funding)	N8	32400	6	1	1	1	3	5	1		5	6
Donegal	Four Lane Rd., Letterkenny	N14	10000	7	1	3	7	11	4		1	2	3
Donegal	Manor Roundabout	N14	15000	7	1	1	4	6	4			2	2
Donegal	Newtowncunningham	N14	3000	8	2	3	2	7	3			1	1
Donegal	Ballintra/Rossnowlagh	N15	5000	7		3	2	5	4		4	5	9
Donegal	Finner Camp	N15	29795	6		2	1	3	5				
Donegal	Laghey Village	N15	5000	6					5				
Fingal	Blakes Cross	N1	12000	7		2	9	11	4	1		4	5
Galway	Loughgeorge to Clare Galway	N17	4225	6			1	1	5			4	4
Galway	To Carofin	N17	2692	7			2	2	4				
Galway	Carnmore Cross	N18	18570	7	1			1	4				
Galway	Kilcolgan	N18	2060	7		2	5	7	4			3	3
Galway	South of Oranmore	N18	2680	7		2	7	9	4			2	2
Kerry	Killarney Bypass at Lewis Rd.	N22	7000	7	2	1	5	8	4	1	1		2
Kerry	From Shrone Cross Westwards	N72	11500	7		3	3	6	4			1	1
Kerry	Gortroe outside Killarney	N72	8600	7	2	3	1	6	4		3	3	6
Kilkenny	Flagmount	N10	6638	7	1	1	1	3	4			2	2
Kilkenny	Parkmore	N76	5687	7	1	3	5	9	4	1	3	5	9
Kilkenny	Dungarvan Village	N9	24725	7		3	1	4	4			2	2
Laois	Holy Cross, Mountrath	N7	8639	7		1		1	4	1	1		2
Laois	Main St. Mountrath	N7	6985	6	1	3	4	8	5		1	8	9
Laois	Crettyard	N78	3932	7		2	2	4	4				
Laois	Newtown Cross	N78	2665	6			2	2	5		2	2	4
Laois	Pedigree Corner	N78	2874	6		1	1	2	5				
Laois	The Rushes	N78	17320	6		1		1	5			1	1
Laois	Wandsford Bridge	N78	8206	6		1		1	5				
Laois	Bloomfield Cross	N80	1350	6		1		1	5				
Leitrim	Aughamore Junction	N4	43220	7	1	1	2	4	4			1	1
Limerick	Daly's Cross	N7	64805	7	4	3	9	16	4			3	3
Louth	Feede Cross	N1	8720	6	1	2	5	8	5		1	1	2

