The national safety camera programme

Four-year evaluation report

December 2005

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Key definitions used

Personal injury collision
A collision involving personal injury occurring on the public highway (including footways) in which a road vehicle is involved and which becomes known to the police within 30 days of its occurrence. One collision may give rise to several casualties. Damage-only collisions are not included in these figures.

Killed
Human casualties who sustained injuries that caused death less than 30 days after the collision.

Serious injury
An injury for which the person is detained in hospital as an in-patient, or any of the following injuries whether or not the casualty is detained in hospital: fractures, concussion, internal injuries, crushings, severe cuts and lacerations, severe general shock requiring medical treatment and injuries causing death 30 or more days after the collision.

Slight injury
An injury of a minor character, such as a sprain, bruise or cut, which is not judged to be severe, or slight shock requiring roadside attention. This definition includes injuries not requiring medical treatment.

Executive summary

In 2000, a system was introduced that allowed eight pilot areas to recover the costs of operating speed and red-light cameras (safety cameras) from fines resulting from enforcement. In 2001, legislation was introduced that allowed the system to be extended to other areas. A national programme was then gradually introduced.

In June 2004, the Department for Transport (DfT) published a research report [1] that analysed the effectiveness of the system in 24 areas over the first three years. This report updates the analysis to the **38** areas that were operating within the programme over the four year period from April 2000 to March 2004. Only areas operating within the programme for at least a year were included in the analysis. High level results are as follows:

- **Vehicle speeds were down** – surveys showed that vehicle speeds at speed camera sites had dropped by around **6%** following the introduction of cameras. At new sites, there was a **31%** reduction in vehicles breaking the speed limit. At fixed sites, there was a **70%** reduction and at mobile sites there was a **18%** reduction. Overall, the proportion of vehicles speeding excessively (ie 15mph more than the speed limit) fell by **91%** at fixed camera sites, and **36%** at mobile camera sites.
- **Both casualties and deaths were down –** after allowing for the long-term trend, but without allowing for selection effects (such as regression-to-mean) there was a 22% reduction in personal injury collisions (PICs) at sites after cameras were introduced. Overall **42%** fewer people were killed or seriously injured. At camera sites, there was also a reduction of over **100** fatalities per annum (**32%** fewer). There were **1,745** fewer people killed or seriously injured and **4,230** fewer personal injury collisions per annum in 2004. There was an association between reductions in speed and reductions in PICs.
- **There was a positive cost-benefit of around 2.7:1**. In the fourth year, the benefits to society from the avoided injuries were in excess of **£258million** compared to enforcement costs of around **£96million.**
- **The public supported the use of safety cameras for targeted enforcement.** This was evidenced by public attitude surveys, both locally and at a national level.

Overall, this report concludes that safety cameras have continued to reduce collisions, casualties and deaths.

The background to this research report

Speed and red-light enforcement cameras (referred to collectively as 'safety cameras') were first deployed in the early 1990s. A large number of research studies, conducted both in the UK and abroad, have demonstrated that cameras are an effective means of reducing speeding and red-light running. One research study[1] concluded that, whilst cameras were effective at reducing casualties, the full benefits were not being realised due to budgetary constraints. The same study noted that these constraints could be removed by allowing local road safety partnerships to recover their enforcement costs from fines incurred by offenders. At that time, all fines were accrued to the Treasury Consolidated Fund.

In 1998, the Department for Transport (then the Department for Environment, Transport and the Regions) and other Government Departments took a policy decision to allow local road safety partnerships to recover their enforcement costs, subject to strict criteria to prevent abuse.

Management arrangements

In 1999, a national board was set up to oversee the introduction and operation of the cost recovery programme. This included representatives from the Association of Chief Police Officers (ACPO), the Home Office, the Department for Transport, the then Lord Chancellor's Department (now the Department for Constitutional Affairs), the Scottish Executive, the National Assembly for Wales, the Crown Prosecution Service (CPS), Her Majesty's Treasury (HMT), the Highways Agency (HA), the County Surveyors Society (CSS) and the Local Government Technical Advisors Group (TAG).

[1] *The national safety camera programme – three year evaluation report*. PA Consulting Group and UCL, June 2003.

To develop the practical arrangements and inform policy development, the national programme board decided to pilot the system in eight areas. The pilots were launched in April 2000 and were originally envisaged to run for two years. Results from the first year, however, were so encouraging that the Government decided to extend the system nationally. Legislation was introduced to allow this in the form of the Vehicles (Crime) Act 2001.

In order to operate the safety camera cost recovery programme, each area was required to form a local partnership and submit an operational case to the national programme board. Local partnerships included local authorities, Magistrates' Courts, the Highways Agency and the police. Treating road casualties represents a significant cost to the Health Service and some partnerships also actively involved their local NHS Trusts.

In February 2003, the Department for Transport published a research paper produced by PA Consulting Group (PA) and University College London (UCL) that analysed the effectiveness of the cost recovery system throughout the eight pilot partnership areas over the first two years (the two-year report)[2].

In June 2004, the Department for Transport published the year three report that analysed the effectiveness of cameras throughout 24 areas that were operational for a year or more'[2a].

By the end of the fourth year there were 38 partnerships that had been operational for a year or more. This report analyses the effectiveness of these partnerships (the four-year report). The following diagram illustrates the scope of the evaluation reports that have been conducted to date.

Figure 1.1 Scope of the two, three and four-year reports

Two year report April 2000 – March 2002	**Three year report** April 2000 – March 2003 In addition to the eight pilot areas, this also covers the following:		**Four year report** April 2000 – March 2004	
Pilot partnerships (April 2000)	**Partnerships that joined the programme in tranche 1 (October 2001)**	**Partnerships that joined the programme in tranche 2 (April 2002)**	**additional partnerships covered in year 4 report that started since tranche 2**	
- Cleveland	- Cambridgeshire	- Avon and Somerset	- Cheshire	- Kent
- Essex	- Derbyshire	- Bedfordshire	- Cumbria	- Northumbria
- Lincolnshire	- Lancashire	- Hampshire	- Devon and Cornwall	- Suffolk
- Northants	- Norfolk	- Leicestershire	- Dorset	- Sussex
- Nottingham	- North Wales	- London	- Greater Manchester	- West Mercia
- South Wales	- Staffordshire	- South Yorkshire	- Hertfordshire	- West Midlands
- Thames Valley	- Warwickshire	- West Yorkshire	- Humberside	- Grampian
- Strathclyde		- Wiltshire		
		- Fife		

[2] *A cost recovery system for speed and red-light cameras – two year pilot evaluation,* PA Consulting Group and UCL, 11 February 2003.

[2a] Cost benefit analysis of traffic light and speed cameras. Police research series, paper 20. A Hooke, J Knox, D Portas. 1996.

How the performance of the system has been evaluated

Since April 2000, each partnership area has provided regular monitoring information to the national programme board. This evaluation report is based on an independent analysis of this data.

In terms of evaluation criteria, the operation of safety cameras within the cost recovery programme was considered to be a success if there was:

1. a significant reduction in speed at camera sites
2. a significant reduction in casualties at camera sites
3. general public acceptance of the road safety benefits
4. satisfactory working of the funding and partnership arrangements.

Each element of the evaluation is covered in turn below.

1. There has been a significant reduction in speeds at camera sites

Each partnership was asked to conduct speed surveys at camera sites before installation and then periodically after. This was to assess the immediate and longer-term impacts on vehicle speed. Over **20,000** speed surveys have now been conducted and analysed. These show that:

- At the vast majority of sites where safety cameras were introduced there was a reduction in vehicle speed. Average speed across all new sites dropped by around **6%** or **2.2mph**.
- The reduction in vehicle speed was particularly noticeable in urban areas (defined for this report as those with 30mph or 40mph limits) where average speed fell by around **7%**. Speed in rural areas (speed limit higher than 40mph) fell by **3%** on average.
- There was a **31%** overall reduction in the proportion of vehicles breaking the speed limit at new camera sites. This was most noticeable at fixed camera sites, where the number of vehicles exceeding the speed limit dropped by **70%**, compared to **18%** at mobile sites.
- There was a **51%** overall reduction in excessive speeding (ie.15mph more than the speed limit) at new camera sites. This fell by **91%** at fixed camera sites and by **36%** at mobile camera sites.

The introduction of speed cameras has reduced excessive speeding. This conclusion is based on a substantial body of evidence, based on a large number of sites across a large number of partnership areas. Speed surveys also confirmed that these reductions were sustained over time.

2. There has been a significant reduction in casualties at camera sites
For the three-year report, UCL developed a statistical model to assess the impact on casualties compared to the national long-term trend. For this report, the model has been extended to include an additional year's data and also to include areas that joined in later tranches. The model takes into account the effects of the introduction of cameras, the effects of a partnership joining the programme and the introduction of the rules on camera visibility and conspicuity (that required fixed cameras to be made more visible and overt). The model adjusts for national trends and sesonality in accidents.

Areas provided detailed casualty information before and after the introduction of cost recovery for over **4,100** sites. The data was subject to a rigorous validation process prior to the modelling.

The following statistically significant results were found:

- There was a **42%** reduction in the number of people killed or seriously injured (KSI)[2b] at sites where safety cameras were introduced. Overall, this equates to around **1,745** fewer KSI casualties per annum, though this is subject to some reduction due to regression-to-mean.
- There was a **22%** reduction in the number of personal injury collisions at camera sites. Overall, this equates to around **4,230** fewer personal injury collisions per annum, though this is subject to a reduction due to regression-to-mean that is probably modest in scale.
- There were reductions in personal injury collisions and KSI casualties at both fixed and mobile safety camera sites. The former appeared to be the most effective – on average, the number of killed or serious injuries fell by around **50%** at fixed sites, and by around **35%** at mobile sites. These results were found to be consistent with speed surveys.
- There were over **100** fewer people killed per annum at camera sites (**32%** fewer).
- There was a **32%** reduction in the number of children killed or seriously injured at camera sites.
- There was a **29%** reduction in the number of pedestrians killed or seriously injured at camera sites.
- There was an association between the fall in speed and the fall in PICs at camera sites.
- An analysis was carried out on a subset of camera sites to estimate the size of any regression-to-mean effects. Whilst regression-to-mean does appear to account for some of the reduction in collisions at cameras, the safety effects of cameras remain substantial.

[2b] All reference in this report to KSI refers to KSI casualties.

Camera sites were selected on several criteria that are described in Appendix A, including the number of recorded accidents. Where the record periods are limited, this will tend to include sites where there have been extra accidents due to random variation. At such sites, there will be fewer accidents in future even if nothing is done to the site: this phenomenon is called regression-to-mean (RTM), and will exaggerate accident savings estimated in the main analysis. The extent of RTM cannot be determined from the monitoring data used in the main analysis. However, estimates have been made for a subset of 216 sites in urban areas for which extra information is available, using empirical Bayes methods with an external accident model. This analysis shows that RTM has only a modest effect on PICs, but may well have an appreciable effect on KSIs. Even in that case, there are significant reductions due to cameras.

The four-year results confirm the findings of both the two and three-year reports and show that the benefits are now extended to more partnership areas. The introduction of safety cameras had reduced collisions, casualties and deaths.

3. The majority of the public support the use of safety cameras for targeted enforcement

All partnerships have put considerable effort into communicating the dangers of excess speed and the rationale for the introduction of safety cameras. Partnerships were encouraged to commission independent surveys to monitor public attitudes towards safety cameras. These showed that the majority of the public supported a targeted approach to speed enforcement.

The level of public support for the use of cameras has been consistently high with **82%** of people questioned agreeing with the statement that ‘ the use of safety cameras should be supported as a method of reducing casualties’ . From the public attitude surveys there was strong evidence that there was overall positive support for the use of cameras and this stemmed from the belief that the cameras were in place to save lives – **71%** of people surveyed agreed that the primary use of cameras was to save lives.

There has been a slight reduction in the level of support for safety cameras in comparison to both the original research by Brunel University[3] and the previous two and three-year reports, however, overall support for safety cameras remained positive.

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[3] *Department for Transport Road Safety Research Report No.11 – The effects of speed cameras: how drivers respond.* Feb 1999.

[4] This figure represents a fairly conservative estimate of the benefits attributed to camera enforcement in areas where the cameras are operating (estimate is based on *Department for Transport Highways Economics Note No1: 2002*). The valuations are based solely upon reductions in PICs, which our investigations show to be affected only modestly by regression-to- mean.

4. The funding mechanism and partnership arrangements have worked well

In the fourth year, the programme had released around **£96million** per annum (in England, Wales and Scotland) for local partnerships to invest in safety camera enforcement and supporting education. Prior to cost recovery, fines accrued wholly to the HMT Consolidated Fund. In the fourth year, we have estimated that the benefits to society, in terms of the value of casualties saved, were in the region of **£258million**[4] per annum.

All 38 partnerships have had their accounts independently audited to ensure that funds were being used in accordance with the strict Government rules under which the safety camera programme operated.

The management arrangements for the programme have encouraged closer working arrangements between the police, highway authorities and other local stakeholders to improve road safety. The programme has also enabled a more consistent, targeted and evidence-based approach to be established for safety camera enforcement. The funding arrangements are working well.

Conclusions

In terms of speed and casualty reduction, public acceptability and funding arrangements we conclude that the programme has met its four main objectives.

Contents

Introduction

Road safety strategies involve a number of differing elements, broadly based around a balance of:

- **Education**, including campaigns aimed at speed reduction, reducing the levels of drink driving and encouraging drivers and passengers to wear seatbelts.
- **Engineering solutions**, aimed at making physical improvements to the infrastructure to improve road safety. These include traffic calming measures, clearer signing and improved road lay-out.
- **Enforcement**, including the use of safety camera equipment to detect offences such as speeding or red-light running.

Although education and engineering have an important safety role to play in their own right, this report focuses on the effect of camera enforcement. Specifically, it analyses the results from a programme that has allowed local partnerships to recover the costs of camera enforcement from fixed penalties paid by offenders. This report covers the first four years of this programme.

1.1 What are the national road safety objectives?

In 2000, the Government published the ten-year road safety strategy. This set out casualty reduction targets for 2010. These were:

"By 2010 we want to achieve (compared with the average for 1994-98):

- 40% reduction in the number of people killed or seriously injured in road collisions
- 50% reduction in the number of children killed or seriously injured
- 10% reduction in the slight casualty rate, expressed as the number of people slightly injured per 100million vehicle kilometres."

The road safety strategy also set out a wide range of initiatives to achieve these targets.

One initiative in the strategy was to introduce a cost recovery element for speed and red-light camera enforcement. The aim was to develop a system that delivered real road safety benefits that was paid for by offenders, rather than through public expenditure.

"Cameras have proved their effectiveness in enforcing speed limits and reducing speed-related collisions and casualties at collision hot spots. They are costly to install, operate and maintain, but these enforcement costs cannot be directly recovered by the police and local authorities where a fixed penalty notice is used. Only where cases are heard in court may the police and others claim their costs. To address this funding problem the Government now accepts that those responsible for installing and operating cameras should be able to retain some of the fine revenue from offences detected by camera, to cover their costs. This would enable better use to be made of existing cameras and for additional cameras to be introduced for road safety purposes. The next generation of cameras will be digital, offering greater capacity and flexibility at lower cost.

We are developing a funding system with effect from April 2000 to enable local authorities, the police, magistrates' courts committees and other agencies involved in the enforcement process to have some of their camera enforcement costs refunded from a proportion of the fine revenue. A programme to pilot a new funding system is being planned and, if successful, will become available country-wide."

Source: Tomorrow's roads: safer for everyone [5]

The funding programme referred to in the strategy was introduced, as planned, in eight pilot areas in April 2000 and in 2001, following the success of the pilot, it was made available country-wide. This research report evaluates the success of the programme after four years.

1.2 The link between speed, collisions and casualties

Research has shown that reducing speed on roads is a major contributor to reducing collisions and injuries. The Transport Research Laboratory (TRL) reported in 1994 that every 1mph reduction in average speed led to a 5% reduction in collisions.[6] A study in 2000[7] validated this figure.

Further details about the link between speed and casualties are given in the DfT speed review (*New Directions in Speed Management*, 2000) and are summarised below:

- Speed was indeed a major contributory factor in casualty collisions. Recent research had added greatly to our knowledge of where the problems were particularly acute.
- Slowing the fastest drivers would yield the greatest safety benefits
- In some areas, quite small reductions in average speed would bring large benefits.
- Speeders were disproportionately involved in collisions.
- Those that drove faster than most on a road, or exceeded speed limits even by relatively small margins, greatly increased the risk to themselves and others.
- The higher speeds on any given road were associated with both more collisions and greater injury severity. This relationship held for all drivers and not just the less experienced.
- The faster the speed at impact, the more severe the resulting injury. This was particularly so for collisions with pedestrians, cyclists and motorcyclists, who were unprotected from the forces of impact, unlike occupants of modern cars.
- Some people did not accept that speed is a problem. Even those that say they did, did not always act accordingly.

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[5] *Tomorrow's roads: safer for everyone.* The Government's road safety strategy and casualty reduction targets for 2010

[6] Finch DJ, Kompfner P, Lockwood CR and Maycock G (1994). *Speed, speed limits and accidents.* Transport Research Laboratory TRL Project Report 58. Crowthorne.

[7] Taylor M, Lynam D and Baruya A (2000). *The effects of drivers' speed on the frequency of road accidents.* Transport Research Laboratory TRL Report 421, Crowthorne.

Fixed speed camera

Time over distance

Mobile camera
(operator)

1.3 The law

Under Section 89 of the Road Traffic Regulations Act 1984 and Schedule 2 of the Road Traffic Offenders Act 1988, it is contrary to the law to exceed the prescribed speed limit on a public highway.

A number of police forces operate speed cameras to enforce the law. These cameras differ from speed-measuring devices, such as radar-guns or in-car devices, in that vehicles are not stopped at the road-side. Instead the offence is dealt with (initially) by post under the Conditional Offer of Fixed Penalty system (see Appendix C). Examples of three different types of speed camera are shown.

- **Fixed speed cameras**. These are usually unmanned and installed in camera housings. These cameras normally enforce road lengths where there has been a cluster of collisions.
- **Time over distance**. An alternative form of fixed speed camera involves two (or more) digital cameras linked to an automatic number-plate reader providing average camera-to-camera speed, based on the distance between the cameras divided by the time taken to travel. These cameras normally enforce roads where there has been a higher density of collisions spread over a distance.
- **Mobile speed cameras**. These are set up by the roadside and attended by a police officer or civilian enforcement officer. The camera is either video based or uses wet film and monitors traffic along a stretch of road. This type of enforcement is often used when collisions have been spread along longer lengths of road, rather than at specific sites, or when collisions occur at particular times of day or times of the year.

Under Section 36 of the Road Traffic Act 1988, it is an offence to contravene a red traffic light. In addition to speeding, cameras can be used to take images of vehicles passing through traffic lights whilst they are on red. They operate in a similar way to fixed site speed cameras.

Speed and red-light running enforcement cameras (henceforth collectively referred to as safety cameras) have to receive Home Office type approval before evidence from them can be used in court proceedings. To gain type approval, the Home Office's Police Scientific Development Branch (PSDB), in conjunction with independent laboratories, carries out rigorous testing to ensure the device in question is robust, reliable and can produce accurate readings or images under a variety of extreme conditions. The PSDB has published handbooks for manufacturers regarding the procedures for type approval, outlining the requirements and specifications for automatic traffic enforcement systems.

Once the PSDB is satisfied that any particular device fully meets the specifications, a type approval order is drawn up and signed by a Home Office Minister. The order includes the date from which the device is approved for police use. The type approval process provides an assurance of any equipment's accuracy and reliability.

1.4 Background to cost recovery

Speed and red-light running cameras were first deployed in the UK in the early 1990s. In 1996 a Home Office research report identified that while safety cameras contribute to road safety, their full benefits were not being realised because of budgetary constraints. In December 1998, the then Department for the Environment, Transport and the Regions (DETR), now the Department for Transport, strongly supported by other Government Departments, took a policy decision to allow fine revenue from enforcement cameras to be used to refund the costs of their installation, operation and maintenance. This was the first self-financing road safety system in Great Britain and was explicitly intended to free up resources to be spent on other local priorities, such as engineering and education.

The process of allowing agencies involved in camera enforcement to recover their costs is sometimes termed 'netting-off' or 'hypothecation', but the term 'cost recovery' is more generally understood and is used in this report. Her Majesty's Treasury applies strict criteria for approving cost recovery programmes. Specifically they must meet five key conditions:

- Will performance against policy objectives, eg crime-fighting and prevention, be likely to be improved?
- Are arrangements in place that will ensure that the activity will not lead to the abuse of fine and penalty collection as a method of revenue-raising and that operational priorities will remain undistorted?
- Will revenues always be sufficient to meet future costs, with any excess revenues over costs being surrendered?
- Can costs of enforcement be readily identified and apportioned without undue bureaucracy, and with inter-departmental and inter-agency agreement where necessary?
- Can savings be achieved through the change and are adequate efficiency regimes in place to control costs, including regular efficiency reviews?

To manage the programme, a national board was set up that included representatives from the Association of Chief Police Officers (ACPO), the Home Office, the Department for Transport, the Highways Agency, the then Lord Chancellor's Department (LCD, now the Department for Constitutional Affairs), the Scottish Executive, the National Assembly for Wales, the Crown Prosecution Service (CPS), Her Majesty's Treasury (HMT), the County Surveyor's Society (CSS) and the Local Government Technical Advisors Group (TAG).

In order to evaluate whether or not cost recovery was an appropriate mechanism for funding safety camera operations, the programme board decided to pilot the approach in eight areas (covering Cleveland, Essex, Lincolnshire, Northamptonshire, Nottingham, South Wales, Thames Valley and Strathclyde), based on local partnerships. These partnerships were comprised of representatives from local police forces, highway authorities, and Magistrates' courts and, where appropriate, the Highways Agency and other key stakeholders. Some of the areas also involved other local agencies recognising that a reduction in casualties has a wider benefit to society – for example for the health, ambulance and fire services.

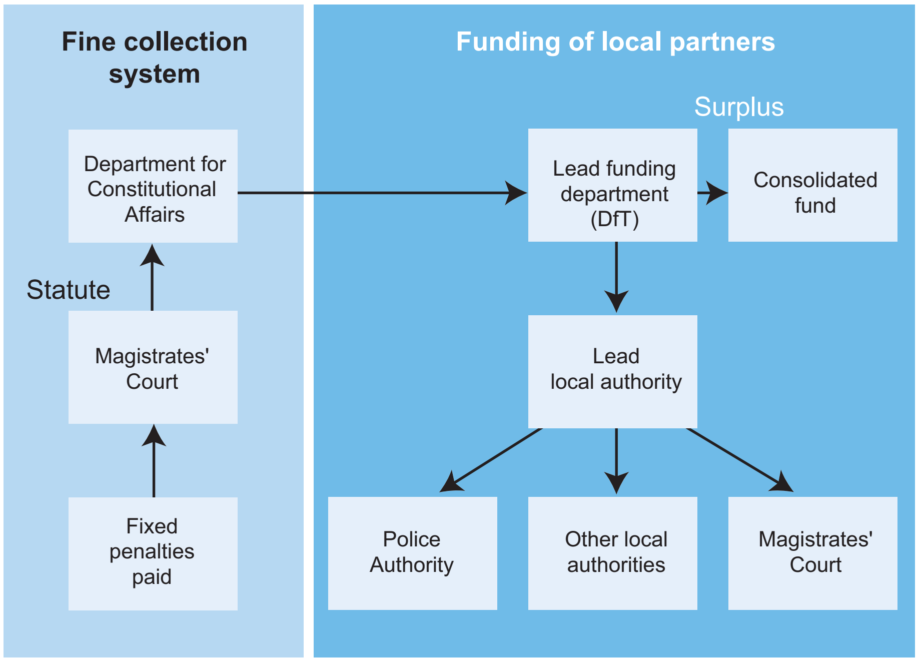
The pilot was scheduled to last for two years, but the evidence of speed and casualty reduction after one year was so compelling that the programme board decided to introduce the system to other areas. To enable this, a clause was introduced into the Vehicles (Crime) Act 2001. Clause 38 of the Act enabled the Secretary of State (DfT) to fund the expenditure of public authorities relating to specific offences in connection with speeding and traffic signals. (The relevant clause permitting this is included in Appendix B.)

1.5 The cost recovery system

The principle behind the introduction of a cost recovery system was that the fine income from the conditional offer of fixed penalties imposed for speeding and red-light running could be reinvested by local partnerships rather than accrued to the Treasury Consolidated Fund. However, it was not a straightforward process to pass money collected by the courts, in the form of penalties, to the police and local authorities involved. There were important issues of legality, accountability and timing that needed to be resolved – not least of which was the need to maintain a clear audit trail.

Legislation (Justices of the Peace Act 1997) requires Magistrates' Courts to pass all fine and fixed penalty revenue to the Department for Constitutional Affairs (DCA). There was, therefore, no opportunity to recycle funds locally without them being passed through a central Government Department.
The system for recovering penalty revenue that was set up in England and Wales is shown in Figure 1.2.

Figure 1.2 Cost recovery system



The key points to make regarding the cost recovery mechanism are:

- All receipts from the fines generated from enforcement cameras were passed from Magistrates' Courts to the DCA, which passed funds to the lead policy Department. This is the DfT as cameras were a policy instrument used to further its road safety objectives.
- The DfT passed the funds for the partnership to a local authority who acted as treasurer to redistribute the funds to each of the partners (police, Magistrates' Courts and other local authorities) to cover their camera enforcement costs.
- At the end of year there was a reconciliation and audit to prove that the receipts were used for the primary purpose which, in this case, was to improve road safety.
- According to HMT rules, the partnerships could only recover the costs of enforcement and supporting education. Any surplus was returned to the HMT Consolidated Fund.

Funding arrangements in Scotland were slightly different in that all receipts from the conditional offer of fixed penalty notices generated from cameras were passed to the Scottish Executive, which forwards income to local partnership treasurers.

1.6 Rules and guidelines that govern the programme

To be included within the cost recovery programme, local partnerships (including as a minimum the local highways authorities, the police and the Magistrates' Courts) had to submit an operational case to the programme board setting out how they proposed to operate safety cameras in their area. The programme board set out the rules of the system in a handbook. This was updated for national rollout. A summary of the rules is given in Appendices A and B. Key aspects included:

- Areas would prioritise enforcement at sites with the worst casualty and speed problems.
- Each area involved in the process was required to subject its accounts to an independent audit each year.
- Each area should sign a service level agreement/memorandum of understanding that committed each member of the partnership to a minimum one-year period.
- Areas were expected to prepare a detailed communications and driver education strategy.
- Areas were expected to put in place robust procedures to deal with drivers who did not pay the fines and also to follow-up enquiries from other forces.
- Areas were expected to appoint a data analyst, whose role was to ensure that enforcement was targeted at the priority sites where most collisions occur. Every quarter, each partnership area had to submit a return to the DfT detailing traffic speed, casualty and collision data.
- Areas were asked to do a detailed site survey and only install cameras as a last resort

To continue operating within the programme, partnerships had to resubmit their operational case to the national programme board on an annual basis. Where appropriate, this case included revisions to the sites planned for enforcement (including casualty history and recent speed surveys), a communications strategy, revised financial projections and a service level agreement/Memorandum of Understanding.

The programme covered only those detections made by speed and red-light cameras that generated a Conditional Offer of Fixed Penalty. The programme rules and guidelines did not have any legal bearing on traffic laws – speeding was and is an absolute offence designated under Section 89 of the Road Traffic Regulations Act 1984 and Schedule 2 of the Road Traffic Offenders Act 1988 and was not dependent on the cost recovery rules being met.

1.7 Evaluation

In order to evaluate the programme, the Department for Transport commissioned research to assess whether or not the programme was meeting its objectives.

1.7.1 Previous research reports

In 2003, the DfT published a research report that evaluated the eight pilot areas after the first two years. The key findings of that report were as follows:

- Vehicle speeds at speed camera sites were down.
- The number of injury collisions at camera enforcement sites was down.
- Public reaction to the safety camera programme had been positive.
- The cost recovery system was working well.

These findings were confirmed in the year-three report, published in 2004

1.7.2 four-year research report

Since the two-year report, there were some substantial changes to the programme:

- **The programme had grown in size and complexity**. In April 2001, legislation was introduced (Vehicles (Crime) Act 2001) that enabled other areas to recover the enforcement costs from speed and red-light camera offenders. At the beginning of April 2003, the fourth year of the programme, 38 areas had been approved by the national programme board to join the national programme in five additional tranches.

Figure 1.3 Scope of four year report

April 2000	October 2001	April 2002	July 2002	October 2002	April 2003	July 2003
Cleveland	Cambridgeshire	Avon & Somerset [9]	Dorset	Devon & Cornwall	Cheshire	Tayside
Essex	Derbyshire	Bedfordshire	Kent	Hertfordshire	Cumbria	Northern Ireland
Lincolnshire	Lancashire	Hampshire		Sussex	Greater Manchester	Dumfries & Galloway 1.8.03
Northants	Norfolk	Leicestershire		West Midlands	Humberside	
Nottingham [10]	North Wales	London		Grampian	Northumbria	
South Wales [11]	Staffordshire	South Yorkshire			Suffolk	
Thames Valley	Warwickshire	West Yorkshire			West Mercia	
Strathclyde		Wiltshire			Lothian & Borders 1.6.03	
		Fife				

This report focuses on the results from the 38 partnership areas up to and including April 2003.

8 *A cost recovery system for speed and red-light cameras – two year pilot evaluation,* Department for Transport, 11 February 2003, PA Consulting Group, UCL.
9 Expanded to include Gloucestershire and called Avon, Somerset and Gloucestershire.
10 Originally just Nottingham City, this expanded in April 2002 to include Nottinghamshire.
11 In April 2002, South Wales expanded to include Gwent and Dyfed Powys and renamed Mid and South Wales.

- **The eight pilot areas had operated an additional year**. More data was, therefore, available to evaluate the longer term effects of the programme.
- **The cameras were made conspicuous**. In June 2002, ministers announced guidelines on camera conspicuity (that made fixed cameras more visible).

This research paper is divided into six further chapters with supporting evidence in the Appendices.

Chapter two – effect that cameras have had on vehicle speed

Chapter three – effect the cameras have had on collisions and casualties

Chapter four – comparison of different approaches to estimation of safety effects

Chapter five – assessment of public awareness

Chapter six – costs and benefits of the programme to date

Chapter seven – conclusions

Have speeds dropped as a result of camera enforcement?

In this section, we set out the results from an analysis of vehicle speeds from evidence collected from over 20,000 speed surveys.

2.1 Why do we need to measure speed?

There are a number of reasons why it is important to collect good information on vehicle speeds before and after enforcement:

1. To confirm whether or not speeding was a problem prior to establishing a site.
2. To provide local partnerships, on a site-by-site basis, with management information that could be used to verify that local enforcement strategies were having a positive effect on local driver behaviour – to reduce speeds at sites with a history of collisions.
3. To establish at a national level whether or not enforcement was having a generally positive effect on driver behaviour and, hence, reducing the risk and severity of collisions. An accepted relationship, derived from research, was that each 1mph reduction in speed should result in around a 5% reduction in collisions. A reduction in speed across all areas should, over time, equate to a reduction in casualties.
4. To ensure that enforcement is intelligently deployed.

2.2 Data collection and validation

In total, there have been more than 20,000 speed surveys taken periodically throughout the first four years of the programme. This presented a substantial body of evidence to establish whether or not cameras have reduced vehicle speeds.

To measure changes in speed and compliance with speed limits the following measures were used across the partnerships (although not all were able to supply all of the measures for all of the sites, due to differences in speed recording equipment):

- average (mean) speed
- 85th percentile speed (the speed at or below which 85% of vehicles are travelling)
- percentage of vehicles exceeding the speed limit
- percentage of vehicles exceeding the speed limit by more than 15mph.

Each area submitted this information using a common format – this was amalgamated to a national database. The validation process is described in Appendix D.

2.3 Data analysis

The first part of the analysis was to assess the overall change at speed camera sites.

1. We selected sites that had valid baseline ‘ before’ surveys, either prior to the introduction of the cameras or for existing camera sites
2. We then selected those sites that had conducted ‘ after’ surveys in 2002/3 and 2003/4 and took an average of these readings.

The second part of the analysis was to look at the effects on vehicle speed split by partnership area, by camera type and by urban/rural. These results are summarised in the tables below and provide a conservative estimate of the true scale of speed reduction since average values have been used rather than final readings that are typically lower. In particular, it underestimates the effects of mobile cameras that were found to become more effective over time.

Given the number of surveys, it was also possible to begin to draw some conclusions about the longer-term effects of speed cameras on vehicle speeds.

More detailed analyses for new fixed and mobile sites are included at Appendix E as supporting information.

2.4 Changes in speed at new camera sites, by partnership area

Table 2.1 summarises the effects of speed cameras on the speed of vehicles before and after enforcement at over 3,800 new camera sites in 34 partnership areas[12]. This is to indicate whether or not there has been variation in changes in vehicle speeds in different areas. For the purposes of this report, a new camera site is defined as a site that has been introduced after a partnership has been accepted to join the national safety camera programme.

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[12] Note that some areas provided only limited data and these effects should be seen to be indicative only.

[13] Thames Valley was excluded last year because of changes to recording method. Fife and London provided no data for new sites.

Table 2.1 Changes in speed at new camera sites ('before' compared to an average of 2002/3 and 2003/4 surveys 'after')

Cameras	Partnership area [13]	Change in average speed (mph)	Change in average speed (%)	Change in 85th percentile speed (mph)	Change in 85th percentile speed (%)	% change in vehicles exceeding the speed limit	% change in vehicles exceeding the speed limit by more than 15mph
143	Avon and Somerset	-3.8	-11%	-3.9	-9%	- 29%	- 67%
62	Bedfordshire	-2.1	-5%	-2.3	-5%	- 23%	- 39%
38	Cambridgeshire	-4.6	-10%	-5.1	-9%	- 55%	- 76%
22	Cheshire	-1.3	-4%	-0.3	-1%	- 23%	- 39%
3	Cleveland	-2.2	-6%	-1.1	-3%	- 21%	- 20%
13	Cumbria	0.2	0%	0.1	0%	- 45%	- 36%
59	Derbyshire	-1.9	-6%	-1.6	-4%	- 9%	- 38%
35	Devon and Cornwall	-0.8	-2%	0.5	1%	- 1%	- 20%
54	Dorset	-0.6	-2%	-1.2	-3%	- 12%	- 48%
267	Essex	-1.7	-5%	-2.0	-5%	- 28%	- 16%
71	Grampian	-0.9	-2%	-2.2	-4%	- 10%	- 44%
20	Hampshire	-3.8	-11%	-4.6	-11%	- 34%	- 51%
66	Humberside	-0.9	-2%	-2.1	-5%	- 32%	- 52%
42	Kent and Medway	-1.9	-5%	-2.7	-6%	- 24%	- 37%
134	Lancashire	-1.9	-7%	-5.6	-16%	- 65%	- 85%
67	Leicestershire	-1.6	-4%	-2.7	-6%	- 20%	- 26%
37	Lincolnshire	-3.7	-8%	-4.6	-9%	- 58%	- 35%
36	Norfolk	-0.4	-1%	-0.4	-1%	- 13%	-6%
60	North Wales	-1.6	-4%	-3.0	-7%	- 31%	- 62%
19	Northamptonshire	-7.7	-21%	-8.4	-20%	- 78%	- 97%
72	Northumbria	-1.1	-3%	-0.5	-1%	3%	49%
37	Nottinghamshire	-1.9	-4%	-1.8	-4%	- 12%	-27%
297	Mid and South Wales	-2.9	-8%	-4.0	-9%	- 35%	- 56%
10	South Yorkshire	-5.9	-15%	-9.4	-20%	- 92%	-100%
21	Staffordshire	-6.0	-17%	-5.1	-13%	- 83%	- 63%
52	Strathclyde	-5.5	-15%	-8.4	-19%	- 68%	-91%
13	Suffolk	-0.6	-1%	-1.2	-2%	- 13%	-71%
35	Sussex	-2.6	-7%	-3.1	-8%	- 42%	- 86%
43	Warwickshire	-1.1	-2%	-1.4	-2%	- 16%	-22%
35	West Mercia	-2.4	-6%	-3.2	-7%	- 35%	- 45%
14	West Mids	-2.4	-7%	-5.7	-13%	2%	-72%
14	West Yorkshire	-8.6	-23%	-13.6	-31%	- 95%	-100%
52	Wiltshire	-0.8	-2%	-1.1	-2%	0%	8%
	All Cameras	-2.3	-6%	-3.1	-7%	- 30%	- 43%

Comments

- Looking across all new camera sites, there was a 2.3mph reduction in average speed.
- The average speed at new camera sites had fallen by 6%. The 85th percentile speed was also down by 7%.
- There was a 30% reduction in vehicles exceeding the speed limit.
- In addition, there was a 43% reduction in vehicles exceeding the speed limit by more than 15mph.
- There was wide variation in changes in speed between areas. The relative maturity of partnerships may be a factor.
- The areas that have been operational much longer than the others appeared to be performing better. This was encouraging as it showed that the effect on speed was not just a one-off reduction but was sustained over time.

