



Safety performance of traffic management at major motorway road works

**Prepared for Safety Standards and Research, Safety and
Information Division, Highways Agency**

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Executive Summary

This report reviews the fourth motorway safety performance study carried out on behalf of the Highways Agency. Previous studies were carried out in 1982, 1987 and 1992. The studies have provided the Agency with key information on the safety of traffic management at major works.

This study has monitored 29 major motorway road work sites over the period November 2001 to July 2003. The sample covered approximately 730km of road, over a total of 3,340 days which equates to an exposure of 4,176 million vehicle kilometres. This level of exposure is approximately 3.5 times greater than the study carried out in 1992. For this exposure, 423 Personal Injury Accidents (PIAs) were recorded at the work sites and, for control, data was also collected for 1187 PIAs over the previous 3 years at the sites when no road works were present.

The study showed that there was no significant difference in the rate of PIAs when road works were present on the motorway. When compared with the 1992 results the 'with' works PIA rate has reduced from 0.174 to 0.101. This figure is same as the National average PIA rate for motorways (0.10) to two decimal places. It is thought that this reduction is due to the many safety measures and practices introduced by the Highways Agency over the past decade. These measures have increased driver awareness and improved driver behaviour through road works to the extent that generally even where the measures have not been introduced the PIA rate has reduced to a figure close to the National average.

The severity and number of casualties were also reduced with the presence of road works. The cumulative cost associated with each fatal, serious and slight PIA was calculated for the 'with' and 'without' works periods using figures from the Highways Economic Note 1 (HEN1). Overall there were less fatal and serious PIAs in the 'with' works period and this resulted in a reduction in PIA costs of £292,860.

No significant difference was observed in the PIA rate for sites with and without speed cameras. However, there was a 2% reduction in the proportion of Fatal PIAs and a 1% reduction in the proportion of Fatal and Serious PIAs recorded at the sites with speed cameras, when compared to the without works period.

The most frequent PIA types observed at the works sites were Multiple Vehicle Shunts, Multiple Vehicle (Overtaking errors) and Single Vehicle (hit other object) accidents.

Factors such as weather, road conditions, number of vehicles involved and lighting conditions were also analysed but all did not have a significant effect on road work PIAs.

The conclusion of this study is that due to the increased number of safety measures and practices over the past decade, the risk (in terms of PIAs) when road works are present is similar to the risk when no road works are present. However, it should be noted that this study has only investigated PIAs and there is no evidence to suggest that the trend has been the same for damage

only accidents. The inclusion of damage only accidents in such a study would be practically impossible as no adequate and formal records of damage only accidents on the roads are recorded. A review of the Highways Agency's HAWSAR records indicate that there have been very few reported workforce accidents associated with the 29 road work sites.

1 Introduction

Road works are a major feature on the motorway network and are essential to ensure that the road surfaces are kept to the correct standards and to enable improvements to be made to the network. The majority of the motorway network is now over 30 years old and maintenance and improvements are therefore a more frequent occurrence on our roads. This has been matched by an increasing traffic demand on the network and there is great pressure on the operators to keep the network running at full capacity. For motorway maintenance work there is therefore a desire to minimise disruption to the traffic flow, whilst maintaining safe operation for the travelling public and a safe area for the workforce.

The Highways Agency is continuously investing in research to develop ways of maximising the throughput at work sites whilst maintaining a satisfactory safety performance. To monitor this progress the Agency have commissioned periodic studies investigating the risk associated with major road works on motorways. Studies were carried out in 1982 (Summersgill), 1987 (Marlow and Coombe) and in 1992 (Hayes, Taylor and Bowman). These studies have provided key information on the safety of traffic management at major road works, and have provided inputs to policy decisions, such as whether or not to encourage diversion from motorways when the road works are in place.

Since the 1992 study, the Agency have invested in many major improvements to the operation of road works such as:

- The more frequent use of narrow lanes to maintain and maximise the capacity of traffic through the works.
- The introduction of speed cameras and increased speed enforcement.
- The use of Temporary Vertical Barriers (TVB) at areas of potential conflict, such as, a cross-over and opposing traffic flow in contra-flow.
- Publicity campaigns to increase driver awareness of the danger associated with road works.

