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Road Safety Research Report 108

Contribution of Local Safety Schemes to Casualty Reduction

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EXECUTIVE SUMMARY

The findings of this study are based primarily on the systematic results from 22 local highway authorities, which consider the before and after casualty or collision[1] records at the 408 locations treated in 2004/05. Collectively these schemes cost about £16.6 million to build, which is about 15% of the local safety schemes' expenditure by local authorities in England (outside London) recorded for 2004/05. These 408 schemes together definitely (i.e. with more than 99.9% confidence) reduced both the total number of road casualties and the combined number of road deaths and serious injuries at the locations treated at a rate greater than the general national casualty reduction. The information submitted by local authorities for the 408 schemes was a mixture of casualty-based and collision-based data. This depended on how individual authorities assessed their schemes. Comparing the actual total numbers of casualties and crashes before and after the schemes were implemented, for this sample of 408 schemes, indicates the following:

- The average safety impact per scheme was a reduction of about one collision or 1.6 casualties per year. This is equivalent to reducing the collisions at those sites analysed using collision information by about a half and reducing casualties at those sites analysed using casualty information by about a third.
- This programme represents very good value for money. Using standard valuations of the collisions and casualties saved, comparing casualties/crashes before and after implementation, suggests that the average first-year value of the savings achieved in one year of operation was between 1.4 times and twice their construction costs. As a group, the first-year value of annual casualty savings for schemes on non-built-up[2] roads was more than treble their total construction costs, while for the group on built-up roads it was just in excess of their construction costs.
- Although all types of scheme, on average, generate very strong returns, the mass action schemes are the type which resulted in the highest returns relative to construction costs, while average returns from traffic calming and route action schemes were lower.
- The ratio of average casualty returns to costs declines with increasing scheme cost. However, a more complex analysis of impacts would normally be appropriate for the larger schemes, particularly those that each cost in excess of £200,000, which may tend to have more durable impacts including benefits other than for road safety.
- There was a wide variety of results across the sample of authorities.

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1 Collision records at sites are the road traffic collisions which involve personal injuries and they differ from casualty records for collisions which involve more than one person dying or being injured.

2 A 'built-up road' has a permanent speed limit of 40 mph or less.

As most schemes are targeted at locations with numbers of collisions and casualties that are statistically small, and because there can be a random element affecting the frequency and severity of collisions in a specific time period at a particular place, some of the sites treated will, and do, have casualty records that are worse for the three years after implementation than before.[3] Among the schemes in this sample, this was least likely to happen with schemes costing between £50,000 and £100,000 to build. There were no strong variations between different types of scheme.

In considering the effectiveness of large programmes of safety schemes as a whole, as opposed to assessing individual schemes, the research includes an extended analysis. This indicates the following:

- The sites of the 408 schemes as a whole have not only had fewer casualties and collisions after their implementation, but the average severity of the casualties and collisions has fallen. Beforehand about 16% of casualties and 17% of injury collisions were fatal or serious. Afterwards this had fallen to about 9% of casualties and collisions.
- When the reduction in average casualty severity is included in the assessment, the value of the programme's benefits increases by about 70% compared with assessment methods not considering that aspect.
- Where information is available, the ancillary costs of implementing schemes (chiefly design and supervision costs) average about 13% of the construction costs. Insufficient information was provided about future maintenance costs to come to any conclusions about them.
- Nationally, casualty and collision numbers and average severities have been falling. At a programme level this reduction can be removed from the savings attributable to schemes derived from a simple comparison of casualty or collision records before and after their implementation. Doing so reduces the value of the assessed casualty/collision savings attributable to the engineering programme by just over 10% for this period.
- Safety engineering schemes may have been implemented partly because there were randomly high levels of collisions or casualties just before decisions to design and fund them were made. Examining a longer period beforehand partially removes this 'site selection bias'.[4] For the schemes analysed in this study, the research suggests that, compared with a longer-term analysis, an analysis based on a three-year period before implementation overestimates the reduction in casualties by about 10%.

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3 Nonetheless, individual schemes in this position may have prevented even more casualties occurring after their implementation.

4 Site selection bias in this context occurs where treatments are prioritised and implemented at sites exhibiting, prior to treatment, relatively high casualty records, which would tend to have fallen in the absence of work at the sites because there are random factors influencing when and where casualties occur.

- Examining a different three-year 'before' period of four to six years before implementation suggests that 'site selection bias' is responsible for about 21% of the casualty/collision reduction observed at the sites of these schemes when the three years before implementation are compared with the three years after.

Taking all the effects outlined above, the sample of schemes implemented in 2004/05 and analysed in this research had safety impacts whose annual value[5] averaged about 1.4 to 1.6 times their implementation costs. The effects are summarised in Table 1, where the term 'factor' refers to the arithmetic factor used in deriving the product of the First Year Rate of Return (FYRR) reported in the top row and the associated analysis adjustment described on each subsequent row.

Table 1: Summary results table

Analysis	Factor	First Year Rate of Return (%)
Simple comparison of casualty/collision numbers for three years before and after	–	173
Comparison of casualty/collision numbers for three years before and after taking into account the reduction in average severity of crashes/collisions	1.70	294
Comparison of casualty/collision numbers for three years before and after using implementation costs rather than only construction costs	0.87	150
Comparison of forecast casualty/collision savings with actual	1.60	276 (predicted)
Control for site selection bias (longer period – six years)	0.89	154
Control for site selection bias (earlier period – four to six years)	0.78	135
Control for national reduction in casualty numbers (three years before period)	0.88	152
Control for national reduction in casualty numbers (four to six years before period)	0.81	140

So, for example, an estimate of the FYRR of the programme based on a comparison of before and after casualty/collision numbers, adjusted to consider the reduction in average casualty/collision severity, which also considers all implementation costs and controls for site selection bias and the prevailing national reduction in casualties, would be:

$$173\% \times 1.70 \times 0.87 \times 0.78 \times 0.81 = 162\%$$

5 2004 valuations of benefits – the 2007 valuations now used are about 20% higher.

The data available are not suitable to perform a full cost–benefit analysis. Nevertheless, it is possible to convert the above FYRRs into approximate benefit to cost ratios. For example, selecting one of the above results, a 154% FYRR is broadly equivalent to a benefit to cost ratio of 7.1, assuming a constant stream of benefits for five years (and no benefits beyond) and a benefit to cost ratio of 13.0, assuming a 10-year constant benefit stream.

During the three years after implementation, the sample of 408 schemes saved a total, estimated by this research, of 8 fatalities, 55 serious injuries and 274 slight injuries per year. This estimate allows for the reduction that would have occurred in any case due to national casualty reductions and a precautionary assessment of the effects of site selection bias. This is equivalent to around four killed or seriously injured (KSI) casualties and 17 other casualties saved per £1 million spent. The safety benefits from £16.6 million worth of schemes are valued as being about £23.3 million for **each** of the three years after implementation.

If these schemes are a typical sample, then the casualty reduction attributable to safety engineering schemes implemented on English local authorities' roads outside London (allowing for the same adjustments) would be 54 fatalities, 361 serious injuries and 1,809 slight injuries per year.

Forecasts for this 2004/05 sample tended to overestimate the casualty impact of schemes by an average factor of about 1.6. The forecast rate of return for the 2007/08 programme was, on average, slightly lower (about 10% less) than the forecast for the 2004/05 programme.

1 INTRODUCTION

The 2000 national road safety strategy includes road casualty reduction targets (DETR, 2000). The current targets are set to expire in 2010 and preparation is underway to set new targets and updated priorities for reducing casualties. This report is aimed primarily at examining the economic performance of safety engineering interventions on English non-trunk roads. The overall objective of the project is to increase knowledge to enable future decisions to be made with a sound evidence base.

This report does not identify specific highway authorities and is not aimed at delivering conclusions on the performance of any authority. Similarly, it does not constitute good practice guidance about the optimal utilisation of engineering-related safety interventions and funding.

The report considers a large sample of road safety expenditure based on a representative spread of local authorities to take account of:

- rural and urban roads;
- geographical spread across all Government Office Regions (excluding London); and
- different authority status (county, metropolitan, unitary).

1.1 Background

Local authorities are responsible for prioritising how funding is directed towards road safety problems. Local authorities deliver the bulk of engineering interventions via funding provided mainly through Local Transport Plan (LTP) allocations. Historically, the identification of 'road safety' projects was a relatively routine task. More recently a large variety of engineering projects can be developed that contribute to the achievement of road safety alongside other policy objectives. This is evidence of local authorities' efforts to achieve joined-up policy making. However, the spread of integrated projects makes it difficult to fully disaggregate information on rates of return for road safety goals. This report covers projects that are primarily instigated to solve a specific road safety problem.

1.2 Specific project objectives

The Department for Transport's specific objectives for this project were to contribute to establishing the level of future resources for local safety highway engineering schemes and their potential contribution to the post-2010 road safety strategy by:

- collecting comprehensive information about the capital costs and actual casualty impacts of local safety schemes implemented in one recent year (2004/05) from a sample of local authorities;
- incorporating the effect of site selection bias (‘regression to the mean’) in an assessment of the impact of local safety schemes;
- estimating the extent of collision migration (collisions happening elsewhere once some locations have been treated) and collision displacement due to traffic re-routing (extra crashes on routes where there is extra traffic due to schemes) for the scheme types most likely to be affected the most by them;
- incorporating the effect of maintenance, preparation and other resource costs within an assessment of the costs and impacts of one year’s local safety scheme programme in a sample of authorities; and
- checking for recent changes in effectiveness by comparing the most recently implemented annual programme with an earlier programme whose actual impacts can be evaluated in a sample of local authorities.

1.3 Definitions

Local safety schemes are normally reported by First Year Rate of Return (FYRR). The basic equation used is:

$$\text{FYRR}(\%) = 100 \times \left(\frac{\text{Annual monetary safety saving}}{\text{scheme cost}} \right)$$

A scheme that costs £100,000 and delivers £100,000 of monetarised casualty savings in the first year alone would have a 100% FYRR.

In this report several types of FYRR have been calculated. To make discussion of these clearer, the terms and definitions listed in Table 1.1 will be used. In the table, the difference between each FYRR type and the top row is shown in bold text.

Generally, local authorities calculate the FYRR of local safety schemes using the approach in Table 1.1 entitled ‘FYRR AVE SEVERITY’ (explained in Table 1.1). When calculating the value of collisions or casualties, an average (weighted) monetarised value is used – this is in contrast to using different values for different severities of collisions/casualties. In this report, where small numbers of collisions/casualties have been analysed, the average severity monetary values have been used. Where larger sample sizes have been analysed, such as at the road type or authority type level, different monetary values have been used for the different severities of the collisions/casualties (values given in Tables 2.1 and 2.2).

Table 1.1: FYRR definitions for 2004/05 schemes			
FYRR type	**Source of casualty/collision numbers**	**Monetary values used to calculate collision/casualty savings**	**Scheme costs**
FYRR AVE SEVERITY (generally used by local highway authorities (LHAs) currently)	Three years before scheme completion and three years after scheme completion	Average severity monetary values as given by the bottom row of Tables 2.1 and 2.2, as appropriate	Construction costs
FYRR ACTUAL SEVERITY	Three years before scheme completion and three years after scheme completion	**True severity monetary values from upper rows of Tables 2.1 and 2.2, as appropriate. Note, if the casualty/collision saving was predicted as a percentage by the LHA, it was assumed that the savings would be equally applied across all severities**	Construction costs
FYRR PREDICTED	**The 'after' casualty/collision figures come from the LHAs' predicted reductions**	Average severity monetary values as given by the bottom row of Tables 2.1 and 2.2, as appropriate.	Construction costs
FYRR TOT COST	Three years before scheme completion and three years after scheme completion	Average severity monetary values as given by the bottom row of Tables 2.1 and 2.2, as appropriate	**Total costs (construction costs plus any additional implementation costs)**
FYRR TIME A	**Six years before scheme completion and three years after scheme completion**	Average severity monetary values as given by the bottom row of Tables 2.1 and 2.2, as appropriate	Construction costs
FYRR TIME B	**Four to six years before scheme completion and three years after scheme completion**	Average severity monetary values as given by the bottom row of Tables 2.1 and 2.2, as appropriate.	Construction costs
FYRR AVE SEVERITY (Do Something)	Three years before scheme completion and three years after scheme completion	**Using average severity values, the value of savings is reduced to take account of the trend reduction in the national numbers of collisions/casualties to take account of savings that would have occurred in the 'do nothin' scenario**	Construction costs

2 METHODOLOGY

A number of main tasks were used to set a framework of activity. These are described below.

2.1 Task 1 – establish the team

Three main teams were developed to deliver this work within the required timescale. Staff with experience of casualty reduction engineering schemes in Atkins' Manchester, Bristol and Epsom offices were identified, with staff in Birmingham offering assistance to Bristol once it became clear that a number of consultee highway authorities were geographically closer to Birmingham than Bristol.

2.2 Task 2 – identify suitable authorities

A list was compiled containing Local Transport Plan (LTP) areas, Government Office Region, authority type and spending on safety schemes. This was sorted so the highest spenders were at the top, decreasing to the lowest spenders at the bottom in order to select those authorities that would be able to provide sufficient overall data, deemed to be at least 20% of total English expenditure on road safety. Expenditure data were retrieved from Atkins' project archives through our involvement in assessment of LTPs.

Certain authorities were then removed from the list of candidates because those local authorities were already involved in other road safety projects with the Department for Transport. No Greater London authorities were included at the Department for Transport's request.

Highways Authorities whom Atkins had existing relationships with were prioritised as ones to include because these authorities were thought to be possibly the most willing to provide data.

For efficient use of resources and in order to obtain a national spread of data, it was decided that the required number of authorities (around the 25 number indicated in the Department for Transport's specification) were to be selected regionally along the following lines: seven local authorities were to be selected from the South West and West Midlands regions and were to be visited from the Bristol/Birmingham office, seven from the South East, East Midlands and East regions, which would be visited by the Epsom office, and 11 from the North East, North West and Yorkshire and Humberside regions to be visited by staff from the Manchester office. The top spenders from each of these groupings were then selected, ensuring a mix of metropolitan, unitary and county authorities.

For grouped authorities, the local authority with the highest population was considered most appropriate to be approached to represent each of the groups, i.e. Manchester for data from Greater Manchester, Liverpool for Merseyside and Leeds for West Yorkshire. The sifted final selection list contained, notionally, around 40% of the total spend on safety schemes for 2004/05 (the designated year) and had a good national spread and mixes of different types of authority. This process was aimed at de-risking the project so that a minimum spend level of 20% could hopefully be achieved or surpassed.

The selection method made no adjustment for previous performance against defined success indicators.

The Department for Transport then approached the identified authorities asking for cooperation in performing this study. Some authorities declined to participate and some did not reply. A small number of supplementary authorities were approached at a later date to bolster the sample size. Again some declined or did not reply. As the study progressed, a small number of authorities withdrew or failed to meet the deadline for return of data. The final number of authorities, including the component parts of metropolitan areas, that returned fully usable or partially usable data was 22.

The Department for Transport had requested that the programmes analysed were to be equivalent to at least 20% of the national spend on local safety schemes. The smaller number of returns than expected and other effects meant that the total expenditure of the schemes was below the expected 20%.

2.3 Task 3 – designing the data sheet

A sample data sheet used for this project is given in Appendix 3. This data sheet was used throughout to ensure consistency of approach. Time constraints meant that the assessment of the data sheet ahead of circulation to local authorities was limited to independent internal testing and client comments. The data sheet was designed to exclude automatic calculations of First Year Rate of Return (FYRR) and to avoid compulsion in the completion of all fields so as to maximise flexibility of use by local authorities. The data sheet was also designed to be easy to check by Atkins' staff for internally inconsistent data being submitted. The data sheet included notes for guidance, and a series of answers to frequently asked questions was developed to aid completion. The data sheets were required for full safety programmes, not a selection of projects for each authority. For each 2004/05 Safety Engineering Project, the data sheet contains information fields (for completion) on the following issues:

- three years after (ensuring construction phase is avoided) collision/casualty data;*
- three years before collision/casualty data;*

- collision/casualty data* for three years before scheme identification (with 1997–99 to be used as a default period);
- implementation costs (including site supervision and/or detailed design); and
- the casualty/collision saving forecast prior to implementation.

  (*Only collision or casualty data, not both, were to be submitted, consistent with the differing existing practices at each authority.)

Schemes were classified by type following a standard typology agreed with the Department for Transport and the data sheet adopted pull down menus for scheme typology, road classification and whether the scheme involved a school-related improvement. The data sheets also required similar information related to each 2007/08 safety project, with the exception that no 'after' data were required.

An additional sheet contained information fields on the overall road safety programme, on how schemes were chosen to enter the programmes and what costs there were in running the programme. This sheet also contained a section where any additional comments could be made.

2.4 Task 4 – meetings with participating local authorities

Atkins' staff sent the blank data sheets to the local authorities selected to participate and arranged an initial meeting. The purpose of the meetings was to:

- understand the process for scheme selection of local authorities;
- answer questions about the project and the processes to be followed;
- reassure participants that individual local highway authority (LHA) performance was not being assessed;
- record differences in approach to casualty reduction, scheme selection and prioritisation;
- offer assistance in carrying out the necessary work;
- understand what existing information might be available on collision migration and displacement; and
- gather qualitative information about the effectiveness of scheme types, risks and opportunities now and in the future

Informal notes were taken at the meetings which were used to help develop Section 3 of this report.

2.5 Task 5 – data gathering and verification

None of the selected authorities asked the project team to carry out a significant element of the work required to complete the data sheets. However, a small number asked, and funded, independent Atkins' staff (through existing Highway Services commissions) to participate as part of their 'day to day' duties.

Owing to the fact that the data sheets specifically required data to be submitted in a different way to that often routinely adopted, a number of queries were raised throughout the process, not least the desirability of distinguishing severity information when many schemes have been historically justified on the basis of total numbers of casualties or collisions. As discussed in Section 3, some authorities give initial weighting in prioritisation of scheme identification to any existing high severity ratios. However, in creating a subsequent local business case to proceed with a scheme, it is common practice that collision/casualty monetary and numerical savings are often based on average values, as at that stage in the process the rate of return has been defined as 'high' and detailed refinement of assessment is often considered unnecessary.

Once initial responses were received, Atkins verified the accuracy of returns using a standardised predefined process to ensure consistency of approach. The verification process was carried out by staff local to the selected authority so as to maintain relationships and understanding that was built up at the initial meetings.

Significant resource and effort were required to work with the local authorities to rectify omissions and errors. Additionally, some authorities requested that Atkins derived the required economic rates of return using the input data they had provided.

Some authorities supplied data for only 2004/05 and not both years due to time and resource constraints. This was considered acceptable as the data for both years' programmes were not inter-related.

2.6 Task 6 – data analysis

The initial data sheet was developed further to offer automatic numerical calculation of a number of additional results using the verified data supplied by authorities. The subsequent analysis was undertaken by pooling the individual verified returns.

FYRR data were summarised on a number of levels: by authority type, road type (built-up, non-built-up and motorway), scheme type and by capital scheme cost range (e.g. less than £10,000, £10,000–50,000, £50,000–100,000, £100,000–200,000 and greater than £200,000).

The casualty savings impact was studied by scheme type in order to determine which schemes saved the most casualties, broken down into built-up and non-built-up areas to assess whether different schemes work better in different settings. Chi-squared analysis was used to determine whether the change in collisions at a treated site or group of sites was likely to have occurred by chance**.**

When producing the scatter graphs in Appendix 2, schemes with negative rates of return were set at 'zero' return as FYRR formulae do not have any meaning when dealing with negative values. All negative schemes were included in summation analyses (unless stated otherwise), for example when assessing the rate of return for a particular programme of schemes by summing the cost and benefits of a number of schemes.

The FYRR for large programmes only (FYRR ACT SEVERITY) was then re-based by using **actual** monetary values of collisions and casualties to scope how much difference results from using average costs compared with true severity costs. The costs used when calculating the valuation of collisions and casualties are from *Highways Economic Note No. 1* (HEN1) for 2004 (published in December 2005 (Department for Transport, 2005a)) and these are given in Tables 2.1 and 2.2. Similar tables are given for 2007 (Tables 2.3 and 2.4) for use with Section 5 of this report.

Table 2.1: Value of casualties, 2004

Severity	Cost (£)
Slight	11,991
Serious	155,563
Fatal	1,384,463
Average*	43,649

* 'Average' is the term used in annual national collision statistics although it is in fact a weighted average that takes account of the proportions of different severities

Table 2.2: Value of collisions, 2004

Severity	Cost (£)		
	Built-up road	Non-built-up road	Motorway*
Slight	17,440	20,740	24,480
Serious	174,900	201,080	206,830
Fatal	1,507,210	1,619,650	1,625,830
Average (injury only)	48,300	102,260	68,840

* Not subsequently required as no motorway schemes were submitted.

The details of the schemes with the highest decile of actual FYRRs, schemes with an FYRR of less than 100% and those with an FYRR less than zero were identified in order to determine any common factors contributing to the best and worst scheme performances. The predicted FYRR was compared with the actual FYRR for all schemes in order to determine the accuracy of predictions. The FYRR PREDICTED was compared with FYRR AVE SEVERITY, broken down into road type, scheme type and scheme construction cost to find out whether any factors produced the greater differences between FYRR PREDICTED and FYRR AVE SEVERITY.

Table 2.3: Value of casualties, 2007	
Severity	**Cost (£)**
Slight	14,280
Serious	185,220
Fatal	1,648,390
Average*	52,850

* 'Average' is the term used in annual national collision statistics although it is in fact a weighted average that takes account of the proportions of different severities

Table 2.4: Value of collisions, 2007			
Severity	**Cost (£)**		
	Built-up road	Non-built-up road	Motorway*
Slight	21,000	24,750	29,490
Serious	207,120	231,110	235,690
Fatal	1,769,900	1,930,740	2,145,280
Average (injury only)	59,240	121,420	91,930

* Not subsequently required as no motorway schemes were submitted.

Further analysis recalculated FYRR using the casualty/collision data for the six years before the scheme was opened to understand the possible effects of regression to the mean (FYRR TIME A). The FYRR was also recalculated using casualty savings from the fourth to sixth year (FYRR TIME B) before the scheme was opened to identify any difference from the original FYRR. This was done to attempt to find scheme typologies that are most prone to any time-based variance.