L.A.	Description	RT	Cost £	Before Period					After Period				
				Yrs	F	S.I.	M.I.	Tot	Yrs	F	S.I.	M.I.	Tot
Louth	Thistle Cross	N1	11250	6		1	3	4	5			3	3
Louth	Blakestown Cross	N2	10900	6		1	1	2	5		1	1	2
Louth	Collon Village	N2	42375	6	2	4	2	8	5		3	5	8
Louth	Curly Hole, Tullyallen	N51	21300	6	2	1	2	5	5				
Louth	Mapastown Bridge	N52	18000	6		1	1	2	5				
Louth	Hackballs Cross	N53	4275	6	2		1	3	5				
Louth	Rathmore	N53	2700	6	1	2	4	7	5		3	10	13
Mayo	Ballindine Village	N17	10000	6	2	3	9	14	5	1	1	3	5
Mayo	Cloongullane Bridge	N26	5000	7		1		1	4				
Mayo	Foxford Town	N26	10000	7	2		6	8	4		3	1	4
Mayo	Stonehall/Corragh/Rathbawn	N26	10000	6	1	3	1	5	5		3	6	9
Mayo	Kilbree/Sheeaun	N5	5000	6	1	3	16	20	5	1	1	8	10
Mayo	Lord Edward St.,Ballina	N59	3000	6		2	8	10	5		5	5	10
Meath	Dunshaughlin Village	N3	41234	6	3	4	3	10	5		3	3	6
Monaghan	Coolshannagh, Monaghan	N2	20000	6		1	4	5	5			5	5
Monaghan	Drumillard Little, Castleblaney	N2	8000	7		8	3	11	4	1	4	1	6
Monaghan	Highfield Estate,Carrickmacross	N2	5500	7		4	2	6	4			2	2
Monaghan	Castleblaney to Border	N53	7500	7	3	7	2	12	4	2	2	2	6
Offaly	Cemetery Road, Crinkle	N62	4500	7	1		4	5	4			2	2
Offaly	Coolderry Rd. & Brosna Rd., Gloster	N62	5500	7		1		1	4		1		1
Offaly	Dromakeenan (near National School)	N62	1000	7	1	2	1	4	4			1	1
Offaly	Jackies Cross, Sharavogue	N62	1500	7					4			1	1
Offaly	Upgrade of Markings & Studs	N62	10000	7	5	7	8	20	4		6	5	11
Roscommon	Croghan Road	N4	3000	6		3		3	5			1	1
Roscommon	Frenchpark	N5	2500	6		1	4	5	5		1		1
Roscommon	Rathcroghan School	N5	3000	6					5				
Roscommon	Corfanulla School	N6	3000	6	1	3	2	6	5				
Roscommon	Cloverhill School	N60	3000	6					5				
Roscommon	Ballybay School	N61	6000	6					5				
Roscommon	Ballyleague School	N63	3000										
Roscommon	Ballyleague(Walshes filling Station)	N63	3500	6		1	2	3	5				
Roscommon	Galway Road (Railway Bridge)	N63	2000	7		2	1	3	4				
Sligo	Cashelgarran	N15	5000	6	1	4	3	8	5		1	2	3
Sligo	Carraroe	N4	5000	6		2	6	8	5		1	2	3
Sligo	Bunnafeida (Complete Funding)	N59	40000	7		2	4	6	4			2	2
Tipp (S.R.)	Pill Road, Carrick-on-Suir	N25	20000	8		5	8	13	3			3	3
Tipp (S.R.)	Biggslot outside Cashel	N8	32190	6	1		1	2	5		1	1	2
Waterford	Carrolls Cross	N25	5518	6		3	3	6	5	1	1	1	3
Waterford	Ring Canal Road	N25	3536	7		4	2	6	4		1		1
Waterford	Tarr's Bridge	N25	10875	7		2	2	4	4				
Waterford	Master McGrath Junction	N72	14797	6		2		2	5		2		2
W.ford Boro	Ferrybank Dual Carriageway	N25	33000	7	3	3	14	20	4			3	3
Westmeath	Ballinafid	N4	19000	7		2	2	4	4				
Westmeath	Corkhill, Kinegad	N4	19000	7	1	2	1	4	4				
Westmeath	Heathstown	N4	3400	7		2	1	3	4			1	1
Westmeath	Lynn Road, Mullingar	N52	11000	7		2	6	8	4	1		1	2
Westmeath	Ballymahon Road, Mullingar	N55	22500	7		2	10	12	4	1		3	4
Westmeath	Tubberclair	N55	1000	7		2	1	3	4		1	2	3

L.A.	Description	RT	Cost £	Before Period					After Period				
				Yrs	F	S.I.	M.I.	Tot	Yrs	F	S.I.	M.I.	Tot
Westmeath	Creggan Roundabout	N6	19700	7			1	1	4		1		1
Westmeath	Kinnegad	N6	5800	7					4				
Westmeath	Moate East-Killeenboylegan	N6	27000	7		4	2	6	4				
Westmeath	Oldtown	N6	1000	7	1		3	4	4				
Westmeath	Pass of Kilbride	N6	2800	7		2	1	3	4				
Westmeath	Kilgarvan Bridge	N62	2900	7					4				
Wexford	Marshmeadows, New Ross	N25	10000	7	1	3	5	9	4		5	4	9
Wicklow	Cullenmore Bends	N11	11000	6	1	3	7	11	5		1	2	3
Wicklow	Johnstown Lane, Nth of Rugby Club	N11	1600	6	1	2		3	5		2	1	3
Wicklow	Milltown Lane / Rosanna, Ashford	N11	6000	7	1	3		4	4			6	6