These and other measures have been introduced to increase the safety performance of road works on motorways. This report describes the latest safety study and provides results obtained on a large sample of major road works collected over the period November 2001 to July 2003.

1.1 Study objectives

The five main objectives of the study were:

- 1 To establish the Personal Injury Accident (PIA) rate and severity split at major road work sites on motorways, and compare this with the rate in the absence of works.
- 2 To compare the number and severity of PIAs at sites with and without speed cameras to establish the effectiveness of speed cameras in reducing the number and/or the severity of PIAs at major road works on motorways.
- 3 To examine the location of PIAs in relation to features of the traffic management scheme to provide indicators for possible safety improvements, and to specifically identify PIA rates associated with features of the

layouts; such as narrow lanes, crossovers, contra-flow working, or where temporary vertical barriers are used.

- 4 To estimate PIA rates at road works in a form suitable for use in economic evaluation models, such as QUADRO.
- 5 To establish PIA risk factors for use in the risk assessment of aspects of traffic management design and operations.

To aid comparisons this report is in a similar format to the reports from the previous studies.

2 Data collection

The data collection period for this study was from November 2001 until July 2003. The aim of the study was to collect information from 30 road work sites during this period and to at least replicate the exposure obtained in the previous studies.

2.1 Site identification

Potential road work sites were identified from the Construction Programme detailed on the Highways Agency web site. For each potential site TRL contacted the listed Project Sponsor and asked them to complete a questionnaire regarding the scheme. Eighty potential sites were contacted. From these sites, a total of 57 responses were received and 42 questionnaires were returned to TRL.

The questionnaire was designed to extract information on the type and duration of works together with traffic management details such as type, whether the site would be using speed cameras and/or temporary vertical barriers. The 42 questionnaires were analysed and 34 suitable sites were selected.

Sites were only rejected on the basis that they were not considered to be Type A¹ works or schemes where no restrictions on traffic were in place. This meant that the 34 sites selected were a true reflection of the types of works being carried out on the network over the study period.

Attempts were made to collect data from all 34 identified sites. For reasons outside of the control of the project, complete data sets could not be collected from 3 of these sites. A further two sites were also excluded as they were considered not to be suitable for the study. This resulted in a sample size of 29 road work sites.

The sample covered approximately 730km of road, over a total period of 3,340 days which equated to an exposure of 4,176 million veh-kms. This exposure is approximately 3.5 times greater than the 1992 study. Seventeen of the sites in the sample used speed camera enforcement.

Details of the sites selected are summarised in Table 2.1 and their geographical location is shown in Figure 1.

2.2 Site road works data

A data collection request was distributed to each site in the study. The request included background information,

¹ Details of temporary traffic management arrangements are given in the *Traffic Signs Manual*, Chapter 8. Department of Transport 1991.

Table 2.1 The selected road works in the sample

<i>Site No.</i>	<i>Motorway</i>	<i>Junction</i>	<i>Agent</i>
1	M5	J12	Halcrow
2	M6	J6-J7	Atkins Highways & Transportation
3	M42	J11-J10	Optima Infrastructure Management
4	M62	J18-J20	Atkins Highways & Transportation
5	M42	J2-J3	Amey Mouchel
6	M11	J8	May Gurney
7	M62	J36-J38	WSP Civils
8	M5	J27-J28	Parsons Brinckerhoff Ltd
9	M5	J30-J31	Parsons Brinckerhoff Ltd
10	M5	J9-J10	WSP Civils
11	M50	J1-J2	WSP Civils
12	M11	J6-J7	RMC Surfacing
13	A1(M)	J63-J65	Halcrow
14	M61	J1-J2	Parkman
15	M6	J43	Amey Mouchel
16	M1	J25-J26	Scott Wilson Kirkpatrick & Co
17	M180	J2	WSP Civils
18	M3	J3-J4	Mott MacDonald, Hampshire CC, Scott Wilson
19	M5	J19-J20	Atkins Highways & Transportation
20	M25	J21-J22	Amey Mouchel
21	M4	J16-J17	Atkins Highways & Transportation
22	M20	J10-J11	Atkins Highways & Transportation
23	M6	J20-J21A	Atkins Highways & Transportation
24	M5	J26-J27	Atkins Highways & Transportation
25	M57	J2-J4	Lancashire County Council Highway Consulting
26	M69	J2-M1 (J21)	Optima Infrastructure Management
27	M42	J10	Optima Infrastructure Management
28	M6	J23-J25	Lancashire County Council Highway Consulting
29	M4	J5-J7	Mott MacDonald, Hampshire CC, Scott Wilson

specified data collection objectives and listed what data was required for each traffic management phase during the works. Where possible, TRL attended site meetings to discuss data collection requirements and to agree how the data was going to be collated.