The FYRR was again recalculated, this time adding the ancillary costs to the headline scheme construction costs to assess whether there is a substantial effect on the FYRR when other costs are included (FYRR TOT COST). Scheme cost data were examined to determine which ancillary costs add the most cost onto a scheme and which add the least. Not all authorities were able to provide data on these aspects. The findings were not extended to the remaining schemes where additional cost data were unavailable.

The programme data sheet was completed by 21 of the 22 authorities, allowing a qualitative analysis to be undertaken. For 2007/08 predictions, only 16 authorities returned data. For 2007/08 predictions, a global comparison was made to the 2004/05 predictions and actual FYRR data to ascertain possible projected changes in FYRR trend. For authorities that returned data for both years, scheme typologies were also compared.

3 QUALITATIVE FINDINGS

3.1 Meeting feedback

As part of the process of engaging the participation of a number of local highway authorities (LHAs) in this project, a series of meetings was held between various representatives from Atkins' regional offices and the relevant road safety engineering personnel from individual LHAs within a reasonable catchment area of each Atkins office. These meetings, although initially intended to act as simply an introduction between Atkins as Department for Transport representatives and the potential participating authority, and to discuss any problems that there might be in obtaining or disseminating the data required, also gave an interesting insight into the range of approaches and local conditions which affected the manner in which each authority conducted its road safety engineering. The following paragraphs summarise the broad findings, grouped under broad headings that were used in the agenda for the meetings

3.1.1 Performance

Most LHAs were able to demonstrate that they were either on-target with respect to the National Casualty Reduction targets or, in some instances, well ahead of them, with sometimes ambitious local targets also being exceeded. However, there were some challenges which varied across the selection of authorities, the main ones being no apparent decline in fatalities despite a drop in KSI, a high proportion of fatalities and KSI being accounted for in rural areas, and no apparent decline in fatalities and KSI among some groups of vulnerable road users, particularly motorcyclists and cyclists.

Some LHAs had problems with good years followed by bad years, which resulted in over-anticipation of meeting targets followed by failure to meet subsequent milestones. This applied particularly to categories of casualty where there were only small numbers locally and so, for these, statistical fluctuation could be very prominent.

Most LHAs are aware of the need to work in partnership, but there are many different approaches being tried. Road Safety Forums are in operation in some, but their effectiveness is still being evaluated. More prevalent are Road Safety Partnerships (RSPs) which have been developed from the previous Safety Camera Partnerships.

3.1.2 Prioritisation

The methods used to identify and then prioritise sites for road safety interventions varied considerably. The variation depended on the sophistication of the software used and on the level of expertise available in analysing the data. Some authorities now employ qualified statisticians for this purpose – this being most common where an RSP gives access to a shared staff resource.

At the lowest level, i.e. where specific localised cluster sites could not be identified easily, some authorities used criteria such as 'x' number of collisions within 'y' radius or, in cases where route treatment predominated, 'x' collisions along defined sections of major routes. At a more advanced level, individual sites could be identified, including weighting for various road users or collision types.

Prioritisation was usually dictated by the estimated FYRR, although in the majority of LHAs additional criteria were also used, such as weighting by collision severity or environmental concerns. The minimum FYRR for qualifying schemes varied, but was generally in the region of 100%, although in a number of authorities this can be as high as 250%.[6] In one authority, the FYRR was not used at all in site prioritisation, the programme being determined by community need, local knowledge and requests from the public. Some authorities divest prioritisation down to an area level. There was no evidence that projects that potentially delivered long-term repeat benefits were given any weighting in the process. This means that two different projects with projected FYRRs of 100%, but with differing probabilities for repeating early years' benefits, would not be formally differentiated.

3.1.3 *Funding*

The allocation of funds across the range of road safety activities was usually predetermined, with engineering schemes being funded through the capital programme stemming from the Local Transport Plan (LTP) and Education, Training and Publicity (ETP) activities being funded via the revenue budget. Most authorities have a large programme of schemes with an outstanding list of projects which are regularly carried over to be considered for implementation in subsequent years. However, if this list is then added to with new schemes, this can result in a delay of some years for some schemes with good but slightly lower FYRR. Authorities claim that they could spend extra funding. It was claimed that the level of funding across England does not seem to be in proportion to the level of collisions, population or traffic levels, with some authorities claiming to be hard pressed for finance while others appear relatively content.

Some authorities reported preparing small value easy-delivery schemes that could be quickly mobilised and delivered as the end of a financial year approaches. This tactic is used particularly within programmes that are heavily reliant on public consultation or on legal processes where delays could be more likely.

6 It is understood that this may be related to informal advice given by the then Department of Transport in the 1990s.

In some authorities there is an overlap between Local Safety Schemes (LSS) that are specifically for casualty reduction and other traffic management and community-led schemes which may have an element of casualty reduction. This often results in the allocation of funds becoming blurred, with schemes not justified entirely on a casualty reduction basis gaining funding, sometimes at the expense of true LSS.

Some authorities explained that some scheme types had significant ongoing maintenance costs (e.g. high friction surfacing), but that these extra costs were not accounted for when deciding priorities. This omission is consistent with the lack of whole life assessments reported in the last paragraph of Section 3.1.2.

3.1.4 Education, training and publicity (ETP)

Although ETP activities are funded predominantly in a separate manner, very often they are allied to physical engineering schemes, particularly where Safer Routes to School schemes and other community-led projects are being applied. How resources are applied in these instances depends very much on the organisation of the LHA.

The targeting of ETP at specific road-user groups is not widespread. Many authorities rely on anecdotal evidence for developing their ETP programme, with usually minor modifications of past practice.

Many local authorities have developed some cross-working relationships between ETP and engineering with input from the emergency services and other stakeholders, including via RSPs. This has included the development of other activities such as speed and driver awareness courses, and has been successful in obtaining additional funding from the Department for Transport. One LHA reported that the road safety culture which had been developed as a result of a previous Department for Transport demonstration project had assisted greatly in publicising road safety problems, with both engineering and ETP work gaining greater acceptance.

3.1.5 Future development

Some authorities are now already experiencing difficulty in finding sufficient new sites which satisfy the past criteria in terms of number of collisions or FYRR. Many are switching from predominantly site-specific schemes to area- or route-based work, but with the realisation that cost effectiveness could reduce.

Most authorities are looking to introduce innovative measures, but often find that there were problems, for example 20 mph speed limits which are viewed by the police as difficult to enforce.

Some authorities are attempting to combine local safety schemes with ETP measures but find there is a lack of guidance in this area and would like a greater lead from the Department for Transport on developing methods of 'joined-up' thinking. LHAs were conscious of the need for a holistic approach, but wanted more guidance on how this was to be accomplished.

Local government reorganisation has created some uncertainty over the future with regard to the availability of data and the organisational structure of new authorities. Some existing authorities are currently going through internal restructuring, with all road safety activities being housed together for the first time.

3.2 Programme data from questionnaires

Four out of the twenty-two authorities solely use FYRR as the basis for selecting schemes. One did not respond to this question and the others used a combination of the following factors (the number of authorities using each factor is given in brackets):

- severity ratio and number/cluster of collisions or casualties (10);
- political pressure or public/councillor request (4);
- meeting other LTP objectives (3);
- potential for developer funding (2);
- scheme cost (2);
- treatability of collisions (2);
- vulnerable road users (1);
- local knowledge (1);
- police and coroner input (1);
- maintenance engineer input (1);
- perceived danger (1);
- improvements for walking and cycling environment (1);
- presence of schools (1);
- casualty/collision rates compared with the national average (1); and
- casualty per kilometre (weighted by severity) (1).

One authority reported that, in years where funding is not constrained, no formal method of prioritisation is used. Another stated that the prospective FYRR is not used to identify suitable schemes, but, instead, it is used as a benchmark to determine the maximum amount of money that can be spent on the scheme. This concept is based on assuming that a scheme will deliver equivalent returns to those quoted in research databases rather than evaluating likely returns from first principles.

When asked whether there was a cut-off FYRR for **investigation**, the lowest minimum cut-off was 1% and the highest minimum cut-off was 100%. One authority reported that they did not have sufficient resources for preliminary investigation. Nine responded ‘not applicable’.

The typical minimum FYRR for **entry** into the programme ranged from 1% to 250%. Other factors were used by some authorities, such as the occurrence of four collisions in an 80 m radius. One authority has a minimum FYRR for the programme as a whole, so among individual schemes there was flexibility.

Sixteen authorities reported using average monetary values for casualties/collisions when calculating savings, two used true severity values.

Two authorities use five years’ worth of data when examining the collision/casualty record for trends in the data as opposed to the norm of three years.

4 2004/05 PROGRAMME – CONSTRUCTION COSTS, SCHEME TYPES, CASUALTY/ COLLISION REDUCTIONS

4.1 Size of programme and types of scheme

The average construction cost of a scheme from this dataset was £40,794. Table 4.1 shows that, on average, county authorities spent less than this per scheme, whereas metropolitan authorities spent significantly more. Gorell and Tootill (2001), from analysis of the MOLASSES database, found the average scheme cost to be £23,409 for all schemes; this is significantly less than the spending by authorities in this dataset, although the cost per scheme will also have been affected by inflation.

Another interesting finding from Gorell and Tootill's work is that the average cost for recent schemes was lower than the average for all schemes, leading them to the conclusion that authorities were becoming more efficient or smaller schemes were being implemented. The results from our latest study seem to contradict this finding, but it has to be remembered that MOLASSES is a selective database which may be unintentionally biased to show the most effective schemes, which could also be the lower cost ones.

Table 4.1: Spending by authority type

Authority type	Average scheme construction cost (£)	Total spend on construction in sample (£)	Total spend* (including additional implementation costs) (£)
Metropolitans	100,451	6,629,778	7,724,631
Unitaries	45,642	1,551,813	1,685,315
Counties	27,169	8,368,176	9,516,363
All	40,794	16,549,767	18,926,309

* Note, only a portion of returns included information on additional costs.

The most expensive scheme was £1,143,000 and the lowest cost scheme was £600. Figure 4.1 shows that most schemes (77%) cost less than £50,000 and the number of schemes in each cost bracket decreased as the cost increased. This pattern was followed for schemes on non-built-up roads, however schemes implemented on built-up roads were most commonly in the £10,000 to £50,000 cost bracket. The most common cost bracket for schemes implemented by unitary and county authorities is £10,000 to £50,000, whereas for schemes implemented by metropolitan authorities the most common cost bracket is higher, at £50,000 to £100,000.

Collectively these schemes cost about £16.6 million to construct, which is about 15% of the local safety schemes expenditure by local authorities in England (outside London) recorded for 2004/05. It was expected that these schemes would have a total value of £23.5 million. The reasons for the discrepancy were not researched on a case-by-case basis, but some authorities explained that:

- data were not universally kept for all schemes; and
- some safety funding was allocated to other schemes that were likely to deliver safety benefits but whose business case was not based on other safety benefits.

A more thorough understanding of the apparent gap in funding and expenditure on safety projects would require an audit type of investigation and this was outside the scope and nature of this project.

Results from groups of a few schemes (up to 10) are shown in some of the tables in this section and following sections. Results for these small groups of schemes must be treated with extreme caution.

Figure 4.1: Scheme construction cost distribution

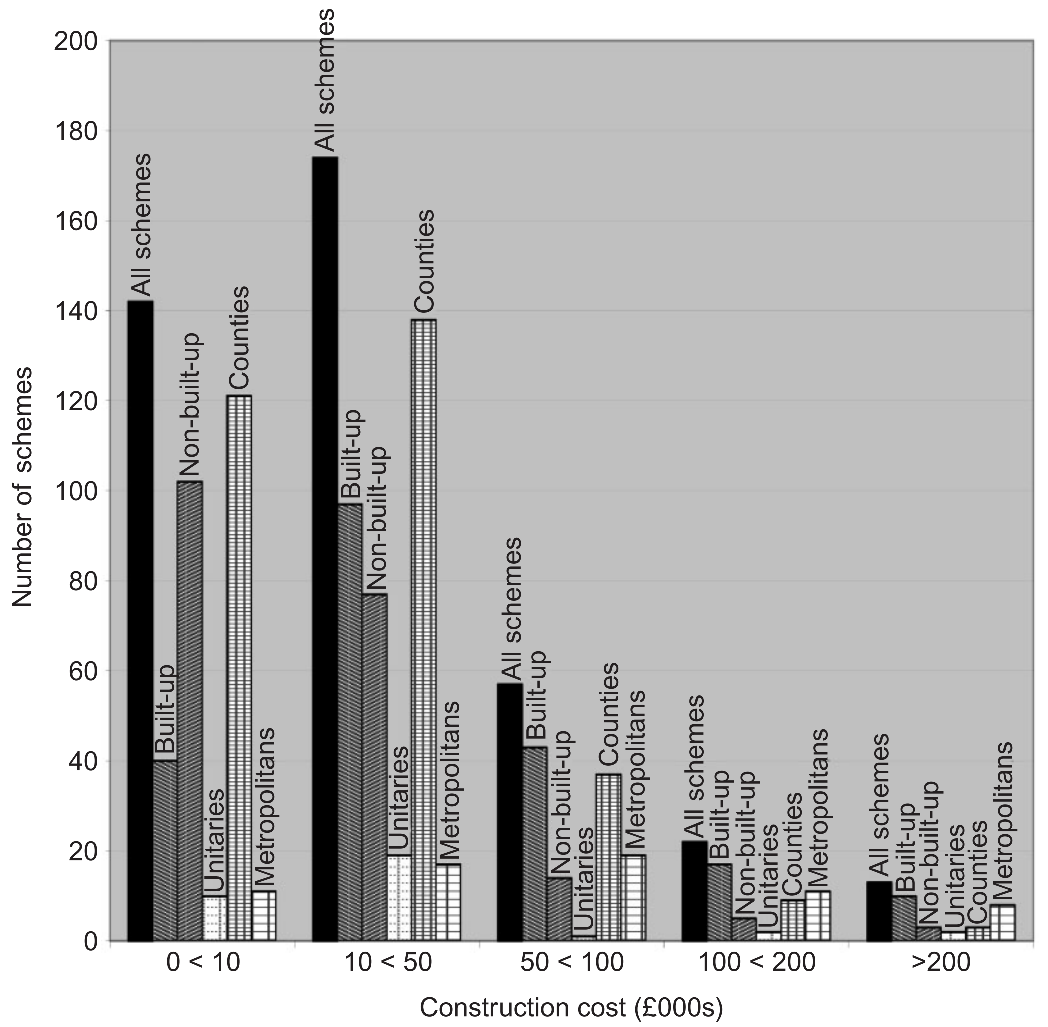


Table 4.2: Type of schemes implemented in 2004/05

Scheme type	Number of schemes
Traffic calming	**55**
20 mph zones (i.e. with traffic calming)	25
Traffic calming with vertical deflections (not in a 20 mph zone)	21
Other traffic calming (i.e. traffic calming with horizontal deflections not in a 20 mph zone)	8
20 mph limit without significant physical traffic calming	1
Single site or single stretch of route	**275**
Signing, lining or surfacing at a single junction	81
Signalisation	12
Pedestrian facilities at a single site	33
Change of junction type, e.g. T-junction to mini roundabout	5
Cycle facilities	3
Other signing, lining or surfacing	88
Street lighting	5
Visibility improvement	4
Road realignment	6
Other – including mixed type	38
Route action	**41**
Speed limit reduction	1
Set of signing and lining changes along a route	22
Bend treatment	2
Other – including mixed type	16
Mass action (no sub-groups)	**31**
Other (no sub-groups)	**6**
Total	**408**

Table 4.2 shows that a total of 408 schemes were submitted in the returns by authorities for this study. Single site or single stretch of route schemes were the most popular, followed by traffic calming schemes. The most popular generic choice of scheme was single site or single stretch of route, and the most popular technique was traffic signing and lining (road markings).

4.2 Collision/casualty numbers and savings

Table 4.3 shows the actual annual collision/casualty savings[7] and the percentage saving by scheme type and road type – where there are negative values, this represents an increase.

The results show that the schemes implemented in the dataset achieved an average casualty reduction of 34.5%, an equivalent of saving 1.6 casualties per year. In terms of collisions, the savings were 47.1%, which is equivalent to 1.0 fewer collisions per year. Section 7.5 reports overall programme savings.

The casualty and collision reduction per scheme achieved was greater on built-up roads. Ignoring the scheme types with very low sample sizes, all scheme types performed well in terms of annual numbers of collisions saved. The savings are similar to those found by Gorell and Tootill (2001), which ranged between 1 and 2, apart from cycle schemes which saved 3.89.

Table 4.3: Percentage and total annual (in brackets) casualty and collision savings by scheme type and road type

Scheme type	Casualty saving per scheme			Collision saving per scheme		
	Built-up	Non-built-up	Average	Built-up	Non-built-up	Average
Traffic calming	45.9% (1.7) (*n* = 34)	-35.0% (-2.3) (*n* = 1)	36.2% (1.6) (*n* = 35)	54.3% (3.1) (*n* = 20)	(*n* = 0)	54.3% (3.1) (*n* = 20)
Single site or single stretch	34.5% (1.6) (*n* = 69)	44.7% (1.5) (*n* = 108)	39.8% (1.5) (*n* = 177)	50.9% (0.9) (*n* = 52)	48.1% (0.85) (*n* = 46)	50.5% (0.9) (*n* = 98)
Route sction	23.9% (1.3) (*n* = 21)	16.8% (2.1) (*n* = 8)	17.7% (1.9) (*n* = 29)	29.6% (1.8) (*n* = 7)	25.0% (1.0) (*n* = 5)	28.4% (1.5) (*n* = 12)
Mass sction	-16.7% (-0.5) (*n* = 2)	(*n* = 0)	-16.7% (-0.5) (*n* = 2)	52.5% (1.1) (*n* = 11)	71.3% (1.9) (*n* = 18)	66.7% (1.5) (*n* = 29)
Other	48.0% (3.5) (*n* = 3)	91.7% (3.7) (*n* = 1)	54.3% (3.6) (*n* = 4)	83.3% (1.0) (*n* = 1)	75.0% (1.7) (*n* = 1)	80.0% (1.4) (*n* = 2)
Average for all scheme types	36.8% (2.1) (*n* = 127)	33.6% (1.7) (*n* = 120)	34.5% (1.6) (*n* = 247)	43.6% (1.1) (*n* = 91)	67.5% (1.0) (*n* = 70)	47.1% (1.0) (*n* = 161)

7 See the note to the bullet list in Section 2.3 for an explanation as to why some returns were based on casualties and some on collisions. It should be noted that these returns are mutually exclusive and none of the reported analysis refers to any collision causing a certain number of casualties. Any reference relates purely to how authorities returned data.

In terms of casualties, the number saved is similar apart from mass action schemes, but there were only two schemes of this type recorded in casualties so the results may not be representative.

The KSI percentage is the ratio of the number of serious and fatal collisions or casualties divided by the total number of collisions or casualties converted to a percentage. Table 4.4 contains the KSI ratio before and after scheme implementation at the sample sites and the national average.[8]

Table 4.4: KSI ratio three years before and after scheme implementation

	Casualty			Collisions		
	KSI before	KSI after	Percentage change	KSI before	KSI after	Percentage change
Non-built-up roads	18.8% (*n* = 127)	12.1% (*n* = 127)	-35	19.8% (*n* = 67)	8.9% (*n* = 67)	-55.0
Built-up roads	13.5% (*n* = 114)	5.3% (*n* = 114)	-60.7	15.2% (*n* = 91)	9.9% (*n* = 91)	-34.9
Average KSI	16.3% (*n* = 241)	9.0% (*n* = 241)	-44.7	17.2% (*n* = 158)	9.5% (*n* = 158)	-44.8
KSI: all England roads, average 2007	12.2%			14.6%		

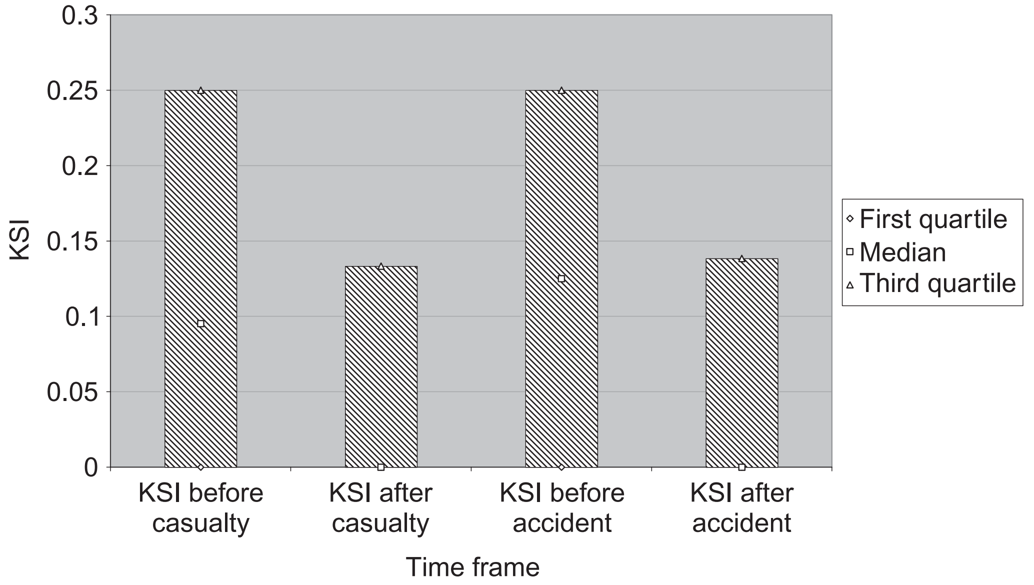
The average KSI figures show that the KSI before scheme implementation was 16.3% in terms of casualties and 17.2% in terms of collisions; this is above the 2007 figure of 12.2% for casualties and 14.6% for collisions on English roads as a whole. The figures also show the KSI was reduced to around 9% for both collision and casualty inspired projects.

However, when the figures are disaggregated by road type it is evident that schemes implemented on built-up roads have a lower ‘before’ KSI ratio than schemes on non-built-up roads. The change in KSI ratio is greatest for built-up roads when looking at casualty KSI, but for collision KSI the greatest reduction is on non-built-up roads.

From the box plots in Figure 4.2 it is evident that there were a few schemes with a 100% KSI ratio either before or after the implementation of schemes. Similarly there were schemes with only slight casualties/collisions either before or after scheme implementation.

8 The *n* values will vary between tables because not all schemes contained all information that was requested so data were not all available for all stages of analysis, for example the scheme type could have been provided but no casualty figures.