Appendix D

STATISTICAL TEST USING THE NORMAL APPROXIMATION TO THE BINOMIAL

1. Fatal Accidents

Period	Schemes	All National Routes	Proportion
Before	62	1189	0.052
After	15	764	0.019

$$z = \frac{(Pb - Pa)}{\sqrt{P(1-P)/(1/nb + 1/na)}} \text{ where}$$

Pb = proportion before = 0.052

Pa = proportion after = 0.019

$$P = \text{pooled proportion} = \frac{(62 + 15)}{(1189 + 764)} = 0.039$$

nb = total number of accidents before = 1189

na = total number of accidents after = 764

$$z = \frac{(0.052 - 0.019)}{\sqrt{0.039 * (1 - 0.039)/(1/1189 + 1/764)}} = 3.67 (p < 0.01)$$

95 per cent confidence for the difference in fatal accident rates

$$Pb - Pa \pm 1.96 \sqrt{P(1-P)/(1/na + 1/nb)}$$

$$= 0.052 - 0.019 \pm 1.96(0.009)$$

$$= 0.033 \pm 0.017$$

2. Serious Injury Accidents

Period	Schemes	All National Routes	Proportion
Before	196	4128	0.047
After	86	2464	0.035

$$z = \frac{(0.047 - 0.035)}{\sqrt{0.0426(1 - 0.0426)/(1/4128 + 1/2464)}} = 2.31 (p < 0.05)$$

95 per cent confidence for the difference in serious injury rates

$$0.047 - 0.035 \pm 1.96 \sqrt{(0.0426(1 - 0.0426)/(1/4128 + 1/2464))}$$

$$= 0.012 \pm 0.000$$

3. Minor Injury Accidents

Period	Schemes	All National Routes	Proportion
Before	298	7391	0.040
After	201	6650	0.029

$$z = \frac{(0.040 - 0.029)}{\sqrt{0.035 * (1 - 0.035) / (1/7391 + 1/6650)}} = 3.625 (p < 0.01)$$

95 per cent confidence for the difference in minor injury rates

$$(0.040 - 0.029) \pm 1.96 \sqrt{(0.035 * (1 - 0.035) / (1/7391 + 1/6650))}$$
$$= 0.01 \pm 0.006$$

Appendix E

TABLE E1 "MAIN STREAM SCHEMES" WITH 3 OR MORE ACCIDENTS, RANKED ACCORDING TO WILLINGNESS TO PAY AVERAGE ANNUAL RATE OF RETURN.