2.5 Changes in speed at new camera sites, by speed limit

Table 2.2 summarises the effects of speed cameras on the speed of vehicles before and after enforcement at nearly 2,000 new camera sites, by speed limit. This was to assess whether or not cameras were more effective at reducing speed in urban[14] or rural areas.

Table 2.2 Changes in speed, by speed limit for new cameras sites ('before' compared to an average of 2002/3 and 2003/4 surveys 'after')

		Change in average speed		Change in 85th percentile speed		% change in vehicles exceeding the speed limit	% change in vehicles exceeding the speed limit by more than 15mph
Speed limit	**Sites**	**mph**	**%**	**mph**	**%**		
30 mph sites	1,253	-2.4	-8%	-3.4	-9%	-32%	-59%
40 mph sites	289	-2.8	-7%	-3.5	-8%	-36%	-42%
Urban Total	**1,542**	**-2.4**	**-7%**	**-3.4**	**-9%**	**-33%**	**-56%**
50 mph sites	76	-1.9	-4%	-2.1	-4%	-24%	-53%
60 mph sites	273	-1.4	-3%	-1.9	-3%	-22%	-35%
70 mph sites	61	-1.7	-3%	-1.9	-3%	-16%	-8%
Rural total	**410**	**-1.5**	**-3%**	**-1.9**	**-3%**	**-22%**	**-36%**
All Cameras	**1,952**	**-2.2**	**-6%**	**-3.0**	**-7%**	**-31%**	**-51%**

Comments

- Cameras appeared to be more effective in urban areas (2.4mph reduction in average speed) than rural areas (1.5mph reduction in average speed).
- This was confirmed across the other speed measures that showed that cameras in urban areas were more effective at reducing vehicle speeds.
- This is perhaps a result of the higher proportion of fixed sites in urban areas and the higher proportion of mobile cameras in rural areas. We will show later (in section 2.6) that there were greater reductions in speed at fixed camera sites.
- In urban areas, the proportion of drivers exceeding the speed limit fell by 33% and the proportion of vehicles excessively speeding (more than 15mph) fell by 56%.
- It is reassuring to see the reduction in excessive speeding (more than 15mph) since it is known that reducing the number of faster drivers will yield the greatest safety benefits (section 1.2).

[14] For the purposes of this report, roads with speed limits of 40mph or below are called urban. Those with a higher speed limit are called rural.

2.6 Changes in speed at camera sites, by camera type

Table 2.3 summarises the effects of new speed cameras on the speed of vehicles before and after enforcement at new camera sites, by camera type. This is to assess whether or not there were different effects on vehicle speeds between different types of camera (fixed, mobile and time over distance – see section 1.3 for descriptions).

Table 2.3 Change in speed, by camera type at new cameras sites ('before' compared to an average of 2002/3 and 2003/4 surveys 'after')

		Change in average speed		Change in 85th percentile speed		% change in vehicles exceeding the speed limit	% change in vehicles exceeding the speed limit by more than 15mph
Camera type	**Sites**	**mph**	**%**	**mph**	**%**		
Fixed	502	-5.3	-15%	-7.6	-18%	-70%	-91%
Mobile	1448	-1.3	-3%	-1.6	-3%	-18%	-36%
Time over distance	2	-1.6	-3%	-3.6	-7%	-53%	-100%
All Cameras	**1952**	**-2.2**	**-6%**	**-3.0**	**-7%**	**-31%**	**-51%**

Comments

- All types of cameras reduced speed against all of the measures.
- Overall, the greatest reduction in average speed was at new fixed cameras with an overall 5.3mph reduction in vehicle speeds (representing a fall of around 15%).
- New fixed cameras reduced the proportion of vehicles exceeding the speed limit by 70%.
- Time over distance cameras have been particularly effective at reducing excessive speeds (more than 15mph over the speed limit).
- New mobile cameras were less effective at reducing average speeds with an overall 1.3mph reduction in vehicle speeds (representing a fall of around 3%).
- The difference between new fixed and mobile cameras was expected. New fixed cameras are affecting driving behaviour all of the time. Mobile cameras, on the other hand, operate periodically at locations and, therefore, one would expect the reductions in speed overall to be less.

2.7 Changes in speed at camera sites, by camera type and speed limit

Tables 2.4 to 2.7 summarise the effects of new speed cameras on the speed of vehicles before and after enforcement at new camera sites, by camera type and by speed limit. This was to assess whether or not there were different effects on vehicle speeds at different speed limits between different types of camera (fixed and mobile).

Table 2.4 Change in average speed, by camera type at new cameras sites urban and rural ('before' compared to an average of 2002/3 and 2003/4 surveys 'after')

	Number of Sites			Change in average speed (mph)		
Camera type	**Urban**	**Rural**	**All roads**	**Urban**	**Rural**	**All roads**
Fixed	444	57	501	-5.3	-5.3	-5.3
Mobile	1096	352	1448	-1.4	-1.0	-1.3
All Cameras	**1540**	**409**	**1949**	**-2.5**	**-1.6**	**-2.3**

Table 2.5 Change in 85th %ile speed, by camera type at new cameras sites urban and rural ('before' compared to an average of 2002/3 and 2003/4 surveys 'after')

	Number of Sites			Change in 85th percentile speed (mph)		
Camera type	**Urban**	**Rural**	**All roads**	**Urban**	**Rural**	**All roads**
Fixed	444	57	501	-7.8	-6.7	-7.7
Mobile	1096	352	1448	-1.7	-1.2	-1.6
All Cameras	**1540**	**409**	**1949**	**-3.5**	**-2.0**	**-3.2**

Table 2.6 Change in % over the speed limit, by camera type at new cameras sites urban and rural ('before' compared to an average of 2002/3 and 2003/4 surveys 'after')

	Number of Sites			Change in percentage of vehicles above the speed limit		
Camera type	**Urban**	**Rural**	**All roads**	**Urban**	**Rural**	**All roads**
Fixed	444	57	501	-72%	-51%	-70%
Mobile	1096	352	1448	-18%	-18%	-18%
All Cameras	**1540**	**409**	**1949**	**-34%**	**-22%**	**-31%**

Table 2.7 Change in % 15mph over the speed limit, by camera type at new cameras sites urban and rural ('before' compared to an average of 2002/3 and 2003/4 surveys 'after')

	Number of Sites			Change in percentage of vehicles 15 mph or more above the limit		
Camera sites	**Urban**	**Rural**	**All roads**	**Urban**	**Rural**	**All roads**
Fixed	444	57	501	-94%	-62%	-90%
Mobile	1096	352	1448	-38%	-32%	-36%
All Cameras	**1540**	**409**	**1949**	**-54%**	**-36%**	**-50%**

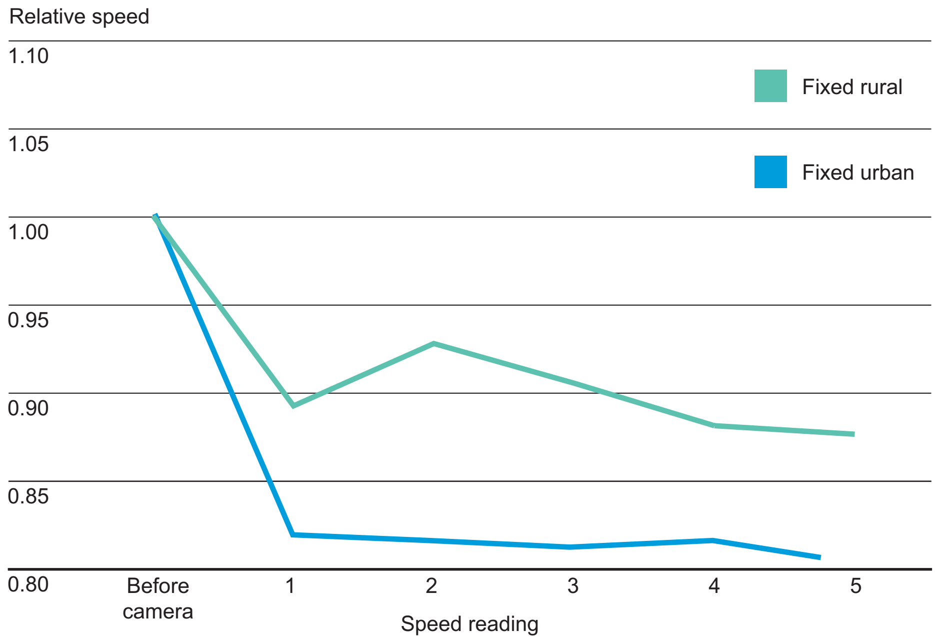
Comments

- Against all four measures, the greatest reduction in speed (in absolute and percentage terms) was found at urban fixed speed camera sites.
- The least reduction in speed was found at rural, mobile speed camera sites.

2.8 Were speed changes at camera sites sustained over time?

Figures 2.8 and 2.9 illustrate the long-term effects of both fixed and mobile cameras on vehicle speeds. They are also split by speed limit (urban and rural). Comparisons are made with sites with the same number of speed-readings.

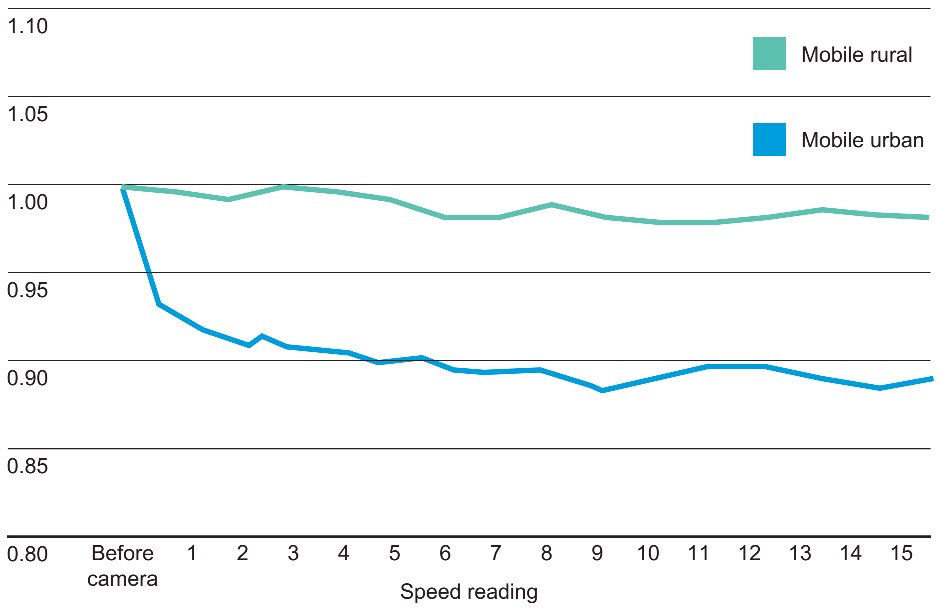
Figure 2.8 Trends in speed at fixed camera sites established under cost recovery (based on 89 sites with at least 5 'after' speed readings)



Comments

- Looking at the long-term effects of cameras, we conclude that fixed-rural cameras reduced long-term average speed by around 10% and fixed urban cameras by around 18%.
- The longer-term findings confirm those found across all cameras – the effect was immediate and sustained.

Figure 2.9 Trends in speed at mobile camera sites established under cost recovery (based on 63 sites with at least 15 'after' speed readings)



Comments

- Looking at the long-term effects of cameras, we conclude that mobile-urban reduce long-term average speed by over 10% and rural-mobile cameras by much less than 5%.

2.9 Conclusions

- We conclude that each of fixed, mobile and time over distance cameras has been effective in reducing speed and maintaining high levels of compliance with speed limits.
- Fixed cameras have proved more effective than mobile cameras in reducing speed.
- Taking all cameras into account, the reductions in speed have been greatest at fixed, urban sites.
- From areas that conducted speed surveys over a sustained period, we conclude that the reductions were not just ' one-off' but were sustained over time. In fact, for mobile sites, the one-off reductions were not only sustained but actually strengthened further as sites matured.

Has there been a reduction in collisions and casualties?

In this section, we set out the results from a statistical analysis of casualties at around 4,000 camera sites.

3.1 Why do we need to measure collisions and casualties?

The central objective of the safety camera programme is to improve road safety. Additionally, good information on collisions and casualties before and after enforcement is needed to:

1. ensure that enforcement is intelligently deployed at the areas of greatest need (by time of day, by location, by day of week etc)
2. provide local partnerships, on a site-by-site basis, with management information that can be used to verify that local enforcement strategies are having a positive effect on driver behaviour
3. identify whether or not the increase in enforcement at a national level is achieving its policy objectives – that is to reduce the number of collisions and their severity.

3.2 Data collection and validation

Throughout this report we use two widely accepted measures for counting road collisions and road casualties. For collisions, we refer to personal injury collisions (PICs) – this is a road collision that results in at least one casualty (fatal, serious or slight). To measure casualties, we refer to people who were killed or seriously injured (KSIs) as a result of a road collision.

Each partnership provided the following baseline information for each camera site:

• Name.

• Local authority.

• Camera type.

• Grid reference.

• Date established.

• Date made conspicuous.

• Total number of PICs and KSIs (in three year baseline period).

• Pedestrian PICs and KSIs (in three year baseline period).

• Child PICs and KSIs (in three year baseline period).

• Speed limit.

The following casualty information was collected for each camera site each month after the camera was installed:

• Total number of PICs and KSIs.

• Pedestrian PICs and KSIs.

• Child PICs and KSIs

This was subject to a rigorous and extensive process of data cleansing to check, where possible, for completeness, consistency and accuracy. This process is included as Appendix D.

The resulting data were then prepared as input for the statistical model developed by UCL.

3.3 Data analysis

We cannot compare before and after frequencies directly to assess the effect of safety cameras because there are a number of other factors that influence the frequency of collisions. These include national trend, seasonality (there are more collisions at certain times of year), speed limit, length of observation, type of camera, location of installation etc. Also, we wished to see if different types of area had different effects and separate out the effect of cost recovery. To separate out all of these effects we adopted a statistical modelling approach.

A statistical analysis of the data was conducted in order to estimate the effect of the introduction of safety cameras on road safety. This analysis separates out those parts of the variations in the observed personal injury collision (PIC), and killed or seriously injured (KSI) casualty data that were associated with safety cameras from others that were present in the data (for example the underlying national trend, seasonality, speed limits, etc). The model allowed for the number of months for which data was available in both the 'before' and 'after' camera period. Whilst it would be desirable to include in an investigative model of this kind some explicit allowance for regression-to-mean, no reliable method has yet been established for doing so.

The safety camera effects on casualties and collisions that were investigated were associated with:

- the introduction of the camera itself (where this occurred after the partnership joined the national safety camera programme)
- increase in conspicuity of the camera (when fixed sites became more visible)
- the change to operation under cost recovery (when the partnership joined the national safety camera programme).

This allowed for cameras that were established before the start of the study period (in which case no effect of camera introduction was applied) and for new cameras. The changes that were made to make cameras more conspicuous were only applied to fixed cameras and not mobile cameras. Table 8 below describes how the model took into account the different combinations of cameras and effects.

Table 3.1 Description of how the model deals with the different combinations of urban/rural, fixed/mobile, existing/new and conspicuity

PIC/ KSI model	Input data			The model examines the combined effect of all three interventions		
	Type	Baseline	After	1. Partnership accepted onto the programme	2. Effect of introduction of camera (urban and rural)	3. Cameras made more conspicuous
Existing cameras	Fixed	Before cost recovery	Number of collisions and casualties	Yes	No	Yes
	Mobile	Before cost recovery	Number of collisions and casualties	Yes	No	No
New cameras	Fixed	Before camera introduction	Number of collisions and casualties	Yes	Yes	Yes
	Mobile	Before camera introduction	Number of collisions and casualties	Yes	Yes	No
Date		**Three years**[15]	**Monthly**	**By area**	**By camera**	**By camera**

All established cameras that were operating under cost recovery were taken to be conspicuous on or before the date that this was made mandatory (June 2002), and those that were established after this date were taken to be conspicuous from the start. The effect of operation under cost recovery was taken to apply to each camera site from whichever date was the later of the

[15] For Thames Valley, one year's baseline data was used due to changes in reporting practice during the relevant period.

partnership's acceptance into the programme and the establishment of the camera site.

3.3.1 Statistical modelling to separate out the effects of the cameras against other factors

Investigation showed that the effects of cameras varied substantially according to whether or not the site was urban or rural (as represented by speed limit: sites with a speed limit of 40mph or less being taken as urban, those with higher speed limits being taken as rural) and the camera type (mobile or fixed). We found no statistically significant difference between fixed, red-light and speed-distance cameras (they were found to be equally effective), and these have been grouped together in the analysis as ' fixed cameras' .

Thus separate estimates of effectiveness in respect of PICs and KSIs were made for each of the four combinations: Urban-Fixed, Urban-Mobile, Rural-Fixed and Rural-Mobile. In order to estimate the combined effect of safety cameras, the proportionate change was aggregated according to the number of collisions or casualties at sites of each combination to achieve weightings that were appropriate to the data. This method was used to find estimates for each of the categories Fixed (Urban-Fixed and Rural-Fixed), Mobile (Urban-Mobile and Rural- Mobile), Urban (Urban-Fixed and Urban-Mobile), Rural (Rural-Fixed and Rural-Mobile), and All.

The model considers variations in the observed numbers of casualties and collisions at each site. Several effects that were not associated with safety cameras are included, such as seasonal variations and long-term trend. Changes in the frequency of casualties and collisions that occur at the same time as safety camera interventions (establishment of a camera, a change in conspicuity requirements, or a change to operation under cost recovery) were then associated with this intervention.

Full details of the modelling approach are given in Appendix G.

As part of the data collection, we were also able to obtain data on the number of people killed at camera sites before and after the introduction of cameras. These were annualised and compared directly.

3.4 Results from statistical modelling

Over the study period there was a national trend of over 3.5% per annum reduction in KSIs and over 1.5% per annum reduction in PICs. All figures quoted in section 3.4 are model estimates over and above these national long-term trends.

3.4.1 Changes in killed or seriously injured casualties at camera sites, by urban/rural and by camera type

Table 3.2 shows the model estimates of the impact of safety cameras, in terms of changes to the frequency of KSIs, by urban (30mph and 40mph) and rural (50mph and above) and by camera type.

Table 3.2 Absolute and % changes in killed or seriously injured, for all cameras split by urban/rural and camera type (all figures over and above national long-term trend)

Changes to killed or seriously injured casualties (all partnership areas excluding South Wales)[16]									
	No of sites			Change in KSIs (absolute numbers)			Change in KSIs (percentage)		
Camera type	**Urban**	**Rural**	**Total**	**Urban**	**Rural**	**Total**	**Urban**	**Rural**	**Total**
Fixed sites	1955	346	2301	-808.6	-230.9	-1039.5	-46.80%	-62.40%	-49.50%
Mobile sites	1367	504	1871	-464.1	-244.3	-708.4	-34.90%	-33.80%	-34.60%
All sites	**3322**	**850**	**4172**	**-1272.7**	**-475.1**	**-1747.9**	**-41.60%**	**-43.50%**	**-42.10%**

Comments

- The headline figure is that KSIs fell by 42% at camera sites.
- This equated to about 1700 fewer KSIs per annum at these camera sites. 27% of this reduction was in rural areas. 73% of the reduction in KSIs was in urban areas.
- Some proportion of the reduction in KSIs is due to regression-to-mean, but the reductions attributable to safety cameras would remain substantial after allowing for this.
- Fixed sites have been more effective at reducing KSIs (-50%) when compared to mobile sites (-35%).
- Cameras have been similarly successful at reducing KSIs in urban and rural areas.
- The most effective combination of camera type and area was fixed camera sites operating in rural areas (-62%).
- The least effective combination of camera type and area at reducing KSIs, although still showing a substantial reduction (-34%), was mobile cameras in rural areas.
- We conclude that fixed sites in both urban and rural areas were more effective than mobile camera sites at reducing KSIs.
- About half of the overall reduction in KSIs was achieved at fixed camera sites in urban areas.
- The findings are also consistent with the speed analysis that also showed fixed camera sites to be more effective than mobile ones.
- The estimate of 42% reduction in KSIs has a 95% confidence interval of 40% to 45% (see Appendix G for a list of all confidence intervals).

[16] South Wales was excluded from the KSI analysis because of changes in reporting practice in the baseline period.

3.4.2 Changes in personal injury collisions at camera sites, by urban/rural and by camera type

Table 3.3 shows the model estimates of the effect of safety cameras, in terms of changes to the frequency of PICs, by urban (30mph and 40mph) and rural (50mph and above) and by camera type.

Table 3.3 Absolute and % changes in personal injury collisions, for all cameras split by urban/rural and camera type (all figures over and above national long-term trend)

Changes to personal injury collisions (all partnership areas)									
	No of sites			Change in PICs (absolute numbers)			Change in PICs (percentage)		
Camera type	**Urban**	**Rural**	**Total**	**Urban**	**Rural**	**Total**	**Urban**	**Rural**	**Total**
Fixed sites	2061	348	2409	-1955.7	-340.7	-2296.4	-22.40%	-33.20%	-23.60%
Mobile sites	1469	523	1992	-1643.4	-298.2	-1941.6	-22.40%	-15.50%	-20.90%
All sites	**3530**	**871**	**4401**	**-3599.2**	**-638.8**	**-4238**	**-22.40%**	**-21.60%**	**-22.30%**

Comments

- The headline figure is that PICs fell by around 22% in total.
- This equated to a reduction in PICs of about 4200 at camera sites.
- A modest proportion of the reduction in PICs is due to regression-to-mean, but the reductions attributable to safety cameras would remain substantial after allowing for this.
- Around 15% of this reduction in PICs was in rural areas. 85% was in urban areas.
- On the whole, fixed sites were slightly more effective at reducing PICs (-24%) when compared to mobile sites (-21%).
- On the whole, cameras were similarly successful at reducing PICs in urban and rural areas (-22%).
- The most effective combination of camera type and location at reducing PICs was fixed camera sites operating in rural locations (-33%).
- The least effective combination of camera type and location at reducing PICs, although still a reduction (-15%), was mobile cameras in rural locations.
- We conclude that fixed camera sites in rural areas are more effective than mobile camera sites at reducing collisions .
- The findings are consistent with the results of the speed analysis, which also showed fixed cameras to be more effective than mobile ones.
- The estimate of 22% reduction in PICs has a 95% confidence interval of 20% to 24%.

3.4.3 Changes in pedestrian collisions and casualties at camera sites, by camera type

In addition to examining the effect on total KSIs and PICs at camera sites, most partnership areas were also able to provide data on the number of pedestrian KSIs and PICs at camera sites. A further run of the model was carried out to establish whether or not there had been an impact on pedestrian collisions and casualties at camera sites.

Tables 3.4 and 3.5 show the model estimates of the combined effect, in terms of changes to the frequency of pedestrian KSIs and PICs, by camera type.

Table 3.4 Absolute and % changes in pedestrian KSI casualties, by camera type (all figures over and above national long-term trend)

	Number of sites contributing to the analysis	Changes in overall number of pedestrian KSIs	Changes in pedestrian KSIs
Camera type		**Total**	**%**
Fixed sites	1893	-113.9	-33.50%
Mobile sites	1738	-77.3	-24.60%
All camera sites	**3631**	**-191.2**	**-29.30%**

Table 3.5 Absolute and % changes in pedestrian PIC collisions, by camera type (all figures over and above national long-term trend)

	Number of sites contributing to the analysis	Changes in overall number of pedestrian PICs	Changes in pedestrian PICs
Camera type		**Total**	**%**
Fixed sites	2001	-247.7	-21.90%
Mobile sites	1856	-278.6	-24.40%
All camera sites	**3857**	**-526.3**	**-23.10%**

Comments

- Overall, across all cameras and partnership areas, there was a 29% reduction in pedestrian KSIs, and a 23% reduction in pedestrian PICs.
- In absolute terms there was a total reduction of about 190 pedestrian KSIs and 520 fewer pedestrian PICs per annum.
- The estimate of 29% reduction in pedestrian KSIs has a 95% confidence interval of 24% to 34%.
- The estimate of 23% reduction in pedestrian PICs has a 95% confidence interval of 20% to 26%.
- The results for pedestrian accidents and casualties will be affected less by regression-to-mean than are all accidents and casualties because these are not an explicit part of the selection rules.

3.4.4 Changes in child collisions and casualties at camera sites by camera type

In addition to examining the effect on KSIs and PICs at camera sites, most partnership areas were also able to provide data on collisions that involved children at camera sites.

Tables 3.6 and 3.7 show the model estimates of the combined effect in terms of changes to the frequency of child KSIs and PICs, by camera type.

Table 3.6 Absolute and % changes in child KSI casualties, by camera type (all figures over and above national long-term trend)

	Number of sites contributing to the analysis	Changes in number of child KSIs	
Camera type		**Total**	**%**
Fixed sites	2142	-74 .0	-36.90%
Mobile sites	1740	-39.6	-25.40%
All camera sites	**3882**	**-113.6**	**-31.90%**

Table 3.7 Absolute and % changes in child PIC collisions, by camera type (all figures over and above national long-term trend)

	Number of sites contributing to the analysis	Changes in number of child PCIs	
Camera type		**Total**	**%**
Fixed sites	2250	-95.4	-10.30%
Mobile sites	1858	-249.6	-24.70%
All camera sites	**4108**	**-345**	**-17.80%**

Comments

- Overall, across all cameras, there was a 32% reduction in child KSIs, and a 18% reduction in child PICs.
- In absolute terms, there was a total reduction of about 110 child KSIs and 345 fewer child PICs per annum.
- The estimate of 32% reduction in child KSIs has a 95% confidence interval of 25% to 38%.
- The estimate of 18% reduction in child PICs has a 95% confidence interval of 14% to 22%.
- The results for child accidents and casualties will be affected less by regression-to-mean than are all accidents and casualties because these are not an explicit part of the selection rules.

3.4.5 Changes in personal injury collisions at camera sites, by partnership area

In order to investigate the possibility of differences between the performance of partnership areas, the statistical model was extended to include a separate effect for each area (details of this are given in Appendix G). This model estimated for each partnership area the performance over and above that attributed to the mix of camera types (fixed/mobile) and their locations (urban/rural).

The results of this model, aggregated over all sites within a partnership area, can be used to provide an indication of the performance of each area. The results of this are shown in Table 3.8. These are area-by-area estimates of changes in PICs due to full implementation of cameras (introduction, cost recovery, and fixed conspicuity), at the camera types and locations in each area's data. They can be compared with the general effect of 22% reduction estimated jointly from all sites in the study.

The first column of figures in Table 3.8 is the estimated number of accidents at the sites in 2004 in the absence of cameras. It broadly indicates the scale of the sample in each area. Each of the area estimates was compared with the general effect of 22% reduction in PICs estimated jointly from all sites in the study, with the results shown graphically in Figure 3.1.

As would be expected, these estimates are distributed around the general value: there are several reasons for these differences in partnerships, including differences in the mix of cameras that were deployed, differences in the types of site that were treated, the level of camera activity present prior to the base-line and in the scope for making improvements in light of the prevailing levels of road safety.

3.4.6 Changes in killed or seriously injured at camera sites, by partnership area

A model similar to that described in 3.4.5 was used to investigate differences between the effects on KSIs between areas. Because KSIs occur relatively infrequently, there was not sufficient data (in terms of active camera months) to produce a reliable estimate for all areas. Evidence is, however, accumulating and subsequent analysis could revisit this once more data is available for these partnerships. Table 3.9 shows the model estimates for KSI's by area. Each of the area estimates was compared with the general effect of 42% reduction in KSIs estimated jointly from all sites in the study.

Table 3.8 Estimates of the combined effect on PICs of cameras operating under cost recovery, by partnership area

Effect on personal injury collisions (per annum) at camera sites				
Partnership	**PIC pa**	**Change (%)**	**Confidence interval 95%**	
Avon and Somerset	1343.5	-11.7	-22.9	1.1
Bedfordshire	262.5	-48.6	-57.2	-38.3
Cambridgeshire	269.7	-1.3	-15.6	15.4
Cheshire	160.8	-5.1	-23.8	18.2
Cleveland	214.2	-44.6	-53.0	-34.7
Cumbria	199.8	-40.7	-52.2	-26.4
Derbyshire	734.6	-24.2	-34.3	-12.5
Devon and Cornwall	220.0	-30.6	-42.5	-16.1
Dorset	562.7	-12.6	-25.2	2.2
Essex	760.1	-20.4	-30.3	-9.2
Fife	182.9	-0.6	-20.7	24.6
Grampian	177.1	36.5	14.3	63.0
Greater Manchester	914.2	-14.2	-25.2	-1.6
Hampshire	640.4	-22.5	-32.9	-10.5
Hertfordshire	235.3	-37.7	-48.1	-25.2
Humberside	259.3	-26.0	-38.8	-10.5
Kent	377.3	-23.9	-34.7	-11.4
Lancashire	578.8	-19.8	-30.1	-8.0
Leicestershire	690.6	-21.6	-32.0	-9.6
Lincolnshire	181.5	-32.2	-44.1	-17.8
London	2749	-17.0	-24.8	-8.4
Norfolk	393.7	-36.3	-46.2	-24.6
North Wales	416.9	-30.8	-40.7	-19.4
Northamptonshire	123.1	-54.3	-62.8	-43.8
Northumbria				
- Northumberland	94.5	-26.5	-44.3	-3.1
- Tyne and Wear	189.5	-6.9	-23.6	13.3
Nottinghamshire				
- Nottingham City	512.8	-14.5	-25.4	-1.9
- Nottinghamshire (XCity)	270.8	-22.7	-34.0	-9.5
South and Mid Wales				
- Dyfed-Powys	310.6	-29.5	-40.0	-17.1
- Gwent	261.4	-36.7	-46.6	-24.9
- South Wales	512.6	-1.8	-14.7	13.0
South Yorkshire	1251.5	-48	-54.7	-40.4
Staffordshire	379.7	-7.6	-22.2	9.7
Stathclyde				
- Glasgow City	150.2	-30.1	-42.8	-14.6
- Strathclyde(new2002)	126.7	-38.5	-52.0	-21.2
Suffolk	116.9	-25.5	-41.2	-5.6
Sussex	337.3	-22.0	-33.2	-9.0
Thames Valley	178.2	-8.9	-25.4	11.3
Warwickshire	212.4	-19.9	-32.5	-4.9
West Mercia	260.0	-33.2	-45.0	-18.8
West Midlands	851.8	-9.0	-20.2	3.8
West Yorkshire	23.5	-72.8	-88.7	-34.5
Wiltshire	193.7	-44.5	-55.8	-30.3

Comment on PIC tables

- Most partnership areas have demonstrated a significant reduction in PICs at camera sites. Other areas are not significantly different from zero, apart from Grampian – the only area to show an increase at camera sites.

Table 3.9 Estimates of the combined effect on KSIs of cameras operating under cost recovery for at least a year, by partnership area

Effect on killed and seriously injured (per annum) at camera sites				
Partnership	KSI pa	Change (%)	Confidence interval 95%	
Avon and Somerset	142.2	8.8	-1.8	20.5
Bedfordshire	72.4	-72.2	-77.8	-65.3
Cambridgeshire	66.7	-45.2	-54.0	-34.8
Cheshire	32.2	4.0	-19.7	34.9
Cleveland	26.5	-14.3	-28.1	2.2
Cumbria	68.4	-47.4	-57.3	-35.1
Derbyshire	163.8	-26.0	-33.5	-17.7
Devon and Cornwall	67.3	-67.5	-75.1	-57.6
Dorset	111.3	-25.1	-35.6	-12.8
Essex	119.6	-10.6	-18.5	-1.9
Fife	43.9	40.9	14.3	73.7
Grampian	58.3	20.7	4.0	40.1
Greater Manchester	111.0	-32.5	-41.7	-21.9
Hampshire	127.0	-39.7	-46.6	-31.9
Hertfordshire	62.3	-69.7	-76.4	-61.1
Humberside	61.7	-51.4	-61.6	-38.5
Kent	100.0	-52.6	-59.4	-44.6
Lancashire	99.1	-24.8	-33.0	-15.5
Leicestershire	111.7	-52.1	-58.6	-44.5
Lincolnshire	62.2	-38.2	-49.1	-25.0
London	539.3	-29.9	-37.4	-21.4
Norfolk	178.9	-66.9	-71.2	-62.1
North Wales	81.9	-51.8	-58.8	-43.5
Northamptonshire	37.4	-47.9	-57.4	-36.2
Northumbria				
- Northumberland	45.9	-68.4	-78.7	-53.0
- Tyne and Wear	45.8	-49.0	-70.9	-10.7
Nottinghamshire				
- Nottingham City	97.1	-27.4	-50.5	6.5
- Nottinghamshire (XCity)	86.5	-46.7	-64.8	-19.2
South and Mid Wales				
- Dyfed-Powys	130.5	-52.2	-57.8	-45.9
- Gwent	80.7	-74.5	-79.2	-68.6
South Yorkshire	177.0	-51.7	-56.7	-46.1
Staffordshire	30.2	5.2	-18.9	36.4
Stathclyde				
- Strathclyde(new2002)	27.7	-22.6	-55.4	34.3
- Glasgow City	34.0	-30.4	-57.8	14.8
Suffolk	53.5	-68.2	-76.2	-57.5
Sussex	61.1	-37.2	-47.0	-25.5
Thames Valley	35.5	-44.7	-59.7	-24.2
Warwickshire	76.5	-39.1	-47.3	-29.7
West Mercia	66.3	-58.4	-67.6	-46.6
West Midlands	284.4	-64.4	-67.9	-60.6
West Yorkshire	2.5	-45.1	-84.1	88.9
Wiltshire	75.5	-65.8	-73.5	-55.9

Comment on KSI tables

- Most partnership areas have demonstrated a significant reduction in KSIs at camera sites. The only areas to show an increase are Grampian and Fife, but on small sample sizes.