Figure 4.2: **KSI ratio box plots**



4.2.1 Chi-squared analysis

The Chi-squared test can be used to determine the likelihood of the change in the number of collisions or casualties at a treated site or group of sites occurring by chance alone. The test (as described in the Department for Transport document *Road Safety Good Practice Guide* (Barker and Baguley, 2001)) is based on a table showing 'observed' values of a set of data and the corresponding 'expected' values. The Chi-squared value is used to calculate the probability that the 'expected' and 'observed' values are drawn from the same population.

The collision and casualty data for the Local Safety Schemes analysed showed an overall reduction in the occurrence of collisions and casualties in the three years after scheme completion compared with the three-year period before improvement measures were introduced, but this trend is also apparent for England as a whole. Therefore, the Chi-squared test was used to determine the likelihood that this reduction occurred as a result of the improvement measures rather than by random fluctuation.

For the Chi-squared analysis, collision and casualty figures for England were used for comparison purposes. It should be noted that for a perfect monitoring trial, data from control sites would be entirely representative of the treated site(s) if no improvement measures have been introduced, though it is rare to find control sites that closely match the test site(s). However, using data for England as a comparison comprises a conservative approach, as this dataset will inevitably include a proportion of collision and casualty figures at treated sites that were outside this sample study. Furthermore, using a large control site combines data from many sites; hence, any fluctuations at individual sites will tend to cancel each other out, giving a more accurate overall picture.

4.2.1.1 Chi-squared test for all collisions/casualties

For the Chi-squared analysis, Local Safety Scheme collisions and casualties were analysed as separate datasets in recognition that some authorities use different methods. Tables 4.5 and 4.6 summarise and compare collision and casualty frequencies for the Local Safety Scheme dataset and also for England, for both built-up and non-built-up road types. The tables list the resultant Chi-squared value and corresponding significance level.

Table 4.5: Local Safety Schemes 2004/05 prioritised by authorities using collision sdata for all severities

	Built-up roads	Non-built-up roads	All road types
Local Safety Schemes study sample: collisions three years before scheme	672 (*n* = 91)	406 (*n* = 67)	1,078 (*n* = 158)
Local Safety Schemes study sample: collisions three years after scheme	379 (−44%)	199 (−51%)	578 (−46%)
England: collisions three years before scheme	420,457	151,740	572,197
England: collisions three years after scheme	367,205 (−13%)	138,315 (−9%)	505,520 (−12%)
Chi-squared	46.60	52.37	95.18
Significance level	0.001	0.001	0.001

Table 4.6: Local Safety Schemes 2004/05 prioritised by authorities using all casualty data for all severities

	Built-up roads	Non-built-up roads	All road types
Local Safety Schemes study sample: casualties three years before scheme	1,546 (*n* = 114)	1,889 (*n* = 127)	3,435 (*n* = 241)
Local Safety Schemes study sample: casualties three years after scheme	1,000 (−35%)	1,285 (−32%)	2,285 (−33%)
England: casualties three years before scheme	541,116	195,219	736,335
England: casualties three years after scheme	474,749 (−12%)	177,005 (−9%)	651,754 (−11%)
Chi-squared	56.42	62.77	111.98
Significance level	0.001	0.001	0.001

The 5% (0.05) significance level is generally accepted as the level at which remedial actions have been demonstrated to have been effective, although the 10% level (0.10) can be regarded as an indication of an effect. For values in excess of the 10% level, there is a lower level of confidence that the 'after' results are linked to the remedial action taken.

Based on the sample of sites in the dataset, the analysis shows that the likelihood of the overall reduction in collision and casualty numbers being due to random fluctuation is only 0.1%. **This demonstrates that there is a high probability that a real decrease in collision and casualty numbers has occurred overall at these sites due to the implementation of improvement schemes. This conclusion applies to both built-up and non-built-up road types.**

4.2.1.2 Chi-squared test for KSI collisions/casualties

A similar analysis has been carried out to determine whether there has been a change in the number of KSI collisions and casualties at the Local Safety Scheme sites. Tables 4.7 and 4.8 summarise and compare KSI (i.e. fatal and serious) collision and casualty frequencies for the Local Safety Schemes and for England, for both built-up and non-built-up road types. The tables list the resultant Chi-squared value and corresponding significance level.

Table 4.7: Local Safety Schemes 2004/05 prioritised by authorities using collision data – KSI collisions only

	Built-up roads	Non-built-up roads	All road types
Local Safety Schemes study sample: KSI collisions three years before scheme	104 (*n* = 47)	76 (*n* = 40)	180 (*n* = 87)
Local Safety Schemes study sample: KSI collisions three years after scheme	53 (–49%)	28 (–63%)	81 (–55%)
England: KSI collisions three years before scheme	54,065	29,195	83,260
England: KSI collisions three years after scheme	47,150 (–13%)	25,055 (–14%)	72,205 (–13%)
Chi-squared	9.85	14.73	24.26
Significance level	0.010	0.001	0.001

Table 4.8: Local Safety Schemes 2004/05 prioritised by authorities using casualty data – KSI casualties only			
	Built-up roads	**Non-built-up roads**	**All road types**
Local Safety Schemes study sample: KSI casualties three years before scheme	166 (*n* = 63)	336 (*n* = 80)	502 (*n* = 143)
Local Safety Schemes study sample: KSI casualties three years after scheme	87 (–48%)	209 (–38%)	296 (–41%)
England: KSI casualties three years before scheme	59,288	33,114	92,402
England: KSI casualties three years after scheme	51,101 (–14%)	27,775 (–16%)	78,876 (–15%)
Chi-squared	13.91	11.21	25.30
Significance level	0.001	0.001	0.001

The analysis of this dataset shows that, for the small dataset comprising collisions, the overall reduction in the KSI collision numbers at the Local Safety Scheme sites due to random fluctuation is 1% for built-up roads and 0.1% for non-built-up roads. For both road types combined, the significance level is 0.1%, which suggests it is very likely that the overall reduction in the KSI collision numbers at the Local Safety Scheme sites can be attributed to the improvement measures.

For the dataset comprising casualties, the likelihood of the overall reduction in the KSI casualty numbers at the Local Safety Scheme sites being due to random fluctuation is only 0.1% for both built-up roads and non-built-up roads. This demonstrates that there is a high probability that a real decrease in KSI casualty numbers has occurred overall at these sites due to the implementation of improvement schemes.

It can be concluded that for both non-built-up and built-up sites, it is very likely that a real decrease in the rate of fatal and serious collisions and casualties has been achieved at Local Safety Scheme sites due to the implementation of improvement measures.

4.2.1.3 Chi-squared test for fatal collisions/casualties

A further Chi-squared analysis has been carried out to determine whether there has been a change in the rate of occurrence of fatal collisions and casualties at the Local Safety Scheme sites. Tables 4.9 and 4.10 summarise and compare fatal collision and casualty frequencies for the Local Safety Schemes and for England, for both built-up and non-built-up road types. The tables list the resultant Chi-squared value and corresponding significance level.

Table 4.9: Local Safety Schemes 2004/05 prioritised by authorities using collision data – fatal collisions only			
	Built-up roads	**Non-built-up roads**	**All road types**
Local Safety Schemes study sample: fatal collisions three years before scheme	12 (*n* = 8)	22 (*n* = 16)	34 (*n* = 24)
Local Safety Schemes study sample: fatal collisions three years after scheme	2 (–83%)	3 (–86%)	5 (–85%)
England: fatal collisions three years before scheme	3,470	4,548	8,018
England: fatal collisions three years after scheme	3,154 (–9%)	4,135 (–9%)	7,289 (–9%)
Chi-squared	4.96	11.30	17.52
Significance level	0.050	0.001	0.001

Table 4.10: Local Safety Schemes 2004/05 prioritised by authorities using casualty data – fatal casualties only			
	Built-up roads	**Non-built-up roads**	**All road types**
Local Safety Schemes study sample: fatal casualties three years before scheme	22 (*n* = 10)	47 (*n* = 33)	69 (*n* = 43)
Local Safety Schemes study sample: fatal casualties three years after scheme	5 (–77%)	37 (–21%)	42 (–39%)
England: fatal casualties three years before scheme	3,629	4,522	8,151
England: fatal casualties three years after scheme	3,314 (–9%)	4,096 (–9%)	7,410 (–9%)
Chi-squared	8.07	0.28	3.84
Significance level	0.010	0.900	0.050

The analysis suggests that, for the dataset comprising fatal collisions, the likelihood of the overall reduction in the fatal collision numbers at the Local Safety Scheme sites due to random fluctuation is 5% for built-up roads and 0.1% for non-built-up roads. For both road types combined, the significance level is 0.1%, which suggests it is very likely that the overall reduction in the fatal collision numbers at the Local Safety Scheme sites can be attributed to the improvement measures.

For the dataset comprising fatal casualties, the likelihood of the overall reduction in the fatal casualty numbers at the Local Safety Scheme sites being due to random fluctuation is 1% for built-up roads and 90% for non-built-up roads. For both road types combined, the significance level is 5%.

The Local Safety Scheme sample data does not provide sufficient evidence to state with an acceptable degree of confidence that a real decrease in the number of fatal casualties on non-built-up roads has occurred overall, despite casualty and collision frequencies being inter-related. Analysis of a larger dataset may offer a higher degree of confidence in this result. We note that relatively low numbers of casualties are particularly vulnerable to chance occurrences, for example a high-speed crash involving a vehicle carrying a large number of unrestrained passengers. Nevertheless, an overall reduction in total fatal casualties has been shown to be highly likely. It has also been shown that the percentage reduction in fatal crashes and casualties at treated sites is similar to that for the all injury category.

4.3 Rates of return by road type, scheme type and authority type

This section explores whether FYRR AVE SEVERITY varies for different road types, authority types and cost ranges. FYRR AVE SEVERITY for a scheme is the difference between the total number of casualties/collisions per year observed before compared with after implementation, with each casualty/crash valued using the average severity split for the relevant road type (built-up or non-built-up) divided by the construction cost.

The programme FYRR AVE SEVERITY for the whole sample is 172.9%, showing that the first year value of savings is nearly double the construction costs. Details are given in Table 4.11.

Table 4.11: FYRR AVE SEVERITY values by authority type and road type

Authority type	Programme FYRR AVE SEVERITY (including negative schemes) (%)
All metropolitans	109 (*n* = 66)
All unitaries	96 (*n* = 34)
All counties	238 (*n* = 299)
Total sample	**173 (*n* = 399)**
Non-built-up roads	338 (*n* = 194)
Built-up roads	107 (*n* = 205)

Schemes on built-up roads achieved savings equivalent to the costs of the scheme, giving an FYRR AVE SEVERITY of 107%, whereas schemes on non-built-up roads achieved savings three times greater than the scheme cost, giving an FYRR AVE SEVERITY of 338%. This is partly because there are more schemes on non-built-up roads with very high rates of return, many of which were very inexpensive to install.

Figure 4.3: FYRR AVE SEVERITY by road type

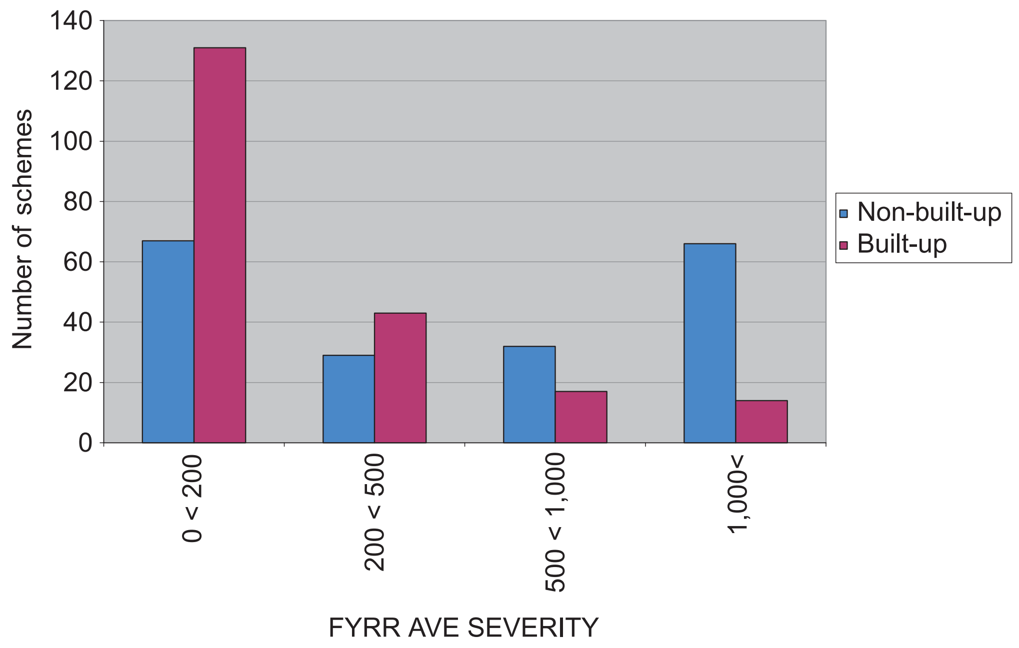


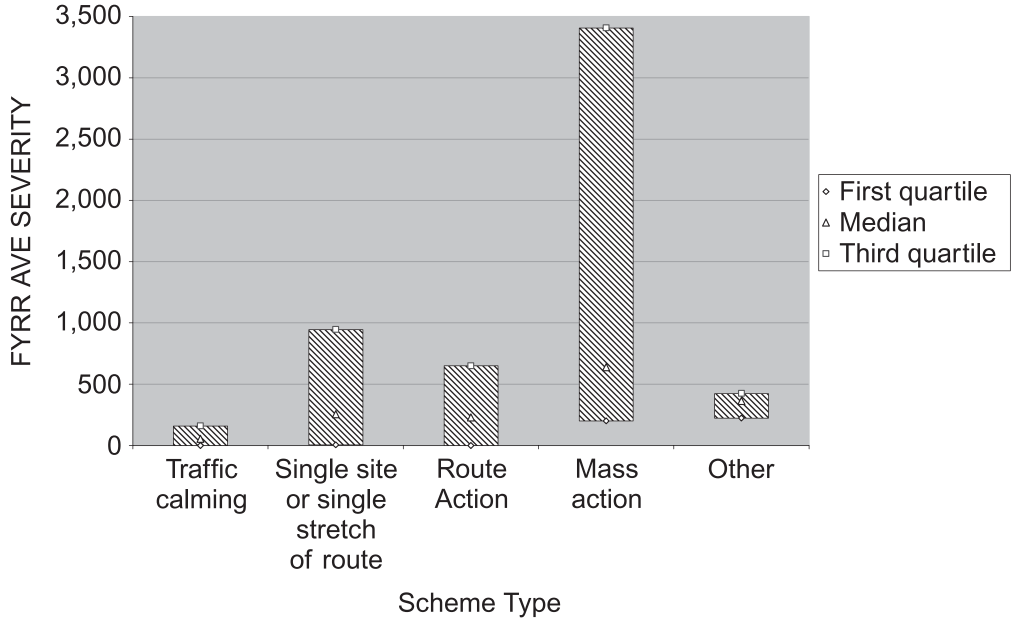
Figure 4.3 shows that schemes implemented on non-built-up roads have a more even distribution in the FYRR AVE SEVERITY values achieved than those on built-up roads. Schemes on built-up roads are more clustered around the lower FYRR AVE SEVERITY values.

Table 4.12 shows a wide range of positive results for FYRR AVE SEVERITY apart from cycle facilities (although there were only three schemes for this analysis so this result should be used with caution). This is interesting considering Gorell and Tootill's findings in 2001, which showed that, from analysis of the MOLASSES database, cycle facility schemes were the most effective, giving returns up to 444%. Gorell and Tootill also found that, out of the older schemes (monitoring completed by 1995), area-wide schemes achieved some of the lowest returns. **Their analysis of newer schemes showed that the FYRR for these schemes is improving and our analysis supports this finding.** Signing and lining changes were very effective at single sites, but less so at the route action scale.

Table 4.12: **FYRR AVE SEVERITY values by scheme type**

Scheme type	FYRR AVE SEVERITY (%)
Traffic calming	**88** (*n* = 55)
20 mph zones with traffic calming	74 (*n* = 25)
Traffic calming with vertical deflections	90 (*n* = 21)
Other traffic calming (i.e. with horizontal deflections not in a 20 mph zone)	206 (*n* = 8)
20 mph limit without significant physical traffic calming	184 (*n* = 1)
Single site or single stretch of route	**211** (*n* = 273)
Signing, lining or surfacing at a single junction	341 (*n* = 79)
Signalisation	96 (*n* = 12)
Pedestrian facilities at a single site	111 (*n* = 33)
Change of junction type, e.g. T-junction to mini roundabout	207 (*n* = 5)
Cycle facilities	-2 (*n* = 3)
Other signing, lining or surfacing	337 (*n* = 88)
Street lighting	190 (*n* = 5)
Visibility improvement	536 (*n* = 4)
Road realignment	137 (*n* = 6)
Other – including mixed type	234 (*n* = 38)
Route action	**124** (*n* = 40)
Speed limit reduction	685 (*n* = 1)
Set of signing and lining changes along a route	82 (*n* = 22)
Bend treatment	896 (*n* = 2)
Other – including mixed type	1139 (*n* = 15)
Mass action	**322** (*n* = 29)
Other	**344** (*n* = 6)

Figure 4.4: **Box plot of FYRR AVE SEVERITY by scheme type**



The box plots in Figure 4.4 show that there is a large range in the FYRR AVE SEVERITY values for mass action schemes, and, to a lesser extent, for single site or single stretch of route and route schemes. Table 4.13 shows the FYRR AVE SEVERITY for different scheme construction cost values.

Table 4.13: **FYRR AVE SEVERITY values by scheme construction cost**

FYRR AVE SEVERITY	Less than £10,000	£10,000–50,000	£50,000–100,000	£100,000–200,000	More than £200,000
Average	1,247 (*n* = 141)	260 (*n* = 200)	142 (*n* = 59)	50 (*n* = 59)	6 (*n* = 15)

The highest average FYRR AVE SEVERITY was achieved by schemes costing less than or equal to £10,000, as the cost increased the FYRR AVE SEVERITY decreased rapidly. For schemes costing £50,000 to £100,000, the return reduced to 142%. For the small number of schemes costing in excess of £200,000, the FYRR is lowest at around 6%.

Further breakdown by scheme cost and scheme type together is given in Appendix 2.

5 2004/05 PROGRAMME – COMPARISON OF FORECAST AND ACTUAL SAVINGS

5.1 Relationship between forecast and actual casualty/collision impacts

The following section looks at whether there is a difference between the FYRR AVE SEVERITY and the FYRR PREDICTED, firstly comparing all schemes, then by scheme type, road type and scheme cost.

5.1.1 All schemes

The average FYRR PREDICTED for all schemes was 276% which compares to the FYRR AVE SEVERITY (for schemes which had predicted data) of 182%. The FYRR PREDICTED tends to overestimate the FYRR AVE SEVERITY by a greater amount for schemes implemented on built-up roads compared with those on non-built-up roads. The FYRR PREDICTED for all schemes recorded in terms of collisions is more accurate than for schemes recorded in terms of casualties.

Table 5.1: FYRR PREDICTED compared with FYRR AVE SEVERITY

	Casualties		Collisions		All schemes	
	FYRR PREDICTED	FYRR AVE SEVERITY	FYRR PREDICTED	FYRR AVE SEVERITY	FYRR PREDICTED	FYRR AVE SEVERITY
Built-up	258 (*n* = 99)	107 (*n* = 99)	150 (*n* = 66)	112 (*n* = 66)	225 (*n* = 165)	108 (*n* = 165)
Non-built-up	406 (*n* = 123)	295 (*n* = 123)	376 (*n* = 60)	452’ (*n* = 60)	396 (*n* = 183)	348 (*n* = 183)
All	302 (*n* = 222)	164 (*n* = 222)	223 (*n* = 127)	223 (*n* = 127)	276 (*n* = 349)	182 (*n* = 349)

Note: the figures for FYRR AVE SEVERITY are different to those in other sections because the table only includes schemes for which predicted figures were available.

5.1.2 Scheme type

Figures A2.1 to A2.6 (Appendix 2) show that across all scheme types lower returns were achieved than were predicted. Mass action schemes appeared to generate particularly optimistic predictions.

5.1.3 Road type

The graphs shown in Figures A2.7 and A2.8 (Appendix 2) show that more predictions for schemes on non-built-up roads underestimate the returns, while on built-up roads the returns are more often overestimated.

5.1.4 Scheme construction cost

Figures A2.9 to A2.13 (Appendix 2) show that as the scheme cost increases proportionally, more points are located below the y = x line, meaning more schemes achieve lower returns than predicted at the higher cost ranges.

5.1.5 Summary

In summary, the FYRR PREDICTED consistently overestimated the FYRR AVE SEVERITY actually achievable when measured in terms of casualties, whereas schemes recorded in terms of collisions showed a good correlation.

6 2004/05 PROGRAMME – IMPACTS OF EXTRA COSTS AND USE OF ACTUAL SEVERITY VALUES

6.1 Scheme construction and other costs

This section investigates the effects of including implementation costs, additional to construction costs, on the FYRR AVE SEVERITY. Only 136 schemes out of the 408 were included in this analysis due to difficulties with authorities providing the data required within the time period available to them. Schemes that had no identified additional costs were also discounted from the analysis. The additional implementation costs are due to:

- consultation;
- surveys;
- road safety audits;
- site supervision;
- detailed design;
- additional annual routine maintenance; and
- other costs.

The average scheme construction cost for this smaller dataset was £40,144; when additional costs are included, the average scheme cost was £46,149.

The average FYRR TOT COST for all schemes where a cost breakdown was available was 169% and the FYRR AVE SEVERITY for the schemes where a cost breakdown was available was 192%. On average, the additional implementation costs adds 13% to the scheme cost.

For the schemes where a cost breakdown was available, consultation costs contributed up to 50% of the total scheme cost. The schemes with consultation costs greater than 10% of the total involved traffic calming, pedestrian facilities, road realignment and signalisation. Other schemes that required consultation were the introduction of parking bays, road narrowing or speed limit reduction.

Survey costs comprised up to 10% of total costs. The schemes where these costs were 5% or more of the total were signing, lining or surfacing or signalisation on a single site or single stretch of site or traffic calming.

Site supervision costs comprised up to 20% of total costs, although for most schemes these costs were less than 12% of the total cost.