Local Authority	Description	Route	Cost £	Before Ann. Acc. Cost.	After Ann. Acc. Cost	AAROR %
Offaly	Dromakeenan (near National School)	N62	1,000	162,847	2,658	16,019
Westmeath	Oldtown	N6	1,000	135,004	0	13,500
Carlow	Carlow town - 3 locations	N9	3,000	337,843	58,910	9,298
Donegal	Newtowncunningham	N14	3,000	271,473	3,543	8,931
Wicklow	Johnstown Lane, Nth of Rugby Club	N11	1,600	188,217	45,358	8,929
Louth	Hackballs Cross	N53	4,275	306,152	0	7,161
Roscommon	Corfanulla School	N6	3,000	209,773	0	6,992
Offaly	Upgrade of Markings & Studs	N62	10,000	772,471	175,408	5,971
Sligo	Cashelgarran	N15	5,000	229,558	25,868	4,074
Louth	Rathmore	N53	2,700	195,303	86,108	4,044
Offaly	Cemetery Road, Crinkle	N62	4,500	136,523	5,315	2,916
Wicklow	Milltown Lane / Rosanna, Ashford	N11	6,000	176,769	15,945	2,680
Carlow	Pollerton Little	N9	5,000	162,847	32,335	2,610
Kerry	Gortroe outside Killarney	N72	8,600	308,736	89,033	2,555
Laois	Main St. Mountrath	N7	6,985	213,317	38,624	2,501
Kilkenny	Flagmount	N10	6,638	147,407	5,315	2,141
Louth	Feede Cross	N1	8,720	197,075	23,742	1,988
Mayo	Foxford Town	N26	10,000	270,009	83,718	1,863
Wicklow	Cullenmore Bends	N11	11,000	218,632	25,868	1,752
Roscommon	Croghan Road	N4	3,000	54,040	2,126	1,730
Mayo	Ballindine Village	N17	10,000	374,365	210,622	1,637
Roscommon	Galway Road (Railway Bridge)	N63	2,000	32,399	0	1,620
Donegal	Four Lane Rd., Letterkenny	N14	10,000	187,399	32,335	1,551
Louth	Curly Hole, Tullyallen	N51	21,300	325,937	0	1,530
Galway	Kilcolgan	N18	2,060	38,473	7,973	1,481
W.ford Boro	Ferrybank Dual Carriageway	N25	33,000	458,926	7,973	1,367
Galway	South of Oranmore	N18	2,680	41,510	5,315	1,351
Mayo	Stonehall/Corragh/Rathbawn	N26	10,000	208,002	77,604	1,304
Westmeath	Pass of Kilbride	N6	2,800	32,399	0	1,157
Meath	Dunshaughlin Village	N3	41,234	533,938	71,226	1,122
Monaghan	Highfield Estate, Carrickmacross	N2	5,500	64,797	5,315	1,081
Waterford	Ring Canal Road	N25	3,536	64,797	27,020	1,068
Donegal	Manor Roundabout	N14	15,000	151,963	5,315	978
Limerick	Daly's Cross	N7	64,805	581,781	7,973	885
Westmeath	Heathstown	N4	3,400	32,399	2,658	875
Laois	Crettyard	N78	3,932	33,917	0	863
Westmeath	Corkhill, Kinegad	N4	19,000	162,847	0	857
Louth	Collon Village	N2	42,375	379,977	75,478	719
Roscommon	Ballyleague(Walshes filling Station)	N63	3,500	21,557	0	616
Kerry	From Shrone Cross Westwards	N72	11,500	50,876	2,658	419
Sligo	Carraroe	N4	5,000	46,657	25,868	416
Kerry	Killarney Bypass at Lewis Rd.	N22	7,000	283,930	255,305	409
Wexford	Marshmeadows, New Ross	N25	10,000	184,361	145,730	386
Carlow	Mortarstown	N9	3,000	18,477	7,973	350
Leitrim	Aughamore Junction	N4	43,220	148,926	2,658	338
Tipp (S.R.)	Pill Road, Carrick-on-Suir	N25	20,000	78,180	10,630	338
Waterford	Tarr's Bridge	N25	10,875	33,917	0	312

Local Authority	Description	Route	Cost £	Before Ann. Acc. Cost.	After Ann. Acc. Cost	AAROR %
Mayo	Kilbree/Sheeaun	N5	5,000	234,577	221,252	266
Westmeath	Moate East-Killeenboylegan	N6	27,000	64,797	0	240
Westmeath	Ballinafid	N4	19,000	33,917	0	179
Kilkenny	Dungarvan Village	N9	24,725	47,839	5,315	172
Louth	Thistle Cross	N1	11,250	23,328	6,378	151
Roscommon	Frenchpark	N5	2,500	25,100	21,616	139
Donegal	Finner Camp	N15	29,795	37,798	0	127
Sligo	Bunnafeida (Complete Funding)	N59	40,000	36,954	5,315	79
Monaghan	Coolshannagh, Monaghan	N2	20,000	25,100	10,630	72
Cavan	College St./Barrick Hill	N3	10,000	52,394	50,938	15
Westmeath	Tubberclair	N55	1,000	32,399	32,335	6
Cork Boro	Skew Bridge, Tivoli (Part Funding)	N8	32,400	171,975	193,258	-66
Carlow	Wallsforge	N80	500	7,593	7,973	-76
Monaghan	Castleblaney to Border	N53	7,500	502,463	515,925	-179
Cavan	Corduff Cross	N55	12,700	35,436	62,013	-209
Cavan	Connolly St./College St.	N3	4,800	32,399	56,698	-506
Westmeath	Ballymahon Road, Mullingar	N55	22,500	46,066	236,258	-845
Clare	Lahinch Road, Ennis	N85	8,000	116,938	210,622	-1,171
Donegal	Ballintra/Rossnowlagh	N15	5,000	49,357	121,368	-1,440
Fingal	Blakes Cross	N1	12,000	44,547	238,915	-1,620
Westmeath	Lynn Road, Mullingar	N52	11,000	39,991	230,943	-1,736
Carlow	Orchard to Millford Cross	N9	7,500	188,917	349,653	-2,143
Mayo	Lord Edward St.,Ballina	N59	3,000	50,200	118,710	-2,284
Kilkenny	Parkmore	N76	5,687	184,361	322,633	-2,431
Monaghan	Drumillard Little, Castleblaney	N2	8,000	128,076	339,023	-2,637
Waterford	Carrolls Cross	N25	5,518	59,355	206,370	-2,664