Figure 3.1 % Change in PICS at camera sites, by partnership area (only significant areas shown)

Figure 3.2 Change in PICs (Percentage) at camera sites

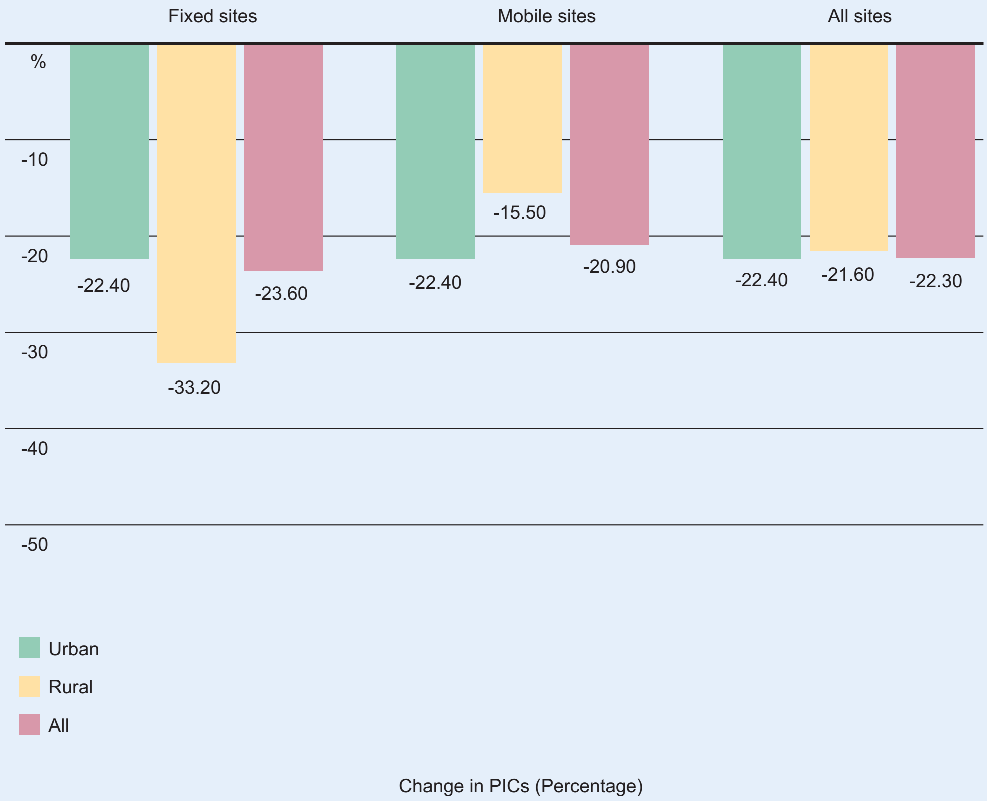


Figure 3.3 % Change in KSIs at camera sites, by partnership area

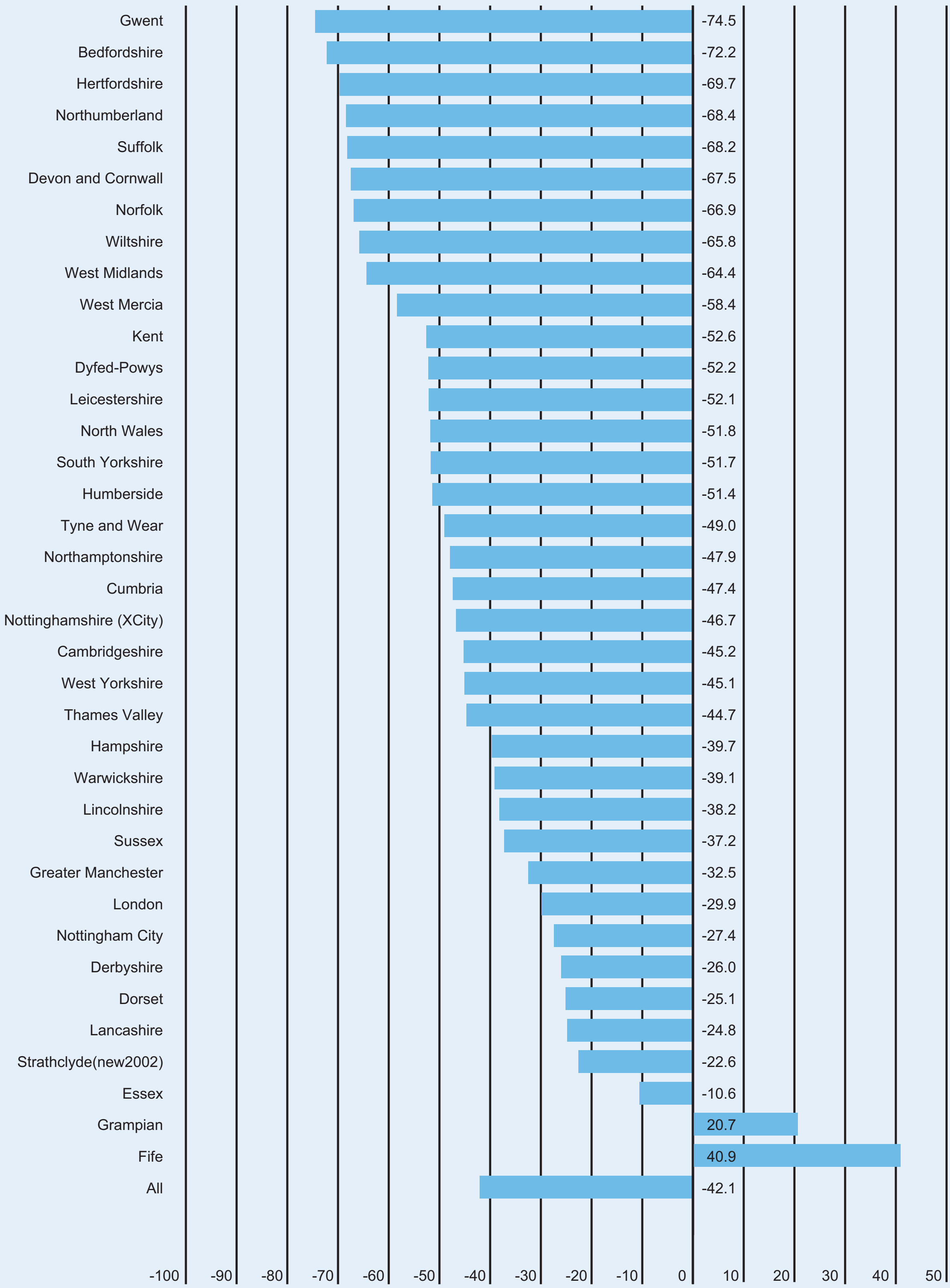
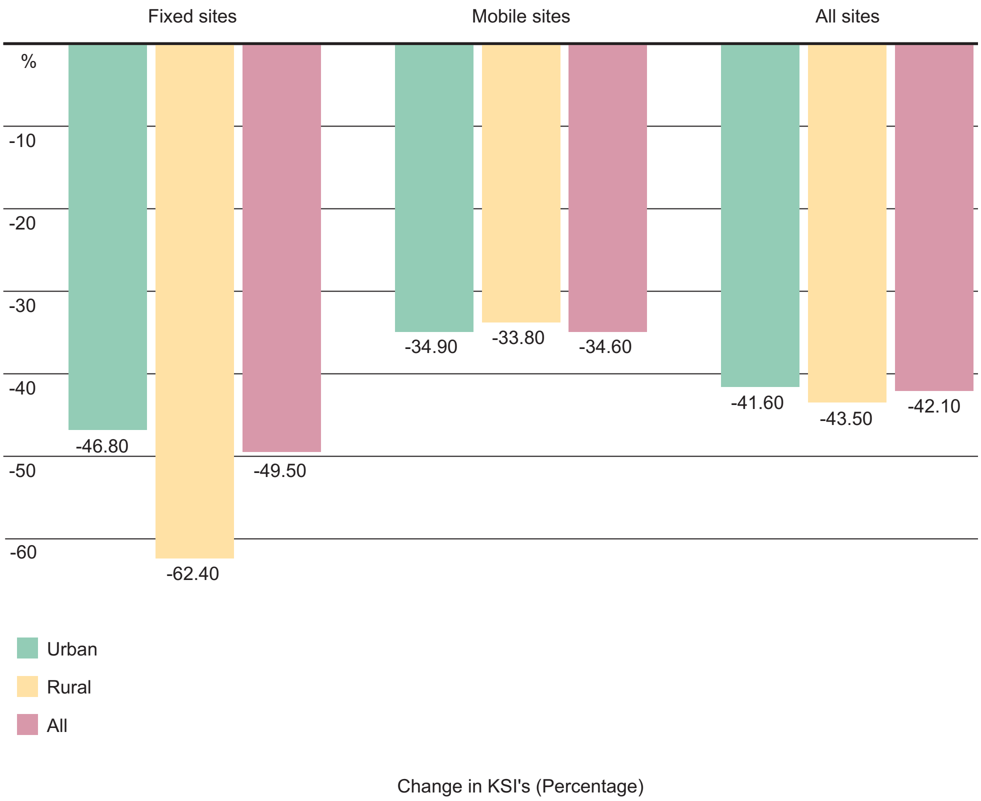


Figure 3.4 Change in KSIs (Percentage)



3.5 Further analysis

3.5.1 Changes in fatalities at camera sites, by camera type

We were also asked to examine whether or not there had been changes in overall number of fatalities at camera sites. Results – shown in Table 3.10 – were annualised to allow a direct before and after comparison.

Table 3.10 Changes in fatalities only, by camera type and urban/rural, showing the before and after frequency at camera sites

Changes to fatalities at camera sites (per annum figures)									
	No of sites			Change in fatalities (absolute numbers)			Change in fatalities (percentage)		
Camera type	**Urban**	**Rural**	**Total**	**Urban**	**Rural**	**Total**	**Urban**	**Rural**	**Total**
Fixed sites	1853	301	2154	-23	-18	-42	-20%	-65%	-29%
Mobile sites	1167	431	1598	-42	-16	-59	-45%	-22%	-35%
All camera sites	**3020**	**732**	**3752**	**-66**	**-34**	**-100**	**-31%**	**-33%**	**-32%**

Comments

- Across 3,752 sites, there were 100 fewer fatalities per annum in the 38 partnership areas.
- This equates to a 32% reduction in frequency of fatalities at these sites.
- No adjustment was applied to account for long-term trend as the number of killed did not drop substantially in this study period.

3.5.2 Can we associate changes in speed with changes in casualties?

In section 2, we compared speeds at camera sites before and after enforcement and showed that there had been substantial reductions in speed at camera sites. In this section, we have also shown that there have been significant reductions in casualties at camera sites. Table 3.11 compared the reductions in casualties to the reductions in speeds to see if there is any association between the reductions in speed and reductions in casualties. This was split between fixed and mobile camera and also urban and rural speed limits.

Table 3.11 Is there an association between changes in speed and casualties (% changes)

	Changes in speed (%)					Changes in casualties (%)			
Camera type	Speed limit	% exceeding limit	% >15mph over limit	Average speed	85th percentile speed	Personal injury collisions	Killed	Killed or seriously injured	Pedestrian KSI
Fixed	Urban	-72%	-94%	-16%	-20%	-22%	-20%	-47%	-34%
	Rural	-51%	-62%	-10%	-11%	-33%	-65%	-62%	–
Mobile	Urban	-18%	-38%	-4%	-4%	-22%	-45%	-35%	-25%
	Rural	-18%	-32%	-2%	-2%	-15%	-22%	-34%	–

Comments

- There is an association between changes in speed and casualties.
- Speed surveys at mobile sites showed that, whilst they do reduce vehicle speeds, greater reductions in speeds were achieved at fixed camera sites.
- This translates into consistently greater casualty reductions at fixed camera sites when compared to mobile sites.
- Mobile cameras affect PICs in a similar way to fixed cameras. Mobile cameras are effective, but less so than fixed cameras.

3.6 Conclusions

- The results showed that, overall, the number of killed or serious casualties and personal injury collisions had reduced at camera sites. These reductions were over and above the national long-term trend.
- There was around 42% fewer KSIs at cameras sites and 22% fewer PICs.
- Some proportion of the reduction observed in KSIs and a modest proportion of that in PICs is attributable to regression-to-mean, though the reductions attributable to cameras would remain substantial after allowing for this.
- Fixed camera sites were more effective at reducing casualties than mobile cameras, although both reduce speed, collisions, casualties and deaths.
- Fatalities were down substantially at camera sites (a reduction in excess of 32%). There were 100 fewer deaths.
- Pedestrian casualties were also down (a reduction of 23% in PICs and a reduction of 29% in KSIs).
- There was an association between the fall in speed and the fall in collisions, casualties or deaths at camera sites.

Comparison of different approaches to estimation of effects of safety cameras.

4.1 Estimation of effects

When assessing the effects of a safety treatment such as the introduction of safety cameras, the observed number of collisions and of casualties that occur following treatment is compared with an estimate of what would have been expected in the absence of the treatment. This will in turn have a direct consequence for the estimate of effectiveness of the treatment. Several different methods are available to estimate what would have been expected in the absence of treatment, each of which has its own properties and takes into account different influences. Three possibilities for this are discussed and the consequences for estimates of effectiveness of safety cameras of adopting an approach that differs from that used in Section 3 of this report are explored.

An important concern in estimating the likely future frequency of collisions and casualties at a road site is the way in which the site is selected for investigation and treatment. In cases where part of the selection criteria for a site requires the number of collisions or casualties to exceed a certain minimum, the frequency observed in the future will tend to be lower than that used as the basis for selection – a general statistical phenomenon that is known as regression-to-mean (RTM). If the frequency used for selection is then used as the basis for estimation of what would have happened in the absence of treatment, the possibility arises that this will be overestimated hence leading to an overestimate of the effectiveness of the treatment. This has been discussed in the present context by Hauer (1997) and Hirst, Mountain and Maher (2004) amongst others, and is recognised by the Department for Transport (2001, p77).

The size of regression-to-mean depends on several factors, including the duration of the period of observation, the minimum number of events that are required for a site to be considered, and which other criteria are used in site selection. The current selection criteria for sites of safety cameras are listed in Appendix A of this report; these include (for speed enforcement cameras) not only numbers of collisions but also presence of speeding during off-peak conditions and speed as a causal factor in some or all collisions. Davis (2000) points out that where criteria of this kind are used in addition to numbers of casualties and accidents, this will tend to reduce the size of the RTM effect, whilst Gorell and Sexton (2004) point out that this use of additional criteria causes difficulty in identifying correctly the population of potential camera sites for use in estimating the effect.

4.2 Methods to estimate frequencies in the absence of treatment.
Several methods are available to estimate the likely future frequency of collisions and casualties at a site; some relevant ones are described here.

The log-linear modelling method that is used in the collision and casualty analysis in Section 3 of this report uses the frequency observed at each site during a baseline period before the introduction of cost recovery at that site. This frequency was then adjusted for seasonality and national long-term trend according to the analysis that is presented in Appendix G of this report. This method makes no adjustment in respect of regression-to-mean.

A method that is based on experimental design is discussed by the Department for Transport (2001, p77). This uses control sites that are eligible for treatment and are selected in exactly the same way as the treated sites: sites from the group that satisfy all selection criteria are allocated at random either to treatment or to control, possibly from matched pairs. Provided that the control sites are independent of those that are treated and are selected in the same way, their safety record will provide an estimate of what would have happened at the treated sites if treatment had been withheld. Because this approach entails non-treatment of eligible sites, it can be difficult to justify, especially in large-scale studies of beneficial treatments. Practical safety studies sometimes use a group of comparison sites that are similar to the study sites rather than a randomly assigned control group (for example, in the case of safety cameras, Christie, Lyons, Dunstan and Jones (2003) and Gorell and Sexton (2004) used nearby untreated sites with similar collision frequencies for comparison). However, when assignment is not made at random there will inevitably be systemmatic differences between the two groups and it cannot then be assumed that non-scheme effects are the same for both. In the present case, no such control sites were identified and left untreated, so this method cannot be applied.

A third method is to use a statistical approach to adjust the observed baseline frequencies according to other estimates of the underlying accident rates for a population of sites from which those being investigated are drawn. When the relevant estimates are based upon observed data from a larger set of sites, this can be achieved by the empirical Bayes method as has been discussed by Hauer (1997) amongst others, and has recently been applied to analysis of the present kind (Hirst, Mountain and Maher, 2004). In the case that the relevant criterion for selection from the larger set of sites is the number of collisions or casualties that have occurred, this is the best available method to correct for effects caused by regression-to-mean. This approach has been applied by Mountain and Maher to a subset of sites from the present study: details of this are given in Appendix H of this report. The estimates of effectiveness of safety cameras operating under cost recovery that result from this analysis are compared in this section with those of the main statistical analysis of this report applied to the same subset of sites.

4.3 Summary of the empirical Bayes method

The empirical Bayes approach developed by Hirst, Mountain and Maher (2004), and that is applied in Appendix H of the present report uses statistical models to estimate the mean frequencies of collisions towards which regression will take place. These models are based upon observations of a set of sites that were made during the years 1980-1991, and are adjusted according to the national trend of collisions that has occurred at sites of the relevant kind between then and the time of the baseline period. The parameters of these models depend on the collision type (all personal injury, or fatal or serious injury), road class, carriageway type and speed limit, and have as explanatory variables vehicular flow, the length of the site, and the number of minor intersections within the site. The models provide an independent estimate of the mean annual number of collisions at the study sites with those characteristics. This prior estimate is used as the mean towards which regression from the observed number of collisions takes place; the strength of that regression is calculated according to the dispersion of the statistical models when calibrated to the original data. The number of collisions estimated by this calculation is the Bayesian posterior estimate, and represents the expected value occurring at sites with the same characteristics and record of collisions.

This method depends on use of a statistical model of mean accident frequency so that it can be used only for sites at which an appropriate statistical model and suitable data are available. In the present case, models are available for the expected annual numbers of each of personal injury collisions (PIC), and fatal or serious collisions (FSC) occurring on single carriageway urban roads. In this context, data could be secured to enable the models to be used at sites where a conspicuous camera was installed to operate under cost recovery and there was no camera present during the baseline period; the sites that were analysed were all urban, had baseline periods of duration 3 years, and had cameras installed after the baseline period. Because the statistical models use certain data (traffic flows and number of minor junctions within the site) that were not recorded as a matter of routine, their application required requests to the partnerships for supplementary data.

4.3.1 Dataset for comparison

Because of the restrictions to the model and requirements for additional data, including records of the numbers of FSC collisions, the empirical Bayes analysis could be applied only to a subset consisting of 216 of the 3530 urban sites within the 4401 that were used for the main study. All of these 216 sites had full 3-year baseline data periods. Of these sites, 52 were for fixed cameras and 164 were for mobile ones, and they all came from 9 of the 40 partnership areas. The distribution of the data between fixed and mobile camera sites is compared in Table 4.1 with the corresponding ones for urban sites, for rural sites and for all sites used in the main study. This shows that whilst about 42 per cent of all urban sites had mobile cameras, the majority (about 75 per cent) of those in the subset of 216 that was investigated using the empirical Bayes analysis had mobile cameras.

Table 4.1: Numbers of sites where the empirical Bayes and the log-linear analyses were applied to data for PICs

Sites	Fixed	Mobile	All cameras
Subset	52	164	216
All areas			
Urban	2061	1469	3530
Rural	348	523	871
Total	**2409**	**1992**	**4401**

In order to provide a basis for comparison, the frequency of PIC collisions that would have occurred at these sites during the camera period of the subset of 216 sites if no cameras had been installed was estimated by projecting the baseline observations for each site forward to a common date allowing for national long-term trend. The results of this are shown in Table 4.2. This was undertaken to provide a common reference period because the baseline periods differed between sites in their timing and the camera periods differed in their duration. This shows that the frequency of PIC collisions at the 216 sites used in the empirical Bayes analysis was lower than usual for urban sites in the full dataset, and that this difference was greater at the fixed camera sites (3.15 vs 4.31 PIC per site-year) than at the mobile ones (4.63 vs 5.11 PIC per site-year). The corresponding estimates for frequency of KSI casualties that would have occurred at the subset of 216 sites during the camera period if no cameras had been installed are shown in Table 4.3. This shows that the estimated mean frequency (0.547 per site-year) of KSI casualties at fixed camera sites in the subset to which the empirical Bayes analysis was applied is less than that (0.863) at all urban fixed camera sites whilst the corresponding frequencies were similar (1.139 vs 1.004 respectively) at mobile camera sites. Taken together, these observations show that the sites used in the empirical Bayes analysis were not typical of the urban fixed camera sites used in the main analysis although reasonably typical of the urban mobile camera sites, so that the results should be treated cautiously in respect of effects that might apply more widely at least for fixed camera sites.

Table 4.2: Summary of estimated frequency of PIC collisions during the camera period at the subset of 216 sites

PIC per site-year	Fixed	Mobile	All cameras
Subset of sites.	3.15	4.63	4.27
All urban	4.31	5.11	4.65
All rural	2.85	3.75	3.39
All areas	**4.10**	**4.75**	**4.40**

Table 4.3: Summary of estimated frequency of KSI casualties during the camera period at the subset of 216 sites

No per site-year	Fixed	Mobile	All cameras
Subset of sites	0.547	1.139	0.997
All urban	0.863	1.004	0.921
All rural	0.997	1.462	1.273
All areas	**0.883**	**1.128**	**0.993**

4.4 Results of the analysis using the log-linear model and the analysis presented in Section 3.

The results of applying the log-linear model for PICs at all 3530 urban sites that were used in the main study are summarised in Table 4.4, together with their application to the subset of 216 urban sites that were available for the empirical Bayes analysis. The aggregate estimate of effectiveness is calculated in each case by estimating effects on numbers of PIC collisions. This was achieved by using the estimated national long-term trend and seasonal effects in the log-linear model to project the baseline observations forward to the time of the camera period. The log-linear model estimates of camera effect for the relevant areas of the 216 sites were then applied to calculate the changes in annual PIC per site associated with introduction of the camera operating under cost recovery. These effects are expressed in terms of changes in the number of PICs occurring at each site during the camera period in order to facilitate comparisons between these estimates of effect and those from the empirical Bayes analysis.

The estimated effect of -0.56 per site-year in reducing PIC collisions of safety cameras at fixed sites in the subset of 216 sites differs significantly at the 5% level from the corresponding estimate of -0.97 per site-year at all urban fixed sites. This is due in part to the lower frequency of PICs at fixed sites in the subset. However, the estimated effect of -0.92 per site-year in reducing PIC collisions of safety cameras at mobile sites in the subset of 216 sites does not differ significantly from the corresponding estimate of -1.15 per site-year at all urban mobile sites.

Table 4.4: Estimated effects of introduction of safety cameras on PICs per site-year at the subset sites during the camera period based upon the log-linear analysis

PIC per site-year	Sites	Estimate	95% Confidence Interval		PICs
Fixed	52	-0.56	-0.93	-0.12	163.7
Mobile	164	-0.92	-1.43	-0.32	759.1
All subset sites	**216**	**-0.83**	**-1.31**	**-0.27**	**922.8**
Urban sites					
Fixed	2061	-0.97	-1.05	-0.89	8934.9
Mobile	1469	-1.15	-1.23	-1.07	7534.1
All urban sites	**3530**	**-1.04**	**-1.12**	**-0.96**	**16469.0**

In summary, the estimated average reduction in PICs during the camera period at the 52 fixed camera sites that is associated with its implementation is about 0.56 PIC per site-year. The corresponding estimate of reduction at the 164 mobile camera sites is larger, at about 0.92 PIC per site-year, which is due in part to the greater length of road over which collisions are recorded at mobile sites. The aggregate estimated saving at all sites during the camera period of 0.83 PIC per site-year is weighted towards the estimate at mobile sites because of their greater proportion in this subset of sites.

The results of these calculations are compared in Table 4.5 with the differences observed at these sites between the baseline period and the camera period: the model-based estimates differ from the observed changes after allowing for trend and seasonal effects because the log-linear model was fitted to data for all sites in the 9 partnership areas rather than to these 216 sites alone.

Table 4.5: Estimated effects of introduction of safety cameras on PICs at the subset sites based upon the log-linear analysis.

	Camera type		
	Fixed	**Mobile**	**All sites**
Sites	52	164	216
PIC per site-year			
Baseline	3.40	5.05	4.65
Estimated after without camera	3.15	4.63	4.27
Observed after	2.53	3.44	3.22
Observed change	-0.87	-1.61	-1.43
of which:			
Change after allowing for trend	-0.62	-1.19	-1.05
Estimated effect of safety camera	-0.56	-0.92	-0.83

The results of the log-linear model for KSIs at all 3322 urban sites in the database are summarised in Table 4.6, together with their application to the 216 urban sites that were available for the empirical Bayes analysis. The aggregate effects are calculated in each case by estimating effects on numbers of KSI casualties.

Table 4.6: Estimated effects of introduction of cameras on KSIs per site-year during the camera period based upon the log-linear analysis

KSI	Sites	Estimate	95% Confidence Interval		KSIs
Subset					
Fixed	52	-0.18	-0.23	-0.12	28.4
Mobile	164	-0.41	-0.48	-0.32	186.8
All subset sites	**216**	**-0.35**	**-0.42**	**-0.27**	**215.3**
Urban sites					
Fixed	1955	-0.43	-0.45	-0.41	1807.6
Mobile	1367	-0.36	-0.38	-0.33	1389.2
All urban sites	**3322**	**-0.40**	**-0.42**	**-0.38**	**3196.9**

According to Table 4.6, the estimated effectiveness of safety cameras in reducing KSIs differs substantially between fixed and mobile sites, with an estimated reduction of about 0.18 KSI per site-year at fixed camera sites in the subset compared with about 0.41 KSI per site-year at mobile camera sites. The estimate for fixed sites in the subset of 216 sites also differs significantly from the corresponding estimate of 0.43 KSI per site-year at all urban fixed sites, though this will be due in part to the lower frequency of KSIs at fixed sites in the subset.

Direct comparisons between these results from the main log-linear analysis and those of the empirical Bayes analysis are not possible in the case of KSI casualties. This is because no statistical model is available to generate the reference values of KSI casualties for use in the empirical Bayes analysis. However, the effects on KSI are now expressed in terms comparable to those of changes in the number of PICs occurring at each site during the camera period, with the calculations undertaken in the corresponding manner. The results of this are shown in Table 4.7: according to this, the estimated average reduction in KSIs during the camera period at the 52 fixed camera sites that is associated with camera implementation is about 0.18 KSI per site-year. The corresponding estimate of reduction at the 164 mobile camera sites is about twice as large, at about 0.41 KSI per site-year, which is due in part to the greater length of road over which collisions are recorded at mobile sites. The aggregate estimated saving at all sites during the camera period of 0.35 KSI per site-year is weighted towards the estimate at mobile sites because of their greater proportion in this subset of sites.

Table 4.7: Estimated effects of introduction of safety cameras on KSIs at the subset sites based upon the log-linear analysis.

	Camera type		
	Fixed	**Mobile**	**All sites**
Sites	52	164	216
KSI per site-year			
Baseline	0.63	1.34	1.17
Estimated after without camera	0.55	1.14	1.00
Observed after	0.38	0.63	0.57
Observed change	-0.25	-0.71	-0.60
of which:			
Change after allowing for trend	-0.17	-0.51	-0.43
Estimated effect of safety camera	-0.18	-0.41	-0.35

4.5 Results of the empirical Bayes analysis

Mountain and Maher have applied their empirical Bayes analysis to the subset of 216 urban sites described above; they describe this application in Appendix H of this report. The results of this are summarised in this section in a form that facilitates their comparison with those from the log-linear analysis. The reference for this comparison is the expected numbers of collisions at these sites during the camera period if cameras had not been installed, and this is calculated by applying estimates of the RTM and trend effects to the data observed during the baseline period.

The results of the empirical Bayes analysis applied to PICs are presented in Table 4.8, which will be compared with Table 4.5 that shows the corresponding results from the log-linear analysis. This starts from the observed change in PICs per site-year (calculated as the difference between the number during the baseline period and that during the after period); the effect associated with implementation of safety cameras is calculated by subtracting estimates of the trend and regression-to-mean from the observed change. According to this, for the 52 fixed camera sites the estimated average annual reduction in PICs that is associated with their implementation is about 0.50 PIC per site-year (95% Confidence Interval (-0.94, -0.09) from Table H.5 of Appendix H). The corresponding estimate of reduction at mobile camera sites is about 0.83 PIC per year (95% Confidence Interval (-1.18, -0.48) from Table H.5 of Appendix H); the central estimate at mobile sites is larger than that for fixed sites, though the difference is not statistically significant at the 5% level.

Table 4.8: Estimated effects of introduction of safety cameras on PICs at the subset sites based upon the empirical Bayes analysis

	Camera type		
	Fixed	Mobile	All sites
Sites	52	164	216
PIC per site-year			
Baseline	3.40	5.05	4.65
Estimated after without camera	3.03	4.28	3.97
Observed after	2.53	3.44	3.22
Observed change	-0.87	-1.61	-1.43
of which:			
Estimated effect of trend	-0.29	-0.39	-0.37
Estimated regression-to-mean	-0.08	-0.38	-0.31
Estimated effect of safety camera	-0.50	-0.83	-0.75

The results of the empirical Bayes analysis applied to FSC collisions are presented in Table 4.9, based upon a corresponding analysis to that of the PICs. Although some comparison is possible with Table 4.7, the comparison is not direct because the log-linear analysis was applied to KSI casualties whilst the empirical Bayes analysis was applied to numbers of FSC collisions. According to Table 4.9, the estimated average annual reduction in FSCs at the 52 fixed camera sites that is associated with camera implementation is about 0.10 FSC per site-year (95% Confidence Interval (-0.23, +0.05) from Table H.9 of Appendix H). The corresponding estimate of reduction at mobile camera sites is similar, at about 0.11 FSC per site-year (95% Confidence Interval (-0.22, -0.02) from Table H.9 of Appendix H). Because the estimates are similar at these different kinds of sites, the proportions in which they occur does not have a strong influence on the aggregated estimate for all sites in the subset, which is therefore about 0.11 FSC per site-year year (95% Confidence Interval (-0.19, -0.02) from Table H.9 of Appendix H).

Table 4.9: Estimated effects of introduction of safety cameras on FSCs based upon the empirical Bayes analysis

	Camera type		
	Fixed	Mobile	All sites
Sites	52	164	216
FSC per site-year			
Baseline	0.60	1.19	1.05
Estimated after without camera	0.43	0.63	0.59
Observed after	0.33	0.52	0.48
Observed change	-0.27	-0.67	-0.57
of which:			
Estimated effect of trend	-0.06	-0.11	-0.10
Estimated regression-to-mean	-0.11	-0.45	-0.36
Estimated effect of safety camera	-0.10	-0.11	-0.11

4.6 Discussion of results

Each of the log-linear and the empirical Bayes analyses presented here provides an estimate of the size of reduction in personal injury collisions (PICs) that result from the introduction of cameras. These estimates, which were introduced in Tables 4.5 and 4.8, are presented together in Table 4.10 for convenient comparison.

Table 4.10: Estimated effects of introduction of safety cameras on PIC collisions per site-year

PIC per site-year	Sites	Estimate	95% Confidence Interval	
Fixed camera	**52**			
Log-linear		-0.56	-0.93	-0.12
Empirical Bayes		-0.50	-0.94	-0.09
Mobile camera	**164**			
Log-linear		-0.92	-1.43	-0.32
Empirical Bayes		-0.83	-1.18	-0.48

From Table 4.10 it can be seen that in the case of fixed cameras, the estimates of reductions for the subset of 216 sites are similar at 0.56 and 0.50 PIC per site-year. The lower estimate of effect arises from the empirical Bayes analysis which includes an allowance for regression-to-mean. Both estimates contrast with the significantly greater estimate of saving at all urban fixed camera sites in the main study which at 0.97 PIC per site-year is nearly twice as great. This arises because of the greater frequency of PICs per site-year and the larger estimated effect of cameras in the main study areas.

In the case of mobile camera sites in the subset of 216, each of the two estimates of reduction of 0.92 and 0.83 PIC per site-year is larger than the corresponding one at fixed sites, and the estimated difference between them is also larger in absolute terms. As before, the lower empirical Bayes estimate takes into account regression-to-mean.

In summary, each of the cases of fixed and mobile sites, allowing for regression-to-mean leads to an estimate of reduction in PIC collisions that is smaller by about one ninth compared with the corresponding estimate using the log-linear analysis.

The comparisons between the log-linear and the empirical Bayes analyses is relatively straightforward for the personal injury collisions (PICs), but is complicated for the more serious injuries. This is because the log-linear analysis was undertaken on numbers of casualties killed or seriously injured whilst the empirical Bayes analysis was undertaken on numbers of collisions in which there was a fatal or seriously injured casualty. This means that the results of these two analyses cannot be compared directly: any such comparison would require some assumption about the ratio of KSI to FSC, which is subject to many sources of variation. Estimates of these distinct quantities, which were introduced in Tables 4.6 and 4.9, are presented together in Table 4.11.

Table 4.11: Estimated effects of introduction of safety cameras on FSCs and KSIs

FSC and KSI per site-year	Sites	Estimate	95% Confidence Interval	
Fixed camera	**52**			
KSI Log-linear		-0.18	-0.23	-0.12
FSC Empirical Bayes		-0.10	-0.23	+0.05
Mobile camera	**164**			
KSI Log-linear		-0.41	-0.48	-0.32
FSC Empirical Bayes		-0.11	-0.22	-0.02

After adjusting for the effects of seasonality and long-term trend, the estimates for the subset of sites from the log-linear analysis of changes in KSI casualties associated with safety cameras are reductions of about 0.18 and 0.41 KSI per site-year respectively for fixed and mobile camera sites. The estimate of reduction of 0.18 KSI per site-year at urban fixed camera sites in the subset of 216 sites is about half of and differs significantly from that of 0.43 KSI per site-year for all urban fixed camera sites in the main study, though this will be due in part to the lower frequency of KSIs at fixed sites in the subset.

The empirical Bayes estimate of changes in FSC casualties associated with safety cameras (see Appendix H for a full description) makes adjustments for the estimated effects of long-term trend and regression-to-mean. For this subset, the estimated reduction is similar at about 0.1 FSC per site-year for each of fixed and mobile camera sites in the subset of 216. An effect of this size would lead to estimates of savings in KSIs due to safety cameras that remain substantial. Although direct comparisons between the changes in KSI casualties and FSC collisions are not possible, this suggests that at fixed camera sites, the effect of RTM in more serious casualties is comparable to that for the less serious but more numerous PIC collisions. Of important note is that the estimated effects of RTM are greater at mobile camera sites than at fixed ones, which is possibly due to the different selection rules on accident and casualty numbers between these kinds of sites or the atypical nature of the fixed camera sites in the subset.

This investigation and comparison was undertaken at a limited number of sites (216 out of the 2493 urban sites in the main study at which a new camera was installed). This was because the empirical Bayes analysis required data that were not collected routinely by the safety camera partnerships (see Appendix H for a full discussion of this). A corresponding comparison could not be made for the 871 rural sites in the main study because the statistical models that are available are not suitable (as described in Appendix H). The urban fixed camera sites for which data were available and therefore formed the subset turned out not to be typical of those used for the main analysis. As shown in Tables 4.2 and 4.3, the fixed camera sites have about three quarters the frequency of PIC collisions and two thirds the frequency of KSI casualties compared to all urban fixed sites in the main analysis, though the mobile sites are more typical, having a slightly lower frequency of PIC collisions. The results from the log-linear analysis in Table 4.4 for PICs and Table 4.6 for KSIs shows that estimated savings at fixed camera sites in the subset of 216 are smaller in each case than at those in all urban areas of the main study. Beyond this, the proportion of mobile sites was substantially greater in the subset of 216 to which the empirical Bayes analysis was applied than in all urban areas of the main study, so that aggregate estimates based on calculations for this subset cannot be applied as they stand to all sites in the main study.