Detailed design costs could be as high as 75% of total costs. No schemes reported any additional annual maintenance costs, although it is understood that schemes such as anti-skid surfacing would incur such costs, albeit normally from different budgets. See Table 6.1 for the additional implementation costs as a percentage of the total scheme cost.

Table 6.1: Additional identified implementation costs

Cost type	Percentage of the total scheme costs (for schemes with additional costs)
Consultation costs	3.1
Survey costs	1.0
Road safety audit cost	0.01
Site supervision cost	2.8
Detailed design costs	15.5
Additional annual routine maintenance cost	0.0

6.2 Average collision/casualty severity

Table 6.2 reports the differences in FYRR AVE SEVERITY and FYRR ACTUAL SEVERITY across different road types and authority types. Individual results for the former are recorded for the participant authorities in Table A2.1 in Appendix 2.

Table 6.2: FYRR ACTUAL SEVERITY and FYRR AVE SEVERITY by authority type and road type

Authority type	Programme FYRR AVE SEVERITY (including negative schemes) (%)	Programme FYRR ACTUAL SEVERITY (including negative schemes) (%)
All metropolitans	109 (*n* = 66)	130 (*n* = 66)
All unitaries	96 (*n* = 34)	222 (*n* = 34)
All counties	238 (*n* = 299)	429 (*n* = 299)
Total sample	**173 (*n* = 399)**	**294 (*n* = 399)**
Non-built-up roads	338 (*n* = 194)	552 (*n* = 194)
Built-up roads	107 (*n* = 205)	184 (*n* = 205)

Table 6.2 shows that:

- **for all authority types the use of actual severity values increases the reportable economic return, but by differing amounts; and**
- **non-built-up roads have the highest uplift in FYRR when it is calculated using true severity values.**

Table A2.1 in Appendix 2 shows that:

- **one authority has an overall negative programme return; and**
- **there is a very wide variety of performance between peer authorities.**

7 2004/05 PROGRAMME – CONTROLLING FOR SITE SELECTION BIAS AND NATIONAL CASUALTY REDUCTIONS

7.1 The effect of national casualty reductions

As national collision numbers have been falling it would be expected that some of the casualty reductions at treated sites would have occurred with no specific action due to advances in vehicle technology and other national changes. Section 4.2.1 reported the statistical significance of national trends against implemented programmes. This section now compares the effect on FYRR by taking account of the proportion of collisions or casualties that may have occurred regardless of the designed interventions.

To calculate this change, the total value of the collision/casualty savings was reduced by the national reduction trends given in Tables 4.5 and 4.6. As there are different reductions for collisions and casualties, the FYRR AVE SEVERITY was calculated separately, therefore the figures are slightly different to the FYRR AVE SEVERITY given in Section 4.3. The 'do something' FYRR represents the reduction in FYRR AVE SEVERITY results due to the national reductions applied in the 'do nothing' local scenario.

Table 7.1: FYRR AVE SEVERITY and FYRR AVE SEVERITY (Do Something) for casualties

Road type	FYRR AVE SEVERITY (Do Something)	Actual FYRR AVE SEVERITY
All	140 (*n* = 247)	157 (*n* = 247)
Built-up	91 (*n* = 127)	104 (*n* = 127)
Non-built-up	268 (*n* = 120)	295 (*n* = 120)

Table 7.2: FYRR AVE SEVERITY and FYRR AVE SEVERITY (Do Something) for collisions

Road type	FYRR AVE SEVERITY (Do Something)	Actual FYRR AVE SEVERITY
All	177 (*n* = 161)	202 (*n* = 161)
Built-up	99 (*n* = 91)	114 (*n* = 91)
Non-built-up	375 (*n* = 70)	412 (*n* = 70)

Tables 7.1 and 7.2 show that the schemes implemented produced high rates of return even after making allowances for the national trend. The reductions in FYRR were 12% for casualties and 14% for collisions. This is also supported by the Chi-squared analysis.

7.2 The effect of using a longer pre-treatment period on the assessed effectiveness of safety engineering schemes

This section considers whether there is a difference between the FYRR AVE SEVERITY and the FYRR TIME A (six years before) and whether particular scheme types are affected differently when using different time sources of casualty/collision data. Other studies reported in the Department for Transport's *Road Safety Good Practice Guide* (Barker and Baguley, 2001) suggest that, in practice, it is believed that the regression-to-the-mean effect can overstate the effect of a treatment by 5–30%. Table 7.3 shows comparison by type of authority and road type. **The programme FYRR TIME A is 155%**.

Table 7.3: FYRR TIME A by authority type

Authority type	FYRR TIME A (%)	FYRR AVE SEVERITY (%)	Change from FYRR AVE SEVERITY to FYRR TIME A (%)
Metropolitan	114 (*n* = 66)	109 (*n* = 66)	+4
Unitary	71 (*n* = 32)	92 (*n* = 32)	−23
County	201 (*n* = 299)	238 (*n* = 299)	−16
Built-up road	105 (*n* = 203)	107 (*n* = 203)	−2
Non-built-up road	277 (*n* = 194)	338 (*n* = 194)	−18
All	155 (*n* = 397)	174 (*n* = 397)	−11

The results for FYRR TIME A are of importance as this reflects a useful scenario of considering a full six years of before data. The overall reduction is consistent with the 5–30% range anticipated.

Figures A2.14 to A2.18 in Appendix 2 show that for traffic calming and route action schemes the FYRR TIME A values are similar to the FYRR AVE SEVERITY values so there is little variation in the returns using different time periods. However, for single site or single stretch, mass action and 'other' type schemes, there is a greater number of points plotted below the y = x line, showing that the FYRR TIME A is more often lower than the FYRR AVE SEVERITY so schemes of this type may be more susceptible to the effects of regression to the mean. However, there is a large amount of variation in the data and some of the sample sizes are small.

7.3 Assessment based on an earlier pre-treatment period to control for site selection bias

This section considers whether there is a difference between the FYRR AVE SEVERITY and the FYRR TIME B (four to six years before data), and whether particular scheme types are affected differently by using different time sources of casualty/collision data. Table 7.4 shows comparison by type of authority. **The programme FYRR TIME B is 136%**.

The average results for FYRR TIME B indicate that using this time period has a greater effect than using FYRR TIME A. The difference between the FYRR AVE SEVERITY and FYRR TIME B for all schemes is within the 5–30% range. However, when this is broken down by authority type and road type, the differences for counties, unitaries and non-built-up roads are sometimes larger.

Table 7.4: FYRR TIME B by authority type

Authority type	FYRR TIME B (%)	FYRR AVE SEVERITY (%)	Change from FYRR AVE SEVERITY to FYRR TIME B (%)
Metropolitan	118 (*n* = 66)	109 (*n* = 66)	+8
Unitary	50 (*n* = 32)	92 (*n* = 32)	−46
County	118 (*n* = 303)	238 (*n* = 303)	−50
Built-up road	103 (*n* = 205)	107 (*n* = 205)	−4
Non-built-up road	220 (*n* = 196)	338 (*n* = 196)	−35
All	136 (*n* = 401)	174 (*n* = 401)	−22

Figures A2.19 to A2.23 in Appendix 2 show that, on average, route action schemes achieve higher returns when measured using the fourth to sixth year before casualty/collision data. For traffic calming, single site or single route and route action schemes, the FYRR TIME B is similar to the FYRR AVE SEVERITY, showing that these schemes are less susceptible to time-based variance in the number of collisions and casualties. Mass action and ‘other’ type schemes are more susceptible, shown where the FYRR TIME B is less than the FYRR AVE SEVERITY. However, there is a lot of variation in the data and samples sizes can be small.

7.4 Overall programme effectiveness controlling for national casualty reductions and site selection bias

This section looks at whether the implemented safety schemes had an impact on the collisions or casualties occurring in the TIME B period by comparing the change between the TIME B numbers of collisions or casualties to the numbers in the after period, relative to the national trend.

To calculate the national trend, the annual collision and casualty figures for 1999 to 2007 were researched. To make the figures consistent with the way the local authorities provided data to us (i.e. in three-year batches), the annual national figures were averaged over 1999 to 2001 and 2005 to 2007. The percentage change was then calculated. This percentage change was then applied to the TIME B collisions and casualties data received from the authorities and compared with the actual reduction at these sites (see Table 7.5).

Table 7.5: Percentage reduction in the national collision/casualty statistics

Road type	Percentage change from 1999–2001 period to 2005–07 period	
	Collisions	Casualties
All	19.0	19.0

Table 7.6: Reduction in collisions from TIME B compared with the national trend

Scheme cost	Annual total in TIME B period	Annual total that would have been achieved if nothing was done	Annual total in after period	Percentage reduction beyond national trend
Less than £10,000 (*n* = 51)	47.0	38.1	36.0	4.4
£10,000 to £50,000 (*n* = 71)	139.0	112.6	95.3	12.4
£50,000 to £100,000 (*n* = 22)	66.0	53.5	33.6	30.1
£100,000 to £200,000 (*n* = 9)	32.0	25.9	12.3	42.6
Equal to or more than £200,000 (*n* = 3)	19.7	16.0	10.0	30.2
All (*n* = 156)	303.7	246.0	187.3	19.3

Table 7.7: Reduction in casualties from TIME B compared with the national trend				
Scheme cost	**Annual total in TIME B period**	**Annual total that would have been achieved if nothing was done**	**Annual total in after period**	**Percentage reduction beyond national trend**
Less than £10,000 (*n* = 87)	246.7	199.8	171.3	11.6
£10,000 to £50,000 (*n* = 101)	382.7	310.0	261.7	12.6
£50,000 to £100,000 (*n* = 35)	180.3	146.0	123.0	12.8
£100,000 to £200,000 (*n* = 13)	161.7	131.0	122.3	5.4
Equal to or more than £200,000 (*n* = 9)	140.7	114.0	84.7	20.8
All (*n* = 245)	1,112.0	900.7	763.0	12.4

Tables 7.6 and 7.7 show that the reduction in collisions and casualties at the sites in this study is greater than the national trend. **So, despite the FYRR TIME B being significantly lower than the FYRR AVE SEVERITY due to lower 'before' casualties/collisions, these tables show that the schemes implemented did have an effect on reducing the number of collisions or casualties from the TIME B period for all scheme costs.**

Table 7.6 also shows that scheme cost may be important. Schemes costing less than £10,000 showed the lowest reduction in collisions when site selection bias and national trend were allowed for. A similar result did not occur for schemes measured in casualties. In some cases the sample size for different cost ranges is small, so firm conclusions are not possible for the cost ranges.

7.5 Casualty reductions reducing the overall programme saving by both national casualty reductions and site selection bias

This section calculates the casualty reduction that can be attributed to safety engineering schemes for the sample and in England (outside London). It is possible to calculate these reductions in a number of ways that take into account the various effects reported throughout this report. Our chosen method is conservative due to the use of data that removes site selection bias (using collision/casualty data from the four to six year period) and by deducting the national trend savings (19%) from Table 7.5.

To include all schemes in the sample, any collision data were converted into casualty figures, using the method in Section A2.5 (Appendix 2). These conversion factors came from the typical relationship between collisions and casualties in 2004 (sourced from *Road Casualties Great Britain: 2004* (Department for Transport, 2005b)). No allowance could be made for the true actual number of casualties for those sites measured using collision data as these relationship data were not provided. As the severity split at sites before interventions tends to be worse than the national average, it is likely that Tables 7.8 to 7.19 underestimate the savings attributable to schemes.

The results are shown in Table 7.8. Equivalent figures can be derived for the whole of England (except London) by scaling up Table 7.8 for all England spend (outside London) as given in Section 4.1. **The results scaled up for all England (outside London) are given in Table 7.9**.

Tables 7.10 to 7.19 give disaggregation in pairs of tables for the sample (by cost range) and scaled for England (outside London).

Table 7.8: **Equivalent casualty savings adjusted for site selection bias and national trend (sample)**

	All	Fatal	Serious	Slight
All	337.0	8.2	54.8	274.0
Built-up	189.8	7.5	20.4	161.8
Non-built-up	147.2	0.7	34.3	112.2

Table 7.9: **Equivalent casualty savings adjusted for site selection bias and national trend (projected figures for England, except London)**

	All	Fatal	Serious	Slight
All	2,224.0	54.0	361.4	1,808.6
Built-up	1,252.6	49.5	134.9	1,068.1
Non-built-up	971.4	4.5	226.4	740.5

Table 7.10: **Equivalent casualty savings adjusted for site selection bias and national trend (sample of schemes costing less than £10,000)**

	All	Fatal	Serious	Slight
All	70.59	2.91	17.96	49.73
Built-up	18.12	2.86	3.59	11.67
Non-built-up	52.47	0.05	14.36	38.06

Table 7.11: Equivalent casualty savings adjusted for site selection bias and national trend for schemes costing less than £10,000 (projected figures for England, except London)				
	All	**Fatal**	**Serious**	**Slight**
All	465.9	19.2	118.5	328.2
Built-up	119.6	18.9	23.7	77.0
Non-built-up	346.3	0.3	94.8	251.2

Table 7.12: Equivalent casualty savings adjusted for site selection bias and national trend (sample of schemes costing £10,000 to £50,000)				
	All	**Fatal**	**Serious**	**Slight**
All	119.95	3.90	26.94	89.12
Built-up	53.57	2.81	9.47	41.29
Non-built-up	66.38	1.09	17.47	47.83

Table 7.13: Equivalent casualty savings adjusted for site selection bias and national trend for schemes costing £10,000 to £50,000 (projected figures for England, except London)				
	All	**Fatal**	**Serious**	**Slight**
All	791.7	25.7	177.8	588.2
Built-up	353.6	18.5	62.5	272.5
Non-built-up	438.1	7.2	115.3	315.7

Table 7.14: Equivalent casualty savings adjusted for site selection bias and national trend (sample of schemes costing £50,000 to £100,000)				
	All	**Fatal**	**Serious**	**Slight**
All	75.15	1.49	5.95	67.70
Built-up	63.50	0.98	4.48	58.04
Non-built-up	11.65	0.51	1.47	9.66

Table 7.15: Equivalent casualty savings adjusted for site selection bias and national trend for schemes costing £50,000 to £100,000 (projected figures for England, except London)				
	All	**Fatal**	**Serious**	**Slight**
All	496.0	9.9	39.3	446.8
Built-up	419.1	6.5	29.6	383.1
Non-built-up	76.9	3.4	9.7	63.8

Table 7.16: Equivalent casualty savings adjusted for site selection bias and national trend (sample of schemes costing £100,000 to £200,000)

	All	Fatal	Serious	Slight
All	31.73	1.11	0.40	30.22
Built-up	33.91	0.66	0.68	32.57
Non-built-up	−2.18	0.45	−0.28	−2.35

Table 7.17: Equivalent casualty savings adjusted for site selection bias and national trend for schemes costing £100,000 to £200,000 (projected figures for England, except London)

	All	Fatal	Serious	Slight
All	209.4	7.3	2.6	199.5
Built-up	223.8	4.4	4.5	215.0
Non-built-up	−14.4	3.0	−1.8	−15.5

Table 7.18: Equivalent casualty savings adjusted for site selection bias and national trend (sample of schemes costing £200,000 or more)

	All	Fatal	Serious	Slight
All	39.51	−1.22	3.52	37.20
Built-up	20.64	0.19	2.24	18.21
Non-built-up	18.87	−1.41	1.29	18.99

Table 7.19: Equivalent casualty savings adjusted for site selection bias and national trend for schemes costing £200,000 or more (projected figures for England, except London)

	All	Fatal	Serious	Slight
All	260.8	−8.0	23.3	245.5
Built-up	136.2	1.3	14.8	120.2
Non-built-up	124.5	−9.3	8.5	125.4

8 2007/08 PROGRAMME: FORECAST IMPACTS AND COMPARISON WITH 2004/05 PROGRAMME

This section compares the 2007/08 predictions with the 2004/05 predictions in order to ascertain whether there is a trend. Sixteen authorities were able to provide 2007/08 data and only these authorities were included when comparing the 2004/05 data. **The FYRR PREDICTED for 2007/08 is given in Table 8.1, this is slightly lower than the FYRR PREDICTED for 2004/05 of 239%.**

Table 8.1: FYRR PREDICTED 2007/08 by road type compared with 2004/05

Road type	FYRR predicted 2007/08 (%)	FYRR predicted 2004/05 (%)
Built-up road	169 (*n* = 137)	194 (*n* = 147)
Non-built-up road	423 (*n* = 59)	341 (*n* = 85)
All	215 (*n* = 196)	239 (*n* = 232)

Table 8.2: Average annual number of collisions predicted to be saved per site

	Slight	Serious	Fatal	Total
2004/05	0.7	0.1	0.0	0.8
2007/08	0.8	0.1	0.0	0.9

Table 8.3: Average annual number of casualties predicted to be saved per site

	Slight	Serious	Fatal	Total
2004/05	1.2	0.2	0.0	1.4
2007/08	1.0	0.1	0.0	1.1

Table 8.2 shows that the number of collisions predicted to be saved in 2007/08 is similar to the predictions for 2004/05, whereas Table 8.3 shows that the number of casualties predicted to be saved in 2007/08 is lower than those predicted to be saved in 2004/05.

In order to investigate any scheme type changes, only 2004/05 data from the authorities that provided 2007/08 data were used; this was to ensure there was the same mix of urban/rural authorities (see Tables 8.4 and 8.5).

Table 8.4: Percentage scheme type composition for 2004/05 and 2007/08 schemes for authorities which provided both 2004/05 and 2007/08 data

	2004/05 schemes			2007/08 schemes		
	Non-built-up roads	**Built-up roads**	**Total**	**Non-built-up roads**	**Built-up roads**	**Total**
Traffic calming	0.4	19.8	20.3	0.9	17.5	18.4
Single site or single stretch of route	26.2	32.1	58.2	26.7	32.7	59.4
Route action	5.9	4.2	10.1	2.3	6.0	8.3
Mass action	4.2	5.1	9.3	0.0	11.5	11.5
Other	0.8	1.3	2.1	0.0	2.3	2.3
Total	37.6	62.4	100	30.0	70.0	100

Table 8.5: Percentage scheme type composition for 2004/05 and 2007/08 schemes for all authorities

	2004/05 schemes			2007/08 schemes		
	Non-built-up roads	**Built-up roads**	**Total**	**Non-built-up roads**	**Built-up roads**	**Total**
Traffic calming	0.2	13.2	13.5	0.9	17.5	18.4
Single site or single stretch of route	37.7	29.7	67.4	26.7	32.7	59.4
Route action	6.1	3.7	9.8	2.3	6.0	8.3
Mass action	4.4	3.2	7.6	0.0	11.5	11.5
Other	0.7	1.0	1.7	0.0	2.3	2.3
Total	49.3	50.7	100.0	30.0	70.0	100.0

When examining the road type breakdown in 2007/08 there seems to be an increase in schemes to be implemented on built-up roads.

9 STUDY FINDINGS, DISCUSSION AND LIMITATIONS

While this study has been based on a comprehensive sample, there have been limitations. It has not been possible to consider the decay of benefits over time or to estimate what effect future maintenance may have on whole life costs and economics. Also, because LHAs do not hold records of traffic displacement or collision displacement, these effects were not investigated.

Table 9.1 summarises factors that affect rates of return. Recommendations are given in Section 10.

Table 9.1: Percentage scheme type composition for 2004/05 and 2007/08 schemes for all authorities

Analysis	Factor	First Year Rate of Return (%)
Simple comparison of casualty/collision numbers for three years before and after	–	173
Comparison of casualty/collision numbers for three years before and after taking into account reduction in average severity of crashes/collisions	1.70	294
Comparison of casualty/collision numbers for three years before and after using implementation costs rather than only construction costs	0.87	150
Comparison of forecast casualty/collision savings to actual	1.60	276 (predicted)
Control for site selection bias (longer period – six years)	0.89	154
Control for site selection bias (earlier period – four to six years)	0.78	135
Control for national reduction in casualty numbers (three-year trend)	0.88	152
Control for national reduction in casualty numbers (four to six years before period)	0.81	140

In Table 9.1 the term ‘factor’ refers to the arithmetic factor used in deriving the product of the First Year Rate of Return (FYRR) reported in the top row and the associated analysis adjustment described on each row.

The information in Table 9.1 could be used to derive combination effects for similar time periods. For example, the increase in rate of return by using actual severity values would be counteracted by the decrease that takes national casualty reduction into account over the same three-year period of assessment.

The sample of schemes saved an annual total of 8 fatalities, 55 serious injuries and 274 slight injuries following implementation in 2004/05 (allowing for the reduction that would have occurred in any case due to national casualty reductions and also allowing for the worst case site selection bias scenario). If these schemes are a typical sample, then the casualty reduction attributable to safety engineering schemes implemented on English local authorities' roads outside London (allowing for the same adjustments) would be 54 fatalities, 361 serious injuries and 1,809 slight injuries per year. This is equivalent to around four KSI casualties and 17 other casualties saved per £1 million spent.

9.1 Other issues

Road safety managers expressed the following views which are not necessarily representative of their authorities, nor the authors of this report:

- If the information gathered proved useful, there may be merits in repeating the exercise each year or bi-annually in a nationally consistent way to avoid different regions and sub-regions gathering the data and assessing FYRR in divergent ways.
- The Department for Transport may wish to include the requirement for this reporting in Local Transport Plan (LTP) related reporting specifications at an early stage in the process. Alternatively each LTP area could be required to publish an annual Road Safety Plan that describes how all the funding has been allocated based on FYRR, and monitoring of previous years' schemes.
- Given the high economic returns, ring fencing of safety funding may be appropriate, with a suitable reporting system to ensure investment.
- There is an emerging problem with schemes that cost more than £300,000 for smaller (generally unitary or metropolitan) authorities and £1.5 million for larger (generally county) authorities. Very large schemes meet the criteria for entry into the national/regional programme for major schemes over £5 million, but those that fall into between £300,000/£1.5 million and the £5 million mark become almost impossible to deliver. This means that significant route and area treatment cannot be easily delivered. The Department for Transport could consider setting aside a top-sliced budget of around £50 million over five years to enable councils to bid for these schemes. With the time needed to develop schemes in the first year, it would probably only require in the region of £2 million for design, consultation, and land acquisition. The first screening could be a based on FYRR, deliverability and year of completion. Once through this stage, then a fuller business case could then be requested.
- Some commented that the Department for Transport was slow to respond and did not support innovative schemes.
- Some local authorities professed that monitoring was not always undertaken and when it is carried out there is a lack of authoritative advice. For example, one

authority queried whether a monitoring study should use just one annual HEN1 (Department for Transport, 2005a) figure when calculating FYRR over the monitoring period of three or five years or whether the relevant HEN1 figure relating to each year of each scheme's implementation should be used.