TABLE E2 "BEST SCHEMES" WITH 3 OR MORE ACCIDENTS, RANKED ACCORDING TO WILLINGNESS TO PAY AVERAGE ANNUAL RATE OF RETURN

Local Authority	Description	Route	Cost £	Before Ann. Acc. Cost.	After Ann. Acc. Cost	AAROR %
Offaly	Dromakeenan (near National School)	N62	1,000	162,847	2,658	16,019
Westmeath	Oldtown	N6	1,000	135,004	0	13,500
Louth	Hackballs Cross	N53	4,275	306,152	0	7,161
Offaly	Upgrade of Markings & Studs	N62	10,000	772,471	175,408	5,971
Sligo	Cashelgarran	N15	5,000	229,558	25,868	4,074
Louth	Rathmore	N53	2,700	195,303	86,108	4,044
Offaly	Cemetery Road, Crinkle	N62	4,500	136,523	5,315	2,916
Carlow	Pollerton Little	N9	5,000	162,847	32,335	2,610
Kerry	Gortroe outside Killarney	N72	8,600	308,736	89,033	2,555
Laois	Main St. Mountrath	N7	6,985	213,317	38,624	2,501
Kilkenny	Flagmount	N10	6,638	147,407	5,315	2,141
Louth	Feede Cross	N1	8,720	197,075	23,742	1,988
Mayo	Foxford Town	N26	10,000	270,009	83,718	1,863
Wicklow	Cullenmore Bends	N11	11,000	218,632	25,868	1,752
Louth	Curly Hole, Tullyallen	N51	21,300	325,937	0	1,530
W.ford Boro	Ferrybank Dual Carriageway	N25	33,000	458,926	7,973	1,367
Westmeath	Pass of Kilbride	N6	2,800	32,399	0	1,157
Meath	Dunshaughlin Village	N3	41,234	533,938	71,226	1,122
Monaghan	Highfield Estate,Carrickmacross	N2	5,500	64,797	5,315	1,081
Limerick	Daly's Cross	N7	64,805	581,781	7,973	885
Westmeath	Heathstown	N4	3,400	32,399	2,658	875
Westmeath	Corkhill, Kinegad	N4	19,000	162,847	0	857
Louth	Collon Village	N2	42,375	379,977	75,478	719
Sligo	Carraroe	N4	5,000	46,657	25,868	416
Leitrim	Aughamore Junction	N4	43,220	148,926	2,658	338
Tipp (S.R.)	Pill Road, Carrick-on-Suir	N25	20,000	78,180	10,630	338
Westmeath	Moate East-Killeenboylegan	N6	27,000	64,797	0	240
Westmeath	Ballinafid	N4	19,000	33,917	0	179
Kilkenny	Dungarvan Village	N9	24,725	47,839	5,315	172
Louth	Thistle Cross	N1	11,250	23,328	6,378	151
Westmeath	Tubberclair	N55	1,000	32,399	32,335	6
Westmeath	Ballymahon Road, Mullingar	N55	22,500	46,066	236,258	-845
Westmeath	Lynn Road, Mullingar	N52	11,000	39,991	230,943	-1,736
Kilkenny	Parkmore	N76	5,687	184,361	322,633	-2,431
Monaghan	Drumillard Little, Castleblaney	N2	8,000	128,076	339,023	-2,637