The correction for regression-to-mean estimated using the empirical Bayes analysis reported in Appendix H depends on use of a model that represents the population of sites from which those investigated are selected solely on the number of casualties or collisions observed during the baseline period. The site selection criteria that are specified in the Handbook (summarised in Appendix A) are broader than this and specify other criteria for site selection such as the proportion of vehicles exceeding the speed limit, speed contributing to cause of collisions, and unsuitability of the site for road engineering measures. As a consequence of this, the population from which the sites were selected may differ from the reference population used in estimating the correction for regression-to-mean. Because of these considerations, the results presented here do not enable a reliable adjusted estimate of the safety improvements associated with all safety cameras in the cost recovery programme.

The analyses presented here, given the constraints discussed above, show that at the subset of sites, the effects of regression-to-mean can be estimated and this leads to estimates of effectiveness of safety cameras that are, as would be expected, reduced. However, even though the effects estimated using the log-linear analysis applied at the subset of 216 sites is smaller than at sites in the main study, the estimates of savings there after allowing for RTM remain substantial. The effect of allowance for RTM is greater at mobile camera sites than at fixed ones, and is greater for collisions in which casualties were killed or seriously injured (FSC) than for personal injury collisions (PIC). Estimates of effects of safety cameras on PICs showed little change as a result of allowing for RTM, whilst those on FSCs were reduced by this allowance suggesting that estimates (if they could be calculated) of KSIs will also be more affected by this. Notwithstanding these reductions, the estimates of effectiveness of safety cameras in the subset that are calculated after allowing for regression-to-mean remain at about 0.1 FSC saved per site-year and 0.5 PICs saved per site-year at fixed camera sites (and more at mobile camera sites). If regression-to-mean had the same influence at all sites as is estimated by the present high-level but limited-scale analysis, the estimated casualty-reducing effect of safety cameras operating under cost recovery would remain substantial. Even if the estimates of effectiveness throughout the study area after allowing for trends and regression-to-mean were of the order of 0.1 FSC and 0.5 PICs as at the fixed sites in the subset, these safety cameras would still remain a valuable component of the national road safety programme.

4.7 Conclusions

In the subset of urban sites for which regression-to-mean effects could be estimated, it was found that:

- A substantial proportion of the reduction observed in KSIs and a modest proportion of that in PICs could be attributable to regression-to-mean.
- After allowing for the whole of this as well as the national long-term trend, the numbers of fatal or serious casualties, and of personal injury collisions had been reduced at camera sites.
- Within this subset of sites, the effect of regression-to-mean on estimates of the benefits of safety cameras appears to be greater at mobile camera sites and less at fixed ones.

The subset was not typical of all sites in the cost recovery programme in that mobile sites predominated and all sites were in urban areas. However, if it were, then:

- If regression-to-mean had the same influence throughout the cost recovery programme as in the subset of sites, the estimated benefits of safety cameras in terms of casualty reduction would still be substantial.
- If the effectiveness of safety cameras throughout the cost recovery programme were of the same order as that estimated for the subset of sites allowing for regression-to-mean, safety cameras would provide a valuable reduction in collisions and casualties.
- The estimates of the economic benefits of safety camera programme are based solely on reductions in PICs so that they are not affected greatly by regression-to-mean.

Estimation of reliable adjustment for the effects of regression-to-mean that apply generally would require substantial efforts in purpose-specific study design, monitoring and data collection that are not readily compatible with monitoring a full scale implementation.

Has there been a general acceptance of the road safety benefits?

In this section, we consider results from independent surveys of public opinion that were commissioned by local partnerships in the four years of the safety cameras cost recovery programme. We also consider a number of results from national surveys.

5.1 Why do we need to measure public awareness?

One of the objectives of the programme was to reassure the public that the primary motivation behind additional enforcement activity was to improve road safety. Each partnership area allocated a proportion of its approved budget for public awareness and communication programmes.

5.2 Data collection and validation

Most areas have commissioned independent research, which asked four standard questions. Results were compared to a previous research study in 1998[17]. In addition to the standard questions, three additional questions were asked. These were first used by the Lincolnshire partnership in 2001/2.

[17] Department for Transport Road Safety Research Report No.11 – *The effects of speed cameras: how drivers respond.* Feb 1999.

Original Brunel University questions (% agree)

- Cameras are meant to encourage drivers to stick to the limits, not punish them
- Fewer collisions are likely to happen on roads where cameras are installed
- Cameras are an easy way of making money out of motorists
- Cameras mean that dangerous drivers are more likely to get caught

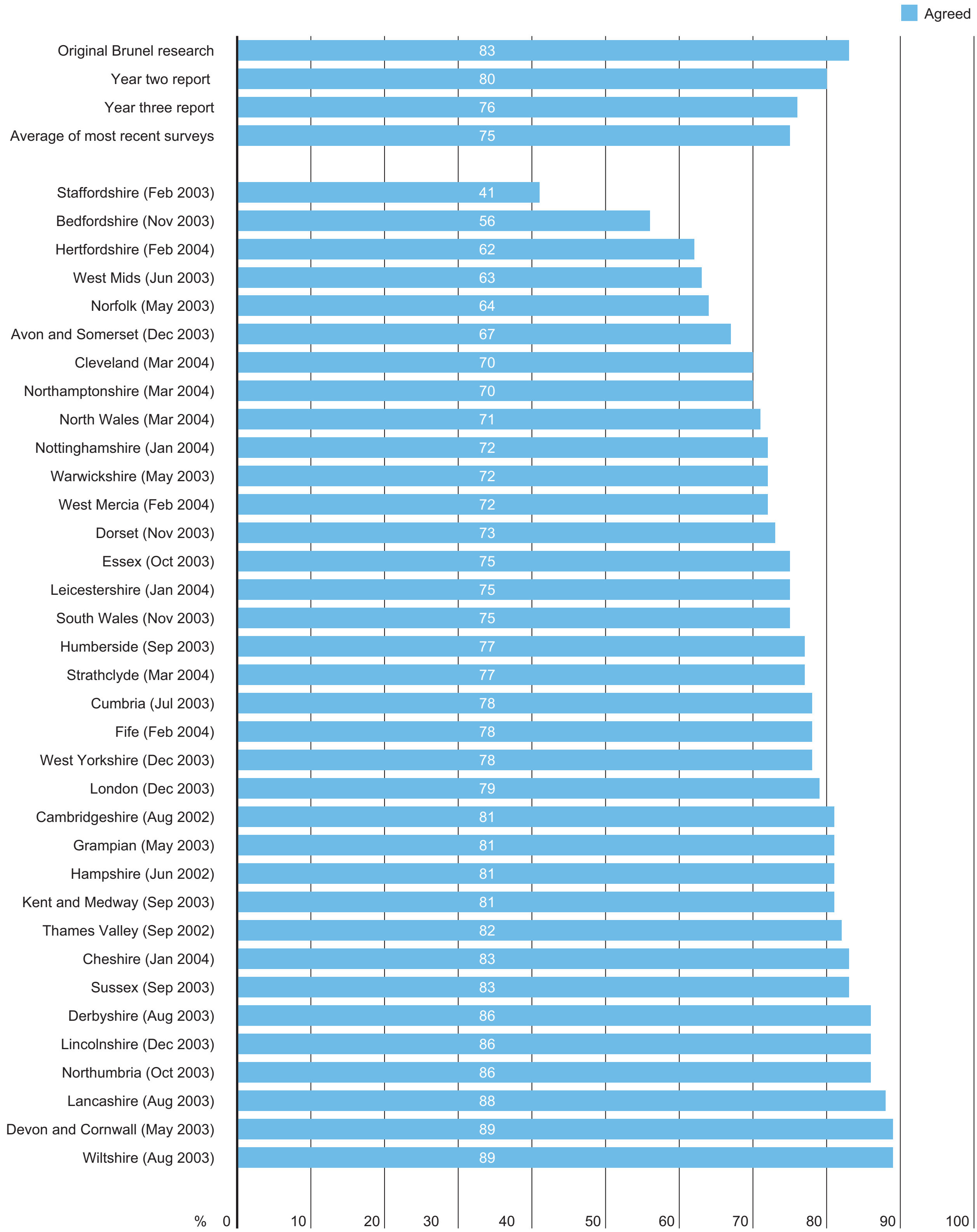
Additional questions (% agree)

- The use of safety cameras should be supported as a method of reducing casualties
- The primary aim of cameras is to save lives
- There are too many safety cameras in our local area

Results for each of these questions are given in Charts 1 to 7, split by partnership area.

5.2.1 Cameras are meant to encourage drivers to stick to the limits

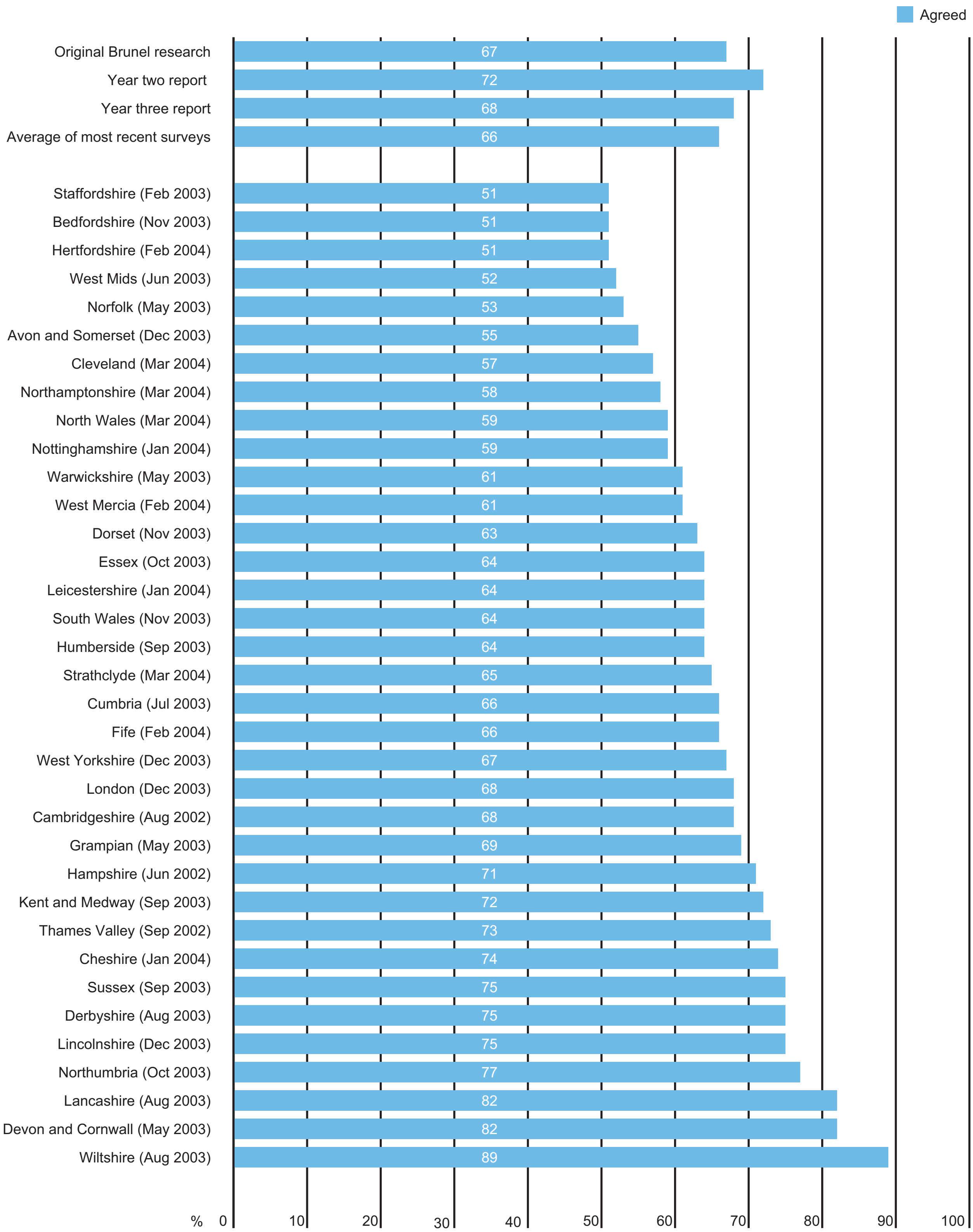
Figure 5.1 Cameras are meant to encourage drivers to stick to the limits, not punish them



- Although there was a wide variation in the responses, a significant majority of respondents still agreed with the statement that the purpose of cameras was to encourage compliance with speed limits.

5.2.2 Fewer collisions are likely to happen on roads where cameras are installed

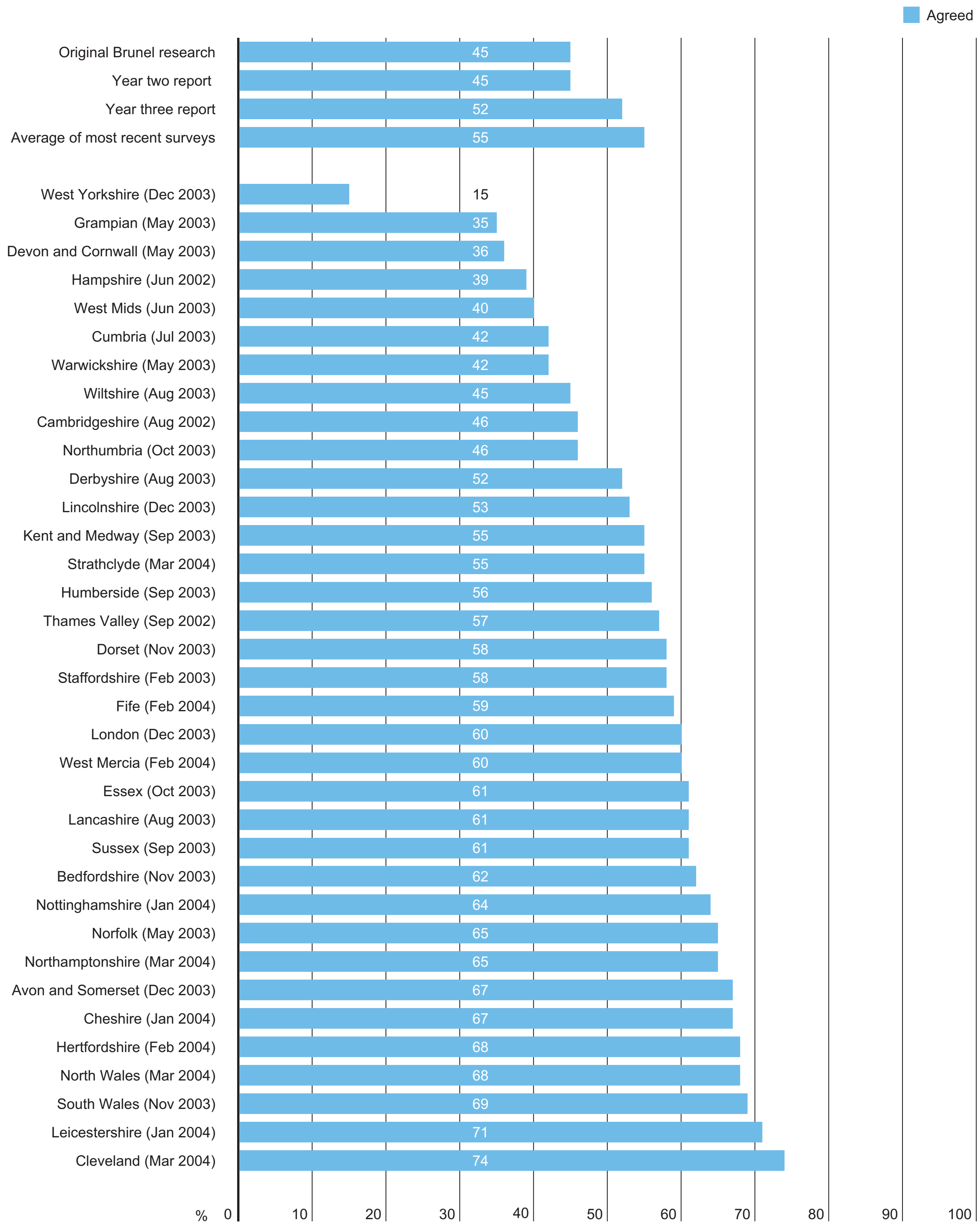
Figure 5.2 % agreement with the statement that 'fewer collisions are likely to happen on roads where cameras are installed'



- The majority of respondents believed that safety cameras were likely to reduce collisions.
- We conclude that the public, in general terms, continued to accept that there was an established link between cameras and collision reduction.

5.2.3 Cameras are an easy way of making money out of motorists

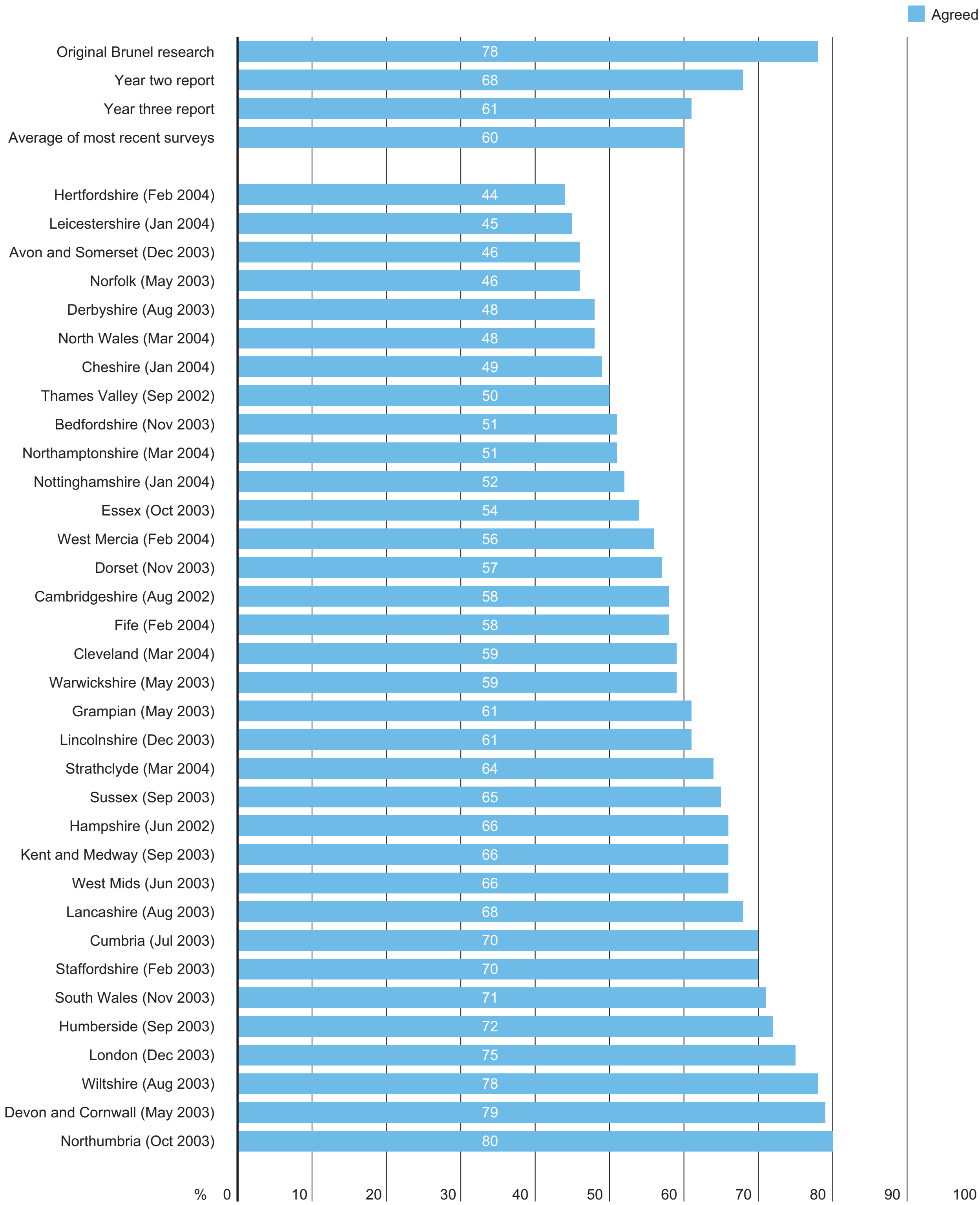
Chart 5.3 Cameras are an easy way of making money out of motorists



- Over half of respondents agreed with the statement that cameras were an easy way of making money out of motorists – an increase over previous surveys (+3%)
- This is not, perhaps, surprising, given the national coverage that the programme has received. What is, perhaps, more surprising is the considerable variation between different partnership areas.

5.2.4 Cameras mean that dangerous drivers are more likely to get caught

Chart 5.4 Cameras mean that dangerous drivers are more likely to get caught

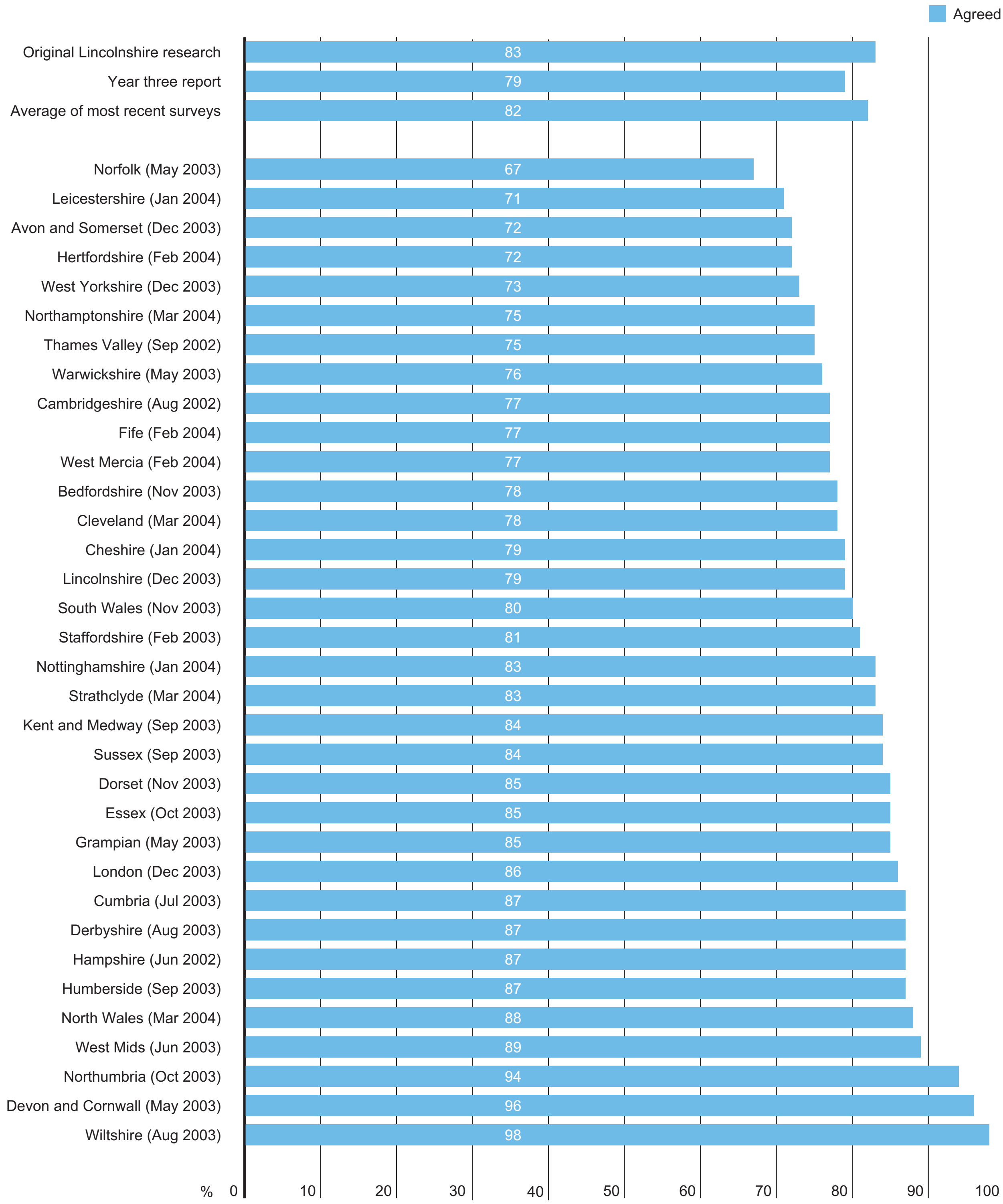


- The survey results indicated that the public generally accepted that cameras increased the probability of catching dangerous drivers, although again there is a wide variation between partnership areas
- Although a significant majority continue to accept this view, this has remained the same for the previous report.

5.2.5 The use of safety cameras should be supported as a method of reducing casualties

In addition, to the standard four questions, an additional three questions were added for national rollout (first asked in Lincolnshire). Results from these are summarised below.

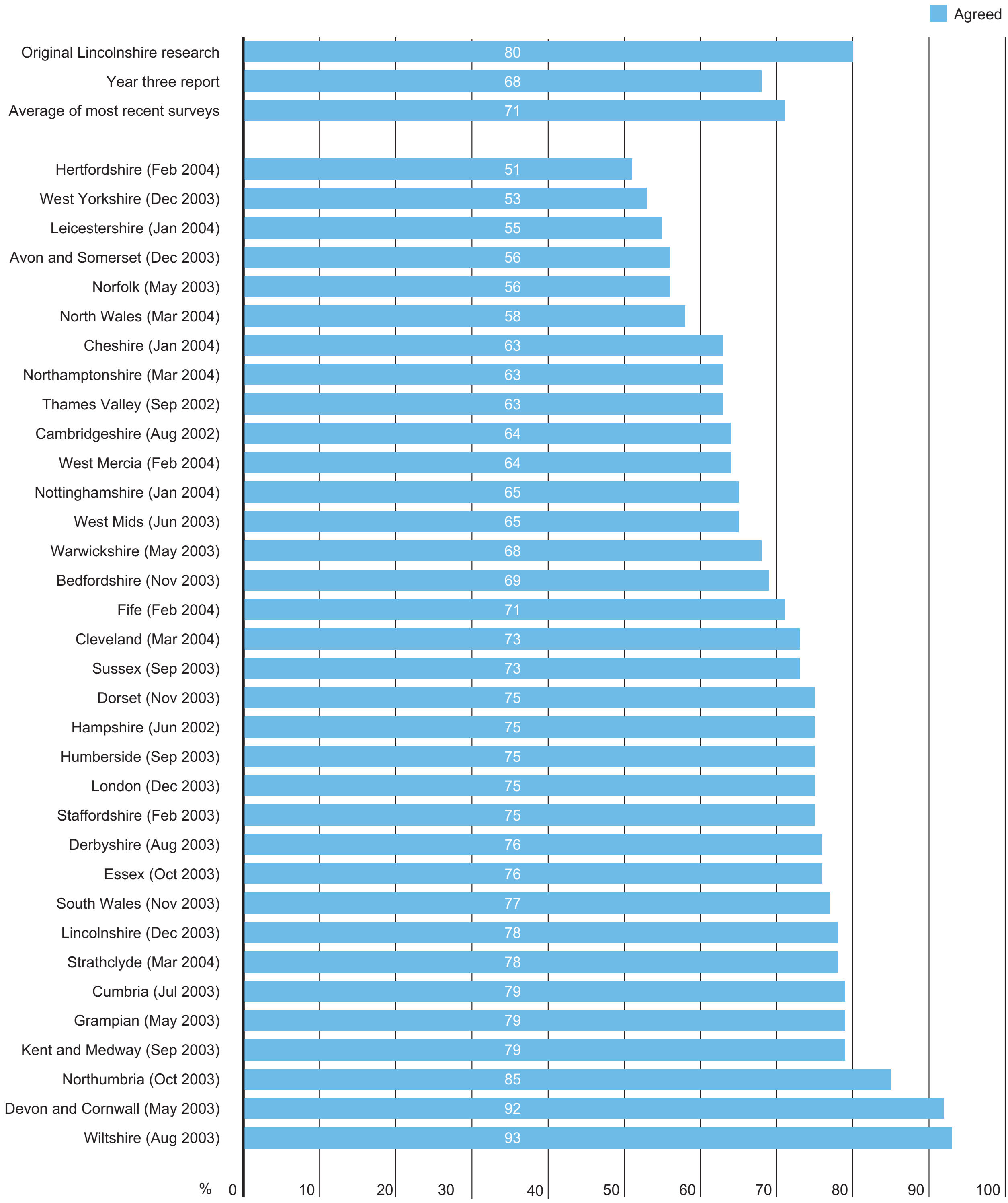
Chart 5.5 The use of safety cameras should be supported as a method of reducing casualties



- Across all partnerships 82% supported the use of cameras to reduce road casualties – a similar effect to that found in Lincolnshire
- We conclude that the public, in general terms, accepted that there is a link between cameras and casualty reduction and continued to be supportive of their use for these purposes.

5.2.6 The primary aim of cameras is to save lives

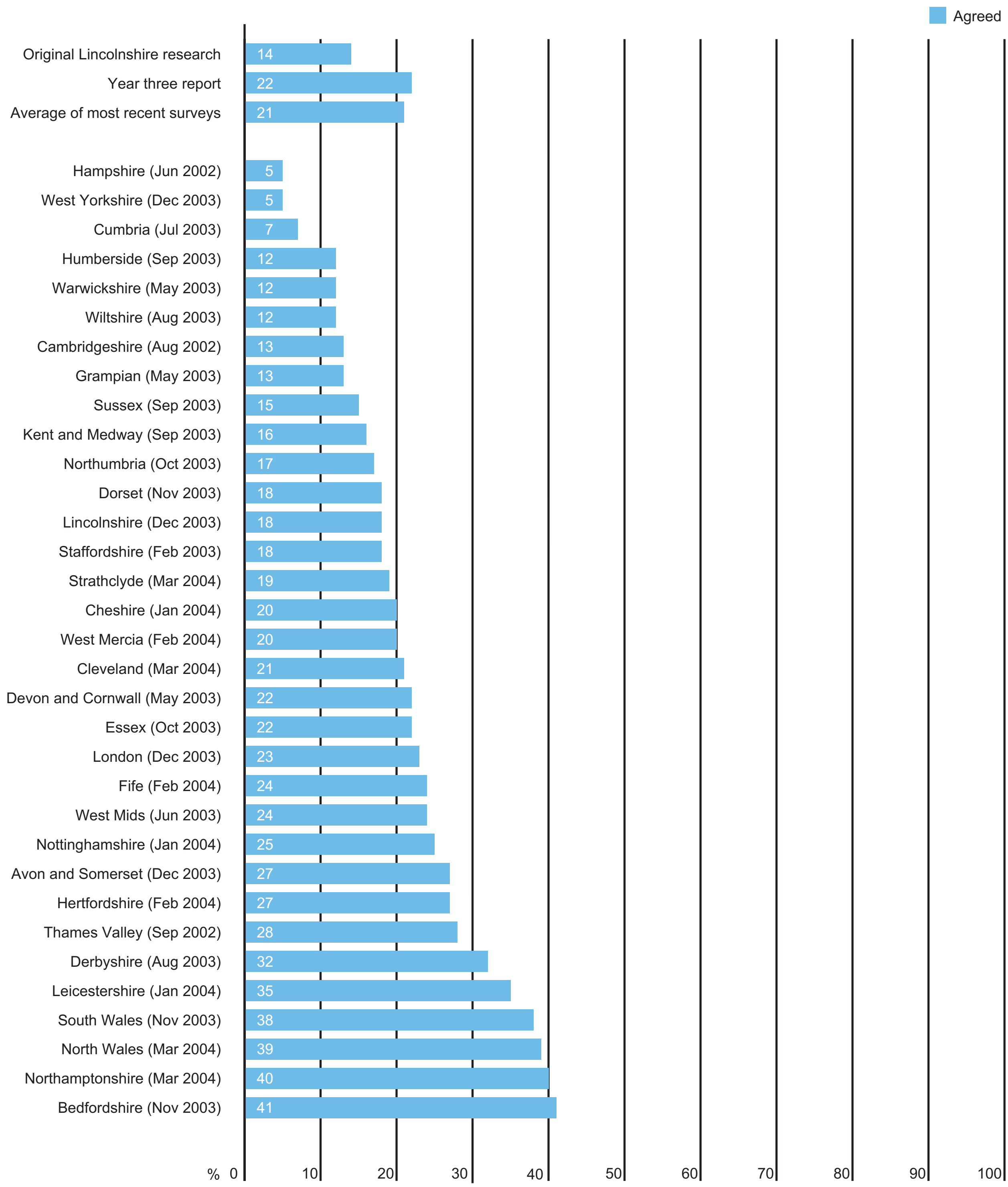
Chart 5.6 The primary aim of cameras is to save lives



- 71% agreed with the statement that the primary use of safety cameras was to save lives. This was less than found in Lincolnshire originally, but remained positive across the majority of partnership areas surveyed
- On this basis and the responses to other questions, we conclude that the majority of the public acknowledge and support the use of cameras to improve road safety.

5.2.7 There are too many safety cameras in our local area

Chart 5.7 There are too many safety cameras in our local area



- Only a small proportion of respondents thought that were too many safety cameras in their area This is about the same from the previous report

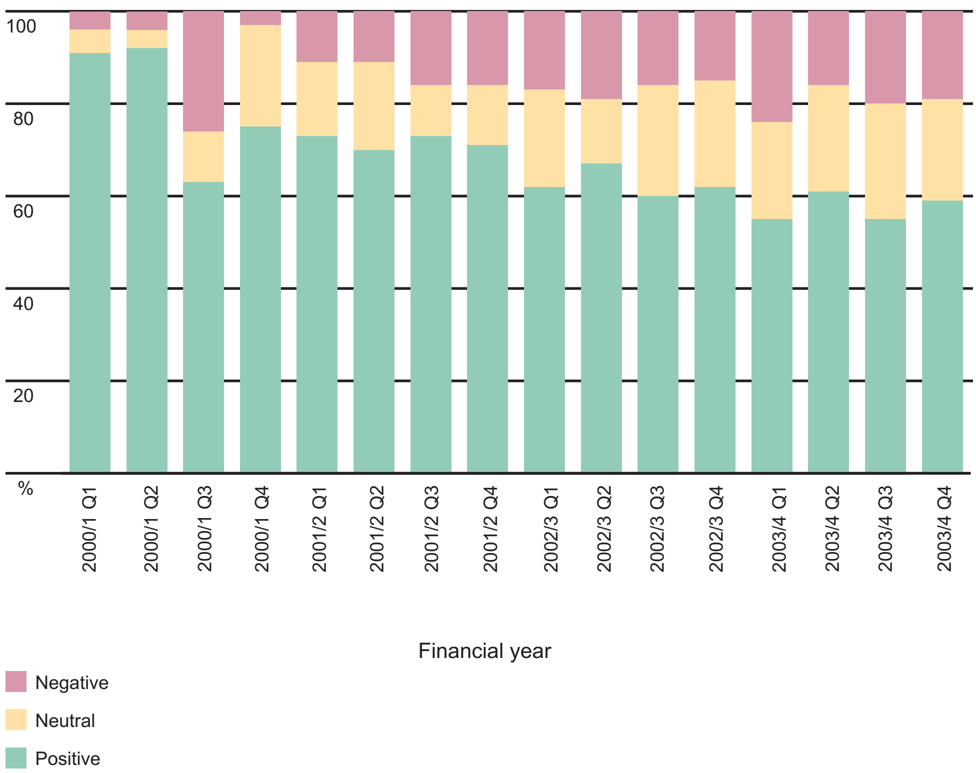
5.3 Local press coverage

Twenty partnership areas recorded the amount of local press coverage (in column inches) relating to the pilot during the first two years of the system and recorded whether or not coverage was positive, negative or neutral. This data was collated on a monthly basis during the first four years of the programme.

5.3.1 Proportion of positive, negative and neutral local press coverage

Chart 8 shows the overall level of support for camera enforcement in 20 areas in the first four years.