10 RECOMMENDATIONS

10.1 Recommendations for the Department for Transport

The Department for Transport should consider the high rates of return when reviewing the priority of local safety scheme funding against other budget heads.

The Department for Transport should consider the appropriate allocation of local safety scheme funding between rural and urban roads by taking into account the difference in achievable rates of return.

The Department for Transport should consider publishing good practice advice to further assist local highway authorities (LHAs) in the delivery of local safety schemes. The topics covered by this advice could include:

- the circumstances where average monetary values of injury should be used and circumstances where true severity monetary values may be used;
- how casualty severity should be taken into account when selecting priority treatment sites;
- how LHAs can set local targets for economic returns of local safety scheme programmes for schemes on built-up and non-built-up roads;
- how LHAs can monitor the effectiveness of safety scheme programmes;
- how LHAs can review future planned safety scheme programmes to maximise likely effectiveness;
- how LHAs should take account of the longevity of benefits when appraising and prioritising local safety schemes using whole life cost techniques;
- how LHAs should take account of non-construction costs when appraising and prioritising local safety schemes; and
- how LHAs should estimate the contribution of road safety engineering in delivering casualty reductions.

10.2 Recommendations for local authorities

Local authorities should distinguish between pre-emptive safety schemes and those aimed at tackling proven casualty problems. It should be recognised that pre-emptive schemes are unlikely to offer significant contributions to casualty reduction targets, but may be more justifiable within other programmes of work.

Local authorities should review the effectiveness of past programmes periodically and feedback this information when selecting forward programmes.

Local authorities should consider setting ‘target’ rates of return for forward programmes. They should critically examine the composition of forward programmes using Value Management techniques to maximise the probability of meeting these targets. The selection of target rates of return could be set by comparing the historical performance of peer authorities.

Local authorities should examine casualty records for a minimum of five years when developing schemes, unless there have been major, material changes locally.

Local authorities should check and, if necessary, change their local prioritisation processes by:

- ensuring that any scheme assessment based on average casualty or collision severities uses the national average severities for built-up and non-built-up roads and not the overall national average;
- however, they should also consider checking the local severity record – if, taking into account at least five years' data, it appears to be significantly different from the national average severity (for built-up or non-built-up roads as appropriate), local authorities may wish to consider how different local severity records would affect their priorities for implementing schemes;
- ensuring the initial identification of sites considers collision severity;
- considering the repeatability of first-year benefits over longer periods, for example 10 years;
- taking account of total costs by assessing the effects on returns by including other costs such as consultation costs and future maintenance costs;
- considering non-safety impacts where these are likely to be significant; and
- considering the overall local safety strategy and delivery plan.

10.3 Recommendations for joint work

The Department for Transport and groups of local authorities should work together in regions or sub-regions to:

- better understand fatal collisions and how engineering programmes may best reduce these collisions together with other programmes; and
- examine possible variations in rates of return between similar authority types.

11 REFERENCES

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Gorell, R. and Tootill, W. (2001) *Monitoring Local Authority Road Safety Schemes Using MOLASSES*. TRL Report No. 512. Crowthorne: Transport Research Laboratory.

APPENDIX 1

Glossary

Table A1.1: **Glossary**	
Term	**Definition**
Collision	A road traffic crash that results in a recoded personal injury
First Year Rate of Return (FYRR)	This is a ratio (expressed as a percentage) of the value of the collisions or casualties prevented (by the implementation of a scheme) in the first year after completion compared with the cost of the scheme to install
Single site or single stretch of route scheme	A scheme that involves the change, improvement or installation of safety measures at a localised site
Route action	A scheme that involves the change, improvement or installation of safety measures along a route
Mass action	A repeated application of a number of similar safety measures over a wide area, for example upgrading a number of pedestrian crossing sites
LSSs	Local Safety Schemes
LHA	Local highway authority
KSI	Combined total of killed and seriously injured (either collisions or casualties)
LTP	Local Transport Plan
RSP	Road Safety Partnership

APPENDIX 2

Further details about scheme effects

A2.1 2004/05 programme – comparisons of forecast and actual savings: charts

In the following graphs (Figures A2.1 to A2.13), points plotted below the y = x line are those for which the FYRR PREDICTED is less than the FYRR AVE SEVERITY, and those points plotted above the line are schemes for which the FYRR PREDICTED is greater than the FYRR actually achieved. Only schemes with an FYRR of equal to or less than 1,000% have been shown on the graphs, apart from groupings where there were no schemes with an FYRR below 1,000%, in this case all schemes were shown. Where there were no schemes with an FYRR above 1,000%, the most appropriate scale was used.

All plots in Appendix 2 show individual scheme results as point data, with casualty and collision (accident) inspired schemes shown in different colours.

A2.1.1 Scheme type

FigureA2.1: FYRR PREDICTED compared with FYRR AVE SEVERITY – all schemes

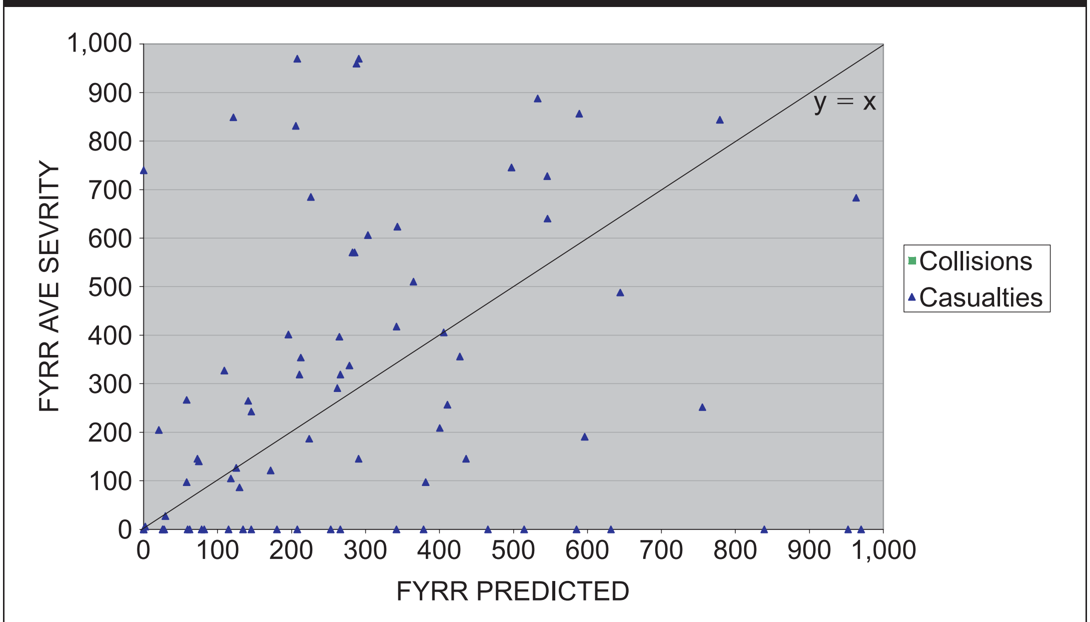


Figure A2.2: **FYRR PREDICTED compared with FYRR AVE SEVERITY for traffic calming schemes**

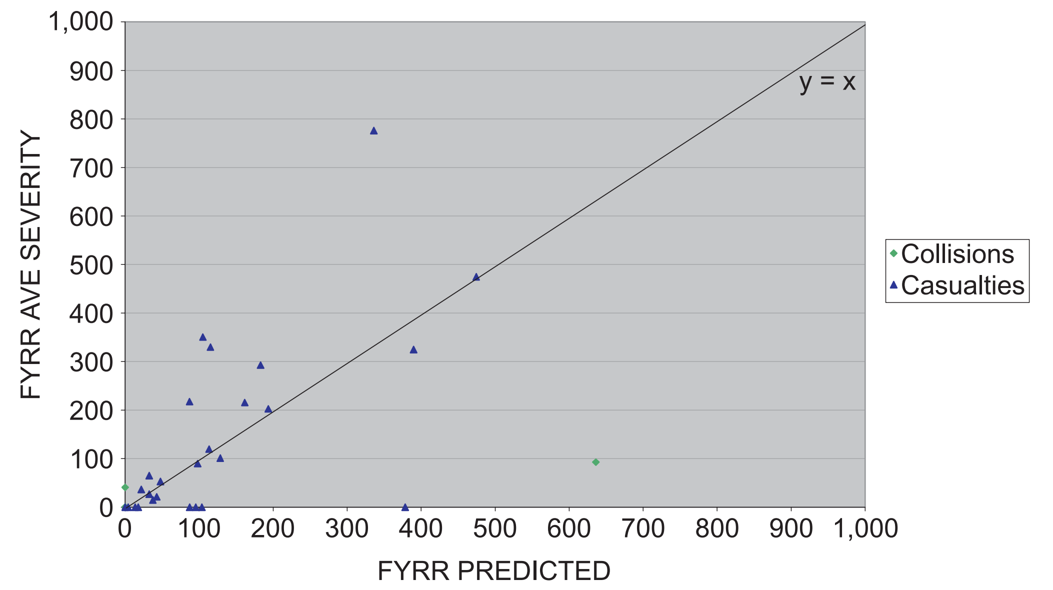


Figure A2.3: **FYRR PREDICTED compared with FYRR AVE SEVERITY for single site or single stretch schemes**

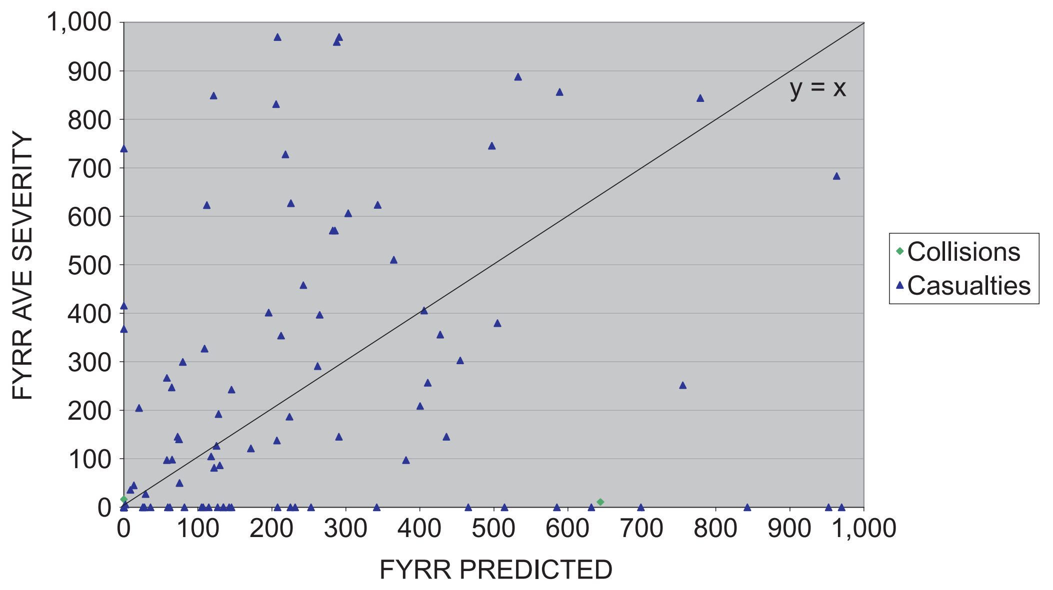


Figure A2.4: FYRR PREDICTED compared with FYRR AVE SEVERITY for route action schemes

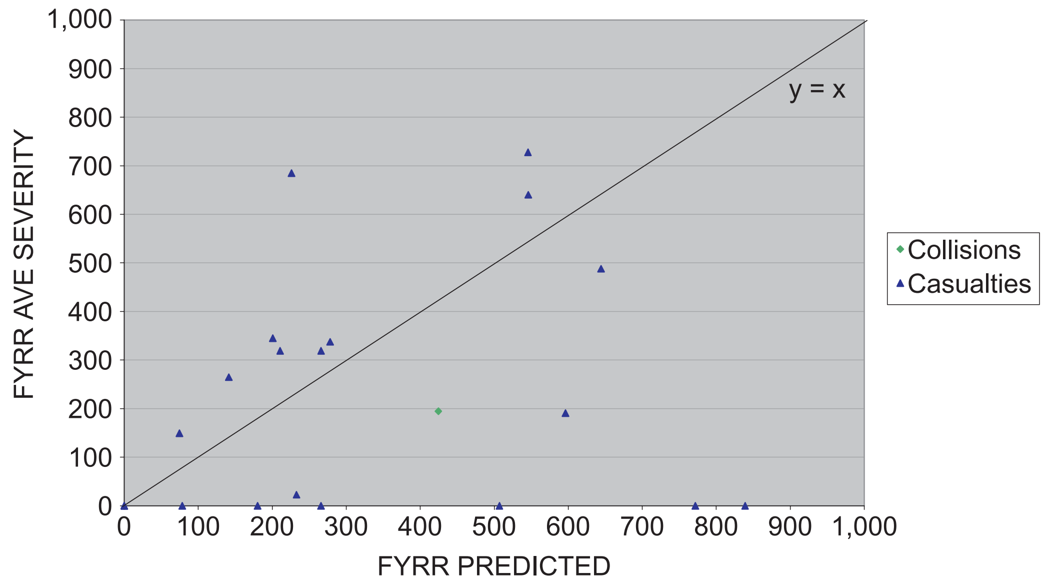


Figure A2.5: FYRR PREDICTED compared with FYRR AVE SEVERITY for mass action schemes

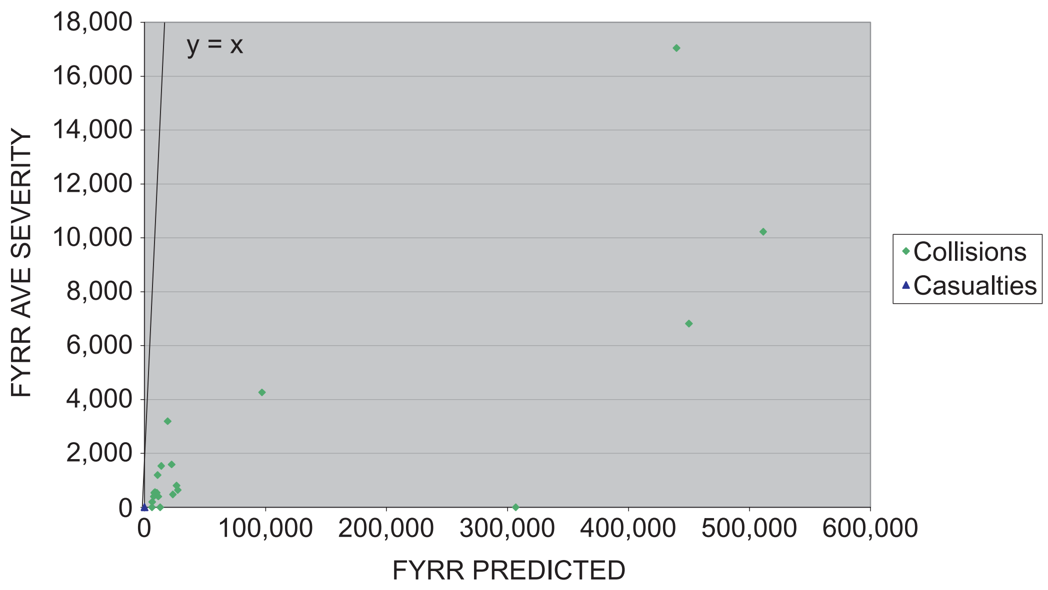
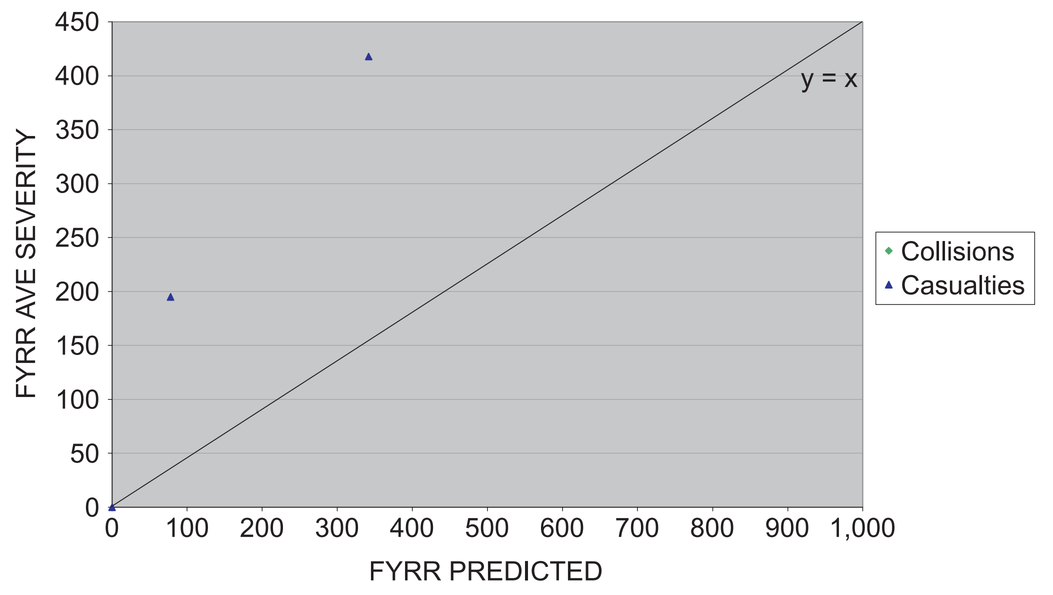


Figure A2.6: FYRR PREDICTED compared with FYRR AVE SEVERITY for other scheme types



A2.1.2 Road type

Figure A2.7: FYRR PREDICTED compared with FYRR AVE SEVERITY for schemes on built-up roads

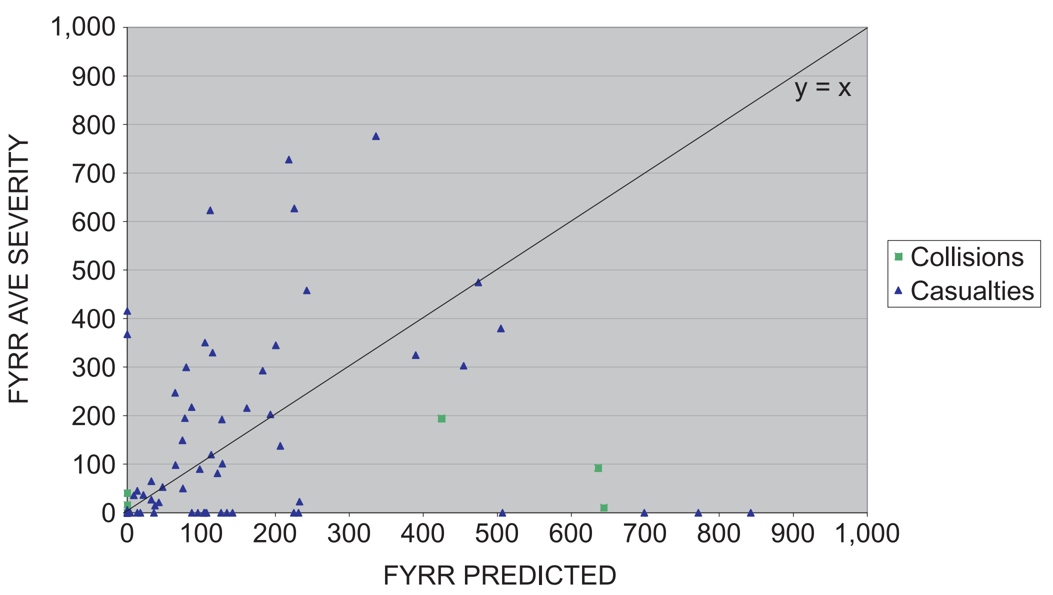
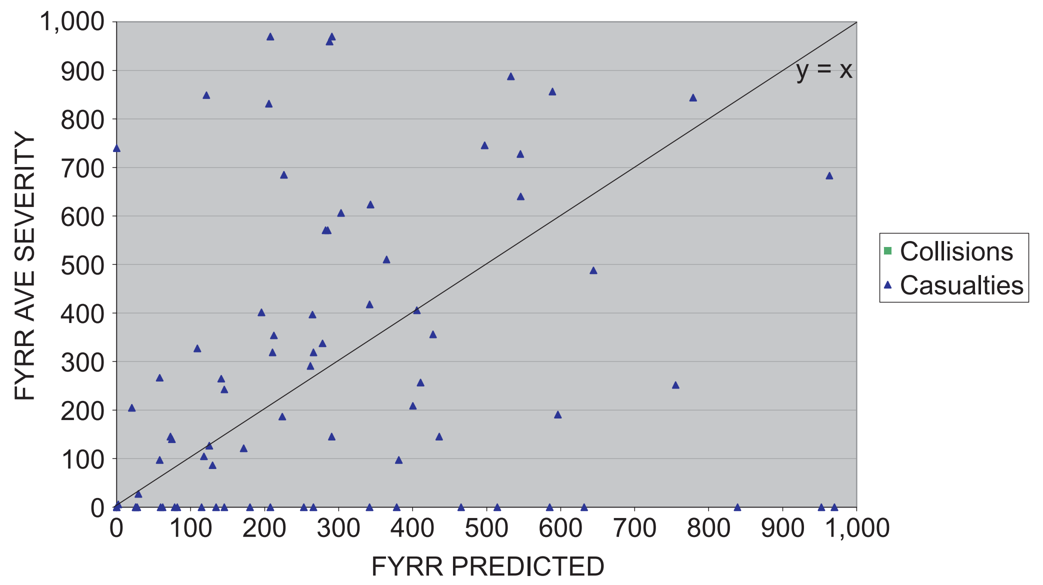


Figure A2.8: **FYRR PREDICTED compared with FYRR AVE SEVERITY for schemes on non-built-up roads**



A2.1.3 Scheme construction costs

FigureA2.9: FYRR **PREDICTED compared with FYRR AVE SEVERITY where construction costs are less than £10,000**