Table E3 "Main Stream Schemes" with 3 or more accidents, Ranked according to Willingness to Pay Average Annual Rate Of Return by accident category

Local Authority	Description	Route	Cost £	Ann. Acc. Cost		Average Annual Rate of Return %			
				Before	After	All Acc	Fatal	Serious	Minor
Offaly	Dromakeenan (near National School)	N62	1,000	162,847	2,658	16,019	13,045	3,088	-114
Westmeath	Oldtown	N6	1,000	135,004	0	13,500	13,045	0	456
Carlow	Carlow town - 3 locations	N9	3,000	337,843	58,910	9,298	8,697	1,158	-557
Donegal	Newtowncunningham	N14	3,000	271,473	3,543	8,931	7,610	1,351	-30
Wicklow	Johnstown Lane, Nth of Rugby Club	N11	1,600	188,217	45,358	8,929	9,512	-450	-133
Louth	Hackballs Cross	N53	4,275	306,152	0	7,161	7,120	0	41
Roscommon	Corfanulla School	N6	3,000	209,773	0	6,992	5,073	1,801	118
Offaly	Upgrade of Markings & Studs	N62	10,000	772,471	175,408	5,971	6,522	-540	-11
Sligo	Cashelgarran	N15	5,000	229,558	25,868	4,074	3,044	1,009	21
Louth	Rathmore	N53	2,700	195,303	86,108	4,044	5,637	-1,067	-525
Offaly	Cemetery Road, Crinkle	N62	4,500	136,523	5,315	2,916	2,899	0	17
Wicklow	Milltown Lane / Rosanna, Ashford	N11	6,000	176,769	15,945	2,680	2,174	772	-266
Carlow	Pollerton Little	N9	5,000	162,847	32,335	2,610	2,609	77	-76
Kerry	Gortroe outside Killarney	N72	8,600	308,736	89,033	2,555	3,034	-404	-75
Laois	Main St. Mountrath	N7	6,985	213,317	38,624	2,501	2,179	464	-142
Kilkenny	Flagmount	N10	6,638	147,407	5,315	2,141	1,965	233	-57
Louth	Feede Cross	N1	8,720	197,075	23,742	1,988	1,745	165	77
Mayo	Foxford Town	N26	10,000	270,009	83,718	1,863	2,609	-811	65
Wicklow	Cullenmore Bends	N11	11,000	218,632	25,868	1,752	1,384	295	74
Roscommon	Croghan Road	N4	3,000	54,040	2,126	1,730	0	1,801	-71
Mayo	Ballindine Village	N17	10,000	374,365	210,622	1,637	1,218	324	96
Roscommon	Galway Road (Railway Bridge)	N63	2,000	32,399	0	1,620	0	1,544	76
Donegal	Four Lane Rd., Letterkenny	N14	10,000	187,399	32,335	1,551	1,304	193	53
Louth	Curly Hole, Tullyallen	N51	21,300	325,937	0	1,530	1,429	85	17
Galway	Kilcolgan	N18	2,060	38,473	7,973	1,481	0	1,499	-18
W.ford Boro	Ferrybank Dual Carriageway	N25	33,000	458,926	7,973	1,367	1,186	140	40
Galway	South of Oranmore	N18	2,680	41,510	5,315	1,351	0	1,152	198
Mayo	Stonehall/Corragh/Rathbawn	N26	10,000	208,002	77,604	1,304	1,522	-108	-110
Westmeath	Pass of Kilbride	N6	2,800	32,399	0	1,157	0	1,103	54
Meath	Dunshaughlin Village	N3	41,234	533,938	71,226	1,122	1,107	17	-3
Monaghan	Highfield Estate, Carrickmacross	N2	5,500	64,797	5,315	1,081	0	1,123	-41
Waterford	Ring Canal Road	N25	3,536	64,797	27,020	1,068	0	982	86
Donegal	Manor Roundabout	N14	15,000	151,963	5,315	978	870	103	5
Limerick	Daly's Cross	N7	64,805	581,781	7,973	885	805	71	9
Westmeath	Heathstown	N4	3,400	32,399	2,658	875	0	908	-33
Laois	Crettyard	N78	3,932	33,917	0	863	0	785	77
Westmeath	Corkhill, Kinegad	N4	19,000	162,847	0	857	687	163	8
Louth	Collon Village	N2	42,375	379,977	75,478	719	718	17	-17
Roscommon	Ballyleague (Walshes filling Station)	N63	3,500	21,557	0	616	0	515	101
Kerry	From Throne Cross Westwards	N72	11,500	50,876	2,658	419	0	403	17
Sligo	Carraroe	N4	5,000	46,657	25,868	416	0	288	128
Kerry	Killarney Bypass at Lewis Rd.	N22	7,000	283,930	255,305	409	466	-165	108
Wexford	Marshmeadows, New Ross	N25	10,000	184,361	145,730	386	1,304	-888	-30
Carlow	Mortarstown	N9	3,000	18,477	7,973	350	0	515	-165
Leitrim	Aughamore Junction	N4	43,220	148,926	2,658	338	302	36	1
Tipp (S.R.)	Pill Road, Carrick-on-Suir	N25	20,000	78,180	10,630	338	0	338	0
Waterford	Tarr's Bridge	N25	10,875	33,917	0	312	0	284	28
Mayo	Kilbree/Sheaun	N5	5,000	234,577	221,252	266	-609	648	227
Westmeath	Moate East-Killeenboylegan	N6	27,000	64,797	0	240	0	229	11