Chart 5.8 Local press coverage for safety camera partnerships



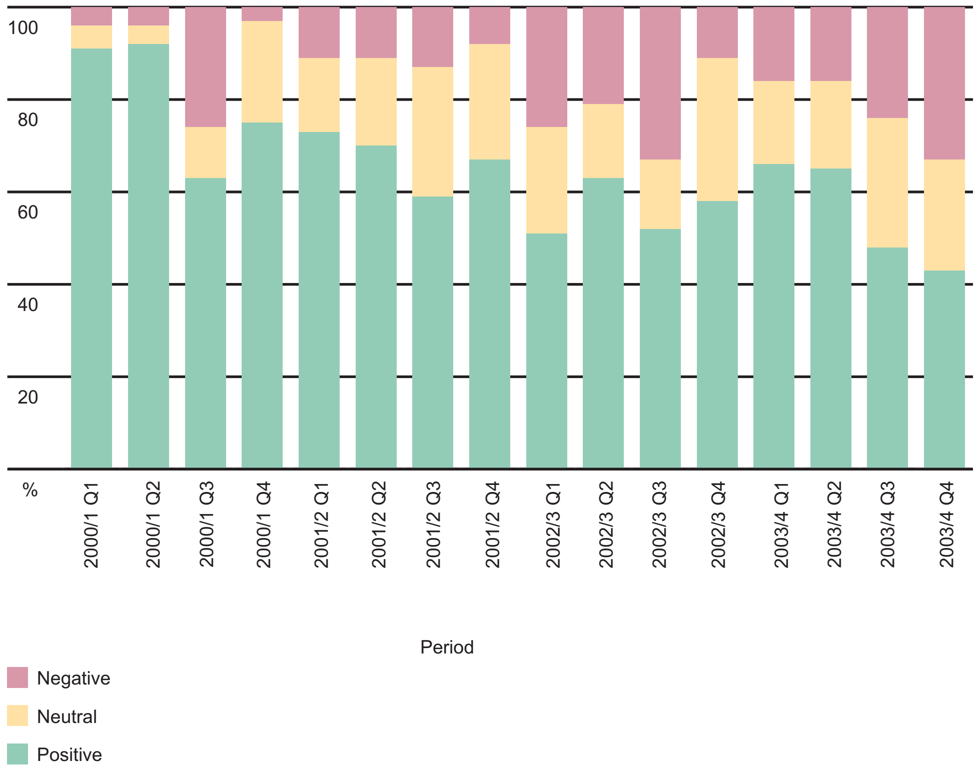
The analysis shows that, in the first two quarters of the programme, local press coverage was overwhelmingly supportive (more than 90% of column inches devoted to cameras supported camera enforcement). After the first six months of the system the percentage of column inches that were in support of camera enforcement remained at around 60-70%.

On average, over the first four years of the programme, 67% of press coverage was supportive of camera enforcement, 18% was neutral and 15% was negative.

5.3.2 Tracking local press coverage in the eight original pilot areas

The chart below shows the local press coverage for camera enforcement in the original eight pilot areas in the first four years.

Chart 5.9 Local press coverage for safety camera programme in eight pilot areas

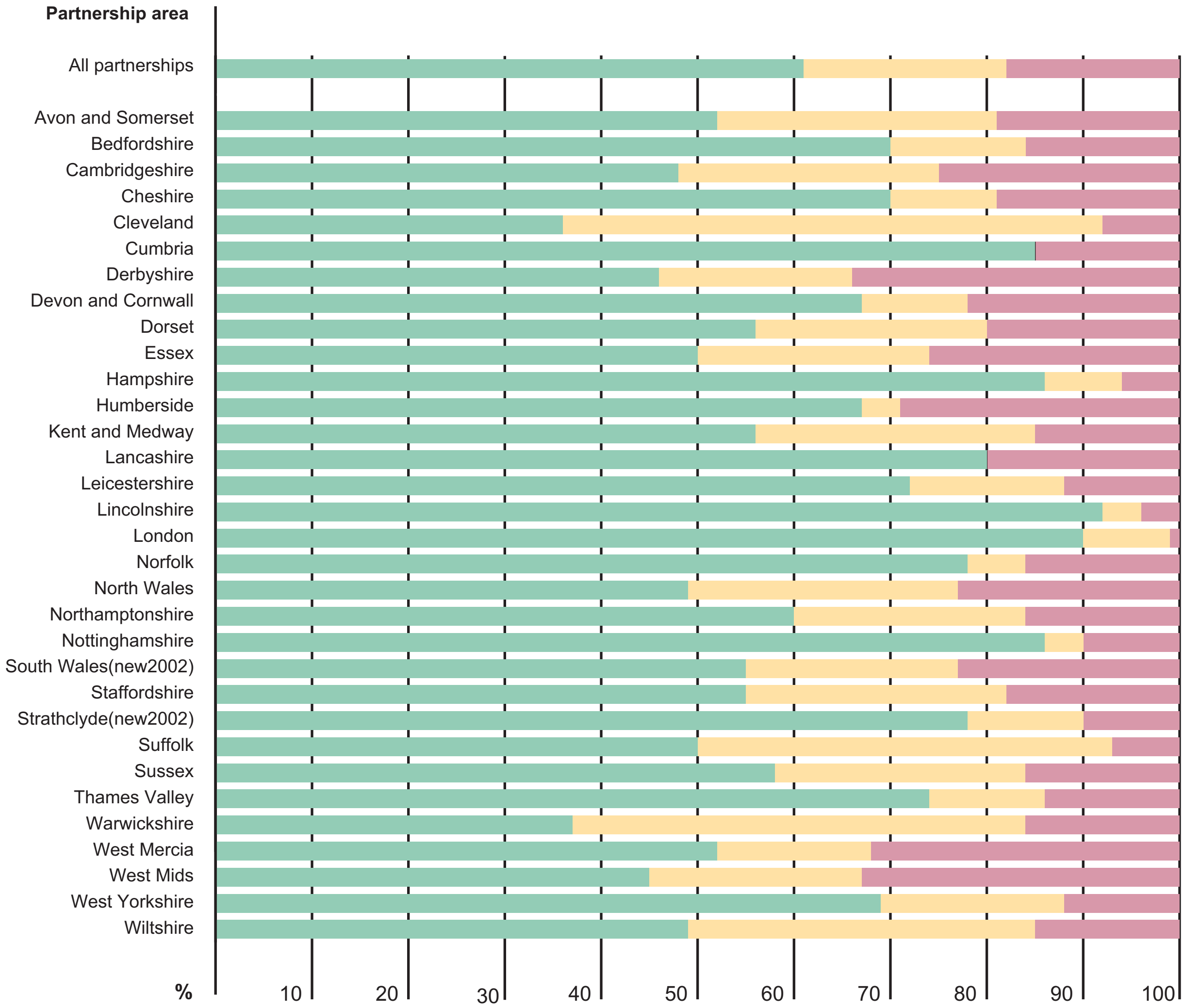


The analysis shows the proportion of positive, neutral and negative press coverage that the eight pilot areas have had in the four years. The majority has been positive or neutral, although there has been more negative publicity in the last three years.

5.3.3 Local press coverage by partnership area

Chart 10 shows the proportion of local press coverage (as measured by column inches) that each partnership has received.

Chart 5.10 Local press coverage by partnership over duration of programme



- On balance, taken across all partnership areas, local press coverage was generally positive towards the safety camera programme, a situation not always reflected in national coverage
- On average, 85% of all local coverage was positive or neutral
- There was a wide variation in the coverage across the country.

5.4 Conclusions

- The majority of people questioned in local surveys believe that cameras are meant to encourage drivers to keep to speed limits rather than to punish them and, as a result, reduce collisions and casualties
- The level of public support for the use of cameras has been consistently high with 82% of people questioned agreeing that the use of safety cameras should be supported as a method of reducing casualties
- On average, over the first four years of the programme, 85% of all local press coverage was positive or neutral
- On balance, whilst support for safety cameras generally varied from area to area, the public remained broadly supportive, although there is some evidence that this support was declining in a number of areas, and there remained some concern that the cameras are associated with revenue raising and not casualty reduction.

Have the funding and partnership arrangements worked well?

In this section, we set out some of the financial aspects of the programme to evaluate the costs and the benefits of the programme as a whole.

6.1 Why measure the funding and partnership arrangements?

As well as putting in place mechanisms to control costs, HMT guidance is that cost recovery systems should also satisfy the following rules:

- are arrangements in place that will ensure that the activity will not lead to the abuse of fine and penalty collection as a method of revenue-raising and that operational priorities will remain undistorted?
- will revenues always be sufficient to meet future costs, with any excess revenues over costs being surrendered?
- can costs of enforcement be readily identified and apportioned without undue bureaucracy, and with interdepartmental and inter-agency agreement where necessary?
- can savings be achieved through the change and are adequate efficiency regimes in place to control costs, including regular efficiency reviews?

Financial systems were put in place to satisfy these rules and these have been operating successfully since the original pilots began in April 2000.

6.2 Data collection

In order to ensure that the partnerships were complying with these rules, a handbook was prepared (summarised in Appendix A) that set out what constitute allowable expenditure. Each year, each partnership submitted an operational case to the national programme board. This included their planned enforcement activity and their expected expenditure. At the end of the year, each partnership submitted their accounts to an independent auditor to ensure that expenditure was in line with the handbook rules.

Under the rules of cost recovery, all eligible costs associated with camera enforcement and the processing of fixed penalty notices were recoverable by members of the partnership (police, local authorities, Magistrates' Courts). Any surplus over and above these costs was returned to HMT Consolidated Fund. At the end of each year, partnerships were required to submit audited accounts showing that only costs relating to camera enforcement had been claimed. Only when a clear audit certificate had been issued did a partnership receive final payment to cover its costs. To date, all partnerships have received clear audit certificates. Figures for costs and income, covered in this section, were obtained from these audit certificates.

6.3 Costs and receipts

In the fourth year, the partnerships have recovered around £96million of their expenditure on camera enforcement, whilst the Department for Constitutional Affairs (originally the Lord Chancellor's Department) has received £119million in fixed penalty receipts with £23million being returned to HMT (after taking into account deficits).

Table 6.1 below summarises the total recovered costs and receipts (excluding grants) in the programme to date.

Table 6.1 Total programme receipts and costs[19] per annum for the four years (excluding grants)

Financial year	Receipts	Costs incurred	Surplus/deficit
2000/1	£10,352,440	£ 8,985,247	£ 1,367,193
2001/2	£19,660,780	£16,106,559	£ 3,554,221
2002/3	£68,872,320	£54,256,502	£14,615,818
2003/4	£118,652,704	£95,820,870	£22,831,834
Four year total	**£217,538,244**	**£175,169,178**	**£42,369,066**

A detailed breakdown of costs and income for each area is provided in Appendix F.

[19] Source: DFT Safety Camera Programme Office

In assessing the management of the safety camera programme, we have also considered the efficiency. The principal measure in this regard is the revenue cost incurred per fixed penalty notice paid. This relates to the costs of administration, education and policing associated with speed and red light camera enforcement (see Table 6.2).

Table 6.2 Revenue cost to process a paid fixed penalty notice

	Financial year			
	2000/2001	**2001/2002**	**2002/2003**	**2003/2004**
Cost per FPN paid	£19.83 [19]	£24.83	£31.13	£33.06

- The revenue costs of processing a fixed penalty notice rose from £31.13 to £33.06 in 2003/4.

6.4 Economic assessment of programme

The annual cost of road collisions in Great Britain is around £18.1bn a year (2004 figures). Table 6.3 below gives a breakdown of the value of preventing all injuries on a per collision basis using DfT values for the costs associated with road injuries. It shows that, on average across all injuries, the cost of a collision, with respect to casualty costs, is approximately £61,000[20].

Table 6.3 Average value of prevention per PIC across all levels of injury

Injury severity	Lost output (£)	Medical and ambulance (£)	Human costs (£)	Total (£)
All personal injury[21]	12,310	2,590	43,290	61,120

It was hoped that safety cameras introduced as part of the programme would bring about a reduction in collisions and casualties and this, in turn, would also bring about a saving in social and human costs. It has been estimated that 4,230 fewer PICs will occur annually as a result of the safety cameras in place across all 38 partnerships, though this is subject to a reduction due to regression-to-mean that is probably modest in scale.

The annual economic benefit of cameras in place at the end of year four is therefore about £258million. This figure incorporates the costs of all personal injuries at collisions (fatal, serious and slight) but does not take account of the fact that safety cameras reduce KSIs more than PICs. However, neither does it allow for the probably modest regression to mean that will affect the estimates of reduction.

One means of assessing the efficiency of spend is the revenue costs per collision prevented which, over the four years, equates to **£22,653** per collision prevented across all injury types. The corresponding economic benefit (as a result of injuries prevented) per collision is **£61,120**. This gives a positive cost-benefit ratio of around **2.7:1**.

6.5 Conclusions

- There have been significant savings in social and human terms across the partnership areas. The estimated value of the reduction in collisions in 2003/4 was in the region of £258million. This equates to a cost-benefit of around 2.7:1.

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[20] Note that the cost recovery rules changed from year one to year two. (In 2000/1, areas were permitted to recover the additional costs of enforcement over and above existing activity – this was changed in 2001/2 to include all costs.)

[21] These costs only relate to injury costs and therefore do not include collision costs such as property damage, police and insurance costs.

[22] Values as per *Highways Economic Note No.1 (HEN1)* Department for Transport. (2004) – Table 3, average value of prevention per collision by severity and element of cost.

Summary of conclusions

In this section, we summarise the conclusions drawn from the previous sections.

The safety cameras cost recovery programme was considered to be a success if there was:

1. A significant reduction in speed at camera sites
2. A significant reduction in casualties at camera sites
3. General public acceptance of the road safety benefits
4. Satisfactory working of the funding and partnership arrangements.

A significant reduction in speed at camera sites

- We conclude that both fixed, mobile and time over distance cameras have been effective in reducing speed and maintaining high levels of compliance with speed limits.
- Fixed cameras have proved more effective than mobile cameras in reducing speed.
- Taking all cameras into account, the reductions in speed have been greatest at urban fixed camera sites.
- From areas that conducted speed surveys over a sustained period, we conclude that the reductions were not just one-off but were sustained over time. In fact, for mobile sites, the one-off reductions are not only sustained but actually are strengthened further as sites matured.

A significant reduction in casualties at camera sites

- Results showed that, overall, the number of killed or serious casualties and personal injury collisions had reduced at camera sites. These reductions were over and above the national long-term trend.
- There were around 42% fewer KSIs at cameras sites and 22% fewer PICs.
- Some proportion of the reduction observed in KSIs and a modest proportion of that in PICs is attributable to regression-to-mean, though the reductions attributable to cameras would remain substantial after allowing for this.
- Fixed camera sites were more effective at reducing casualties than mobile cameras, although both reduce speed, collisions, casualties and deaths.
- Fatalities were down substantially at camera sites (a reduction of 32%). There were over 100 fewer deaths.
- Pedestrian casualties were also down (a reduction of 23% in PICs and a reduction of 29% in KSIs).
- There was a strong association between the fall in speed and the fall in collisions, casualties and deaths at camera sites.

General public acceptance of the road safety benefits

- The majority of people questioned in local surveys believed that cameras are meant to encourage drivers to keep to speed limits rather than to punish them and, as a result, reduce collisions and casualties
- The level of public support for the use of cameras has been consistently high with 82% of people questioned agreeing that the use of safety cameras should be supported as a method of reducing casualties
- On average, over the four years of the programme, arround 85% of all local press coverage was positive or neutral
- On balance, whilst support for safety cameras generally varied from area to area, the public remained broadly supportive, although there is some evidence that this support was declining in a number of areas, and there remained some concern that the cameras are associated with revenue raising and not casualty reduction.

Satisfactory working of the funding and partnership arrangements

- There have been significant savings in social and human terms across the partnership areas. The estimated value of the reduction in collisions in 2003/4 was in the region of £258million
- This equates to a cost-benefit of around 2.7:1.

In general, we conclude that the programme is extremely successful at reducing speed, collisions, casualties and saving lives. The cost recovery element is working well and substantial savings to society have been identified. The general public are broadly supportive of the safety camera programme objectives, which is to use safety cameras to reduce road casualties.

Appendix A: Handbook summary

Prior to the start of the programme a handbook was developed which gave guidance about how the cost recovery system should operate. As the pilots progressed, and more was learned about best practice, this guidance has been strengthened. These are summarised in the table below.

Guidelines for pilot areas	Guidelines for national rollout
1. The effects on speed and casualties must be monitored	
Camera sites must be located where there is a history of speed related collisions. Cameras cannot be located for political and/or revenue generating purposes. All sites must be monitored for before and after speeds in areas where the cameras are operating.	Prior to approval, partnerships must prioritise sites and have quantified evidence that those selected have the greatest casualty problems. Broadly, these should follow the guidelines in Table 22 below although there is some flexibility. In total, enforcement should aim to cover at least 10% of KSIs in an area and ideally more. Partnerships must collect data on child and pedestrian casualties and hospital bed data. Partnerships must have conducted speed surveys in advance of case approval to demonstrate that excess speed is a problem at the priority sites.
2. Public perception must be actively managed	
All areas should produce a robust strategy as to how they are handling local education and communication issues	All partnerships must have a dedicated communications manager. The cameras should be well signed and highly visible. The location of the cameras should be published in local papers, local radio and on web-sites.

3. Partnerships must include all relevant local organisations	
Partnerships must include police, highways authorities and Magistrates Courts.	Should also involve local health authority, CPS and Highways Agency.
All parties must sign up to a Service Level Agreement/Memorandum of Understanding. – this committed each partnership at a senior level for the duration of the project.	Each partnership should have a dedicated project manager. All local authorities in an area should be part of the partnership.
4. Financial protocols	
All capital and revenue expenditure has to be directly attributable to additional speed and red-light camera enforcement - these are detailed in a handbook which set out the rules of the system	All costs attributable to speed and red-light cameras are recoverable rather than additional costs.
Each partnership should have a treasurer who keeps the accounts	No change.
Partners should be paid on the basis of receipts for expenditure incurred.	No change.
At the end of the financial year, these accounts should be audited by the District Auditor against rules set out by the Audit Commission (for England and Wales – Accounts Commission in Scotland)	No change. Revised guidelines are produced in conjunction with the Audit Commission (and Accounts Commission) following the end of year audit.
Failure to receive a clear audit certificate will result in the privilege to 'net off' receipts' to be withdrawn.	No change.
5. Benchmarking	
Partnerships should produce benchmark costs that proved that unit costs are reducing	Partnerships must compare favourably in efficiency with existing partnerships before being accepted on to the system. The use of new technology to reduce manual processes and, in particular, police intervention is encouraged. Chasing non-payers and making out of force enquiries is mandatory.
6. Signing and visibility	
Partnerships should ensure that signing arrangements comply with Traffic Signs Regulations and General Directions appropriate for various circumstances.	Fixed speed camera housings in all but exceptional circumstances should be yellow. All camera housings (existing and new) should be visible to road users and not hidden behind bridges, signs, trees or bushes. The minimum visibility distance should be 60 metres where the speed limit is 40 mph or less and 100 metres for all other limits. For mobile cameras, camera operatives at the mobile camera sites should wear fluorescent clothing and abide by all Health and Safety requirements, and vehicles should be clearly marked as camera enforcement vehicles. Camera warning and speed limit reminder signs must be placed in advance of fixed or mobile speed enforcement taking place. Ideally these should be placed within 1km of fixed camera housings and at the beginning of a targeted route for mobile enforcement sites. Signs must only be placed in areas where camera housings are present or along routes where mobile enforcement will be targeted.

Table A1 provides a summary of the guidance issued to local partnerships to assist in prioritising sites for enforcement (these were the rules from the handbook that was in operation at the time). It is at the discretion of the local partnerships as to the proportion of enforcement that is allocated to these priority sites. Some discretion is allowed to enforce at sites where there is genuine public concern about speeding and also at roadworks.

Table A1 Site selection guidelines

Criteria	Fixed	Mobile	Time over distance	Red-light
1. Site length	Between 400-1500 metres metres (can be linked into a longer route strategy if more than three stretches satisfy the criteria)	Between 400 and 3000 metres	Between 3000 and 10000 metres	50 metres
2. Number of killed collisions (KSI) and serious	At least 4 KSI per km in (not per annum) last three calendar years	At least 2 KSI per km in last three calendar years (not per annum)	At least 5 KSI per km in last three calendar years along a minimum 3km stretch of road (not per annum). At least 4KSIs in previous three calendar years in each subsequent km (not per annum).	2 KSI at junction (+/- 50m) in last three years (not per annum)
3. Number of personal injury collisions (PIC)	At least 8 PIC per km in last three calendar years	At least 4 PIC per km in last three calendar years	At least 10 PIC per km in last three calendar years (min 3km). At least 8 PIC in previous 3 calendar years in each subsequent km.	At least 4 PIC at junction (+/- 50m)
4. Causation factors	Causation factors indicate that speeding was a contributory factor in some or all of the collisions - sites that are clearly not speed-related have been de-selected			Red-light running is a causation factor in some or all of the collisions (including child and pedestrians)
5. 85th percentile speed at (or approach to) collision hot spots	85th percentile speed at least 10% above speed limit plus 2mph - i.e. 35mph in a 30 zone) for free-flowing traffic (excluding any rush-hour periods)			N/A
6. Percentage over the speed limit	At least 20% of drivers are exceeding the speed limit			N/A
7. Site conditions are suitable for the type of enforcement proposed	Loading and unloading the camera can take place safely	Location for mobile enforcement is easily accessible, there is space for enforcement to take place in a visible and safe manner	Loading and unloading the camera can take place safely	Loading and unloading the camera can take place safely
8. Distribution of collisions	Collisions are clustered close together around a single stretch of road or junction	Collisions are more likely to be evenly distributed along a route	High density of collisions distributed evenly along a stretch of road	Collisions are clustered at a road junction with traffic lights
9. No other engineering solutions are appropriate	There has been a site survey by a qualified road safety engineer and there are no obvious viable measures to improve road safety along this stretch of road			
10. Camera visibility	Enforcement cameras are well signed and highly visible in line with DfT guidelines			

Appendix B:
Allowable expenditure

B.1 Legislative provisions

Section 38 of the Vehicles (Crime) Act 2001 contains the primary legislation that enables the Secretary of State to make payments to local partnerships for speed and red-light camera enforcement.

(1) The Secretary of State may make payments in respect of the whole or any part of the expenditure of a public authority in relation to:

a. the prevention or detection of offences to which subsection (2) applies; or
b. any enforcement action or proceedings in respect of such offences or any alleged such offences.

(2) This subsection applies to offences under:

a. section 16 of the Road Traffic Regulation Act 1984 (c. 27) which consist in contraventions of restrictions on the speed of vehicles imposed under section 14 of that Act;

b. subsection (4) of section 17 of that Act which consist in contraventions of restrictions on the speed of vehicles imposed under that section;

c. section 88(7) of that Act (temporary minimum speed limits);

d. section 89(1) of that Act (speeding offences generally);

e. section 36(1) of the Road Traffic Act 1988 (c. 52) which consist in the failure to comply with an indication given by a light signal that vehicular traffic is not to proceed.

(3) Payments under this section shall be made to:

a. the public authority in respect of whose expenditure the payments are being made; or

b. any other public authority for payment, in accordance with arrangements agreed with the Secretary of State, to, or on behalf of, the public authority in respect of whose expenditure the payments are being made.

(4) Payments under this section shall be paid at such times, in such manner and subject to such conditions as the Secretary of State may determine.

(5) In this section "public authority" means:

a. any highway authority (within the meaning of the Highways Act 1980 (c. 66));

b. any police authority established under section 3 of the Police Act 1996 (c. 16), the Metropolitan Police Authority or the Common Council of the City of London in its capacity as a police authority;

c. any responsible authority (within the meaning of section 55 of the Justices of the Peace Act 1997 (c. 25)) or the Greater London Magistrates' Courts Authority; and

d. any body or other person not falling within paragraphs (a) to (c) and so far as exercising functions of a public nature

B.2 Allowable expenditure – enforcement equipment

- Speed and red-light cameras that are Home Office type approved
- Fixed (time over distance and wet-film) and mobile camera systems, including housings, alarms, 'permanent' mobile sites and signs
- Analysis, design, planning, installation, test and set-to-work costs are allowable (in order to be accepted onto the programme, partnerships must demonstrate that cameras will be operating in areas where there is a history of both collisions and speeding)
- Signing in order to comply with DfT guidance on camera conspicuity.

B.3 Allowable expenditure – supporting equipment

- IT and communication systems
- Speed monitoring equipment
- Office equipment
- Film processing and viewing
- Printing, scanning, copying and mailing
- Filing and archiving
- Vehicles (only those required for the purpose of enforcement and not patrol vehicles)
- Collision mapping and recording systems.

B.4 Allowable expenditure – revenue costs

- Partnership staff salaries and on-costs (training, national insurance, etc) but not, for example, shared management costs
- Police officer and civilian staff costs
- Camera and system maintenance – only those directly associated with camera activity
- Camera and system lease costs
- Communication and education programmes directly related to this system
- Reasonable IT and communication systems maintenance associated with camera activity
- Vehicle maintenance and running costs (including fuel) – only for vehicles solely employed on camera activity or pro-rata
- Speed and casualty analysis (including that required to build up the operational case)
- Consumables and ancillary costs (stationery, film, print etc)
- Leased accommodation (including office and IT equipment if applicable).

Appendix C:
The enforcement process

The administrative process

Partnerships were allowed to keep some of the fixed penalty revenue from speeding drivers (or drivers passing through red-lights) to pay for the costs associated with processing the associated conditional offer fixed penalty notices. There are a number of stages in this process and these are explained below.

The key elements of the enforcement process are as follows:

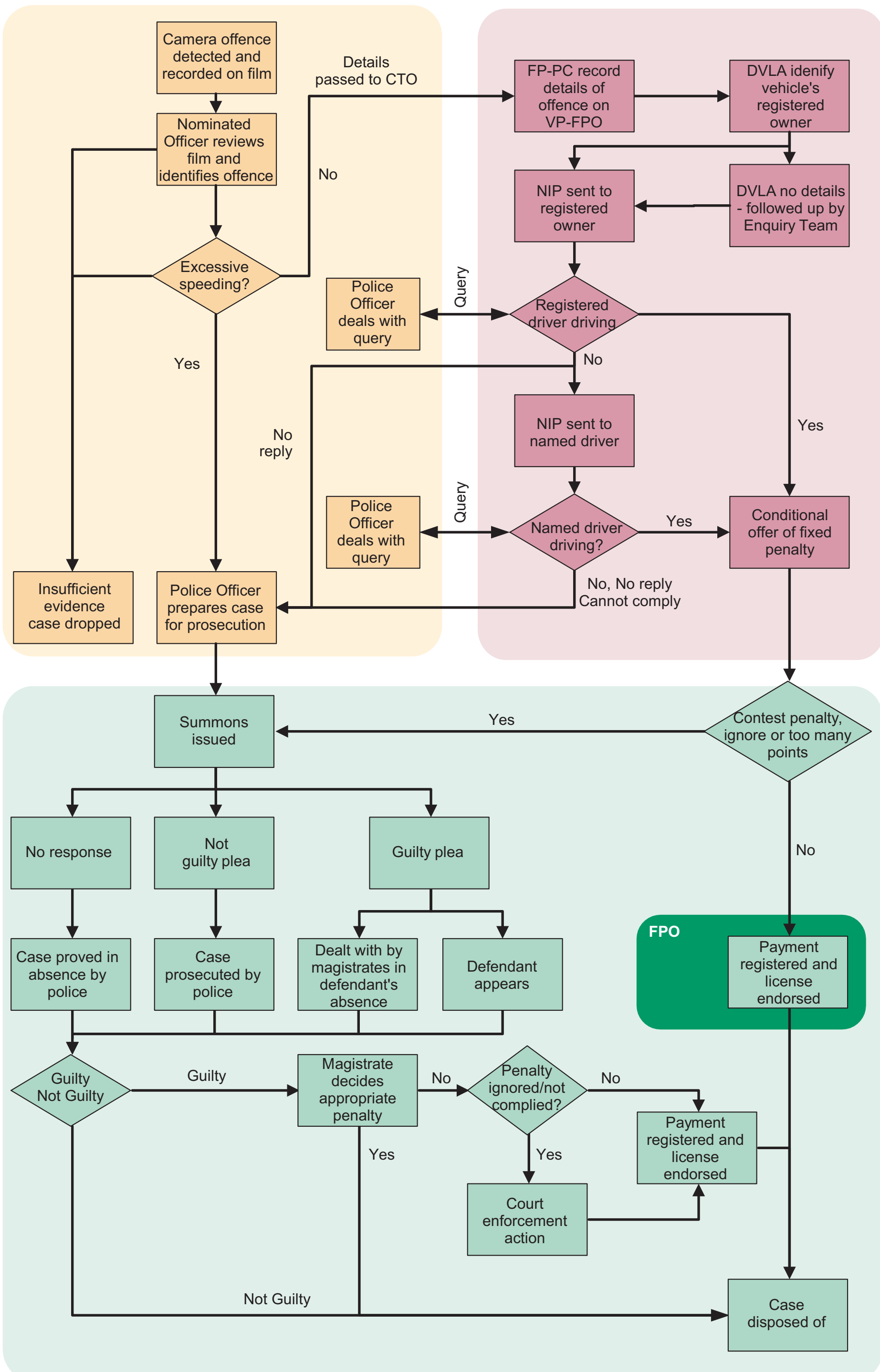
- A Notice of Intended Prosecution (NIP) is sent to the registered vehicle keeper. This identifies that the vehicle was recorded on film committing a speeding or red-light offence and that the registered keeper is required to provide the full name and address of the driver at the time of the alleged offence. The law states that in order for a prosecution to proceed the NIP needs to be served to the registered keeper within 14 days of the alleged offence taking place.
- Where the registered keeper does not reply to the NIP or does not identify the driver, The Central Ticket Office (CTO) notifies the enforcement officer who recorded the alleged offence. This enforcement officer reviews the video evidence and seeks to interview the registered vehicle keeper with a view to preparing a file for prosecution by the police.
- Where the registered vehicle keeper replies that they were not the driver at the time of the alleged offence, they are required to notify the CTO who was. A NIP is then sent to the driver identified.
- Once the driver at the time of the alleged offence is identified, the CTO sends a Conditional Offer of a Fixed Penalty (assuming the speed is below the prosecution threshold). The driver then has the opportunity to pay a fixed

penalty fine (£60) and accept three penalty points or they may contest the offence in a Magistrates' Court. Where they accept the Conditional Offer, the driver is required to present the required monies and their driving licence to the Fixed Penalty Office (usually by post).

- If a driver contests the offence or fails to pay the fine, the police prepare a file for prosecution in the courts. In any case where the addition of Penalty Points will lead to a ban (for example where a driver has already amassed nine or more points), the case is dealt with via the local Magistrates' Court.

A map of the administrative processes associated with camera enforcement is shown below.

Figure C1: The process associated with camera enforcement



Appendix D:
Data validation process

D.1 Speed data validation

In order to get to the dataset used for the four-year analysis, the information in the database has been through a number of 'filters'. These were as follows:

- only sites in the year-four group of partnerships (latest joining date 1st April 2003) have been included
- camera should have a meaningful identifier – ie cameras with names containing "duplicate" or "xx" are excluded
- camera should have specified a 'date established', which should be before 1st April 2004.

Additional checks applied for the speed analysis on baseline data are:

- baseline 85th percentile speed is greater than baseline average speed
- baseline percentage more than 15mph above speed limit less than or equal to baseline percentage above speed limit
- only fixed, time over distance and mobile cameras are included
- speed limit should be specified
- new cameras introduced within cost recovery have been analysed

For speed-readings conducted in the after period the following criteria have been applied:

- only speed-readings performed between April 2002 and April 2004 have been included.
- 85th percentile speed > Average speed
- percentage more than 15mph above speed limit should be less than the percentage above speed limit

This produced a list of eligible sites that were then used equally in the analysis.

D.2 Collision and casualty data collection

This involved a six-stage process:

Data cleansing activity

1 A query was run on the un-cleansed database, highlighting cameras with missing or unusual values (for example where the KSIs were larger than PICs) a list of cameras with 'issues' was identified for each partnership. This was sent to the partnerships with a request for them to correct the issues in their local database and resubmit.

2 When a partnership returned a database, the data was again submitted to the same set of checks. If some issues were still not addressed, a list describing the issues was sent to the partnership. This was repeated until all issues were either solved or explained. Only cameras with a reasonable or valid baseline would proceed to the next step.

3 After the baseline issues were resolved, a list with missing monthly casualty registrations was sent to the partnerships. The missing registrations would typically be caused by either the appearance of inactive cameras in the database or by partnerships having inadvertently missed an entry.

4 Again, when a partnership returned their database, the data was again submitted to the same rigorous check. If some monthly entries were still missing this was communicated to the partnerships. This was repeated until all missing entries are either present or explained.

5 The final set of checks was undertaken on the data. We tested for extreme values (outliers), excessive uniformity (every month having identical values), and radical effects (large differences in baseline and after values). Based on these checks, a list of cameras and monthly casualty entries were sent to the partnerships for confirmation.

6 Based on this list, the partnerships confirmed and, where necessary, corrected their database.

On the basis of the cleansing exercise, all of the partnership areas invested a considerable amount of time into validating their PIC and KSI data. The above six stages were repeated until we had a full, cleansed national dataset. We also examined the data on a site-by-site, month-by-month basis to identify further outliers and unusual behaviours. This involved checks on around 120,000 records (PICs and KSIs).

In parallel with the submission of 'cleansed' data, we requested additional information such as:

- start and end date of the baseline period for each camera
- confirmation that baseline data for KSIs was casualties and for PICs was collisions (and they were consistent before and after)
- confirmation that before and after camera site data covered the same geographic area
- confirmation for all partnerships that were featured in the eight pilot area report that the database contained data that was consistent with the data supplied to UCL
- confirmation that the area wide data was consistent with published Road Accident Great Britian (RAGB) figures
- information on overlapping camera sites, and major changes to sites (eg speed limit changes, single to dual carriageway, traffic calming).

Appendix E:
Detailed speed analysis

The number of cameras that have contributed data to the speed analysis is 1,876. Of these 1,059 are new. The different numbers in different tables are a result of the 'individual filtering' process where we try to maximise the number of sites for any part of the analysis (see D1).