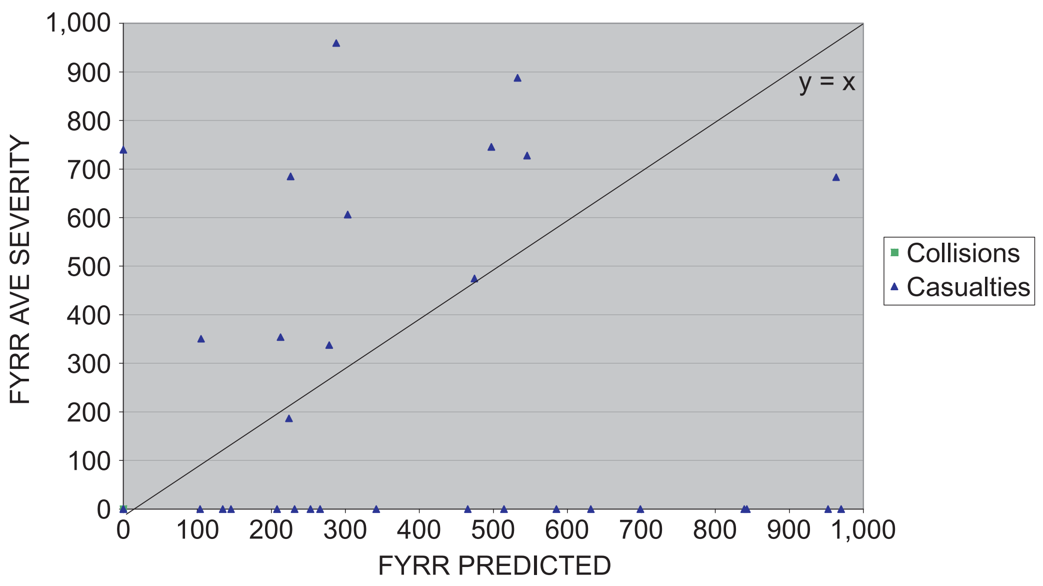


Figure A2.10: **FYRR PREDICTED compared with FYRR AVE SEVERITY where construction costs are more than or equal to £10,000 and less than £50,000**

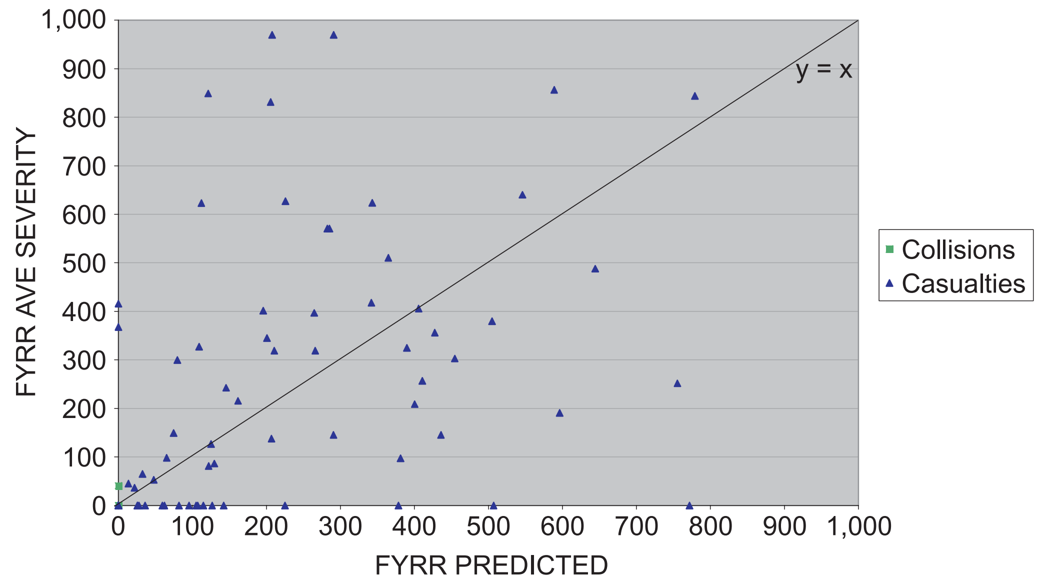


Figure A2.11: **FYRR PREDICTED compared with FYRR AVE SEVERITY where construction costs are more than or equal to £50,000 and less than £100,000**

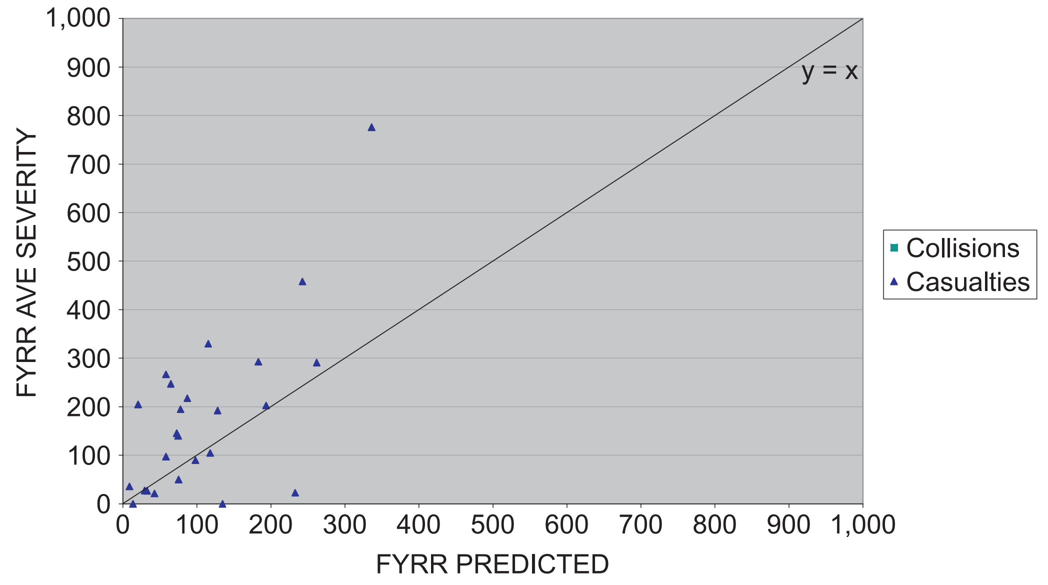


Figure A2.12: FYRR PREDICTED compared with FYRR AVE SEVERITY where construction costs are more than or equal to £100,000 and less than £200,000

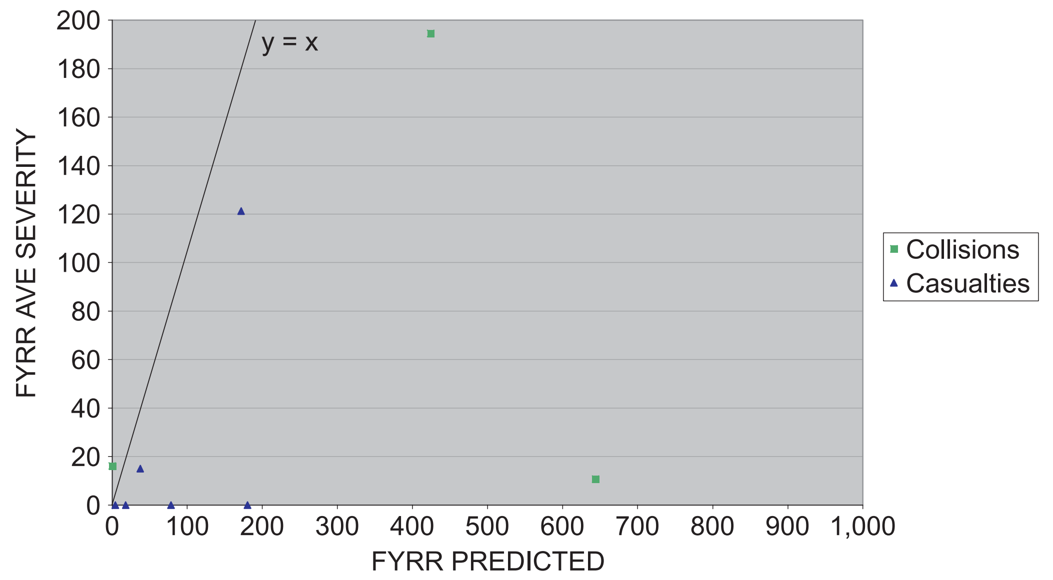
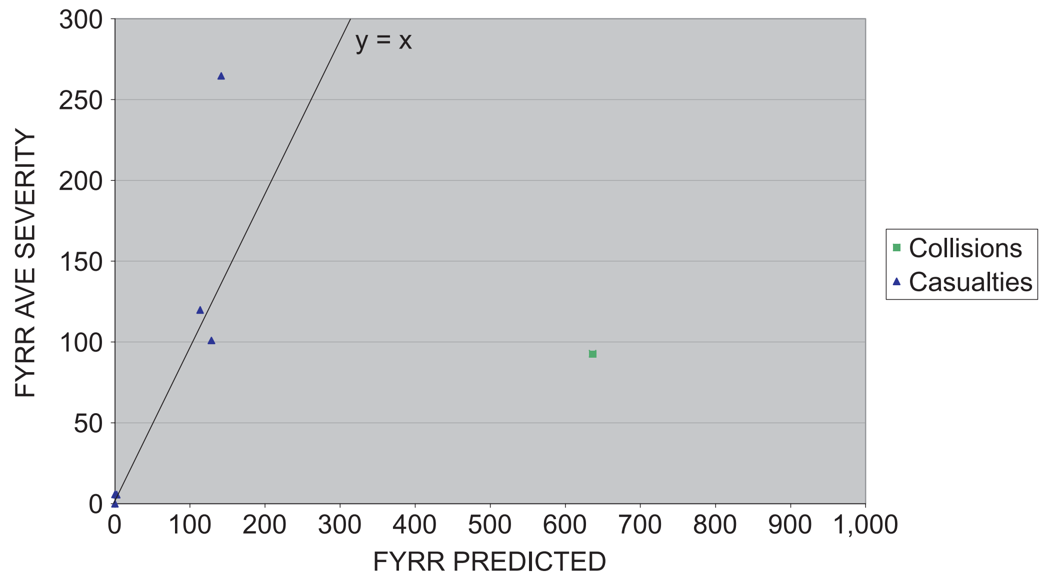


Figure A2.13: FYRR PREDICTED compared with FYRR AVE SEVERITY where construction costs are more than or equal to £200,000



A2.2 2004/05 programme – comparison of results by local authority and casualty/collision reductions for varying construction costs

Table A2.1: **FYRR by authority**	
Authority type	**FYRR AVE SEVERITY**
Metropolitan	112 (*n* = 16)
Metropolitan	78 (*n* = 22)
Metropolitan	323 (*n* = 6)
Metropolitan	153 (*n* = 7)
Metropolitan	126 (*n* = 15)
Unitary	−15 (*n* = 7)
Unitary	115 (*n* = 2)
Unitary	311 (*n* = 8)
Unitary	394 (*n* = 5)
Unitary	312 (*n* = 12)
County	34 (*n* = 17)
County	154 (*n* = 44)
County	306 (*n* = 4)
County	249 (*n* = 9)
County	91 (*n* = 24)
County	91 (*n* = 19)
County	445 (*n* = 26)
County	317 (*n* = 53)
County	160 (*n* = 26)
County	263 (*n* = 35)
County	461 (*n* = 24)
County	850 (*n* = 18)

Table A2.2: **FYRR by scheme cost of scheme type (1)**					
FYRR AVE SEVERITY	**Less than £10,000**	**£10,000–50,000**	**£50,000–100,000**	**£100,000–200,000**	**More than £200,000**
Traffic calming	**156** (*n* = 5)	**49** (*n* = 23)	**154** (*n* = 16)	**17** (*n* = 6)	**91** (*n* = 4)
20 mph zones with traffic calming	0 (*n* = 2)	112 (*n* = 6)	74 (*n* = 8)	20 (*n* = 4)	91 (*n* = 4)
Traffic calming – vertical deflections	416 (*n* = 2)	52 (*n* = 11)	156 (*n* = 6)	10 (*n* = 2)	(*n* = 0)
Other traffic calming	−416 (*n* = 1)	−71 (*n* = 5)	501 (*n* = 2)	(*n* = 0)	(*n* = 0)
20 mph limit without traffic calming	(*n* = 0)	184 (*n* = 1)	(*n* = 0)	(*n* = 0)	(*n* = 0)
Single site/stretch of route	**211** (*n* = 110)	**247** (*n* = 123)	**128** (*n* = 36)	**97** (*n* = 12)	**17** (*n* = 5)
Signing/lining/surfacing at junction	1390 (*n* = 42)	271 (*n* = 27)	141 (*n* = 8)	−24 (*n* = 1)	(*n* = 0)

(*continued*)

Table A2.2: (*continued*)					
FYRR AVE SEVERITY	**Less than £10,000**	**£10,000–50,000**	**£50,000–100,000**	**£100,000–200,000**	**More than £200,000**
Signalisation	(*n* = 0)	461 (*n* = 3)	97 (*n* = 6)	46 (*n* = 2)	55 (*n* = 2)
Pedestrian facilities at a single site	155 (*n* = 3)	152 (*n* = 22)	124 (*n* = 6)	21 (*n* = 2)	(*n* = 0)
Change of junction type	293 (*n* = 1)	201 (*n* = 4)	(*n* = 0)	(*n* = 0)	(*n* = 0)
Cycle facilities	(*n* = 0)	−1,127 (*n* = 1)	247 (*n* = 1)	(*n* = 0)	−23 (*n* = 1)
Other signing, lining or surfacing	1,374 (*n* = 52)	186 (*n* = 30)	149 (*n* = 9)	122 (*n* = 1)	(*n* = 0)
Street lighting	574 (*n* = 4)	(*n* = 0)	(*n* = 0)	127 (*n* = 1)	(*n* = 0)
Visibility improvement	(*n* = 0)	536 (*n* = 4)	(*n* = 0)	(*n* = 0)	(*n* = 0)
Road realignment	(*n* = 0)	291 (*n* = 3)	85 (*n* = 1)	101 (*n* = 2)	(*n* = 0)
Other – including mixed type	1,638 (*n* = 8)	374 (*n* = 19)	103 (*n* = 5)	255 (*n* = 3)	24 (*n* = 2)
Route action	**805** (*n* = 19)	**327** (*n* = 38)	**114** (*n* = 5)	**−65** (*n* = 3)	**83** (*n* = 4)
Speed limit reduction	685 (*n* = 1)	(*n* = 0)	(*n* = 0)	(*n* = 0)	(*n* = 0)
Set of signing and lining changes	1,382 (*n* = 6)	265 (*n* = 15)	23 (*n* = 1)	−221 (*n* = 2)	(*n* = 0)
Bend treatment	(*n* = 0)	896 (*n* = 2)	(*n* = 0)	(*n* = 0)	(*n* = 0)
Other – including mixed type	207 (*n* = 5)	192 (*n* = 5)	135 (*n* = 2)	195 (*n* = 1)	83 (*n* = 2)
Mass action	**2,871** (*n* = 7)	**792** (*n* = 13)	(*n* = 0)	(*n* = 0)	**9** (*n* = 2)
Other	(*n* = 0)	**416** (*n* = 3)	**303** (*n* = 2)	(*n* = 0)	(*n* = 0)
Average	1,247 (*n* = 141)	260 (*n* = 200)	142 (*n* = 59)	50 (*n* = 59)	6 (*n* = 15)

Table A2.3: **FYRR by scheme cost of scheme type (2)**				
FYRR AVE SEVERITY	**Less than £10,000**	**£10,000–50,000**	**£50,000–200,000**	**More than £200,000**
Traffic calming	**156** (*n* = 5)	**49** (*n* = 23)	**97** (*n* = 22)	**91** (*n* = 4)
20 mph zones with traffic calming	0 (*n* = 2)	112 (*n* = 6)	49 (*n* = 12)	91 (*n* = 4)
Traffic calming – vertical deflections	416 (*n* = 2)	52 (*n* = 11)	99 (*n* = 8)	(*n* = 0)
Other traffic calming	−416 (*n* = 1)	−71 (*n* = 5)	501 (*n* = 2)	(*n* = 0)
20 mph limit without traffic calming	(*n* = 0)	184 (*n* = 1)	(*n* = 0)	(*n* = 0)
Single site/stretch of route	**211** (*n* = 110)	**247** (*n* = 123)	**115** (*n* = 48)	**17** (*n* = 5)
Signing/lining/surfacing at junction	1,390 (*n* = 42)	271 (*n* = 27)	110 (*n* = 9)	(*n* = 0)
Signalisation	(*n* = 0)	461 (*n* = 3)	80 (*n* = 8)	55 (*n* = 2)
Pedestrian facilities at a single site	155 (*n* = 3)	152 (*n* = 22)	77 (*n* = 8)	(*n* = 0)
Change of junction type	293 (*n* = 1)	201 (*n* = 4)	(*n* = 0)	(*n* = 0)
Cycle facilities	(*n* = 0)	−1,127 (*n* = 1)	247 (*n* = 1)	−23 (*n* = 1)
Other signing, lining or surfacing	1,374 (*n* = 52)	186 (*n* = 30)	144 (*n* = 10)	(*n* = 0)
Street lighting	574 (*n* = 4)	(*n* = 0)	127 (*n* = 1)	(*n* = 0)
Visibility improvement	(*n* = 0)	536 (*n* = 4)	(*n* = 0)	(*n* = 0)
Road realignment	(*n* = 0)	291 (*n* = 3)	98 (*n* = 3)	(*n* = 0)
Other – including mixed type	1,638 (*n* = 8)	374 (*n* = 19)	182 (*n* = 8)	24 (*n* = 2)
Route action	**805** (*n* = 19)	**327** (*n* = 38)	**−11** (*n* = 6)	**83** (*n* = 4)
Speed limit reduction	685 (*n* = 1)	(*n* = 0)	(*n* = 0)	(*n* = 0)

(*continued*)

Table A2.3: (*continued*)				
FYRR AVE SEVERITY	**Less than £10,000**	**£10,000–50,000**	**£50,000–200,000**	**More than £200,000**
Set of signing and lining changes	1,382 (*n* = 6)	265 (*n* = 15)	–178 (*n* = 3)	(*n* = 0)
Bend treatment	(*n* = 0)	896 (*n* = 2)	(*n* = 0)	(*n* = 0)
Other – including mixed type	207 (*n* = 5)	192 (*n* = 5)	177 (*n* = 3)	83 (*n* = 2)
Mass action	**2,871** (*n* = 7)	**792** (*n* = 13)	(*n* = 0)	**9** (*n* = 2)
Other	(*n* = 0)	**416** (*n* = 3)	**303** (*n* = 2)	(*n* = 0)
Average	1,247 (*n* = 141)	260 (*n* = 200)	102 (*n* = 78)	6 (*n* = 15)

A2.3 2004/05 programme controlling for site selection bias and national casualty reductions: charts

The following graphs (Figures A2.14 to A2.18) are used to investigate whether a particular scheme type is more susceptible to which time period of casualty/collision data is used. The schemes plotted below the y = x line are those in which the FYRR AVE SEVERITY gives higher values than the FYRR TIME A method. Those schemes plotted above the line are vice versa. Only schemes with an FYRR less than or equal to 1,000% have been included on the graphs.

A2.3.1 Scheme type

Figure A2.14: FYRR TIME A compared with FYRR AVE SEVERITY for traffic calming schemes

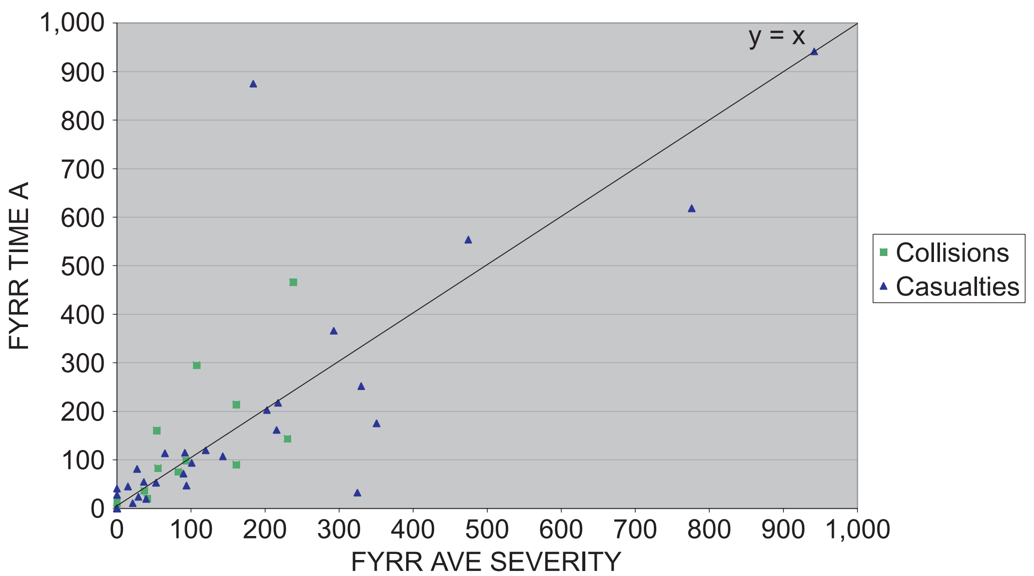


Figure A2.15: **FYRR TIME A compared with FYRR AVE SEVERITY for single site or single stretch of route schemes**

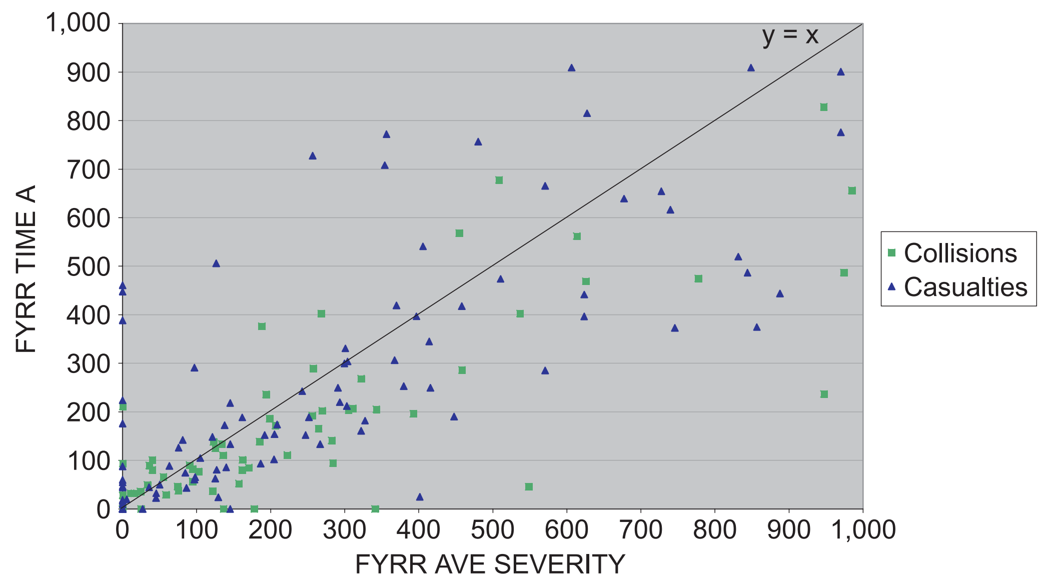


Figure A2.16: **FYRR TIME A compared with FYRR AVE SEVERITY for route action schemes**