To assist data collection, a data entry spreadsheet and paper data entry sheets were offered to each site though data was accepted in other formats. The following sections describe the data that was requested.

2.2.1 General site data

The following general information was requested from each site:

- Road surface type (e.g. concrete).
- Location of infrastructure at the site, for example, bridges and gantries.
- Traffic flow.
- Street lighting.
- Use of speed cameras.
- Use of Police speed check signing.
- Use of Closed Circuit Television (CCTV).
- Use of Temporary Vertical Barriers (TVB).

Details of all the information requested are given in Appendix A.

2.2.2 Traffic management data

The following data was requested for each Traffic Management Phase even if no PIAs occurred:

- Site traffic management drawings.

- Actual time and date of traffic management phase changes (inc. sub phases and overnight additional closures).
- Confirmation of traffic management positions (in particular, speed cameras and TVBs).
- Traffic management type.
- Temporary speed limit.
- Lane widths used for narrow lane layouts.
- Vehicle recovery provision.

2.2.3 Personal Injury Accident (PIA) data

The following details were requested for each PIA:

- Type (i.e. category, shunt etc.).
- Plain language description.
- Date & Time of day.
- Causation factors.
- No. of vehicles involved (classified by type).
- Direction of travel.
- Incident carriageway.
- Incident lane.
- Affected lanes.
- No. of casualties.
- Severity (fatal, serious or slight).
- Light/dark.
- Pedestrian?
- Weather conditions.
- Road surface conditions.