E.1 Changes in average speed at new camera sites

Table E1: Changes in the average speed of vehicles at camera sites

Camera Type	Partnership area	Number of sites 03/04	Number of visits in FY	Average speed before (mph)	Average speed after (mph) (mph)	Change in average speed	% change in average speed
Digital	Northamptonshire	1	5	47	45.6	-1.4	-3.0%
Digital	Nottinghamshire	1	2	40	38	-2.0	-5.0%
All Digital		2	7	45.0	43.4	-1.6	-3.5%
Fixed	Avon and Somerset	7	14	36.6	27.4	-9.1	-25.0%
Fixed	Bedfordshire	16	41	45.9	41.3	-4.5	-9.8%
Fixed	Cambridgeshire	17	81	41.2	34.2	-7.0	-17.0%
Fixed	Cheshire	4	6	36.7	32.1	-4.6	-12.6%
Fixed	Derbyshire	17	27	30.2	26.7	-3.5	-11.6%
Fixed	Devon and Cornwall	7	22	37.8	36.7	-1.1	-2.9%
Fixed	Dorset	11	29	35.4	30.1	-5.2	-14.8%
Fixed	Essex	53	166	33.9	28.4	-5.5	-16.3%
Fixed	Grampian	1	2	36.0	46.5	10.5	29.2%
Fixed	Hampshire	11	17	37.1	31.0	-6.1	-16.3%
Fixed	Kent and Medway	9	9	38.9	33.4	-5.4	-14.0%
Fixed	Lancashire	95	173	27.2	25.1	-2.1	-7.8%
Fixed	Leicestershire	5	9	32.8	26.7	-6.1	-18.6%
Fixed	Lincolnshire	23	163	40.3	33.2	-7.1	-17.6%
Fixed	Norfolk	8	51	32.1	29.4	-2.8	-8.6%
Fixed	North Wales	14	70	30.5	29.6	-0.9	-3.0%
Fixed	Northamptonshire	18	71	35.0	26.9	-8.1	-23.2%
Fixed	South Wales (new2002)	61	225	33.5	26.1	-7.4	-22.1%
Fixed	South Yorkshire	10	10	38.6	32.7	-5.9	-15.3%
Fixed	Staffordshire	21	24	35.1	29.1	-6.0	-17.1%
Fixed	Strathclyde (new2002)	45	140	33.3	26.9	-6.4	-19.1%
Fixed	Sussex	7	12	39.3	30.2	-9.2	-23.3%
Fixed	Warwickshire	8	68	48.9	46.8	-2.1	-4.2%
Fixed	West Mercia	3	6	29.7	25.2	-4.5	-15.2%
Fixed	West Mids	14	20	34.9	32.6	-2.4	-6.7%
Fixed	West Yorkshire	14	21	37.0	28.4	-8.6	-23.3%
All Fixed		502	1484	35.2	29.9	-5.3	-15.0%
Mobile	Avon and Somerset	136	310	36.2	32.7	-3.6	-9.9%
Mobile	Bedfordshire	46	123	36.8	35.4	-1.3	-3.6%
Mobile	Cambridgeshire	21	109	52.8	50.0	-2.8	-5.3%
Mobile	Cheshire	18	38	34.4	33.7	-0.8	-2.3%
Mobile	Cleveland	3	11	34.6	32.5	-2.2	-6.3%
Mobile	Cumbria	13	13	49.5	49.6	0.2	0.3%
Mobile	Derbyshire	42	94	35.5	34.1	-1.4	-4.0%
Mobile	Devon and Cornwall	28	73	37.9	37.2	-0.7	-1.8%
Mobile	Dorset	43	201	37.8	37.9	0.1	0.2%
Mobile	Essex	214	586	30.6	30.0	-0.6	-1.9%
Mobile	Grampian	70	152	45.0	44.0	-1.0	-2.2%
Mobile	Hampshire	9	24	34.6	32.3	-2.3	-6.5%
Mobile	Humberside	66	318	34.6	33.7	-0.9	-2.5%
Mobile	Kent and Medway	33	87	41.9	40.4	-1.5	-3.6%
Mobile	Lancashire	39	121	24.7	23.1	-1.6	-6.3%
Mobile	Leicestershire	62	107	39.5	38.3	-1.3	-3.2%
Mobile	Lincolnshire	14	190	50.9	50.1	-0.8	-1.7%
Mobile	Norfolk	28	399	52.5	52.4	-0.1	-0.2%
Mobile	North Wales	46	325	38.3	36.5	-1.7	-4.5%
Mobile	Northumbria	72	140	35.9	34.8	-1.1	-3.2%
Mobile	Nottinghamshire	36	67	43.5	41.6	-1.9	-4.4%
Mobile	South Wales (new2002)	236	831	37.7	36.0	-1.7	-4.5%
Mobile	Strathclyde (new2002)	7	25	53.2	52.3	-1.0	-1.8%
Mobile	Suffolk	13	14	45.2	44.6	-0.6	-1.4%
Mobile	Sussex	28	77	33.3	31.8	-1.5	-4.6%
Mobile	Warwickshire	35	206	48.7	47.9	-0.8	-1.6%
Mobile	West Mercia	32	52	41.2	39.1	-2.1	-5.2%
Mobile	Wiltshire	52	98	46.2	45.4	-0.8	-1.6%
All Mobile		1448	4806	39.4	38.1	-1.3	-3.2%
All Cameras		1952	6297	38.4	36.2	-2.2	-5.7%

E.2 Changes in the 85th percentile speed

Table E2: Changes in the 85th percentile speed of vehicles at camera sites

Camera Type	Partnership area	Number of sites	Number of visits	85th percentile before (mph)	85th percentile after (mph)	Change in 85th percentile (mph)
Digital	Northamptonshire	1	5	54	50.6	-3.4
Digital	Nottinghamshire	1	2	44	40	-4.0
All Digital		2	7	51.1	47.6	-3.6
Fixed	Avon and Somerset	7	14	41.8	32.3	-9.5
Fixed	Bedfordshire	16	41	54.9	48.5	-6.4
Fixed	Cambridgeshire	17	81	46.3	39.9	-6.3
Fixed	Cheshire	4	6	40.7	37.4	-3.3
Fixed	Derbyshire	17	27	39.1	35.3	-3.8
Fixed	Devon and Cornwall	7	22	42.7	42.3	-0.4
Fixed	Dorset	11	29	40.8	34.9	-5.9
Fixed	Essex	53	166	39.5	33.1	-6.4
Fixed	Grampian	1	2	40.0	51.0	11.0
Fixed	Hampshire	11	17	44.9	35.6	-9.3
Fixed	Kent and Medway	9	9	45.3	38.4	-6.9
Fixed	Lancashire	95	173	34.9	26.9	-8.0
Fixed	Leicestershire	5	9	41.6	31.4	-10.1
Fixed	Lincolnshire	23	163	47.4	38.3	-9.2
Fixed	Norfolk	8	51	37.1	33.5	-3.6
Fixed	North Wales	14	70	37.1	34.3	-2.9
Fixed	Northamptonshire	18	71	40.8	32.0	-8.8
Fixed	South Wales (new2002)	61	225	39.5	28.0	-11.5
Fixed	South Yorkshire	10	10	47.2	37.8	-9.4
Fixed	Staffordshire	21	24	38.5	33.4	-5.1
Fixed	Strathclyde (new2002)	45	140	40.5	31.0	-9.5
Fixed	Sussex	7	12	45.7	34.8	-10.9
Fixed	Thames Valley	3	7	34.3	37.4	3.1
Fixed	Warwickshire	8	68	57.1	54.4	-2.7
Fixed	West Mercia	3	6	35.7	28.8	-6.8
Fixed	West Mids	14	20	43.2	37.5	-5.7
Fixed	West Yorkshire	14	21	44.0	30.3	-13.6
All Fixed		502	1484	41.8	34.1	-7.6
Mobile	Avon and Somerset	136	310	42.1	38.4	-3.7
Mobile	Bedfordshire	46	123	42.8	42.0	-0.9
Mobile	Cambridgeshire	21	109	63.1	59.0	-4.1
Mobile	Cheshire	18	38	39.7	39.8	0.2
Mobile	Cleveland	3	11	39.6	38.5	-1.1
Mobile	Cumbria	13	13	56.7	56.8	0.1
Mobile	Derbyshire	42	94	44.3	43.4	-0.9
Mobile	Devon and Cornwall	28	73	43.4	44.1	0.7
Mobile	Dorset	43	201	45.3	44.8	-0.6
Mobile	Essex	214	586	36.4	35.7	-0.7
Mobile	Grampian	70	152	53.0	50.7	-2.3
Mobile	Hampshire	9	24	41.7	40.4	-1.3
Mobile	Humberside	66	318	41.5	39.4	-2.1
Mobile	Kent and Medway	33	87	48.5	46.3	-2.3
Mobile	Lancashire	39	121	34.0	31.8	-2.2
Mobile	Leicestershire	62	107	47.3	45.2	-2.1
Mobile	Lincolnshire	14	190	58.6	58.0	-0.7
Mobile	Norfolk	28	399	59.8	59.8	0.0
Mobile	North Wales	46	325	45.5	42.5	-3.0
Mobile	Northumbria	72	140	42.7	42.2	-0.5
Mobile	Nottinghamshire	36	67	49.0	47.3	-1.7
Mobile	South Wales (new2002)	236	831	43.5	41.5	-2.0
Mobile	Strathclyde (new2002)	7	25	63.5	60.9	-2.6
Mobile	Suffolk	13	14	53.9	52.6	-1.2
Mobile	Sussex	28	77	39.8	37.9	-1.9
Mobile	Thames Valley	6	15	45.0	45.1	0.1
Mobile	Warwickshire	35	206	56.1	55.2	-0.9
Mobile	West Mercia	32	52	47.7	44.9	-2.7
Mobile	Wiltshire	52	98	53.3	52.2	-1.1
All Mobile		1448	4806	46.2	44.6	-1.6
All Cameras		1952	6297	45.1	42.1	-3.0

E.3 Change in percentage of vehicles exceeding speed limit

Table E3: Changes in the number of vehicles exceeding the speed limit at camera sites

Camera Type	Partnership area	Number of sites	Number of visits in FY 02/03	% > speed before	% > speed after	% change in speed
Digital	Northamptonshire	1	5	22.0	11.0	-50%
Digital	Nottinghamshire	1	2	36.0	15.5	-57%
All Digital		2	7	26.0	12.3	-53%
Fixed	Avon and Somerset	7	14	34.9	35.6	2%
Fixed	Bedfordshire	16	41	24.1	9.6	-60%
Fixed	Cambridgeshire	17	81	40.5	9.0	-78%
Fixed	Cheshire	4	6	25.2	6.7	-73%
Fixed	Derbyshire	17	27	25.7	19.1	-26%
Fixed	Devon and Cornwall	7	22	50.7	38.1	-25%
Fixed	Dorset	11	29	70.9	41.0	-42%
Fixed	Essex	53	166	46.7	11.1	-76%
Fixed	Grampian	1	2	12.0	19.0	58%
Fixed	Hampshire	11	17	45.3	18.5	-59%
Fixed	Kent and Medway	9	9	48.6	19.0	-61%
Fixed	Lancashire	95	173	33.3	4.0	-88%
Fixed	Leicestershire	5	9	64.2	26.6	-59%
Fixed	Lincolnshire	23	163	29.6	4.0	-87%
Fixed	Norfolk	8	51	47.2	25.8	-45%
Fixed	North Wales	14	70	52.1	32.2	-38%
Fixed	Northamptonshire	18	71	37.8	7.9	-79%
Fixed	South Wales(new2002)	61	225	63.2	8.9	-86%
Fixed	South Yorkshire	10	10	41.7	3.5	-92%
Fixed	Staffordshire	21	24	61.3	10.2	-83%
Fixed	Strathclyde(new2002)	45	140	53.9	11.8	-78%
Fixed	Sussex	7	12	60.1	5.9	-90%
Fixed	Warwickshire	8	68	39.0	29.1	-25%
Fixed	West Mercia	3	6	42.7	11.0	-74%
Fixed	West Mids	14	20	60.6	61.8	2%
Fixed	West Yorkshire	14	21	68.6	3.2	-95%
All Fixed		502	1484	45.6	13.5	-70%
Mobile	Avon and Somerset	136	310	51.9%	36.5%	-30%
Mobile	Bedfordshire	46	123	36.7%	31.2%	-15%
Mobile	Cambridgeshire	21	109	41.1%	25.4%	-38%
Mobile	Cheshire	18	38	58.0%	46.7%	-20%
Mobile	Cleveland	3	11	72.1%	57.1%	-21%
Mobile	Cumbria	13	13	47.9%	26.2%	-45%
Mobile	Derbyshire	42	94	30.4%	28.8%	-5%
Mobile	Devon and Cornwall	28	73	39.5%	43.0%	9%
Mobile	Dorset	43	201	50.6%	47.5%	-6%
Mobile	Essex	214	586	44.0%	37.9%	-14%
Mobile	Grampian	70	152	48.9%	44.0%	-10%
Mobile	Hampshire	9	24	38.6%	33.9%	-12%
Mobile	Humberside	66	318	48.3%	33.0%	-32%
Mobile	Kent and Medway	33	87	45.8%	36.5%	-20%
Mobile	Lancashire	39	121	23.8%	19.1%	-20%
Mobile	Leicestershire	62	107	44.8%	38.1%	-15%
Mobile	Lincolnshire	14	190	17.2%	14.3%	-17%
Mobile	Norfolk	28	399	23.4%	22.2%	-5%
Mobile	North Wales	46	325	54.2%	37.9%	-30%
Mobile	Northumbria	72	140	39.1%	40.1%	3%
Mobile	Nottinghamshire	36	67	59.4%	52.6%	-11%
Mobile	South Wales (new2002)	236	831	51.2%	42.1%	-18%
Mobile	Strathclyde (new2002)	7	25	54.4%	47.5%	-13%
Mobile	Suffolk	13	14	40.6%	35.5%	-13%
Mobile	Sussex	28	77	67.2%	43.1%	-36%
Mobile	Warwickshire	35	206	30.0%	26.4%	-12%
Mobile	West Mercia	32	52	53.1%	36.7%	-31%
Mobile	Wiltshire	52	98	36.4%	36.5%	0%
All Mobile		1448	4806	43.2	35.4	-18%
All Cameras		1952	6297	43.8	30.2	-31%

E.4 Percentage change in vehicles exceeding the speed limit by more than 15mph

Table E4: Change in the number of vehicles exceeding the speed limit by more than 15mph at camera sites

Camera Type	Partnership area	Number of sites	Number of visits in FY 02/03 and 03/04	% > speed by 15mph	% > speed by 15mph	% change in speed
Digital	Northamptonshire	1	5	1.0	0.0	-100%
Digital	Nottinghamshire	1	2	1.0	0.0	-100%
All Digital		2	7	1.0	0.0	-100%
Fixed	Avon and Somerset	7	14	1.9	0.2	-88%
Fixed	Bedfordshire	16	41	3.9	0.5	-86%
Fixed	Cambridgeshire	17	81	3.1	0.2	-92%
Fixed	Cheshire	4	6	0.3	0.2	-50%
Fixed	Derbyshire	17	27	1.3	0.7	-47%
Fixed	Devon and Cornwall	7	22	1.6	1.1	-31%
Fixed	Dorset	11	29	4.2	1.0	-77%
Fixed	Essex	53	166	0.9	0.1	-87%
Fixed	Grampian	1	2	1.0	1.0	0%
Fixed	Hampshire	11	17	7.0	0.4	-95%
Fixed	Kent and Medway	9	9	2.7	0.1	-96%
Fixed	Lancashire	95	173	1.3	0.0	-99%
Fixed	Leicestershire	5	9	5.4	0.4	-92%
Fixed	Lincolnshire	23	163	1.2	0.1	-93%
Fixed	Norfolk	8	51	1.0	0.5	-48%
Fixed	North Wales	14	70	2.0	0.5	-77%
Fixed	Northamptonshire	18	71	8.2	0.2	-97%
Fixed	South Wales(new2002)	61	225	6.4	0.0	-100%
Fixed	South Yorkshire	10	10	2.9	0.0	-100%
Fixed	Staffordshire	21	24	0.3	0.1	-63%
Fixed	Strathclyde(new2002)	45	140	6.9	0.1	-99%
Fixed	Sussex	7	12	4.5	0.1	-98%
Fixed	Thames Valley	3	7	1.6	3.4	118%
Fixed	Warwickshire	8	68	3.7	2.4	-35%
Fixed	West Mercia	3	6	1.3	0.2	-88%
Fixed	West Mids	14	20	8.1	2.3	-72%
Fixed	West Yorkshire	14	21	2.8	0.0	-100%
All Fixed		502	1484	3.5	0.3	-91%
Mobile	Avon and Somerset	136	310	3.8	1.3	-67%
Mobile	Bedfordshire	46	123	3.0	2.5	-19%
Mobile	Cambridgeshire	21	109	5.8	1.8	-70%
Mobile	Cheshire	18	38	3.1	1.9	-39%
Mobile	Cleveland	3	11	3.2	2.5	-20%
Mobile	Cumbria	13	13	5.5	3.5	-36%
Mobile	Derbyshire	42	94	1.7	1.1	-36%
Mobile	Devon and Cornwall	28	73	2.4	1.9	-18%
Mobile	Dorset	43	201	4.7	2.6	-44%
Mobile	Essex	214	586	0.9	1.0	3%
Mobile	Grampian	70	152	4.8	2.7	-44%
Mobile	Hampshire	9	24	8.0	6.1	-24%
Mobile	Humberside	66	318	2.6	1.3	-52%
Mobile	Kent and Medway	33	87	2.8	1.9	-31%
Mobile	Lancashire	39	121	0.8	0.4	-52%
Mobile	Leicestershire	62	107	2.6	2.3	-15%
Mobile	Lincolnshire	14	190	1.4	1.5	7%
Mobile	Norfolk	28	399	1.8	1.8	-2%
Mobile	North Wales	46	325	2.5	1.0	-59%
Mobile	Northumbria	72	140	2.9	4.3	49%
Mobile	Nottinghamshire	36	67	4.4	3.3	-26%
Mobile	South Wales (new2002)	236	831	3.2	2.2	-32%
Mobile	Strathclyde (new2002)	7	25	4.4	3.5	-22%
Mobile	Suffolk	13	14	11.1	3.3	-71%
Mobile	Sussex	28	77	9.2	1.4	-85%
Mobile	Thames Valley	6	15	2.1	1.9	-10%
Mobile	Warwickshire	35	206	2.0	1.8	-14%
Mobile	West Mercia	32	52	3.2	1.8	-43%
Mobile	Wiltshire	52	98	2.0	2.2	8%
All Mobile		1448	4806	2.8	1.8	-36%
All Cameras		1952	6297	3.0	1.4	-51%

Appendix F:
Detailed cost analysis

F.1 Detailed cost and income analysis

The table below summarises the receipts (partnership income from fines paid by speed and red-light offenders) against the costs incurred, by partnership, for the fourth year of the programme (these were obtained from the DfT safety camera programme office).

Table F1 Costs and receipts for all partnership areas in the fourth year of the programme

	Income	Cap ex	Revenue exp	Projected year end position Expenditure	Surplus / deficit	FPNs paid	revenue cost per FPN
	£			£	£		£
Avon & Somerset	5,949,060.00	1,688,910.00	2,896,436.00	4,649,063.00	1,299,997.00	99,151.00	29.21
Bedfordshire	3,655,200.00	540,923.00	1,751,337.00	2,292,260.00	1,362,940.00	60,920.00	28.75
Cambridgeshire	1,245,780.00	449,285.00	641,652.00	1,090,937.00	154,843.00	20,763.00	30.90
Cheshire	1,803,840.00	724,715.00	1,097,225.00	1,821,940.00	-18,100.00	30,064.00	36.50
Cleveland	1,268,640.00	206,300.00	867,125.00	1,073,425.00	195,215.00	21,144.00	41.01
Cumbria	1,618,740.00	315,371.00	540,282.00	1,094,121.00	524,619.00	26,979.00	20.03
Derbyshire	2,822,400.00	480,492.00	1,470,735.00	1,951,227.00	871,173.00	47,040.00	31.27
Devon & Cornwall	2,938,440.00	643,139.00	1,233,841.00	1,876,980.00	1,061,460.00	48,974.00	25.19
Dorset	3,959,040.00	739,907.00	2,334,918.00	3,074,825.00	884,215.00	65,984.00	35.39
Essex	5,137,740.00	1,451,189.00	3,586,104.00	5,037,293.00	100,447.00	85,629.00	41.88
Fife	618,540.00	77,876.00	40,6637.00	484,513.00	134,027.00	10,309.00	39.44
Grampian	1,012,860.00	0.00	719,311.00	719,311.00	293,549.00	16,881.00	42.61
Greater Manchester	2,887,080.00	1,056,463.00	1,288,051.00	2,445,144.00	441,936.00	48,118.00	26.77
Hampshire	2,495,220.00	657,203.00	1,429,196.00	2,086,399.00	408,821.00	41,587.00	34.37
Hertfordshire	1,901,700.00	885,341.00	926,051.00	1,811,392.00	90,308.00	31,695.00	29.22
Humberside	2,680,860.00	963,607.00	1,260,121.00	2,367,151.00	313,709.00	44,681.00	28.20
Kent	3,295,740.00	705,471.00	2,304,232.00	3,009,703.00	286,037.00	54,929.00	41.95
Lancashire	5,073,600.00	1,208,198.00	2,199,515.00	3,407,713.00	1,665,887.00	84,560.00	26.01
Leicestershire	2,312,280.00	326,440.00	1,237,835.00	1,564,275.00	748,005.00	38,538.00	32.12
Lincolnshire	1,423,020.00	429,931.00	795,076.00	1,225,007.00	198,013.00	23,717.00	33.52
London	6,497,460.00	1,787,200.00	5,449,534.00	7,236,734.00	-739,274.00	108,291.00	50.32
Norfolk	1,629,420.00	698,470.00	835,459.00	1,533,929.00	95,491.00	27,157.00	30.76
North Wales	3,374,820.00	357,008.00	2,521,864.00	2,878,872.00	495,948.00	56,247.00	44.84
Northamptonshire	3,349,140.00	948,993.00	1,946,102.00	2,895,095.00	454,045.00	55,819.00	34.86
Northumbria	3,205,560.00	1,204,454.00	1,174,265.00	2,595,040.00	610,520.00	53,426.00	21.98
Nottingham	3,331,800.00	1,986,560.00	1,322,708.00	3,309,268.00	22,532.00	55,530.00	23.82
South Wales	7,281,180.00	1,151,295.00	3,915,959.00	5,067,254.00	2,213,926.00	121,353.00	32.27
South Yorkshire	3,168,960.00	241,849.00	1,351,929.00	1,593,778.00	1,575,182.00	52,816.00	25.60
Staffordshire	2,436,240.00	381,814.00	1,569,048.00	1,950,862.00	485,378.00	40,604.00	38.64
Strathclyde	3,453,524.00	737,512.00	2,002,176.00	2,739,688.00	713,836.00	57,559.00	34.78
Suffolk	1,448,640.00	567,491.00	880,801.00	1,746,931.00	-298,291.00	24,144.00	36.48
Sussex	3,772,820.00	636,996.00	1,542,665.00	2,179,661.00	1,593,159.00	62,880.00	24.53
Thames Valley	6,698,760.00	0.00	5,338,779.00	5,338,779.00	1,359,981.00	111,646.00	47.82
Warwickshire	3,051,720.00	668,223.00	1,222,089.00	1,890,312.00	1,161,408.00	50,862.00	24.03
West Mercia	3,086,160.00	1,274,742.00	1,257,848.00	2,607,770.00	478,390.00	51,436.00	24.45
West Midlands	2,760,000.00	1,052,702.00	1,464,824.00	2,517,526.00	242,474.00	46,000.00	31.84
West Yorkshire	3,625,920.00	1,760,930.00	1,636,638.00	3,397,568.00	228,352.00	60,432.00	27.08
Wiltshire	2,380,800.00	292,538.00	966,586.00	1,259,124.00	1,121,676.00	39,680.00	24.36
	118,652,704.00	**29,299,538.00**	**65,384,954.00**	**95,820,870.00**	**22,831,834.00**	**1,977,545.00**	**33.06**

Appendix G: Technical details of casualty analysis

G.1 Background

This work has been undertaken to provide a statistical analysis of road collision and casualty data in the 38 partnership areas that had joined the national safety camera programme for at least one of the four years April 2000 to March 2004. The data that are investigated here relate to road collisions and casualties that occurred at camera sites during the period following acceptance onto the programme. These are compared with baseline data for the corresponding site, which generally come from an earlier three-year period.

In view of the long-term general downward trend in frequency of collision and casualty occurrence, the impact is estimated here in a way that reflects this trend. Consideration was also given to seasonal variation in the frequency of personal injury collisions (PIC) and killed and seriously injured casualties (KSI). To undertake this investigation, data for KSIs and for PICs from all areas of Great Britain were used.

The purpose of this analysis is to estimate the effect on KSIs and PICs at safety camera sites, after taking into account relevant background reductions and other variations.

G.2 Description of the data

By the end of the study period, 38 partnerships had been accepted onto the national safety camera programme and were able to provide at least one year's data. These areas supplied data on the numbers of killed and seriously injured casualties (KSI) and the number of personal injury collisions (PIC) at each site. Collision and casualty data for each site was split according to the following time periods:

1. Within a certain distance of a camera site during a period (generally 36 months duration) preceding entry into partnership for that area (referred to as the baseline period)
2. For a camera site (starting from the date at which it was established) the number of PICs and KSIs occurring during each month up to and including March 2004 (referred to as the after period).

The fixed camera sites were generally the section of road within 0.5 km of the location of the camera itself. This varied by location but was consistent between baseline and after periods.

Other data that were reported for each site were:

- a unique identifier for that site
- the kind of camera that was used
- the date at which the camera site was established
- the date of entry into the cost recovery partnership
- the date at which the site was made conspicuous
- prevailing speed limit.

In this analysis, the data for the different sites were not all for periods of identical duration. For this reason, the start date and the months that the camera was active was taken into consideration on the modelling.
Four main kinds of cameras were used under cost recovery. These were:

- standard fixed camera installations
- digital cameras (time over distance)
- red light cameras
- mobile cameras

Initial investigation showed that the effect of cameras differed largely according to whether the camera site was fixed (standard fixed, digital and red light cameras) or mobile. For this reason, two groups of camera kinds were used in the statistical analysis: fixed, and mobile. Data for sites at which mobile cameras were used were collected continuously from the date that the site was established, irrespective of the frequency of enforcement.

The number of sites was cross-classified by urban-rural and fixed-mobile.
The sites that contributed to the analysis are shown in Table G1. This included two digital cameras; one in Northamptonshire (50 mph speed limit, hence classed as rural), and one in Nottingham City (40 mph speed limit, hence classed as urban). This also includes 612 red-light cameras. These are shown in Table G2. The clear majority of the red light cameras are in urban locations, with 29 in rural ones.

Table G1: Numbers of sites of each kind for which data were used in the present analysis.

Area	Urban		Rural		
	Fixed	Mobile	Fixed	Mobile	All
Avon, Somerset and Gloucestershire					
- Avon and Somerset	77	145	20	27	269
Bedfordshire	28	43	22	13	106
Cheshire	7	23	7	1	38
Cleveland	2	40	1	4	47
Cumbria	0	13	0	27	40
Derbyshire	36	63	2	19	120
Devon and Cornwall	17	30	1	3	51
Dorset	54	48	5	27	134
Essex	82	152	3	0	237
Fife	0	30	0	20	50
Glasgow City	56	0	1	0	57
Grampian	6	34	18	37	95
Greater Manchester	121	64	3	2	190
Hampshire	20	27	4	3	54
Hertfordshire	38	8	6	0	52
Humberside	0	60	0	7	67
Kent	35	26	5	16	82
Lancashire	105	30	9	2	146
Leicestershire	24	46	1	27	98
Lincolnshire	24	1	26	13	64
London	452	0	67	0	519
Norfolk	20	11	4	56	91
North Wales	14	42	0	11	67
Northamptonshire	27	0	10	0	37
Northumberland	13	17	12	12	54
Nottinghamshire					
- Nottingham City	22	16	0	0	38
- Nottinghamshire (XCity)	10	14	4	14	42
South and Mid Wales					
- South Wales	106	102	2	16	226
- Dyfed-Powys	8	87	0	35	130
- Gwent	13	53	1	19	86
South Yorkshire	59	53	6	0	118
Staffordshire	182	0	36	6	224
Strathclyde (new 2002)	29	5	0	4	38
Suffolk	2	26	3	15	46
Sussex	53	28	2	0	83
Thames Valley	22	6	0	2	30
Tyne and Wear	20	47	4	3	74
Warwickshire	7	15	9	23	54
West Mercia	4	32	0	14	50
West Midlands	223	0	26	0	249
West Yorkshire	3	0	0	1	4
Wiltshire	6	27	7	28	68
All areas	**2061**	**1469**	**348**	**523**	**4401**

Table G2: Red light cameras (which are included as Fixed in Table G1)

	Red light		
Area	**Urban**	**Rural**	**All**
Avon, Somerset and Gloucestershire			
- Avon and Somerset	29	4	33
Cleveland	1		1
Derbyshire	1		1
Devon and Cornwall	2		2
Dorset	20	2	22
Essex	17	2	19
Glasgow City	21		21
Greater Manchester	63		63
Hampshire	5	2	7
Hertfordshire	6	1	7
Leicestershire	12		12
London	225	9	234
Norfolk	6		6
Northumberland	1		1
Nottinghamshire			
- Nottingham City	21		21
- Nottinghamshire (XCity)	7	3	10
South and Mid Wales			
- South Wales	31		31
- Dyfed-Powys	1		1
- Gwent	3		3
South Yorkshire	19	1	20
Strathclyde (new 2002)	3		3
Sussex	20	2	22
Tyne and Wear	10		10
Warwickshire	4	2	6
West Midlands	54	1	55
Wiltshire	1		1
All areas	**583**	**29**	**612**

Data on collisions in which pedestrians were injured and on pedestrian casualties at safety camera sites were available from 38 partnerships. Similarly, data on collisions in which children were injured and on child casualties at safety camera sites were also available from these areas and the number of sites for which data are were made available from each of them are shown in Table G2a.

Because of this, the results of analysis of the effect of the safety cameras on pedestrian and child collision involvement can be estimated for those sites that these partnerships contributed, but are not directly comparable with results from the other analyses.

Table G2a: Number of sites in partnership areas contributing pedestrian and child collision data

Area	Pedestrian		Child	
	PIC	**KSI**	**PIC**	**KSI**
Avon Somerset and Gloucestershire				
- Avon and Somerset	269	269	269	269
Bedfordshire	104	104	104	104
Cambridgeshire	76	76	76	76
Cheshire	38	38	38	38
Cleveland	47	47	47	47
Cumbria			2	2
Derbyshire	120	120	120	120
Dorset	134	134	134	134
Essex	235	235	235	235
Fife	50	50	50	50
Glasgow City	57	57	57	57
Grampian	95	95	95	95
Greater Manchester	190	190	190	190
Hertfordshire	52	52	52	52
Humberside	67	67	67	67
Kent	82	82	82	82
Leicestershire	98	98	98	98
Lincolnshire	64	64	64	64
London	519	519	519	519
Norfolk	91	91	91	91
North Wales	67	67	67	67
Northamptonshire	37	37	37	37
Northumberland	54	54	54	54
Nottinghamshire				
- Nottingham City	38	38	38	38
- Nottinghamshire (XCity)	42	42	42	42
South and Mid Wales				
- South Wales	226		226	
- Dyfed-Powys	130	130	130	130
- Gwent	86	86	86	86
South Yorkshire	118	118	118	118
Staffordshire	224	224	224	224
Strathclyde(new2002)	38	38	38	38
Suffolk	46	46	46	46
Sussex	83	83	83	83
Thames Valley	30	30	30	30
Tyne and Wear	74	74	74	74
Warwickshire	54	54	54	54
West Mercia	50	50	50	50
West Midlands			249	249
West Yorkshire	4	4	4	4
Wiltshire	68	68	68	68
All areas	**3857**	**3631**	**4108**	**3882**
Number of areas	**38**	**37**	**40**	**39**

G.3 Comparison with national trends

In order to eliminate the effect on collision and casualty numbers of long-term national trend and of seasonal variation within year, these variations were investigated using national data for the period that is relevant to this study. The Department for Transport provided data on national KSI and PIC numbers in three-month observations for the period from the start of 1997 to the end of March 2004. Long-term trends and seasonal variations, separate for urban and rural areas, calculated from these data were incorporated into the model, and therefore form part of the reference against which the effects of interventions are estimated. This process was repeated separately for all KSI casualties and PIC collisions, and then for those involving pedestrians and those involving child casualties. Safety improvements in these estimates included all those arising from the introduction of safety cameras, but were considered not to be influenced strongly by them.

The sites that were accepted for inclusion in the cost recovery programme conformed to the handbook requirements that are specified in Appendix A of the present research report. The requirement for a record of PICs during recent years is a central criterion for selection. However, there was also a requirement to identify speed as a contributory factor to these collisions, a clear indication of motorists speeding or running red lights, suitability of the site for treatment by enforcement, and unsuitability of further engineering remedial measures. The results of the statistical analysis of casualties and collisions at speed cameras are consistent with the observed reductions in speeding, showing that the enforcement measures are working as intended.

G.4 Data issues

Certain features of the data that were used in the present modelling and analysis are recorded here.

Nottingham City

The Nottingham City digital camera site was on the ring road.

Strathclyde

Strathclyde provided data for 57 sites located in Glasgow City and a further 38 new sites elsewhere. These were analysed in separate groups.

South Wales

There was a change in reporting practices in South Wales around the end of 1999 or early on in 2000. The effect of these changes is thought to have increased the recording of KSI casualties. It was concluded that given the uncertainties with regard to the impact of the reporting changes at safety cameras (and given that the implementation of safety cameras could affect the ratio of KSI to slight casualties) South Wales data were excluded from the analysis of KSI casualties.

Thames Valley

Due to a change in KSI casualty reporting practice in Thames Valley from 1999, data prior to 1999 is not comparable with later years. Sufficient comparable data was available to provide data for 30 sites that had at least one year of baseline (i.e. pre cost-recovery programme) and continuity of site definitions.

Data provided by the Department for Transport

The Department for Transport provided data from Quarter 1 (Q1) 1997 to Q1 2004 for each of the police force area in Great Britain. These data corresponded to the quantities for which statistical models were developed, namely all PIC collisions, all KSI casualties, those involving pedestrian casualties, and those involving child casualties.

G.5 Analysis

In order to estimate the part of the variations in the observed occurrence of PIC and KSI at camera sites that can be associated with introduction of safety cameras, we undertook a statistical modelling exercise. The model that was developed is log-linear in form, to estimate the mean frequency (number per unit time) of a Poisson process. The modelling was undertaken using the GenStat statistical analysis package (GenStat Committee, 2002).

Because the observations are reported in units of various durations, the durations were accommodated by using the GenStat offset facility. We supposed that the data have a Poisson distribution with mean frequency that is modelled as follows. The same model form was developed for each of KSIs and for PICs, and for all collisions, those involving pedestrian casualties, and those involving child casualties, but with different parameter values fitted for each.

In order to represent changes due to long-term national trend and seasonal variations in each of the categories of PIC collision and KSI casualties, statistical models were fitted to these totals for all police force areas in Great Britain. A distinct form of seasonal variation was estimated for urban and for rural areas in each case events. The form of these models was the same in each case, and has the same form as was used for KSI casualties:

$$M_{rt} = \exp\left(R_r + Tt + Q_{u(r),q(t)}\right) + \eta_{rt}$$

where

M_{rt} is the recorded number of KSI casualties observed in area r during the quarter year dated t ,

R_r is a parameter to allow for the differing number of KSI casualties occurring during each quarter year between areas r due to their sizes, populations and their other fixed attributes,

T is a parameter that represents the general change in frequency of KSI casualties over time t , which is measured from the start of the study period,

Q_{uq} is a parameter to represent the seasonal variation in KSI casualties within each year with a value that varies between quarters q at sites in location of kind u (u = 1 for urban areas, u = 0 for rural areas),

u(r) is an indicator of whether area r is urban with speed limit < 40 mph (when u(r) = 1) or is rural with speed limit > 40 mph (when u(r) = 0),

q(t) is the quarter year during which the observation was made, and

η_{rt} is an error term that is assumed to have Poisson distribution.

During this part of the modelling process, the parameters *T* and **Q** were fitted to the quarterly data; distinct seasonal variations were fitted for the urban and the rural parts of each of the partnership areas. Their fitted values were then adopted as constants to be used as offset parameters within the statistical model of collision and casualty numbers at individual sites. Use of the separate parameters *R* for the partnership areas means that the effects of long-term trend and seasonal variation are estimated whilst allowing for the differences between other aspects of the size and nature of the partnership areas.