Local Authority	Description	Route	Cost £	Ann. Acc. Cost		Average Annual Rate of Return %			
				Before	After	All Acc	Fatal	Serious	Minor
Westmeath	Ballinafid	N4	19,000	33,917	0	179	0	163	16
Kilkenny	Dungarvan Village	N9	24,725	47,839	5,315	172	0	187	-15
Louth	Thistle Cross	N1	11,250	23,328	6,378	151	0	160	-9
Roscommon	Frenchpark	N5	2,500	25,100	21,616	139	0	-144	283
Donegal	Finner Camp	N15	29,795	37,798	0	127	0	121	6
Sligo	Bunnafeida (Complete Funding)	N59	40,000	36,954	5,315	79	0	77	2
Monaghan	Coolshannagh, Monaghan	N2	20,000	25,100	10,630	72	0	90	-18
Cavan	College St./Barrick Hill	N3	10,000	52,394	50,938	15	0	193	-178
Westmeath	Tubberclair	N55	1,000	32,399	32,335	6	0	386	-380
Cork Boro	Skew Bridge, Tivoli (Part Funding)	N8	32,400	171,975	193,258	-66	-94	56	-27
Carlow	Wallsforge	N80	500	7,593	7,973	-76	0	0	-76
Monaghan	Castleblaney to Border	N53	7,500	502,463	515,925	-179	-870	721	-30
Cavan	Corduff Cross	N55	12,700	35,436	62,013	-209	0	-182	-27
Cavan	Connolly St./College St.	N3	4,800	32,399	56,698	-506	0	-483	-24
Westmeath	Ballymahon Road, Mullingar	N55	22,500	46,066	236,258	-845	-1,015	137	32
Clare	Lahinch Road, Ennis	N85	8,000	116,938	210,622	-1,171	-2,283	1,081	31
Donegal	Ballintra/Rossnowlagh	N15	5,000	49,357	121,368	-1,440	0	-1,235	-205
Fingal	Blakes Cross	N1	12,000	44,547	238,915	-1,620	-1,902	257	25
Westmeath	Lynn Road, Mullingar	N52	11,000	39,991	230,943	-1,736	-2,075	281	59
Carlow	Orchard to Millford Cross	N9	7,500	188,917	349,653	-2,143	-1,304	-823	-15
Mayo	Lord Edward St., Ballina	N59	3,000	50,200	118,710	-2,284	0	-2,402	118
Kilkenny	Parkmore	N76	5,687	184,361	322,633	-2,431	-1,720	-611	-100
Monaghan	Drumillard Little, Castleblaney	N2	8,000	128,076	339,023	-2,637	-2,854	193	24
Waterford	Carrolls Cross	N25	5,518	59,355	206,370	-2,664	-3,310	588	58

Table E4 "Best Schemes" with 3 or more accidents, Ranked according to Willingness to Pay Average Annual Rate of Return by accident category.