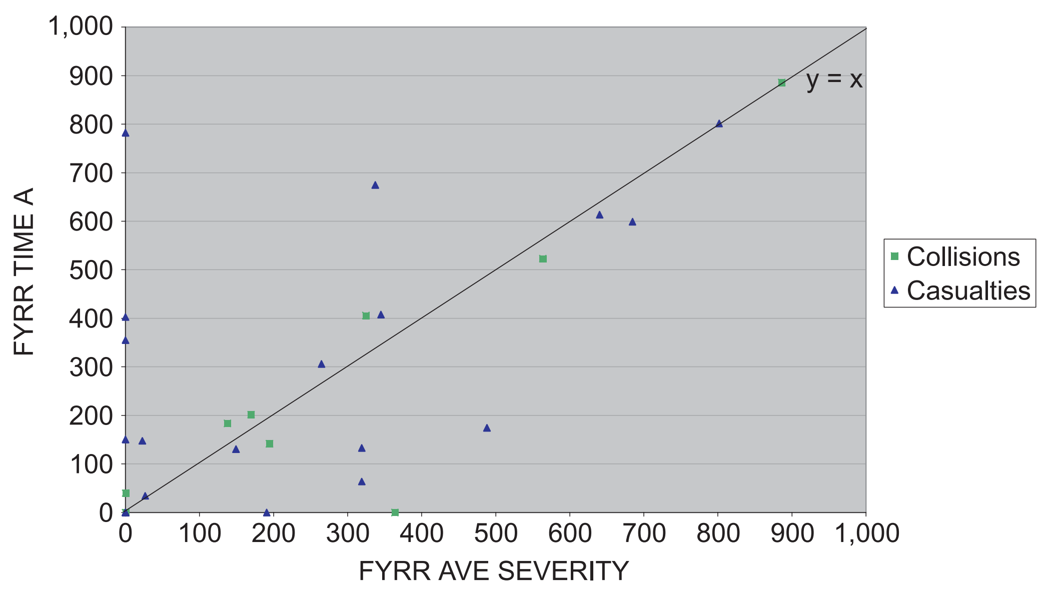


Figure A2.17: FYRR TIME A compared with FYRR AVE SEVERITY for mass action schemes

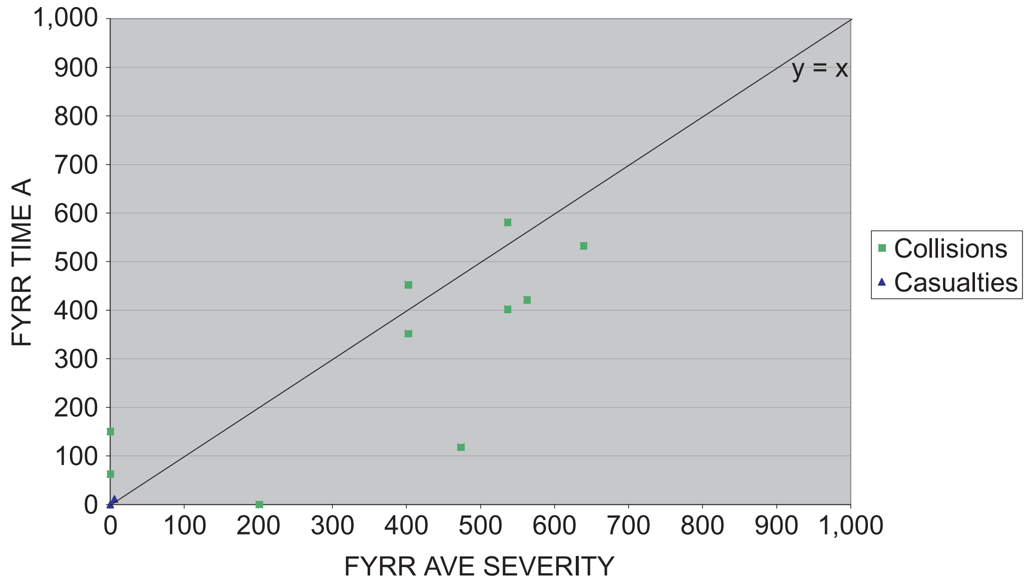
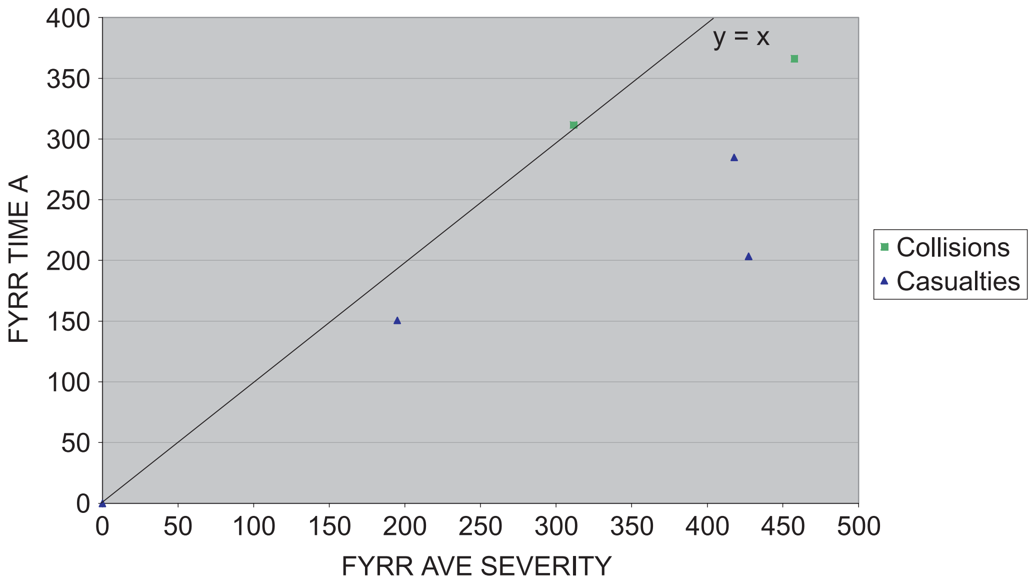


Figure A2.18: FYRR TIME A compared with FYRR AVE SEVERITY for other schemes



The following graphs (Figures A2.19 to A2.25) are used to investigate whether a particular scheme type is more susceptible to which time period of casualty/collision data is used. The schemes plotted below the y = x line are those in which the FYRR AVE SEVERITY gives higher values than the FYRR TIME B method. Those schemes plotted above the line are vice versa.

Figure A2.19: FYRR TIME B compared with FYRR AVE SEVERITY for traffic calming schemes

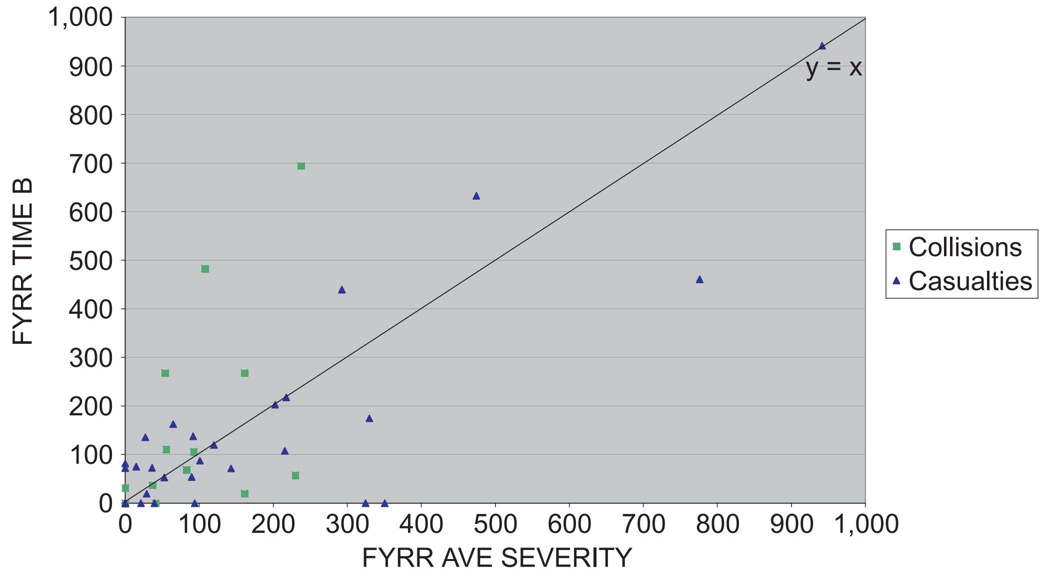


Figure A2.20: FYRR TIME B compared with FYRR AVE SEVERITY for single site or single stretch of site schemes

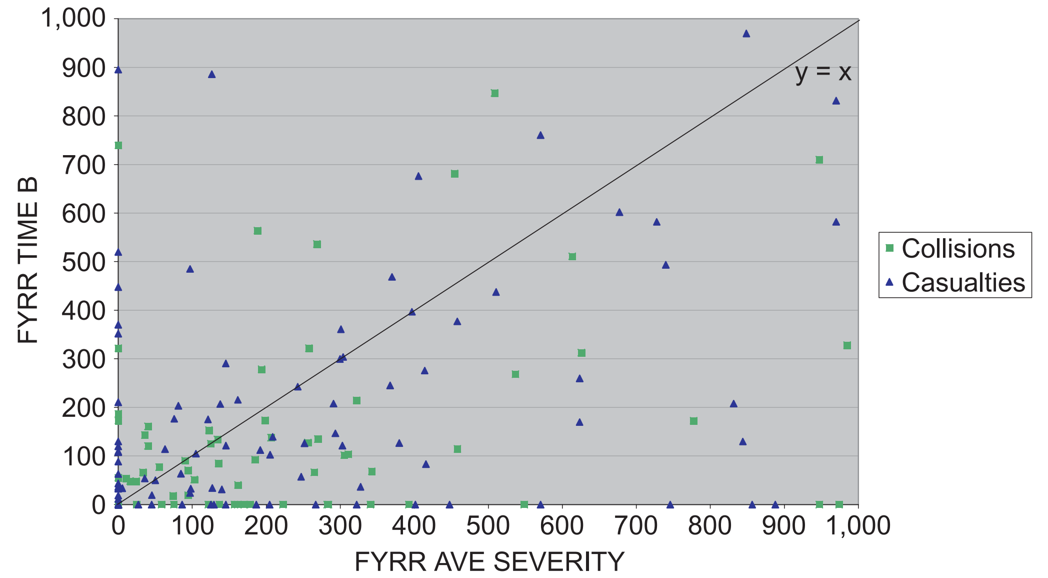


Figure A2.21: FYRR TIME B compared with FYRR AVE SEVERITY for route action schemes

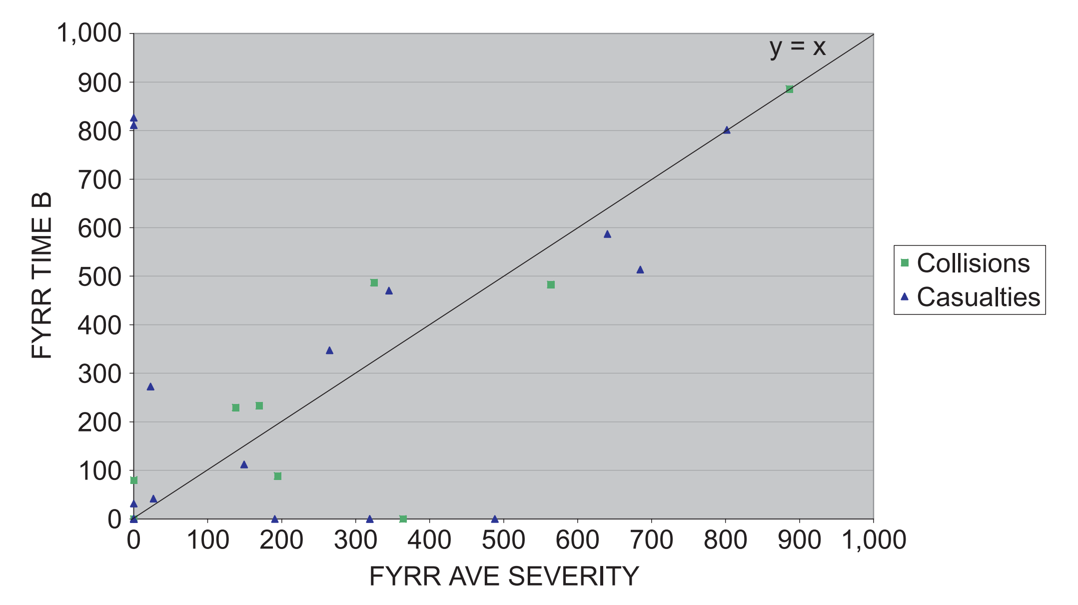


Figure A2.22: FYRR TIME B compared with FYRR AVE SEVERITY for mass action schemes

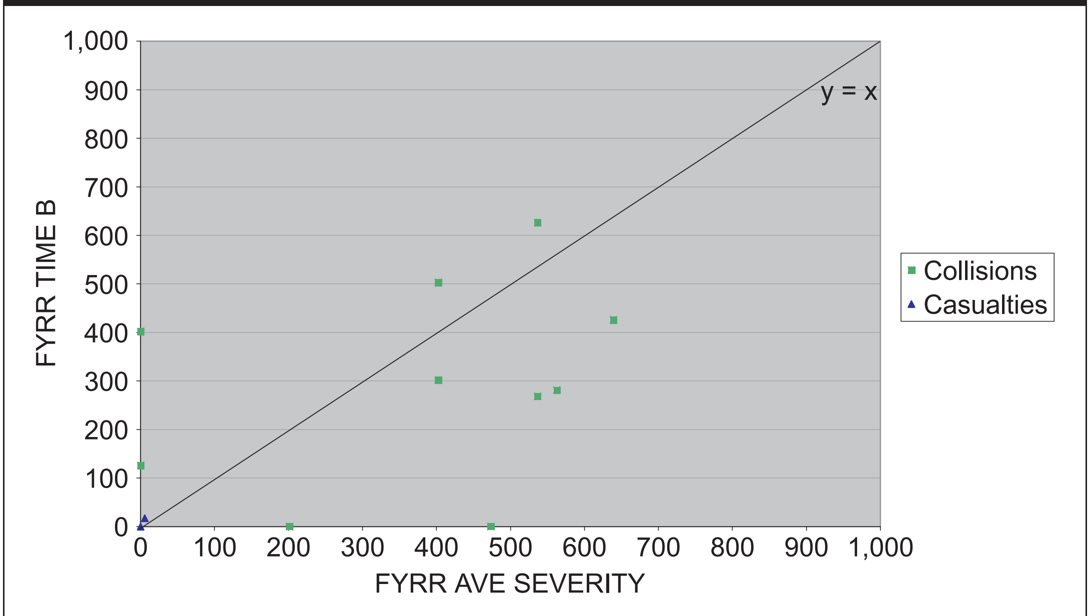
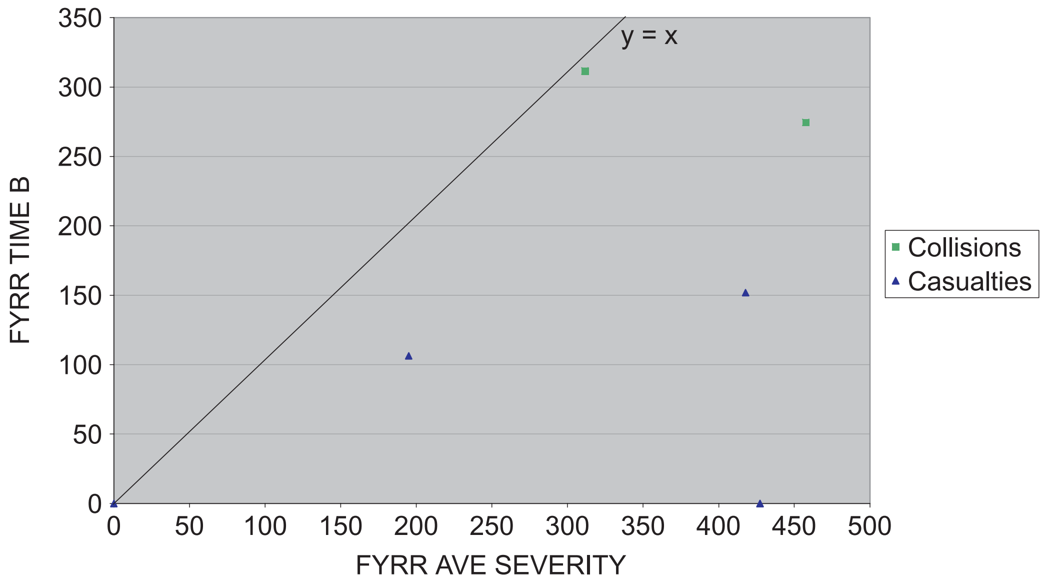


Figure A2.23: **FYRR TIME B compared with FYRR AVE SEVERITY for other schemes**



A2.3.2 Road type

Figure A2.24: **FYRR TIME B compared with FYRR AVE SEVERITY for schemes on built-up roads**

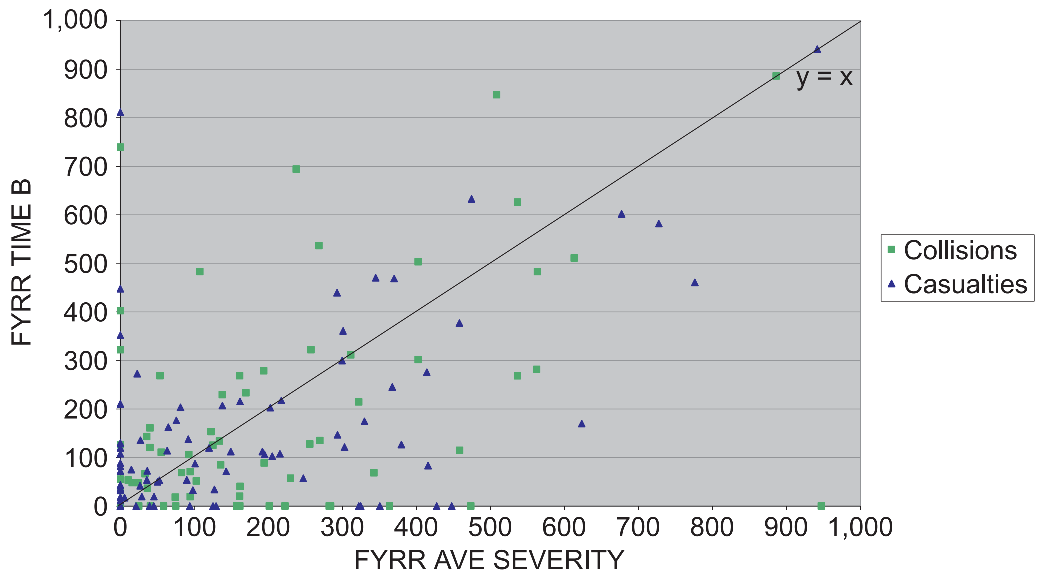
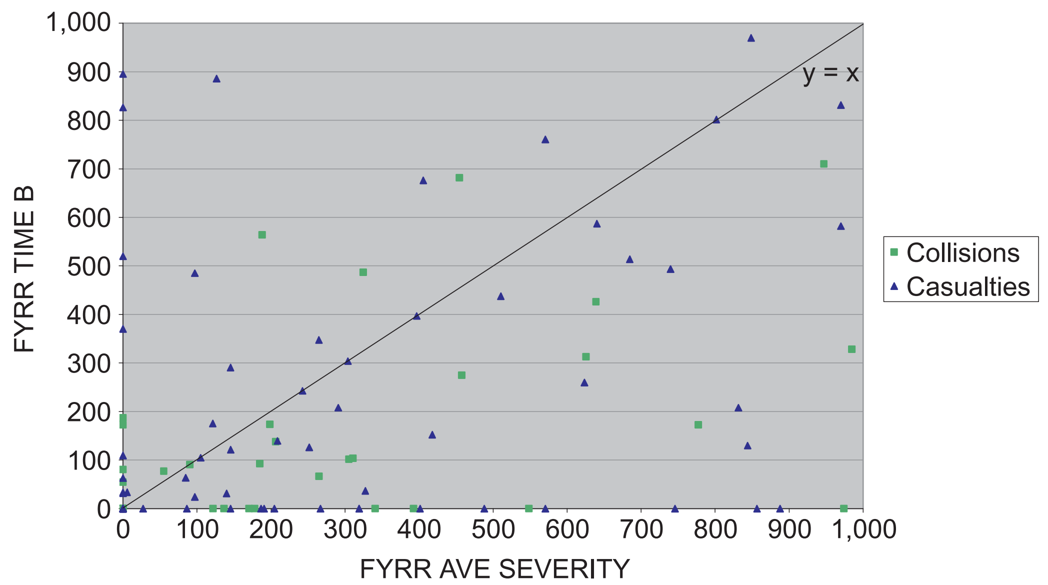


Figure A2.25: **FYRR TIME B compared with FYRR AVE SEVERITY for schemes implemented on non-built-up roads**



A2.4 2004/05 programme: characteristics of schemes appearing to yield poor or very high returns

As the frequencies of crashes and casualties at particular locations are partly random, there will be particular locations where the costs of crashes soon after treatment are higher or much lower than the costs beforehand. The purpose of this section is to check whether there are common features to the locations that have emerged within the sample of schemes with negative returns or extremely high returns.

A2.4.1 Schemes with negative FYRR AVE SEVERITY values

16.2% of schemes (66 in total) returned a negative FYRR AVE SEVERITY. This section investigates whether there are any common characteristics of these schemes.

All of the schemes with a negative FYRR AVE SEVERITY reported the number of collisions or casualties increasing after scheme completion. The increase ranged from 7% to 450%. Seventy-four per cent experienced an increase of less than 100%, 12% increased by 100–200% and 9% increased by more than 200%. A further two schemes had no collisions in the before period and one after, another scheme had no collisions in the before period and seven after.