The statistical model that was used to investigate the effect of safety cameras has the same form for each case of events that was analysed. In the case of KSI casualties, the form is

$$N_{pt} = \exp\left(O_{pt} + Tt + Q_{u(p),q(t)} + P_p + A_{f(p),u(p)}\, a(p,t) + B\, b(p,t) + C\, c(p,t)\, f(p)\right) + \varepsilon_{pt}$$

where

N_{pt} is the recorded number of KSI casualties at site *p* for the observation dated *t*,

O_{pt} is the logarithm of the duration of the observation period dated *t* at site *p*,

T and Q_{uq} are parameters that represent respectively the long-term temporal and seasonal variation in KSI casualties within each year with fixed values that were calculated in the first part of the modelling process,

P_p is a parameter to allow for the differing number of KSI casualties between sites p due to their sizes and other fixed attributes,

A_{fu} is a 2 x 2 parameter to represent the effect associated with a camera site of kind *f* *(f = 1 for fixed, f = 0 for mobile)* in location of kind *u (u = 1 for urban, u = 0 for rural)*,

a(p,t) is the proportion of the period of the observation at site *p* dated *t* for which the camera was established,

B is a parameter to represent the effect associated with operation under cost recovery,

b(p,t) is the proportion of the period of the observation at site *p* dated *t* for which the camera operated under cost recovery,

C is a parameter to represent the effect associated with increased conspicuity,

c(p,t) is the proportion of the period of the observation at site *p* dated *t* for which the camera had increased conspicuity,

f(p) is an indicator of whether the camera site *p* has is fixed *(when f(p) = 1)* or mobile (when f(p) = 0), and

e_{pt} an error term that is assumed to have Poisson distribution.

In this model, the parameters **O, T** and **Q** are fixed, being represented as offset variables to account for effects that are established elsewhere. Use of the separate parameters **P** for the sites means that comparisons are made for each site individually according to its collision record.

Further models of this form were estimated using distinct estimates of effect $(A_{fu} + D_r)$ for a camera site of kind *f* in a location of kind *u* in partnership *area r* .

The effect of the interventions at a camera site is represented through the parameters A, B and C . In the case of fixed cameras, all three components of the effect are taken to apply. In the case of mobile sites, the additional conspicuity requirements are believed not to have has any substantial influence, so that the conspicuity component represented by parameter C was not modelled at them and is not applied in estimating their effect: this is included in the structure of the model by multiplying the conspicuity parameter C by c(p, t) to represent the conspicuity requirement and by f(p) to represent its application only at fixed sites. Similarly, where a camera was established before the start of the baseline period, the camera component represented by parameter A was not modelled at them; this was controlled by the presence indicator a(p, t) , which takes the value 1 throughout at such sites.

Thus the proportional effect on the mean frequency of occurrence of KSI casualties of establishing a conspicuous fixed camera operating under cost recovery at a site p is estimated as

$$\exp\left(A_{1,u(p)} + B + C\right)$$

Similarly, the proportional effect on the mean frequency of occurrence of KSI casualties of establishing a mobile camera operating under cost recovery at a site p is estimated as

$$\exp\left(A_{0,u(p)} + B\right)$$

Because of the nature of the data from which this model was estimated, estimates of the parameters A, B and C are correlated. For this reason, the standard error s of the sum of parameters (here denoted generically as r and s) was calculated using the formula

$$s = \sqrt{s_r^2 + 2 s_r r_{rs} s_s + s_s^2}$$

where s_r denotes the standard error of estimation of parameter r, and r_{rs} denotes the correlation between estimates of parameters r and s.

The GenStat software provided values for the parameter estimates, their standard errors of estimation, and the correlation between estimates: these values were used in the analysis of results presented here.

G.6 Results

The results are presented separately for the KSI data and the PIC data. We investigated the general effects at camera sites on the basis of the results as a whole. In this, we considered the different effects of the different kinds of cameras (fixed and mobile) in different locations (urban and rural).

G.6.1 KSI casualties.

The results of fitting the full model described in the previous section to the KSI data are shown in Table G3 and Table G4. The parameter estimates shown in Table G3 describe the general development of KSI casualties during the seven years of the study period, whilst those in Table G4 describe the differences from the general development that are associated with the various combinations of kind of camera and kind of location. The content of each of these tables is discussed below

Table G3: Parameter estimates ($\hat{\theta}$) for those non-treatment factors that were significant in the Poisson/log-linear model of KSIs together with estimates for upper and lower limits on their 95% confidence intervals, calculated as $\hat{\theta} \pm 1.96\,\sigma_{\hat{\theta}}$.

KSI	Estimate	Standard error	95% Confidence interval	
Factor	$\hat{\theta}$	$\sigma_{\hat{\theta}}$	Lower	Upper
Time (year)	-0.0361	0.0014	-0.0387	-0.0334
Quarter 2 (urban)	0.0495	0.0103	0.0293	0.0698
Quarter 3 (urban)	0.0574	0.0103	0.0372	0.0775
Quarter 4 (urban)	0.1405	0.0101	0.1207	0.1603
Quarter 2 (rural)	0.0766	0.0164	0.0445	0.1087
Quarter 3 (rural)	0.1620	0.0161	0.1304	0.1937
Quarter 4 (rural)	0.0043	0.0162	-0.0275	0.0361

Note: In a log-linear model of the kind used here, the proportionate effect of a unit change in variable x that has associated parameter $\hat{\theta}$ is $\exp(\hat{\theta})$ -1 . Thus for small absolute values of (a few percent), a unit change in the value of x will result in a proportionate change of approximately $\hat{\theta}$ in the estimated quantity.

The fitted value of the parameter for time shows that the frequency of occurrence of KSI casualties in the whole of GB fell at a little over 3.5% each year throughout the study period. This reflects the general improvement in road safety and includes the effects of the introduction of safety cameras during this period. The effects for quarters 2, 3 and 4 of the year are referenced to the first quarter of the year, and these show that the frequency of KSI casualties increases progressively in urban areas from quarter to quarter through the year. By contrast, the frequency of KSI casualties peaks in rural areas during the third quarter of the year (July–September). The seasonal effects represented by quarters differ with statistical significance between urban and rural sites.

Table G4: Parameter estimates ($\hat{\theta}$) for the camera effects in the Poisson/log-linear model for KSI casualties together with standard errors of estimation for the various kinds of area.

KSI		Estimate	Standard error
Fixed	Urban	-0.631	0.021
	Rural	-0.978	0.058
Mobile	Urban	-0.430	0.018
	Rural	-0.413	0.025

(This dataset excludes South Wales)

The fitted value of the model parameters for each of the four combinations of fixed and mobile cameras at urban and rural sites are shown in Table G4. This shows that the effects of safety cameras differed between camera types and location of deployment, with fixed cameras having a greater effect than mobile ones on the frequency of occurrence of KSI casualties. The proportionate effect of the different kinds of cameras in these locations can be estimated from these parameters by exponentiation. These estimates, together with their 95% confidence intervals, are given in Table G5. This shows that according to this analysis, fixed cameras had the effect of reducing KSI casualties by about half when introduced (together with conspicuity and cost recovery) at urban and rural sites. Mobile cameras had the effect of reducing KSI casualties at urban and rural sites where they were used under cost recovery by about one third.

Table G5: Estimates of proportionate change in frequency of KSI casualties at sites after introduction of cameras, together with 95% confidence intervals.

KSI		Proportion	95% Confidence interval	
Urban	Fixed	-0.468	-0.489	-0.446
	Mobile	-0.349	-0.372	-0.327
Rural	Fixed	-0.624	-0.664	-0.579
	Mobile	-0.338	-0.371	-0.304
All camera sites		**-0.421**	**-0.447**	**-0.395**

(This dataset excludes South Wales)

The proportionate estimates of changes can be aggregated according to the number of KSI casualties at sites of each kind that contributed to the study. In order to make this estimate, the frequency of KSI casualties that would have occurred at these sites during the year 2004 if no cameras had been installed was estimated projecting the observations for each site forward to that date allowing for national long-term trend. These values are given in Table G6, and the estimates of proportions, calculated by aggregating values in Tables G4 according to those in G6, are given in Table G7. This shows that, after taking into account the different kinds of camera that are used in each of urban and rural areas, the typical changes in frequency of KSI casualties are similar between urban and rural areas at about 40% reduction.

Table G6: Estimated mean frequency of KSI casualties at sites of each kind during 2004.

	No of KSIs expected during 2004		
Speed limit	**Urban**	**Rural**	**Total**
Fixed sites	1728	370	2098
Mobile sites	1328	722	2050
All camera sites	**3056**	**1092**	**4148**

(This dataset excludes South Wales)

Table G7: Estimates of changes in frequency of KSI casualties, expressed as a proportion of those expected to occur without a camera.

KSI	Proportion	95% Confidence interval	
Fixed	-0.498	-0.512	-0.485
Mobile	-0.346	-0.359	-0.332
Urban	-0.418	-0.429	-0.406
Rural	-0.447	-0.467	-0.427
All camera sites	**-0.426**	**-0.439**	**-0.412**

(This dataset excludes South Wales)

Finally, the change in numbers of KSI casualties can be estimated from this according to the mean number of KSI casualties at sites of each kind. In order to make these estimates, the frequency of KSI casualties that would have occurred at these sites during the year 2004 if no cameras had been installed, as given in Table G6, were used together with the estimates of changes given in Table G5. The results of this, which are given in Table G8, represent estimates of the annual savings in KSI casualties that arise from the introduction of safety cameras operating under the prevailing rules of cost recovery summed across all of the sites that contributed data to the study. They show that the bulk of the savings (about 1200 per annum out of 1700) accrue at urban sites. Although the effectiveness of cameras at mobile sites is less than that at fixed ones, the frequency of KSI casualties at mobile rural sites is about twice that at fixed rural sites, so that the reduction (about 240 per annum) in frequency of KSI casualties at mobile rural sites is slightly greater than that (about 230 per annum) at fixed rural ones.

Table G8: Estimated total change in frequency of KSI casualties during 2004 at sites of each kind

	Change in KSIs (Absolute numbers)		
Speed limit	**Urban**	**Rural**	**All**
Fixed sites	**-808.6**	**-230.9**	**-1039.5**
Mobile sites	**-464.1**	**-244.3**	**-708.4**
All camera sites	**-1272.7**	**-475.1**	**-1747.9**

(This dataset excludes South Wales)

G.6.2 PICs.

The results of fitting the full model described in the previous section to the PIC data are shown in Table G9 and Table G10. The parameter estimates shown in Table G9 describe the general development of PICs during the seven years of the study period, whilst those in Table G10 describe the differences from the general development that are associated with the various combinations of kind of camera and kind of location. The content of each of these tables is discussed below.

Table G9: Parameter estimates ($\hat{\theta}$) for those non-treatment factors that were significant in the Poisson/log-linear model of KSIs together with estimates for upper and lower limits on their 95% confidence intervals, calculated as $\hat{\theta} \pm 1.96\, \sigma_{\hat{\theta}}$.

PIC	Estimate	Standard error	95% Confidence Interval	
Factor	$\hat{\theta}$	$\sigma_{\hat{\theta}}$	**Lower**	**Upper**
Time (year)	-0.0196	0.0006	-0.0208	-0.0183
Quarter 2 (urban)	0.0469	0.0044	0.0383	0.0555
Quarter 3 (urban)	0.0454	0.0044	0.0368	0.0539
Quarter 4 (urban)	0.1371	0.0043	0.1287	0.1455
Quarter 2 (rural)	-0.0312	0.0085	-0.0478	-0.0145
Quarter 3 (rural)	0.0560	0.0083	0.0396	0.0723
Quarter 4 (rural)	0.0240	0.0082	0.0079	0.0401

The fitted value of the parameter for time shows that the frequency of occurrence of PICs in the whole of GB fell at over 1.5% each year throughout the study period. This reflects the general improvement in road safety and includes the effects of the introduction of safety cameras during this period. The effects for quarters 2, 3 and 4 of the year are referenced to the first quarter of the year, and these show that in urban areas, the frequency of PICs increases from quarter to quarter through the year. By contrast, the frequency of PIC collisions peaks in rural areas during the third quarter of the year (July–September). The seasonal effects represented by quarters differ with statistical significance between urban and rural sites.

Table G10: Parameter estimates ($\hat{\theta}$) for the After periods in the Poisson/log-linear model for PICs together with standard errors of estimation for the various kinds of area.

PIC		Estimate	Standard error
Fixed	Urban	-0.254	0.012
	Rural	-0.404	0.042
Mobile	Urban	-0.253	0.010
	Rural	-0.168	0.021

The proportionate effect of the different kinds of cameras in these locations can be estimated from these parameters by exponentiation. These estimates, together with their 95% confidence intervals, are given in Table G11. This shows that cameras had the effect of reducing PICs by about 20% when introduced under cost recovery in urban areas. In rural areas, the reduction of PICs at fixed sites was about 30% whilst that at mobile sites it was urban about half that at 15%.

Table G11: Estimates of change in frequency of PIC collisions at sites after introduction of cameras, together with 95% confidence intervals.

Speed limit	Camera site	Proportion	95% Confidence Interval	
Urban	Fixed	-0.224	-0.243	-0.206
	Mobile	-0.224	-0.239	-0.208
Rural	Fixed	-0.332	-0.386	-0.274
	Mobile	-0.155	-0.188	-0.120
All camera sites		**-0.223**	**-0.243**	**-0.201**

The proportionate estimates of changes can be aggregated according to the number of PIC collisions at sites of each kind that contributed to the study.
In order to make this estimate, the frequency of PIC collisions that would have occurred at these sites during the year 2004 if no cameras had been installed was estimated projecting the observations for each site forward to that date allowing for national long-term trend. These values are given in Table G12, and the estimates of proportions, calculated by aggregating values in Tables G10 according to those in G12 are given in Table G13. This shows that, after taking into account the different kinds of camera that are used in each of urban and rural areas, the typical changes in frequency of PIC collisions are similar between urban and rural areas at about 20% reduction.

Table G12: Estimated mean frequency of PIC collisions at sites of each kind during 2004.

	No of PICs expected during 2004		
Speed limit	**Urban**	**Rural**	**Total**
Fixed sites	8887.7	991.7	9879.3
Mobile sites	7509.4	1961.0	9470.4
All camera sites	**16397**	**2953**	**19350**

Table G13: Estimates of proportionate changes in frequency of PIC casualties, expressed as a proportion of those expected to occur without a camera.

PIC	Proportion	95% Confidence Interval	
Fixed	-0.236	-0.247	-0.224
Mobile	-0.210	-0.219	-0.200
Urban	-0.224	-0.233	-0.215
Rural	-0.219	-0.241	-0.197
All camera sites	**-0.223**	**-0.234**	**-0.212**

Finally, the change in numbers of PIC collisions can be estimated from this according to the mean number of PIC collisions at sites of each kind. In order to make this estimate, the frequency of PIC collisions that would have occurred at these sites during the year 2004 if no cameras had been installed, as given in Table G12, were used together with the estimates of changes given in Table G11. The results, of this, which are given in Table G14, represent estimates of the annual savings in PICs that arise from the introduction of safety cameras operating under the prevailing rules of cost recovery summed across all of the sites that contributed data to the study. They show that the bulk of the savings (about 3500 per annum out of 4200) accrue at urban sites.

Table G14: Estimated total change in frequency of KSI casualties during 2004 at sites of each kind

	Change in PICs (Absolute numbers)		
Speed limit	**Urban**	**Rural**	**All**
Fixed sites	-1955.7	-340.7	-2296.4
Mobile sites	-1643.4	-298.2	-1941.6
All camera sites	**-3599**	**-639**	**-4238**

G.6.3 Differences between partnerships

In order to investigate the difference in changes between partnership areas, a further model was developed that included the interaction between introduction of cameras and the partnership areas. This model included all of the effects of the main model to account for differences between areas in composition of urban and rural, fixed and mobile sites. Because of this, these coefficients can be interpreted as representing an estimate of the difference between the safety performance of each partnership after allowance has been made for the different kinds of safety cameras and their location of deployment. These coefficients provide an indication of the combination of scope for improvement in the circumstances of the area and the performance within that scope. The coefficients in the log-linear model for each partnership area that would apply at a fixed camera site in an urban area in the PIC model are shown in Table G15, together with their standard errors of estimation and resulting T values.

Table G15: Coefficients in the log-linear model for PICs for each partnership area at a fixed camera site in an urban area

Partnership name	Parameter	SE	T
Avon, Somerset and Gloucestershire			
- Avon and Somerset	-0.207	0.067	-3.09
Bedfordshire	-0.72	0.091	-7.91
Cambridgeshire	-0.057	0.077	-0.74
Cheshire	-0.12	0.110	-1.09
Cleveland	-0.682	0.082	-8.32
Cumbria	-0.675	0.108	-6.27
Derbyshire	-0.347	0.071	-4.88
Devon and Cornwall	-0.423	0.095	-4.44
Dorset	-0.215	0.077	-2.78
Essex	-0.275	0.066	-4.15
Fife	-0.152	0.113	-1.35
Glasgow City	-0.358	0.102	-3.50
Grampian	0.191	0.088	2.18
Greater Manchester	-0.191	0.069	-2.77
Hampshire	-0.333	0.071	-4.68
Hertfordshire	-0.477	0.092	-5.19
Humberside	-0.404	0.095	-4.24
Kent	-0.316	0.076	-4.13
Lancashire	-0.252	0.069	-3.65
Leicestershire	-0.331	0.070	-4.70
Lincolnshire	-0.428	0.094	-4.53
London	-0.181	0.049	-3.72
Norfolk	-0.567	0.083	-6.85
North Wales	-0.454	0.076	-5.94
Northamptonshire	-0.77	0.103	-7.46
Northumberland	-0.387	0.139	-2.79
Nottinghamshire			
- Nottingham City	-0.225	0.068	-3.29
- Nottinghamshire (XCity)	-0.354	0.077	-4.58
South and Mid Wales			
- South Wales	-0.074	0.070	-1.05
- Dyfed-Powys	-0.459	0.080	-5.71
- Gwent	-0.554	0.085	-6.50
South Yorkshire	-0.714	0.068	-10.45
Staffordshire	-0.096	0.086	-1.12
Strathclyde (new 2002)	-0.542	0.126	-4.31
Suffolk	-0.393	0.118	-3.32
Sussex	-0.282	0.078	-3.62
Thames Valley	-0.139	0.101	-1.37
Tyne and Wear	-0.148	0.099	-1.50
Warwickshire	-0.319	0.084	-3.82
West Mercia	-0.5	0.098	-5.11
West Midlands	-0.091	0.066	-1.37
West Yorkshire	-1.312	0.448	-2.93
Wiltshire	-0.682	0.114	-5.99

The results in Table G15 show that there was sufficient evidence from the clear majority of partnerships individually to establish that the effect of introduction of a safety camera led to reduction in the mean frequency of PICs in those areas. The coefficients in this table represent only part of the effect of safety cameras: other terms representing the effects of rural location, mobile camera sites, and their interaction apply at other sites. The proportion of sites of different kinds will influence the performance of each area beyond that shown in this table.

The coefficients in the log-linear model for each partnership area that would apply at a fixed camera site in an urban area in the KSI model are shown in Table G16, together with their standard errors of estimation and resulting T values. These results show that there was sufficient evidence from the clear majority of the partnerships individually to establish that the effect of introduction of a safety camera led to reduction in the mean frequency of KSIs in those areas. The coefficients in this table represent only part of the effect of safety cameras: other terms representing the effects of rural location, mobile camera sites, and their interaction apply at other sites. The proportion of sites of different kinds will influence the performance of each area beyond that shown in this table.

Table G16: Coefficients in the log-linear model for KSIs for each partnership area at a fixed camera site in an urban area

Partnership name	Parameter	SE	T
Avon, Somerset and Gloucestershire			
- Avon and Somerset	-0.098	0.057	-1.71
Bedfordshire	-1.402	0.113	-12.42
Cambridgeshire	-0.786	0.088	-8.98
Cheshire	-0.117	0.135	-0.87
Cleveland	-0.372	0.094	-3.94
Cumbria	-0.991	0.113	-8.80
Derbyshire	-0.486	0.057	-8.46
Devon and Cornwall	-1.239	0.135	-9.14
Dorset	-0.508	0.080	-6.32
Essex	-0.216	0.047	-4.58
Fife	0.009	0.113	0.08
Glasgow City	-0.361	0.255	-1.42
Grampian	-0.110	0.082	-1.35
Greater Manchester	-0.495	0.074	-6.69
Hampshire	-0.701	0.066	-10.55
Hertfordshire	-1.204	0.126	-9.57
Humberside	-0.958	0.125	-7.69
Kent	-0.875	0.077	-11.39
Lancashire	-0.348	0.057	-6.08
Leicestershire	-0.968	0.077	-12.65
Lincolnshire	-0.586	0.098	-6.00
London	-0.336	0.055	-6.13
Norfolk	-1.389	0.077	-18.07
North Wales	-0.950	0.084	-11.34
Northamptonshire	-0.608	0.101	-6.05
Northumberland	-1.252	0.201	-6.23
Nottinghamshire			
- Nottingham City	-0.477	0.196	-2.43
- Nottinghamshire (XCity)	-0.868	0.213	-4.08
South and Mid Wales			
- Dyfed-Powys	-1.002	0.069	-14.51
- Gwent	-1.596	0.107	-14.91
South Yorkshire	-0.863	0.060	-14.44
Staffordshire	0.007	0.130	0.05
Strathclyde (new 2002)	-0.429	0.281	-1.52
Suffolk	-1.402	0.150	-9.38
Sussex	-0.536	0.086	-6.23
Thames Valley	-0.673	0.162	-4.15
Tyne and Wear	-0.845	0.287	-2.94
Warwickshire	-0.714	0.076	-9.41
West Mercia	-1.127	0.130	-8.66
West Midlands	-1.017	0.050	-20.41
West Yorkshire	-0.636	0.631	-1.01
Wiltshire	-1.283	0.131	-9.78

G.6.4 Time of joining the programme

The time at which areas joined the cost recovery programme varied substantially. The initial group of 8 pilot partnerships joined in April 2000, whilst the most recent areas that were considered in the present study joined in April 2003. The distribution of numbers of partnership areas at each date are shown in Table G17.

Table G17: Dates of areas joining the cost recovery programme.

Date of joining	Number of areas
April 2000	8
October 2001	6
April 2002	12
July 2002	2
October 2002	4
April 2003	8

In order to investigate whether or not the date at which these partnerships joined the programme had an influence of the effectiveness of safety cameras in their areas, further log-linear models were fitted and compared with corresponding ones that included individual effects for each area. The volume of data from areas joining after July 2002 was small, in part due to their number and in part to their relatively late date, so they were also considering together as a group joining in or after July 2002. The change in deviance of the log-linear model was measured as each of the 4-level and the 6-level factors describing these joining groups were added to the statistical model described in section G5 above. The mean deviance per degree of freedom for this enhancement to the model was compared to the corresponding quantity for adding a separate effect for each partnership area. The ratio of these quantities was assessed using the F test, with the results presented in Table G19. This shows that although the inclusion of 4 and 6-level factors for the joining groups enhanced the model substantially, this enhancement was not significantly greater than would be expected given the variability between partnership areas. For this reason, we conclude that the date of joining the cost recovery programme has no statistically significant effect on safety performance of cameras.

Table G19: Analysis of model enhancement for date of joining compared with between-partnership areas.

Variable	Degrees of freedom	Deviance	Mean deviance	*F*	Probability of *F* under H_0
KSI Partnership areas	41	344.0	8.4	-	-
Date of joining	3	42.2	14.1	1.68	0.19
	5	44.2	8.8	1.05	0.40
PIC Partnership areas	42	488.9	11.6	-	-
Date of joining	3	43.7	14.6	1.25	0.30
	5	52.6	10.5	0.90	0.49

G.6.5 Pedestrian collisions

We now consider the effect of safety camera operation under cost recovery on collisions that involve pedestrian casualties. The pedestrian data cannot be compared directly to the data for all user groups because the data came from only some of the sites within 38 of the partnership areas. The data that were used in this part of the analysis are summarised in Table G20.

Investigation of non-treatment effects showed that the seasonal variations differed significantly between urban and rural areas; this was therefore respected in the models of pedestrian PICs and KSIs that were developed. Different effects at safety cameras sites were investigated according to whether they were fixed or mobile. In estimating and using this model, the effects of changes in conspicuity requirements were not applied at mobile sites.

Table G20: Summary of number of sites from which data were used in analysis of pedestrian casualties.

Area	PIC	KSI
Avon Somerset and Gloucestershire		
- Avon and Somerset	269	269
Bedfordshire	104	104
Cambridgeshire	76	76
Cheshire	38	38
Cleveland	47	47
Derbyshire	120	120
Dorset	134	134
Essex	235	235
Fife	50	50
Glasgow City	57	57
Grampian	95	95
Greater Manchester	190	190
Hertfordshire	52	52
Humberside	67	67
Kent	82	82
Leicestershire	98	98
Lincolnshire	64	64
London	519	519
Norfolk	91	91
North Wales	67	67
Northamptonshire	37	37
Northumberland	54	54
Nottinghamshire		
- Nottingham City	38	38
- Nottinghamshire (XCity)	42	42
South and Mid Wales		
- South Wales	226	
- Dyfed-Powys	130	130
- Gwent	86	86
South Yorkshire	118	118
Staffordshire	224	224
Strathclyde(new2002)	38	38
Suffolk	46	46
Sussex	83	83
Thames Valley	30	30
Tyne and Wear	74	74
Warwickshire	54	54
West Mercia	50	50
West Yorkshire	4	4
Wiltshire	68	68
All areas	**3857**	**3631**
Number of areas	**38**	**37**

The results of fitting the model corresponding to that in the previous section to data for pedestrian casualties who were either killed or seriously injured are shown in Table G21 and Table G22. The parameter estimates shown in Table G21 describe the general development of pedestrian KSI casualties during the study period, whilst those in Table G22 describe the differences from the general development that are associated with introduction of safety cameras. The content of these tables is discussed below.

Table G21: Parameter estimates ($\hat{\theta}$) for those non-treatment factors that were significant in the Poisson/log-linear model of pedestrian KSI casualties together with estimates for upper and lower limits on their 95% confidence intervals, calculated as $\hat{\theta} \pm 1.96\, \sigma_{\hat{\theta}}$.

Pedestrian KSI	Estimate	Standard error	95% Confidence Interval	
Factor	$\hat{\theta}$	$\sigma_{\hat{\theta}}$	Lower	Upper
Time (year)	-0.0521	0.0021	-0.0561	-0.0480
Quarter 2 (urban)	-0.0675	0.0127	-0.0924	-0.0426
Quarter 3 (urban)	-0.1211	0.0129	-0.1463	-0.0958
Quarter 4 (urban)	0.1215	0.0121	0.0977	0.1453
Quarter 2 (rural)	-0.1322	0.0473	-0.2250	-0.0394
Quarter 3 (rural)	0.0804	0.0455	-0.0088	0.1695
Quarter 4 (rural)	0.0824	0.0429	-0.0017	0.1665

Table G22: Estimates of proportionate change in frequency of pedestrian KSI casualties at sites after introduction of cameras, together with 95% confidence intervals.

Speed limit	Proportion	95% Confidence Interval	
Fixed	-0.335	-0.386	-0.277
Mobile	-0.246	-0.291	-0.198
All camera sites	-0.293	-0.340	-0.239

(This dataset excludes South Wales)

The fitted value of the parameter for time shows that the frequency of occurrence of pedestrian KSIs in Britain fell at a little over 5 per cent each year throughout the study period. This reflects the general improvement in road safety and includes the effects of the introduction of safety cameras during this period. The effects for quarters 2, 3 and 4 of the year are referenced to the first quarter of the year, and these show that in both urban and rural areas, the frequency of pedestrian KSIs is greatest during the final quarter of the year.

The proportionate effect of the different kinds of cameras in these locations can be estimated from the model. These estimates, together with their 95% confidence intervals, are given in Table G22. This shows that fixed cameras had the effect of reducing pedestrian KSI casualties by about a third when introduced together with conspicuity and cost recovery. Mobile cameras had the effect of reducing pedestrian KSI casualties where they were used under cost recovery by about a quarter. Aggregating these estimates of effectiveness using the numbers of casualties at sites of each kind shown in Table G20 leads to an estimate of effectiveness of about 30 per cent reduction in frequency of pedestrian KSI casualties at these camera sites.

The results of fitting the corresponding model to data for pedestrian PICs are shown in Table G23 and Table G24. The parameter estimates shown in Table G23 describe the general development of pedestrian PICs during the study period, whilst those in Table G24 describe the differences from the general development that are associated with introduction of safety cameras. The content of these tables is discussed below.

Table G23: Parameter estimates ($\hat{\theta}$) for those non-treatment factors that were significant in the Poisson/log-linear model of pedestrian PIC collisions together with estimates for upper and lower limits on their 95% confidence intervals, calculated as $\hat{\theta} \pm 1.96\ \sigma_{\hat{\theta}}$.

Pedestrian PCI	**Estimate**	**Standard error**	**95% Confidence Interval**	
Factor	$\hat{\theta}$	$\sigma_{\hat{\theta}}$	**Lower**	**Upper**
Time (year)	-0.0362	0.0011	-0.0382	-0.0341
Quarter 2 (urban)	-0.0107	0.0063	-0.0230	0.0017
Quarter 3 (urban)	-0.0582	0.0064	-0.0706	-0.0457
Quarter 4 (urban)	0.1049	0.0061	0.0930	0.1169
Quarter 2 (rural)	-0.1651	0.0329	-0.2296	-0.1005
Quarter 3 (rural)	0.0080	0.0318	-0.0544	0.0704
Quarter 4 (rural)	0.0646	0.0302	0.0054	0.1237

Table G24: Estimates of proportionate change in frequency of pedestrian pedestrian PIC collisions at sites after introduction of cameras, together with 95% confidence intervals.

Speed limit	**Proportion**	**95% Confidence Interval**	
Fixed	-0.219	-0.256	-0.177
Mobile	-0.244	-0.272	-0.213
All camera sites	-0.231	-0.264	-0.195

(This dataset excludes South Wales)

The fitted value of the parameter for time shows that the frequency of occurrence of pedestrian PICs in Britain fell at about 3.5 per cent each year throughout the study period. This reflects the general improvement in road safety and includes the effects of the introduction of safety cameras during this period. The effects for quarters 2, 3 and 4 of the year are referenced to the first quarter of the year, and these show that in both urban and rural areas, the frequency of pedestrian PICs is greatest during the final quarter of the year.

The proportionate effect of the different kinds of cameras in these locations can be estimated from the model. These estimates, together with their 95% confidence intervals, are given in Table G24. This shows that safety cameras had the effect of reducing pedestrian PIC collisions by about 20 per cent when introduced together with conspicuity and cost recovery.

G.6.5 Child casualties

We now consider the effect of safety camera operation under cost recovery on collisions that involve child casualties. The pedestrian data cannot be compared directly to the data for all user groups because the data came only some of the sites within 39 of the partnership areas. The data that were used in this part of the analysis are summarised in Table G25.

Investigation of non-treatment effects showed that the seasonal variations differed significantly between urban and rural areas; this was therefore respected in the models of child PICs and KSIs that were developed. Different effects at safety cameras sites were investigated according to whether they were fixed or mobile. In estimating and using this model, the effects of changes in conspicuity requirements were not applied at mobile sites.

Table G25: Summary of number of sites from which data were used in analysis of child casualties.

Area	PIC	KSI
Avon Somerset and Gloucestershire		
- Avon and Somerset	269	269
Bedfordshire	104	104
Cambridgeshire	76	76
Cheshire	38	38
Cleveland	47	47
Cumbria	2	2
Derbyshire	120	120
Dorset	134	134
Essex	235	235
Fife	50	50
Glasgow City	57	57
Grampian	95	95
Greater Manchester	190	190
Hertfordshire	52	52
Humberside	67	67
Kent	82	82
Leicestershire	98	98
Lincolnshire	64	64
London	519	519
Norfolk	91	91
North Wales	67	67
Northamptonshire	37	37
Northumberland	54	54
Nottinghamshire		
- Nottingham City	38	38
- Nottinghamshire (XCity)	42	42
South and Mid Wales		
- South Wales	226	
- Dyfed-Powys	130	130
- Gwent	86	86
South Yorkshire	118	118
Staffordshire	224	224
Strathclyde(new2002)	38	38
Suffolk	46	46
Sussex	83	83
Thames Valley	30	30
Tyne and Wear	74	74
Warwickshire	54	54
West Mercia	50	50
West Midlands	249	249
West Yorkshire	4	4
Wiltshire	68	68
All areas	4108	3882
Number of areas	**40**	**39**

The results of fitting the model corresponding to that in the previous section to data for child casualties who were either killed or seriously injured are shown in Table G26 and Table G27. The parameter estimates shown in Table G26 describe the general development of child KSI casualties during the study period, whilst those in Table G27 describe the differences from the general development that are associated with introduction of safety cameras. The content of these tables is discussed below.

Table G26: Parameter estimates ($\hat{\theta}$) for those non-treatment factors that were significant in the Poisson/log-linear model of child KSI casualties together with estimates for upper and lower limits on their 95% confidence intervals, calculated as $\hat{\theta} \pm 1.96\, \sigma_{\hat{\theta}}$.

Child KSI	Estimate	Standard error	95% Confidence Interval	
Factor	$\hat{\theta}$	$\sigma_{\hat{\theta}}$	Lower	Upper
Time (year)	-0.0723	0.0029	-0.0780	-0.0666
Quarter 2 (urban)	0.2750	0.0184	0.2390	0.3110
Quarter 3 (urban)	0.2411	0.0185	0.2048	0.2774
Quarter 4 (urban)	0.0663	0.0195	0.0282	0.1044
Quarter 2 (rural)	-0.0060	0.0478	-0.0997	0.0877
Quarter 3 (rural)	0.1264	0.0471	0.0342	0.2186
Quarter 4 (rural)	0.0895	0.0496	-0.0077	0.1867

Table G27: Estimates of proportionate change in frequency of child KSI casualties at sites after introduction of cameras, together with 95% confidence intervals.

Speed limit	Proportion	95% Confidence Interval	
Fixed	-0.369	-0.424	-0.304
Mobile	-0.254	-0.312	-0.188
All camera sites	-0.319	-0.375	-0.254

(This dataset excludes South Wales)

The fitted value of the parameter for time shows that the frequency of occurrence of child KSIs in Britain fell at a little over 7 per cent each year throughout the study period. This reflects the general improvement in road safety and includes the effects of the introduction of safety cameras during this period. The effects for quarters 2, 3 and 4 of the year are referenced to the first quarter of the year, and these show that in urban areas, the frequency of child KSI casualties is greatest during quarters 2 and 3, whilst in rural areas, it is greatest during the third and fourth quarters of the year.

The proportionate effect of the different kinds of cameras in these locations can be estimated from the model. These estimates, together with their 95% confidence intervals, are given in Table G27. This shows that fixed cameras had the effect of reducing child KSI casualties by about a third when introduced together with conspicuity and cost recovery. Mobile cameras had the effect of reducing child KSI casualties where they were used under cost recovery by about a quarter. Aggregating these estimates of effectiveness using the numbers of casualties at sites of each kind shown in Table G25 leads to an estimate of effectiveness of about 30 per cent reduction in frequency of child KSI casualties at these camera sites.

The results of fitting the corresponding model to data for pedestrian PICs are shown in Table G28 and Table G29. The parameter estimates shown in Table G28 describe the general development of child PICs during the study period, whilst those in Table G29 describe the differences from the general development that are associated with introduction of safety cameras. The content of these tables is discussed below.

Table G28: Parameter estimates ($\hat{\theta}$) for those non-treatment factors that were significant in the Poisson/log-linear model of child PIC collisions together with estimates for upper and lower limits on their 95% confidence intervals, calculated as $\hat{\theta} \pm 1.96\,\sigma_{\hat{\theta}}$.