Local Authority	Description	Route	Cost £	Ann. Acc. Cost		Average Annual Rate of Return %			
				Before	After	All Acc	Fatal	Serious	Minor
Offaly	Dromakeenan (near National School)	N62	1,000	162,847	2,658	16,019	13,045	3,088	-114
Westmeath	Oldtown	N6	1,000	135,004	0	13,500	13,045	0	456
Louth	Hackballs Cross	N53	4,275	306,152	0	7,161	7,120	0	41
Offaly	Upgrade of Markings & Studs	N62	10,000	772,471	175,408	5,971	6,522	-540	-11
Sligo	Cashelgarran	N15	5,000	229,558	25,868	4,074	3,044	1,009	21
Louth	Rathmore	N53	2,700	195,303	86,108	4,044	5,637	-1,067	-525
Offaly	Cemetery Road, Crinkle	N62	4,500	136,523	5,315	2,916	2,899	0	17
Carlow	Pollerton Little	N9	5,000	162,847	32,335	2,610	2,609	77	-76
Kerry	Gortroe outside Killarney	N72	8,600	308,736	89,033	2,555	3,034	-404	-75
Laois	Main St. Mountrath	N7	6,985	213,317	38,624	2,501	2,179	464	-142
Kilkenny	Flagmount	N10	6,638	147,407	5,315	2,141	1,965	233	-57
Louth	Feede Cross	N1	8,720	197,075	23,742	1,988	1,745	165	77
Mayo	Foxford Town	N26	10,000	270,009	83,718	1,863	2,609	-811	65
Wicklow	Cullenmore Bends	N11	11,000	218,632	25,868	1,752	1,384	295	74
Louth	Curly Hole, Tullyallen	N51	21,300	325,937	0	1,530	1,429	85	17
W.ford Boro	Ferrybank Dual Carriageway	N25	33,000	458,926	7,973	1,367	1,186	140	40
Westmeath	Pass of Kilbride	N6	2,800	32,399	0	1,157	0	1,103	54
Meath	Dunshaughlin Village	N3	41,234	533,938	71,226	1,122	1,107	17	-3
Monaghan	Highfield Estate,Carrickmacross	N2	5,500	64,797	5,315	1,081	0	1,123	-41
Limerick	Daly's Cross	N7	64,805	581,781	7,973	885	805	71	9
Westmeath	Heathstown	N4	3,400	32,399	2,658	875	0	908	-33
Westmeath	Corkhill, Kinegad	N4	19,000	162,847	0	857	687	163	8
Louth	Collon Village	N2	42,375	379,977	75,478	719	718	17	-17
Sligo	Carraroe	N4	5,000	46,657	25,868	416	0	288	128
Leitrim	Aughamore Junction	N4	43,220	148,926	2,658	338	302	36	1
Tipp (S.R.)	Pill Road, Carrick-on-Suir	N25	20,000	78,180	10,630	338	0	338	0
Westmeath	Moate East-Killeenboylegan	N6	27,000	64,797	0	240	0	229	11
Westmeath	Ballinafid	N4	19,000	33,917	0	179	0	163	16
Kilkenny	Dungarvan Village	N9	24,725	47,839	5,315	172	0	187	-15
Louth	Thistle Cross	N1	11,250	23,328	6,378	151	0	160	-9
Westmeath	Tubberclair	N55	1,000	32,399	32,335	6	0	386	-380
Westmeath	Ballymahon Road, Mullingar	N55	22,500	46,066	236,258	-845	-1,015	137	32
Westmeath	Lynn Road, Mullingar	N52	11,000	39,991	230,943	-1,736	-2,075	281	59
Kilkenny	Parkmore	N76	5,687	184,361	322,633	-2,431	-1,720	-611	-100
Monaghan	Drumillard Little, Castleblaney	N2	8,000	128,076	339,023	-2,637	-2,854	193	24

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