Table A2.4: Total number of casualties/collisions (three years) before scheme implementation for schemes with a negative FYRR AVE SEVERITY and schemes with a positive FYRR AVE SEVERITY				
	Average number of collisions per scheme before scheme implementation		Average number of casualties per scheme before scheme implementation	
	Schemes with a positive FYRR AVE SEVERITY	Schemes with a negative FYRR AVE SEVERITY	Schemes with a positive FYRR AVE SEVERITY	Schemes with a negative FYRR AVE SEVERITY
Total	6.9 (*n* = 142)	6.4 (*n* = 16)	15.7 (*n* = 191)	8.8 (*n* = 50)

From Table A2.4 it is evident that schemes with a negative FYRR AVE SEVERITY have, on average, a lower total number of collisions/casualties before scheme implementation than positive schemes. The low number of collisions/casualties in the before could result in an upwards regression to the mean, i.e. for a small number of collisions/casualties at the site, the number may rise simply due to the randomness of the occurrences of collisions and casualties. The proportion of built-up and non-built-up schemes which produced negative rates of return was the same.

Table A2.5: Comparison of scheme types in schemes with a positive FYRR AVE SEVERITY and those with a negative FYRR AVE SEVERITY		
Scheme type	**Percentage of all positive schemes**	**Percentage of all negative schemes**
Traffic calming	13.8	13.6
Single site or single stretch of route	67.8	65.2
Route action	9.0	15.2
Mass action	7.5	6.1
Other	1.8	0.0

The proportion of scheme types when comparing those with a positive FYRR AVE SEVERITY to those with a negative FYRR AVE SEVERITY is similar, apart from route action schemes which are more represented among schemes with a negative FYRR AVE SEVERITY (see Table A2.5).

The average construction cost for schemes with a negative FYRR AVE SEVERITY is £38,482, which is similar to the overall average cost.

Figure A2.26: Scheme cost distribution for schemes with a negative FYRR AVE SEVERITY compared with those with a positive FYRR AVE SEVERITY

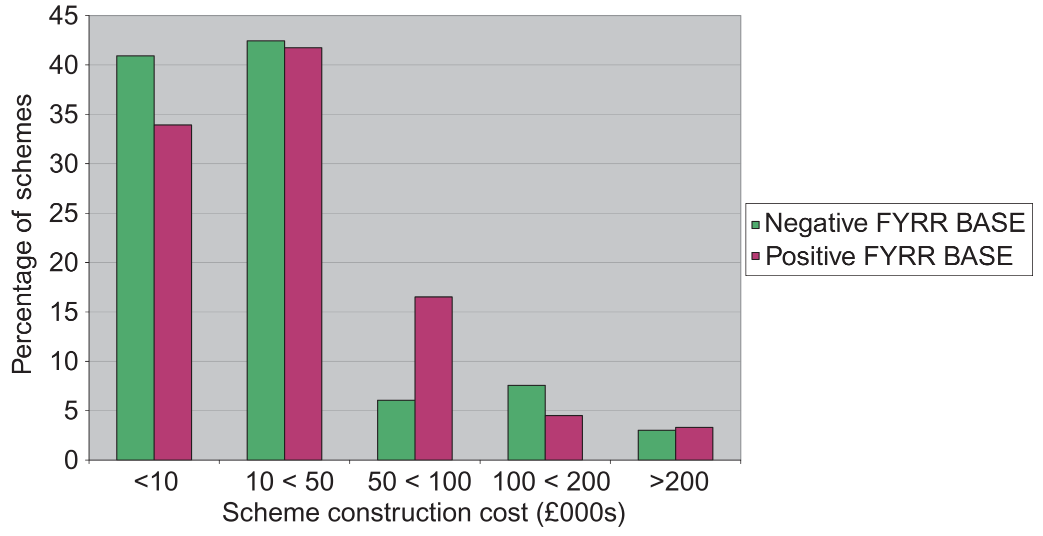


Figure A2.26 shows that schemes with a construction cost less then £50,000 or between £100,000 and £200,00 were more likely to have a negative FYRR AVE SEVERITY. Schemes in the middle cost category, £50,000 to £100,000, were less likely to achieve negative rates of return.

Table A2.6: Number of casualties/collisions (three years) by severity before scheme implementation for schemes with a negative FYRR AVE SEVERITY and schemes with a positive FYRR AVE SEVERITY

	Percentage of total collisions (average number of collisions given in brackets) per scheme before scheme implementation		Percentage of total casualties (average number of casualties given in brackets) per scheme before scheme implementation	
	Schemes with a positive FYRR AVE SEVERITY (*n* = 142)	Schemes with a negative FYRR AVE SEVERITY (*n* = 16)	Schemes with a positive FYRR AVE SEVERITY (*n* = 191)	Schemes with a negative FYRR AVE SEVERITY (*n* = 50)
Fatal	3.2 (0.2)	2.9 (0.2)	1.9 (0.3)	2.7 (0.2)
Serious	13.9 (1.0)	9.7 (0.6)	12.8 (2.0)	11.4 (1.0)
Slight	82.9 (5.6)	87.4 (5.6)	85.3 (13.3)	85.9 (7.5)

From Table A2.6 it is evident that the severity breakdown is similar for schemes with a negative FYRR AVE SEVERITY and schemes with a positive FYRR AVE SEVERITY.

From this analysis it has been identified that schemes with a negative FYRR AVE SEVERITY are more likely to have the following characteristics:

- a lower total number of collisions or casualties before scheme implementation;
- route action characteristics; and
- cost less than £50,000 or more than £100,000.

A2.4.2 *Schemes with an FYRR AVE SEVERITY less than 100% (including negative schemes)*

Of 408 schemes, 153 schemes had an FYRR AVE SEVERITY value less than 100% (including 'negative' schemes). This section will investigate whether there are any common characteristics of these schemes.

Some authorities reported in the 'further comments' column of the datasheet why the FYRR AVE SEVERITY was low. Eight authorities reported that the before period they used to investigate whether to install a scheme was different to the ones used to calculate the FYRR in this study so the FYRR AVE SEVERITY would be different to what was envisaged. Two schemes were reported specifically targeting pedestrian casualties, not all road casualties (although this statement is actually likely to be true for a larger number of schemes). Three schemes were reported by the authorities to have after collisions or casualties that did not fit the original pattern, for example a collision involving a stolen car chase. Three schemes were implemented in 2004/05 as part of a wider scheme which was started at an earlier date, so the before and after periods used in this study are different to those used in the authority's investigation. Two schemes were changed from the original design which would have had an effect on the cost and may have had a negative effect on the FYRR AVE SEVERITY. Two of the schemes with an FYRR AVE SEVERITY of less than 100% were reported to be implemented because of political pressure at sites with perceived problems.

More schemes implemented on built-up roads returned an FYRR AVE SEVERITY of less than 100% (49.8% of all built-up roads) compared with schemes implemented on non-built-up roads, where only 25.4% returned FYRR AVE SEVERITY of less than 100%.

Fifty-eight of the 153 schemes had an FYRR AVE SEVERITY of less than 100% because there was an increase in the total number of collisions or casualties.

Twenty schemes were implemented where there were no collisions or casualties in the before period.

Table A2.7: Comparison of total casualties/collisions before and after and construction costs of schemes with an FYRR AVE SEVERITY less than 100% compared with all schemes

	Casualty numbers (three years)			Collision numbers (three years)		
	Before	After	Percentage change	Before	After	Percentage change
FYRR AVE SEVERITY less than 100%	7.7 (*n* = 100)	8.9 (*n* = 100)	+15.6	5.9 (*n* = 53)	5.6 (*n* = 53)	−5.1
All scheme average	14.3 (*n* = 247)	9.3 (*n* = 247)	−35.4	6.9 (*n* = 161)	3.6 (*n* = 161)	−47.8

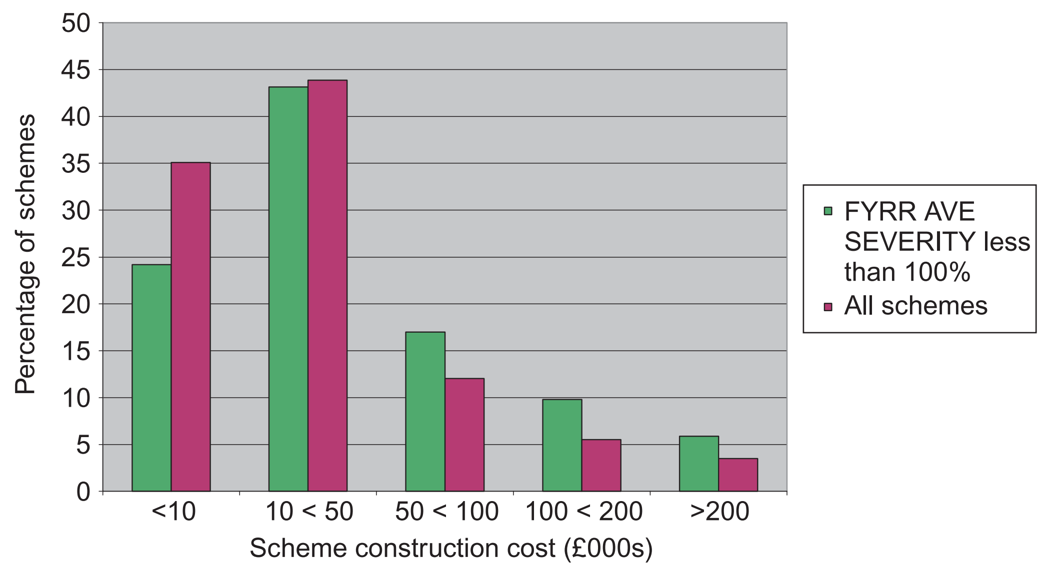
Table A2.7 shows that schemes with a low FYRR had a much lower number of casualties before scheme implementation compared with all schemes, and after scheme completion there was an increase in the number of casualties. In terms of collisions, there was again a lower average number before than compared with the average for all schemes, but a reduction, albeit a small reduction, was achieved.

Table A2.8 shows that schemes with an FYRR AVE SEVERITY less than 100% have a similar severity breakdown compared with all schemes.

Table A2.8: Number of casualties/collisions (three years) by severity before scheme implementation for schemes with an FYRR AVE SEVERITY of less than 100% and all schemes

	Percentage of total collisions (average number of collisions given in brackets) per scheme before scheme implementation		Percentage of total casualties (average number of casualties given in brackets) per scheme before scheme implementation	
	All schemes (*n* = 161)	< 100% FYRR AVE SEVERITY (*n* = 53)	All schemes (*n* = 247)	< 100% FYRR AVE SEVERITY (*n* = 100)
Fatal	3.9 (0.2)	4.1 (0.2)	2.6 (0.3)	3.5 (0.2)
Serious	14.2 (0.9)	14.9 (0.9)	14.6 (1.8)	14.3 (0.9)
Slight	81.9 (5.7)	81.0 (4.8)	82.9 (12.2)	82.2 (6.6)

Figure A2.27: Scheme cost distribution for schemes with an FYRR AVE SEVERITY less than 100% compared with all schemes



Schemes with an FYRR AVE SEVERITY of less than 100% have an average construction cost of £60,258; this is much higher than the average for all schemes (£40,794). Figure A2.27 also demonstrates this, showing that there are more schemes with a low FYRR AVE SEVERITY in the construction cost categories above £50,000.

Table A2.9: Comparison of scheme type for schemes with an FYRR AVE SEVERITY of less than 100% and all schemes

Scheme type	Schemes with an FYRR AVE SEVERITY less than 100% (%)	All schemes (%)
Traffic calming	**22.2**	**13.5**
20 mph zones with traffic calming	11.1	6.1
Traffic calming with vertical deflections	8.5	5.2
Other traffic calming	2.6	2.0
20 mph limit without significant physical traffic calming	0.0	0.2
Single site or single stretch of route	**62.7**	**67.3**
Signing, lining or surfacing at a single junction	16.3	19.9
Signalisation	3.9	2.9
Pedestrian facilities at a single site	13.7	7.9
Change of junction type, e.g. T-junction to mini roundabout	0.7	1.2
Cycle facilities	1.3	0.7
Other signing, lining or surfacing	16.3	21.6
Street lighting	0.7	1.2
Visibility improvement	0.0	1.0
Road realignment	1.3	1.5
Other – including mixed type	8.5	9.3
Route action	**9.8**	**10.1**
Speed limit reduction	0.0	0.2
Set of signing and lining changes along a route	6.5	5.4
Bend treatment	0.0	0.5
Other – including mixed type	3.3	3.9
Mass action	**4.6**	**7.6**
Other	**0.7**	**1.5**

Table A2.9 shows that 20 mph zones with traffic calming, pedestrian facilities and cycle facilities are almost doubly represented among schemes with an FYRR less than 100%, suggesting that these schemes have the potential to give lower returns.

In summary, schemes with an FYRR AVE SEVERITY of less than 100% are more likely to:

- be on built-up roads;
- have a higher than average construction cost; and
- have a lower than average number of collisions or casualties at the site in the before period.

A2.4.3 Top 10% FYRR AVE SEVERITY

This section will analyse the schemes with the highest 10% of FYRR AVE SEVERITY values (schemes with an FYRR AVE SEVERITY greater than 2,726.9%) to find out if there are any common characteristics.

Table A2.10: Comparison of total casualties/collisions before and after, and construction costs of schemes with the highest 10% FYRR AVE SEVERITY compared with all schemes

	Casualty numbers (three years)			Collision numbers (three years)			Average scheme construction cost
	Before	After	Percentage drop	Before	After	Percentage drop	
Top 10% average	20.0 (*n* = 21)	7.7 (*n* = 21)	61.5	5.8 (*n* = 18)	1.6 (*n* = 18)	72.4	£3,584
All scheme average	14.3 (*n* = 247)	9.3 (*n* = 247)	35.0	6.8 (*n* = 161)	3.7 (*n* = 161)	45.6	£40,794

Table A2.10 shows that there was also a much larger percentage reduction in the number of collisions/casualties in schemes in the top 10% compared with all schemes. Table A2.10 also shows that the construction cost for schemes in the top 10% is much lower than the overall scheme average, which would contribute to achieving a higher FYRR AVE SEVERITY.

Table A2.11: Number of collisions/casualties (three years) by severity split before scheme implementation for schemes in the top 10%

	Percentage of total collisions (average number of collisions given in brackets) per scheme before scheme implementation		Percentage of total casualties (average number of casualties given in brackets) per scheme before scheme implementation	
	All schemes (*n* = 161)	Top 10% FYRR AVE SEVERITY (*n* = 18)	All schemes (*n* = 247)	Top 10% FYRR AVE SEVERITY (*n* = 21)
Fatal	3.9 (0.2)	3.5 (0.2)	2.6 (0.3)	2.3 (0.6)
Serious	14.2 (0.9)	11.8 (0.7)	14.6 (1.8)	17.4 (3.0)
Slight	81.9 (5.7)	84.7 (4.9)	82.9 (12.2)	80.4 (16.4)

Table A2.11 shows that the severity breakdown is broadly similar for schemes in the top 10% and all schemes.

Table A2.12: Comparison of scheme types in schemes in the top 10% and all schemes

Scheme type	Top 10% of schemes (%)	All schemes (%)
Traffic calming	0	13.5
Single site or single stretch of route	71.8	67.3
Route action	5.1	10.1
Mass action	23.1	7.6
Other	0	1.5

Table A2.12 shows that the majority of schemes in the top 10% were single site or single stretch of route schemes, followed by mass action. Mass action schemes are a much higher proportion of the top 10% of schemes compared with all schemes. When the sub-type of schemes was analysed, it was found that the schemes in the top 10% mostly involved signing, lining or surfacing.

Table A2.13: Comparison of road types in schemes in the top 10% and all schemes

Road type	Top 10% of schemes (%)	All schemes (%)
Built-up	17.9	62.4
Non-built-up	82.1	37.6

Table A2.13 shows that schemes implemented on non-built-up roads dominate the top 10% of schemes.

In summary, schemes that achieved a high FYRR AVE SEVERITY had the following characteristics:

- a higher than average number of collisions/casualties before scheme implementation;
- a low construction cost;
- implemented on non-built-up roads; and
- tend to be single site or single stretch of site schemes involving signing, lining or surfacing.

A2.5 Actual casualty reductions reducing the overall programme saving by both national casualty reductions and site selection bias

The method for converting collisions to casualties and then allowing for the site selection bias and national trend effects is given in Tables A2.14 to A2.19. This method was used for each sample set (for all schemes and also for scheme cost ranges), but only the process for all schemes is shown below. The results for the different scheme cost ranges are shown in Tables 7.10 to 7.19. Table A2.14 shows the number of casualties involved in each accident type in 2004, both for built-up roads and non-built-up roads. The proportion of each casualty severity for each collision severity type was calculated, giving the conversion factors in Table A2.15. These values were then multiplied by the appropriate collision severity savings reported by the LHAs to give an equivalent casualty value. This was then added to the number of casualty savings reported separately by the other LHAs.

The total number of casualties was then reduced by 40%, i.e. 21% to account for site selection bias and 19% for the national trend. When scheme subsets by cost range were analysed, the site selection bias varied.

Table A2.14: Great Britain casualty and collision figures, 2004

Built-up						
Collisions		Casualties involved				
		Fatal	Serious	Slight	All
Fatal	1,238.0	1,301.0	315.0	438.0	2,054.0
Serious	17,371.0	0	18,706.0	5,229.0	23,935.0
Slight	129,768.0	0	0	164,449.0	164,449.0
Non-built-up					
Collisions		Casualties involved			
		Fatal	Serious	Slight	All
Fatal	1,591.0	1,756.0	724.0	1,038.0	3,518.0
Serious	8,479.0	0	10,248.0	5,229.0	15,477.0
Slight	39,891.0	0	0	57,219.0	57,219.0

Table A2.15: 2004 factors used to convert collisions to casualties

Collisions	**Equivalent casualties per collision type**					
	Built-up			Non-built-up		
	Fatal	Serious	Slight	Fatal	Serious	Slight
Fatal	1.1	0.3	0.4	1.1	0.5	0.7
Serious	0.0	1.1	0.3	0.0	1.2	0.6
Slight	0.0	0.0	1.3	0.0	0.0	1.4

Table A2.16: Annual number of collisions saved reported by authorities in sample

	All	Fatal	Serious	Slight
All	116.4	9.0	18.0	89.4
Built-up	90.0	8.3	7.0	74.7
Non-built-up	26.4	0.7	11.9	14.7

Table A2.17: Number of collisions saved converted to casualties (Table A2.16 data converted using factors from Table A2.15)

Built-up

Collisions reported by authorities		Equivalent number of casualties involved			
		Fatal	Serious	Slight	All
Fatal	8.3	8.7	2.1	2.9	13.8
Serious	7.0	0.0	7.6	2.1	9.6
Slight	74.7	0.0	0.0	94.7	94.7

Non-built-up

Collisions reported by authorities		Equivalent number of casualties involved			
		Fatal	Serious	Slight	All
Fatal	0.7	0.8	0.3	0.5	1.5
Serious	11.0	0.0	13.3	6.8	20.1
Slight	14.7	0.0	0.0	21.1	21.1

Table A2.18: Total casualties saved by programme (Table A2.17 results added to schemes derived using casualty figures)

	All	Fatal	Serious	Slight
All	526.6	12.8	85.6	428.2
Built-up	296.6	11.7	31.9	252.9
Non-built-up	230.0	1.1	53.6	175.3

Table A2.19: Casualties saved reduced by TIME B (21%) and national trend (19%)

	All	Fatal	Serious	Slight
All	337.0	8.2	54.8	274.0
Built-up	189.8	7.5	20.4	161.8
Non-built-up	147.2	0.7	34.3	112.2

APPENDIX 3

Sample questionnaire

Figure A3.1: Sample questionnaire

	Section 1: Project Details							Section 2. Accident/casualty data								
				Scheme typology (See Note 1)					Section 2a. Total number of casualties/accidents in the three years before scheme completion							
									Number of casualties (Three years)				Number of accidents (Three years)			
	Safety Engineering Project Name	Is this project related to schools?	Road Type	Type	Sub-Type	If 'other' describe here	Year of completion	Will the data be provided as casualties or accidents?	Slight casualties	Serious casualties	Fatal casualties	Total number of casualties	Slight accidents	Serious accidents	Fatal accidents	Total number of accidents
	Speed bumps on High Street	Yes	built-up	Traffic Calming	20mph zones with traffic calming		2004/05	Casualty	20	10	5	30				
1							2004/05									
2							2004/05									

	Section 2. Accident/casualty data												
	Section 2b. Total number of casualties/accidents in the previous three years (i.e. 3 years of data before timeframe for Section 2a data)								Section 2c. Forecast Saving in First Year After				
	Number of casualties (Three years)				Number of accidents (Three years)				Predicted Casualty reduction (First year after scheme completion)				Predicted percentage casualty saving
	Slight casualties	Serious casualties	Fatal casualties	Total casualties	Slight accidents	Serious accidents	Fatal accidents	Total accidents	Slight casualties	Serious casualties	Fatal casualties	Total casualties	
	10	10	0	20					3	1	1	5	50
1													
2													

	Section 2. Accident/casualty data												
	Section 2c. Forecast Saving in First Year After					Section 2d. Actual total number of casualties/accidents in the three years after scheme completion							
	Predicted Accident reduction (First year after scheme completion)				Predicted percentage accident saving	Actual number of casualties (Three years)				Actual number of accidents (Three years)			
	Slight accidents	Serious accidents	Fatal accidents	Total accidents		Slight casualties	Serious casualties	Fatal casualties	Total casualties	Slight accidents	Serious accidents	Fatal accidents	Total accidents
						8	4	3	15				
1													
2													

	Section 3: Project costs (2004/05 schemes)													
	Construction Cost	Other Implementation Costs												Total cost (£)
		Were there consultation costs?	Consultation costs	Were there survey costs?	Survey costs	Were there road safety audit costs?	Road safety audit cost	Were there site supervision costs?	Site supervision cost	Were there detailed design costs?	Detailed design costs	Are there additional annual maintenance costs?	Additional annual routine maintenance cost	
	80,000	Yes	500	No	0	No	0	No	0	Yes	4000	No	0	84,500
1														0
2														0

Section 4a FYRR based on construction costs (2004/05 schemes) NB Use monetary values as given in "Notes" tab		Section 4b: FYRR based on true total cost (From column U) (2004/05 schemes). NB Use monetary values as given in	
Predicted	Actual	Predicted	Actual

Further Comments