Child PICs	Estimate	Standard error	95% Confidence Interval	
Factor	$\hat{\theta}$	$\sigma_{\hat{\theta}}$	Lower	Upper
Time (year)	-0.0536	0.0012	-0.0559	-0.0513
Quarter 2 (urban)	0.2624	0.0072	0.2482	0.2766
Quarter 3 (urban)	0.2506	0.0073	0.2364	0.2648
Quarter 4 (urban)	0.0692	0.0076	0.0542	0.0842
Quarter 2 (rural)	-0.0710	0.0199	-0.1099	-0.0321
Quarter 3 (rural)	0.1006	0.0193	0.0629	0.1383
Quarter 4 (rural)	0.1296	0.0200	0.0903	0.1689

Table G29: Estimates of proportionate change in frequency of child PIC collisions at sites after introduction of cameras, together with 95% confidence intervals.

Speed limit	Proportion	95% Confidence Interval	
Fixed	-0.103	-0.145	-0.057
Mobile	-0.247	-0.279	-0.213
All camera sites	-0.178	-0.215	-0.139

The fitted value of the parameter for time shows that the frequency of occurrence of child PICs in Britain fell at about 5 per cent each year throughout the study period. This reflects the general improvement in road safety and includes the effects of the introduction of safety cameras during this period. The effects for quarters 2, 3 and 4 of the year are referenced to the first quarter of the year, and these show that in urban areas, the frequency of child PICs is greatest during quarters 2 and 3, whilst in rural areas, it is greatest during the third and fourth quarters of the year.

The proportionate effect of the different kinds of cameras in these locations can be estimated from the model. These estimates, together with their 95% confidence intervals, are given in Table G29. This shows that safety cameras had the effect of reducing child PIC collisions by about 10 per cent at fixed camera sites and by about 20 per cent at mobile ones when introduced together with conspicuity and cost recovery.

Appendix H:

Estimates of regression-to-mean effects at safety cameras

H.1 Background

Since the site selection guidelines for cameras include threshold levels of both all personal injury collisions (PICs) and fatal and serious collisions (FSCs), it is likely that some of the observed reductions in collisions will be attributable to regression-to-mean (RTM) effects rather than the effects of the cameras. Whenever site selection is based on particularly high numbers of observed collisions in a particular period of time, the sites identified will tend to be those with more collisions than expected during the period of observation. Such locations will then tend to have fewer collisions in a subsequent time period (with or without a camera) simply because the collision count in the first time period was abnormally high. This is the RTM effect. If RTM effects are not allowed for there is a danger that the effectiveness of cameras will be over-estimated.

The purpose of the analysis described in this appendix is to estimate the size of the reduction attributable to RTM effects and hence to estimate the safety effects of cameras, free of the effects of both the general long-term trend in collision frequencies and RTM.

It is important to recognise that the size of any RTM effect will vary depending on the selection criteria used and the expected collision frequency. In general, the more stringent the selection criterion and the lower the expected collision frequency, the greater the RTM effect will tend to be. Since the selection criteria for cameras include both the total number of personal injury collisions

(PICs) and the number of fatal and serious collisions (FSCs), with the latter the more stringent of the two, the size of the RTM effect may be expected to vary with collision type. The current collision criteria also vary with camera type, because the threshold values for fixed cameras are higher than for mobile cameras. The collision criteria for cameras do not vary with speed limit (urban or rural) but expected collision frequencies tend to be lower on rural roads. Thus the RTM effect is also likely to vary with speed limit.

In order to estimate the size of any RTM effect it is necessary to estimate the number of collisions that would have occurred in the period after camera installation if the camera had not been installed. This expected number of collisions is unlikely to be the same as the number observed in the before period when sites have been selected on the basis of high observed collision frequencies because of RTM and will, in any case, be subject to the effects of general trends in collision risk and traffic flows.

In this appendix, the effects of RTM are estimated using an empirical Bayes (EB) approach. This approach has been used by researchers to correct for RTM in the evaluation of road safety schemes because of the difficulty of obtaining a group of randomly assigned control sites (see, for example, Hauer 1997, Elvik 1997, Hirst et al. 2004a & 2004b). In the EB approach, the expected collision frequency is estimated using two sources of information about each site: the observed collisions at the site prior to the implementation of the safety measure and predictive model estimates of the expected collisions for sites similar to the study site in terms of observable characteristics and levels of traffic flow. The inclusion of observed collisions allows some account to be taken of the characteristics of the sites which are not included in the prediction model, while the model estimates smooth out the effects of random variation in the observed values. Trends in collision frequencies during the period of observation can be allowed for using a comparison ratio approach (Hirst et al. 2004b).

H.2 The data

The number of sites that could be analysed using the EB approach was limited only by the availability of suitable data. The method requires more data concerning individual sites than has been routinely collected by the safety camera partnerships. In particular, the application of the predictive models used here requires details of two-way annual traffic flows and the numbers of minor junctions within the section over which collisions are monitored. These data could not be obtained for all camera sites.

For dual-carriageway sites, in particular, collision and flow data have only been routinely collected by the partnerships for the carriageway with a camera but available predictive models require data for both carriageways. As two-way data could not be supplied by the partnerships, dual-carriageway sites had to be excluded from this part of the analysis.

It should also be noted that predictive models are available for collisions but not for casualties. The safety data collected by the partnerships has traditionally been the observed number of PICs together with numbers of killed and seriously injured casualties (KSIs). For this part of the analysis data were required concerning numbers of PICs and FSCs (for which predictive models are available) rather than KSIs (for which they are not).

Collision data are obtained during a period (generally 36 months) immediately preceding the partnership joining the national safety programme (referred to as the baseline period). The baseline data for cameras installed prior to cost recovery will thus include at least some time with a camera in operation.
In this part of the analysis, only the effect of the introduction of cameras was to be investigated and thus only cameras installed after cost recovery commenced were included. The 'after' period for the collision data started from the date the camera became operational and varied in duration.
In order to ensure that reasonably reliable observations of after collisions were obtained, only cameras with collision data available for a minimum period of 1-year after the start of camera enforcement were included in the sample.

After excluding dual-carriageway sites, existing cameras, and cameras with less than 1-year of after collision data, a sub-set of 317 sites were obtained for which sufficient data were available to allow the EB method to be applied.

The information obtained for these sites was as follows:

- Name
- Camera type
- Road class (A-road or other)
- Speed limit
- Date 3-year baseline period ends
- Date after period starts
- Duration of after period
- Baseline traffic flow (million vehicles per year)
- Length of section over which collisions are monitored
- Number of minor junctions within monitored section
- Number of PICs and FSCs in baseline period
- Number of PICs and FSCs in after period

There are difficulties in establishing verifiably representative predictive collision models for camera sites on rural roads (section H.3.1 of this appendix gives a fuller discussion of this point). This may lead to over-estimates of the RTM effect for rural roads. Equally, it is likely that RTM effects will be larger for rural roads because expected collision frequencies tend to be lower than on urban roads while the selection criteria are the same for both. Initial analysis of the data confirmed that the estimated RTM effects were indeed higher for rural sites. However, it was not possible to confirm the extent to which the larger RTM effects estimated for rural cameras were genuine and the extent to which they were attributable to unrepresentative predictive models. In consequence it was decided that the detailed analysis to determine RTM and scheme effects would only be carried out for urban camera sites. There were 216 urban cameras with suitable data available. A summary of the numbers of these, by camera type, speed limit and area, is given in Table H1.

Table H1: Summary of number of sites by camera type, speed limit and area

Number of sites					
	Urban Fixed		Urban Mobile		All urban
Speed limitArea	**30mph**	**40mph**	**30mph**	**40mph**	
Cleveland	-	-	18	3	21
Derbyshire	9	2	25	9	44
Dorset	-	-	8	4	12
Hampshire	-	-	8	8	16
Norfolk	-	-	-	3	3
Nottinghamshire	1	-	6	1	8
South Wales	5	1	47	14	67
Staffordshire	25	9	-	-	34
Wiltshire	-	-	6	4	10
All areas	**40**	**12**	**118**	**46**	**216**

The sub-set of camera sites for which RTM effects could be estimated is not a representative sub-set of all camera sites nationally. In particular it should be noted that:

1. All cameras are on urban, single-carriageway roads with the majority (73%) on 30mph roads.
2. The sub-set comprises predominantly (76%) mobile cameras. Many fixed cameras had to be excluded from this analysis because they were existing cameras which changed operation to cost-recovery. These could not be included because the baseline collision data for such sites includes time with a camera in operation.

3. Only 9 partnership areas were able to provide the data required. In the case of fixed cameras, only 4 partnerships were able to provide data and the majority of these cameras (65%) are in one area (Staffordshire).

The sub-set represents some 6% of the total number of cameras included in the main part of this report: 2.5% of the fixed cameras and 11% of the mobile cameras.

H.3 Analysis

H.3.1 Choice of a suitable reference population

The aim of the EB method is to produce an unbiased estimate of the true mean collision frequency at the study site, by using all available information. This includes: (i) the observed collisions at the study site and (ii) the collision history at sites with similar characteristics to the study site. Hauer (1997) refers to these sites as the 'reference population'. The reference population may on the one hand be quite narrow, and consist of sites that are very similar to the study site in terms of measured characteristics (carriageway type, speed limit, surrounding land use, and so on); on the other hand, it may be quite diverse. The weight given to the information from the reference population reflects this degree of narrowness or diversity. When some of the measured characteristics are continuous (such as traffic flow) it is preferable to use regression modelling to produce a predictive collision model using the data from a suitable reference population. The goodness-of-fit of the predictive model is reflected in the weight accorded to this estimate in the EB method. Provided that sites are selected for treatment on the basis of observed collision frequencies and modelled site characteristics, the EB estimates will be unbiased.

For camera sites, the primary selection criteria are the observed frequencies of PICs and FSCs: for fixed cameras the current guidelines suggest at least 8 PICs per km in a 3-year period of which at least 4 are FSCs; for mobile cameras the corresponding frequencies are 4 PICs and 2 FSCs per km in a 3-year period. However, threshold values of the 85th percentile speed and percentages of speeding vehicles are also used as secondary selection criteria. Ideally the predictive models should include these measures of speed, but predictive models can only be developed using variables for which data are readily available at all sites. Data concerning speeds are not routinely collected for road sections before they have been selected for further investigation and possible remedial treatment. As a consequence 85th percentile speeds and the percentage of vehicles speeding are not included in available collision models. This may lead to bias in the EB estimates: specifically the predictive models may tend to under-estimate collisions so that the RTM effect may tend to be over-estimated and the treatment effect under-estimated.

Whether the omission of the speed variables will lead to errors in estimates depends on the extent to which the speed variables play a part in site selection. For 30 mph roads, since speeding is endemic (DfT 2004), any site meeting the collision criteria is likely to also meet the speed criteria (at least 20% speeding and and an 85th percentile speed of 35mph). Thus, for 30mph roads the speed criteria are largely irrelevant, and the predictive models derived from a typical sample of such roads are appropriate at camera sites.

For higher speed roads the issue is less clear cut because higher speed limits are not so widely disregarded as the 30mph limit: mean speeds on these roads tend to be less than the speed limit and the percentage speeding lower. It is thus more likely that sites on higher speed limit roads which are selected on the basis of observed PICs and FSCs alone will not meet the speed criteria. The speed criteria would then become relevant to site selection. Table H2 illustrates this point.

Nationally, in 2000 on 30mph roads (which is fairly typical of the baseline periods), 66% of car drivers exceeded the speed limit with a mean speed of 32mph. Table H2 indicates that, for 30mph roads, the national average mean speed and percentage speeding was similar to (indeed marginally higher than) the corresponding data for the camera sites included in the three-year evaluation report. Thus there is no reason to suppose that the speed related criteria played much part in selecting 30mph camera sites. This also appears to be broadly the case for 40mph sites. With 60mph speed limits, however, the camera sites do tend to have higher mean speeds and higher percentages speeding than national roads with the same speed limit. The speed criteria may then have been relevant in the selection of camera sites on rural roads although it is also possible that the collision criteria have simply (as intended) identified roads with higher mean speeds and higher percentages speeding. To avoid the possibility of bias, however, rural roads were excluded from this part of the analysis.

Table H2: Comparison of speed distributions at camera sites with national average speeds

	Speed limit			
	30mph	40mph	50mph	60mph
Data from national safety camera 3-year evaluation				
Sample size	673	128	45	152
Mean speed (mph)	31.3	38.5	45.7	52.8
% above speed limit	53.9%	37.0%	24.3%	20.7%
From "Vehicle speeds in GB 2003" (DfT 2004)				
Mean speed (cars) 2000 (mph)	32	37	-	45
% above speed limit (cars) 2000	66%	25%	-	9%
Mean speed (cars) 2003 (mph)	31	36	-	48
% above speed limit (cars) 2003	58%	27%	-	9%

It is important to stress that the possible problem of bias in the EB estimates only arises if sites are selected using site characteristics that are not included in the predictive model. If the sites are selected on the basis of collision frequencies and modelled variables, the EB estimates will be unbiased. Indeed, provided that collision frequency is the primary criterion for site selection, any bias introduced by using unmodelled site characteristics for site selection is likely to be small.

It is worth noting that, at a successful camera site (which achieves a reduction in speeds and hence collisions), the collisions observed in the period after camera installation (X_A) may still be higher than those predicted for sites with similar measured characteristics (μ). Since camera sites are primarily selected on the basis of high numbers of observed collisions, it is likely that the predictive model estimates (μ) will be less than the expected collision frequency at the selected sites simply because the high observed collision frequency (X_B) will in part tend to arise because of site features which are not included in the model (such as high speeds, large numbers of pedestrians crossing, poor visibility and so on). The EB estimates of the expected collision frequencies before and after camera installation ($\hat{M}_B$ and $\hat{M}_A$) allow for these unmeasured (or unmeasurable) site characteristics and will thus also be larger than the model estimates (μ).

Although successful cameras reduce one factor known to affect collisions (ie speeds), there may well be other unmeasured site variables that continue to give rise to relatively high collision frequencies. The success of a camera is measured by the extent to which it reduces collisions below $\hat{M}_A$ not below μ. It is only if it were possible to include all of the variables which affect collisions in the model (flow, speed limit, number of minor junctions, various measures of speed distribution, pedestrian flows etc) that the after collisions at the camera sites could be expected to be less than the modelled values for these sites.

(In this case, everything that affects collisions is represented in the model so that if the speed variables were reduced by the camera the observed collisions would then have to be less than the model predictions.) If any relevant variables are omitted from the model (which in practice is inevitable), the site selection process will tend to select sites which have a positive contribution from the omitted variables. Whether the observed mean collision frequencies after camera installation at the selected sites are below the mean model predictions for these sites would depend entirely on the relative sizes of the effects of the omitted variables and the reduction in the speed variables.

H.3.2 Methodology

The approach to the analysis is described in detail elsewhere (Hirst et al 2004a and 2004b) and will only be briefly summarised here. The predictive models used were those derived by Mountain et al. (1997). The parameters of this model depend on the accident type (all PICs or FSCs), road class, speed limit and carriageway type. For example, for a 30mph, single carriageway, B-road the model for annual PICs is:

$$\hat{\mu} = 0.72 q_B^{0.626} L \exp(0.083 n / L)$$

where $\hat{\mu}$ is the predicted number of annual PICs, q_B is the annual flow in the baseline period (in million vehicles per year), L is the section length (km) and n is the number of minor intersections.

The estimate of the total baseline collisions in a period of t_B years is then

$$\hat{\mu}_B = t_B . \hat{\mu}$$

As the predictive models were derived from data for the 12-year period 1980 to 1991, a correction was applied to allow for the fact that the model will be outdated due to trends in collision risk between the modelled period and the baseline period of observation at the camera sites (Hirst et al 2004b).
To obtain an estimate of the average national trend, a model of the form

$$\hat{\mu}_T = \alpha_0 \gamma^T Q_T{}^{\beta}$$

was fitted to national collision data for the period 1980 to 2004. In this $\hat{\mu}_T$ was the total number of collisions nationally (PICs or FSCs as appropriate) in year T (T = 0 for 1980) and Q_T was the total national annual traffic volume in year T (measured in vehicle-kilometers). The average factor by which risk changes from year to year, g, was estimated to be 0.98 for all PICs and 0.95 for FSCs.

The corrected estimate of the total baseline collisions is then

$$\hat{\mu}_{\text{B CORRECTED}} = \gamma^{t} \hat{\mu}_{\text{B}}$$

where t is the elapsed time between the middle of the modelled and study periods. Thus, for example, for a camera with a baseline period from January 1998 to December 2000, t = 13.5 and, for all PICs, γ^{t} = 0.76.

Normally predictive collision models assume that the random errors are from the negative binomial (NB) family. If K is the shape parameter for the NB distribution (K is estimated to be 1.92 for the above model for PICs), the EB estimate of total collisions in the baseline period, $\hat{M}_B$, is calculated as

$$\hat{M}_B = \alpha \hat{\mu}_{B\text{ CORRECTED}} + (1-\alpha) X_B$$

where

$$\alpha = \left(1 + \frac{\hat{\mu}_{B\text{ CORRECTED}}}{K}\right)^{-1}$$

The next step is to estimate the expected number of collisions in the after period in the absence of cameras, $\hat{M}_A$. This will differ from the estimate for the baseline period ($\hat{M}_B$) because of the effects of the general downward trend in collision frequencies, as well as any differences in the durations of the periods of observation. To allow for this, the expected collisions in the after period were estimated using a comparison group approach. The comparison group for this study comprised national total collisions on urban roads (all PICs or FSCs as appropriate) during the relevant baseline and after periods for each camera scheme. The estimate of the expected after collisions in the absence of a camera, $\hat{M}_A$, is then

$$\hat{M}_A = \left(\frac{A_{A\_NAT}}{A_{B\_NAT}}\right) \cdot \hat{M}_B$$

where

A_{B_NAT} = total national urban collisions in the baseline period of t_B years

A_{A_NAT} = total national urban collisions in the after period of t_A years

The use of a comparison group ratio implicitly assumes that flows at the cameras have changed in line with national trends. It is possible to estimate the effects on collisions of any flow changes which arise due to the implementation of the cameras separately from the effects of any speed changes (Hirst et al. 2004a). This, however, requires data concerning traffic flows in the after period. This information was not available for the present study.

The proportional change in annual collisions attributable to the effect of a camera, *S*, was then estimated as

$$\hat{S} = \frac{X_A/t_A - \hat{M}_A/t_A}{X_B/t_B}$$

The non-scheme effects which would have occurred with or without cameras (the effects of trend between the baseline and after periods, N_T, and RTM effects, N_R) are estimated as

$$\hat{N}_T = \frac{\hat{M}_A/t_A - \hat{M}_B/t_B}{X_B/t_B}$$

$$\hat{N}_R = \frac{\hat{M}_B/t_B - X_B/t_B}{X_B/t_B}$$

The observed proportional change in collisions, *B*, which can be written

$$B = \frac{X_A/t_A - X_B/t_B}{X_B/t_B}$$

is thus given by $B = \hat{S} + \hat{N}_T + \hat{N}_R$

The estimates of the average effects were obtained by using summations over all cameras in the category of interest (say urban fixed cameras). Thus, for example, the proportional change in observed annual collisions over all sites in a category was calculated as

$$B = \frac{\sum\left(X_A/t_A\right) - \sum\left(X_B/t_B\right)}{\sum\left(X_B/t_B\right)}$$

Standard errors and confidence intervals were calculated using the bootstrap (Efron and Tibshirani 1993).

H.3.3 Calculation of proportional changes

It should be noted that, as described above, all changes are expressed relative to the observed baseline collisions (X_B) and are thus additive. This is in line with some previous analyses of speed camera sites (Mountain et al. 2004, Mountain et al. 2005). This approach was used because expressing all percentage changes (due to the camera, RTM and trend) relative to observed collisions prior to camera installation was considered to be the most readily interpretable quantity. This approach gives a measure of the safety effect of cameras relative to what is known prior to any intervention.

An alternative approach is to use expected after collisions as a base. This is the approach used elsewhere in this report. This approach gives a measure of the safety effect of cameras relative to what would have been expected had the camera not been installed. As trend and RTM effects mean that the outcome expected in the after period will not be the same as that observed in the before period, this approach has its merits: the percentage reduction expressed in this way gives a direct measure of the safety effect of cameras relative to what would otherwise have occurred. The difficulty, however, is that what would have happened in the after period had the camera not been installed is not known: it can only be estimated and the estimate will depend on the extent to which the confounding factors (trend, RTM and changes in flow) are allowed for. Because of the general downward trend in collisions and RTM effects, the percentage scheme effects calculated using expected after collisions as a base will tend to be higher than those calculated using observed baseline collisions as a base.

The percentage changes obtained using the alternative methodologies both have their merits but are not directly comparable. Both values are given in this appendix.

H.4 Results

H.4.1 Personal injury collisions (PICs)

Table H3 summarises the estimated percentage changes in all PICs relative to the observed collisions prior to camera installation. The overall average observed reduction in PICs is 31%. After allowing for trend and RTM effects, the average reduction in all PICs attributable to the cameras is 16% of those observed in the baseline period. RTM effects account for a fall of 7% with trend accounting for a further fall of 8%. Thus, on average, the effects of the cameras accounted for just over half of the observed reduction in PICs with RTM and trend effects each accounting for about a quarter.

Table H3: Estimated proportional changes in PICs relative to observed baseline collisions

Percentage changes in PICs {95% confidence interval}			
	Urban Fixed	**Urban Mobile**	**All urban**
No. of sites	52	164	216
Total observed PICs*:			
before	531	2484	3015
after	225	1150	1375
Observed change	-25.6%	-31.8%	-30.7%
	{-12.2%, -39.4%}	{-26.1%, -37.2%}	{-25.8%, -35.6%}
Scheme effect	-14.8%	-16.4%	-16.2%
	{-3.6%, -27.4%}	{-10.4%, -22.0%}	{-10.8%, -21.4%}
RTM effect	-2.5%	-7.6%	-6.7%
	{+0.6%,-5.2%}	{-6.0%,-9.6%}	{-5.1%,-8.2%}
Trend effect	-8.4%	-7.8%	-7.9%
	{-8.0%, -8.7%}	{-7.5%, -8.1%}	{-7.7%, -8.1%}

* The durations of the before and after periods are not equal.

With only 52 fixed cameras from 4 partnerships included in the sub-set (see Table H1) it is not possible to draw general conclusions about the comparative effectiveness of fixed and mobile cameras. Average scheme effects are similar at both types of camera included in the sub-set and inspection of the confidence intervals shows that the differences are not statistically significant. RTM effects are, however, significantly smaller at the fixed cameras. Indeed, at the fixed cameras the estimated reduction due to RTM effects is small (2.5%) and not significantly different from 0. This is a somewhat unexpected result: given that the current selection criterion for fixed camera sites is rather higher than for mobile sites (8 PICs per km in 3 years as compared with 4 PICs) the RTM effect at fixed camera sites would, if anything, be expected to be larger than at mobile sites. These results may, however, arise as result of the nature of the particular sites included in the sub-set and a larger, more representative sample of fixed cameras would be needed to draw more general conclusions about the relative sizes of the RTM effects at fixed and mobile cameras.

Table H4: Estimated proportional effects of cameras on PICs relative to expected after collisions

Percentage changes in PICs {95% confidence interval}			
	Urban Fixed	**Urban Mobile**	**All urban**
No. of sites	52	164	216
Scheme effect allowing for both trend and RTM	**-16.6% {-3.2%, -31.9%}**	**-19.4% {-12.4%, -26.0%}**	**-18.9% {-13.1%, -24.5%}**
Scheme effect allowing only for trend	**-18.8% {-5.2%, -32.9%}**	**-26.0% {-19.6%, -32.4%}**	**-24.8% {-19.4%, -30.4%}**

Table H4 gives estimated scheme effects expressed relative to what would have been expected in the after period without the camera (as in the main part of the report). The estimates are given in two forms: the EB estimates (having allowed for reductions due to both trend and RTM) and the scheme effects that would have been estimated if RTM effects were not taken into account. The comparatively small RTM effects mean that the base used to calculate percentages has relatively little effect on the estimated values and the EB estimates of scheme effects in Table H4 are only marginally higher than those in Table H3. Relative to the PICs that would have been expected without the camera, the estimated average effect of the cameras is a fall of 19%, with little difference between fixed and mobile cameras.

When RTM effects are not taken into account (last row of Table 4) the errors in the percentages expressed in this way are less than when expressed relative to observed baseline collisions (Table H3): not only is the change attributed to the cameras increased (since it includes any reductions actually due to RTM) but the expected after collisions are also higher (since any reductions due to RTM are excluded). Although the estimates ignoring RTM effects are larger than those obtained using the EB method (about 25% on average as compared with 19%), comparison of the confidence intervals suggests that the difference is not significant. Given the fairly small size of the RTM effect for all PICs this is not an unexpected result.

Table H5 summarises the absolute changes in PICs in terms of average annual collisions per site while Table H6 summarises the overall annual scheme effect. The average annual effect of the cameras is a saving of 0.75 PICs per site with RTM and trend accounting for additional annual reductions of 0.31 and 0.37 PICs respectively. Although the observed annual PICs and changes in them are larger at mobile cameras this is primarily due to the longer average monitoring length used at mobile sites. When length is taken into account the values are much more similar: for example the average annual number of PICs per km in the before period are 3.45 at the fixed cameras and 3.32 at the mobile cameras.

In total the 216 cameras were estimated to be saving 162 PICs each year with a further fall of 67 PICs attributable to RTM effects.

Table H5: Estimated changes in average annual PICs per site

Changes in annual PICs per site {95% confidence interval}			
	Urban Fixed	**Urban Mobile**	**All urban**
No. of sites	52	164	216
Observed annual PICs /site:			
before	3.40	5.05	4.65
after	2.53	3.44	3.22
Observed change	-0.87	-1.61	-1.43
	{-0.42, -1.36}	{-1.22, -2.01}	{-1.13, -1.77}
Scheme effect	-0.50	-0.83	-0.75
	{-0.09, -0.94}	{-0.48, -1.18}	{-0.50, -1.02}
RTM effect	-0.08	-0.38	-0.31
	{+0.02, -0.19}	{-0.29, -0.48}	{-0.24, -0.39}
Trend effect	-0.29	-0.39	-0.37
	{-0.23, -0.34}	{-0.32, -0.47}	{-0.32, -0.43}

Table H6: Estimated effects of cameras on annual PICs

Changes in annual PICs {95% confidence interval}			
	Urban Fixed	**Urban Mobile**	**All urban**
No. of sites	52	164	216
Observed annual PICs:			
before	177.0	828.0	1005.0
after	131.6	564.6	696.3
Scheme effect	-26.2	-136.1	-162.3
	{-3.2, -49.8}	{-83.9, -192.0}	{-107.6, -224.8}

The absence of data concerning traffic flows in the after period meant that it was not possible to separate the effects of cameras on collisions into those due to changes in speeds and those due to changes in flows. Previous research (Mountain et al 2004 and 2005), however, suggests that part of the reduction in collisions attributable to the cameras may be due to diversion of traffic away from routes with cameras. There is thus a possibility that some of the collision reduction attributable to cameras may be compensated for by an increase in collisions on diversionary routes. Further research is needed to establish whether such increases occur and the magnitude of any changes.

H.4.2 Fatal and serious collisions (FSCs)

Table H7 summarises the estimated percentage changes in FSCs attributable to the effects of the cameras, RTM and trend relative to the observed FSCs prior to camera installation. The overall average observed reduction in FSCs is 55%. After allowing for trend and RTM effects, the overall average reduction in FSCs attributable to these cameras is 10% of those observed in the baseline period. RTM effects account for a fall of 35% with trend accounting for a further fall of 9%. Thus RTM accounts for about three fifths of the observed reduction in FSCs with the effects of the cameras and trend each accounting for a fifth.

Again there are too few fixed cameras in the sample to draw definite conclusions about the comparative effectiveness of fixed and mobile cameras in terms of changes in FSCs. Indeed, with only 93 FSCs at the 52 fixed cameras in the baseline period the results must be regarded with considerable caution. The data indicate that, on average, the scheme effect for the fixed cameras was larger than for the mobile cameras and the RTM effect smaller. As with PICs, the smaller RTM effect at fixed cameras was an unexpected result given the more stringent criteria for fixed camera sites. A larger, more representative sample would be needed to establish whether these results apply more generally.

Table H7: Estimated proportional changes in FSCs relative to observed baseline collisions

Percentage changes in FSCs {95% confidence interval}			
	Urban Fixed	**Urban Mobile**	**All urban**
No. of sites	52	164	216
Observed FSCs*:			
before	93	585	678
after	26	178	204
Observed change	-45.3%	-56.0%	-54.5%
	{-11.9%, -67.4%}	{-47.3%, -64.0%}	{-46.6%, -61.8%}
Scheme effect	-16.8%	-9.4%	-10.4%
	{+8.7%, -39.5%}	{-1.2%, -16.7%}	{-3.1%, -17.8%}
RTM effect	-18.0%	-37.5%	-34.8%
	{+2.2%, -30.7%}	{-33.2%, -42.2%}	{-30.8%, -39.4%}
Trend effect	-10.4%	-9.1%	-9.3%
	{-8.7%, -13.0%}	{-7.7%, -10.5%}	{-8.1%, -10.5%}

* The durations of the before and after periods are not equal.

Table H8 gives the estimated scheme effects expressed relative to what would have been expected had the camera not been installed (as in the main part of the report). The estimates are given in two forms: the EB estimates (having allowed for reductions due to trend and RTM) and the scheme effects that would have been estimated if RTM effects were not taken into account. The larger RTM effects for FSCs mean that the base used to calculate percentages has a greater effect on the estimated values than for PICs: the expected frequency of FSCs in the after period is much smaller than the observed frequency in the baseline period. The estimated average effect of the cameras is a fall of 19% relative to the FSCs that would have been expected without the camera, with the fixed cameras achieving rather larger average reductions in FSCs (24%) than mobile cameras (18%).

The larger RTM effects for FSCs, mean that if these effects are not taken into account (last row of Table H8) the estimates of scheme effects are much larger than those obtained using the EB method (an average fall of about 50% as compared with 19%). Comparison of the confidence intervals suggests that the difference is statistically significant at the mobile camera sites and when the estimates are aggregated over all sites. (The difference, although large, is not statistically significant at the urban fixed sites but this is most likely to be due to the rather small number of these sites and FSCs at them.)

Table H8: Estimated proportional effects of cameras on FSCs relative to expected after collisions

Percentage changes in FSCs {95% confidence interval}

	Urban Fixed	Urban Mobile	All urban
No. of sites	52	164	216
Scheme effect allowing for both trend and RTM	-23.5% {+10.4%, -51.3%}	-17.6% {-1.6%, -31.5%}	-18.7% {-6.3%, -31.7%}
Scheme effect allowing only for trend	-38.9% {-4.2%, -65.5%}	-51.6% {-41.5%, -60.2%}	-49.9% {-40.2%, -58.2%}

Table H9: Estimated changes in average annual FSCs per site

Changes in annual FSCs per site {95% confidence interval}

	Urban Fixed	Urban Mobile	All urban
No. of sites	52	164	216
Observed annual FSCs/site:			
before	0.60	1.19	1.05
after	0.33	0.52	0.48
Observed change	-0.27	-0.67	-0.57
	{-0.06, -0.48}	{-0.52, -0.81}	{-0.44, -0.70}
Scheme effect	-0.10	-0.11	-0.11
	{+0.05, -0.23}	{-0.02, -0.22}	{-0.02, -0.19}
RTM effect	-0.11	-0.45	-0.36
	{+0.01, -0.24}	{-0.37, -0.51}	{-0.30, -0.43}
Trend effect	-0.06	-0.11	-0.10
	{-0.05, -0.08}	{-0.08, -0.14}	{-0.08, -0.12}

Table H10: Estimated effects of cameras on annual FSCs

Changes in annual FSCs {95% confidence interval}			
	Urban Fixed	Urban Mobile	All urban
No. of sites	52	164	216
Observed annual FSCs:			
before	31.0	195.0	226.0
after	17.0	85.8	102.8
Scheme effect	-5.2	-18.4	-23.6
	{+2.2, -11.9}	{-2.5, -35.4}	{-4.8, -40.2}

Table H9 summarises the absolute changes in FSCs in terms of average annual collisions per site while Table H10 summarises the overall annual scheme effect. The average annual effect of the cameras is a saving of 0.11 FSCs per site with RTM and trend accounting for additional annual reductions of 0.36 and 0.10 FSCs respectively. Although the observed annual FSCs and changes in them are larger at mobile cameras this is again primarily due to the longer average monitoring length used at mobile sites. When length is taken into account the values are more similar: for example the average annual numbers of FSCs per km in the before period are 0.61 at the fixed cameras and 0.82 at the mobile cameras.

In total the 216 cameras were estimated to be saving 24 FSCs each year with a fall of 78 FSCs attributable to RTM effects.

Comparison of the estimates of RTM effects for FSCs in Table H9 with those in Table H5 for all PICs indicates that there is no significant difference between the estimates. The reductions in FSCs attributable to RTM (an annual average of 0.36 FSC per site and a total annual reduction over all sites of 78 FSCs) are in fact marginally higher than for all PICs (an annual average of 0.31 PIC per site per year and a total annual reduction over all sites of 67 PICs) suggesting a small positive RTM effect for slight collisions.

H.4.3 Summary of results

After allowing for both RTM and long-term trends in collision frequencies, the average effect of these 216 cameras was a reduction of 19% in both PICs and FSCs relative to what would have been expected in the after period had the cameras not been installed.

In total the 216 cameras were estimated to be saving 162 PICs each year of which 24 involved fatal or serious injuries.

RTM effects were estimated to account for an average fall relative to the observed baseline collisions of 7% in all PICs and of 35% in FSCs. RTM effects represented one quarter of the observed fall in PICs and three fifths of the observed fall in FSCs.

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Appendix I:
Glossary of terms

ACPO	Association of Chief Police Officers (for England and Wales)
CS	Court Service
COFPN	Conditional Offer of a Fixed Penalty Notice
CSS	County Surveyors Society
CPS	Crown Prosecution Service
CTO	Central Ticket Office
DfT	Department for Transport
DVLA	Driver and Vehicle Licensing Agency
FPO	Fixed Penalty Office
FPN	Fixed Penalty Notice
FSC	Fatal or serious collision
HA	Highways Agency
HMT	Her Majesty's Treasury
KSI	Killed or Serious Injury
LCD	Lord Chancellor's Department
NHS	National Health Service
NIP	Notice of Intended Prosecution
NS	Not significant
PA	PA Consulting Group
PIC	Personal Injury Collision
PFA	Police Force Area
RTM	Regression-to-mean
TAG	Local Government Technical Advisers Group
UCL	University College London
VP-FPO	Vehicle Procedures – Fixed Penalty Office (an IT System)
VRM	Vehicle Registration Mark

Appendix J:
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The Centre for Transport Studies (CTS) at UCL (University College London) is one of the leading inter-disciplinary transport research and teaching centres in Europe. It consists of six permanent academic staff with backgrounds in Mathematics, Geography, Economics, and Engineering, and over 20 research staff and doctoral students. The Centre is based within the Department of Civil and Environmental Engineering, which has achieved the distinction of receiving the top rating (5) in the Government's most recent research assessment exercise. The CTS undertakes research across a broad range of transport-related topics, including transport safety, transport planning, traffic management and control, infrastructure design and accessibility.

Appendix H was produced by Dr Linda Mountain, Department of Engineering University of Liverpool and Professor Mike Maher, School of the Built Environment, Napier University. Both have many years of experience of road safety research and they have successfully collaborated on a number of research projects on various aspects of road safety. Their previous work has specifically dealt with appropriate methodologies for the assessment of the effectiveness of accident remediation schemes and in particular the issue of regression-to-mean effects.

Although this report was commissioned by the Department, the findings and conclusions are those of the authors and do not necessarily represent the views of the Department for Transport.

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