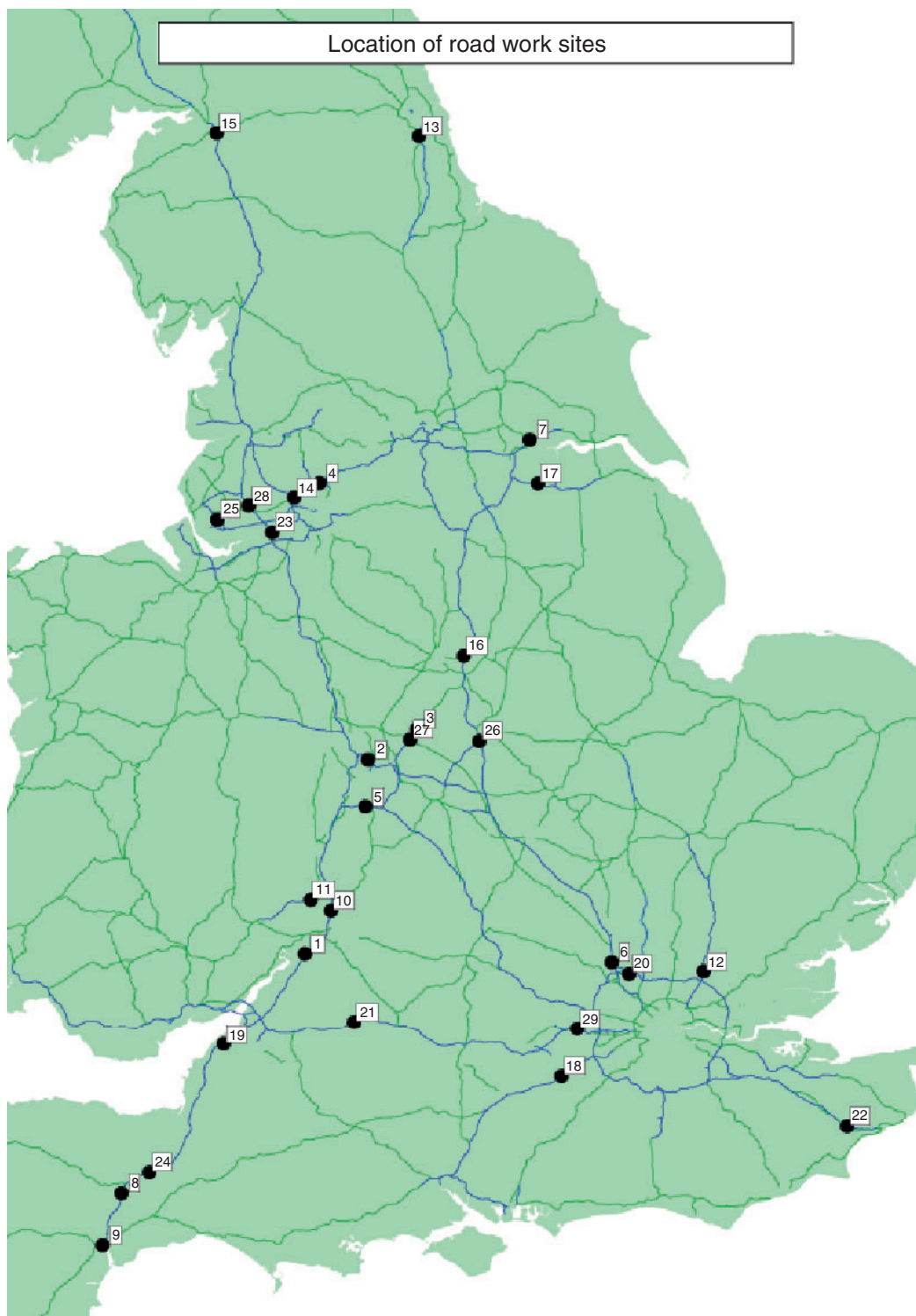


Figure 1 Location of the selected road works in the sample

- If the site is street lit, were the lights in working order?
- Records of ‘damage only’ accidents, if they were readily available.

2.3 Traffic management layouts

The types of traffic management used in the sample and the duration of each traffic management phase is detailed in Table 2.2 and represented graphically in Figure 2. In this study, the ‘primary’ direction has been defined as the

carriageway directly affected by the works activity. At some sites, for example where there were works on a bridge either side of the central reserve, both directions were classified as primary.

2.3.1 Truncation of sites

PIA data was collected for a length of carriageway 10km before and after the works area. A distance of 6km was used in the previous study, the increased distance allowed a comparison to be made of the zone of influence of the

Table 2.2 The 'with' road works period

Site No.	Motorway	Junction	Works	TM type	Phase	Works period	
						Start	End
1	M5	J12	Bridge works	3F	2	05/11/2001	28/11/2001
1	M5	J12	Bridge works	3C	3	28/11/2001	30/01/2002
1	M5	J12	Bridge works	3F	2	31/01/2002	04/02/2002
1	M5	J12	Bridge works	3F	4	10/02/2002	04/03/2002
1	M5	J12	Bridge works	3C	5	05/03/2002	10/04/2002
1	M5	J12	Bridge works	3C	6	11/04/2002	04/07/2002
1	M5	J12	Bridge works	3C	7	05/07/2002	24/07/2002
1	M5	J12	Bridge works	3F	8	25/07/2002	06/08/2002
1	M5	J12	Bridge works	3C	9	07/08/2002	10/10/2002
2	M6	J6-J7	Hybrid	3E	2	07/07/2001	20/07/2001
2	M6	J6-J7	Hybrid	CFA	3	21/07/2001	14/12/2001
2	M6	J6-J7	Hybrid	CFA	4	15/12/2001	01/03/2002
2	M6	J6-J7	Hybrid	CFA	5	02/03/2002	09/06/2002
2	M6	J6-J7	Hybrid	CFA	6	10/06/2002	17/06/2002
3	M42	J11-J10	Road repairs	3D	1	12/04/2002	12/04/2002
3	M42	J11-J10	Road repairs	CFA	2	13/04/2002	23/04/2002
3	M42	J11-J10	Road repairs	CFA	3	23/04/2002	03/05/2002
3	M42	J11-J10	Road repairs	CFA	4	03/05/2002	14/05/2002
3	M42	J11-J10	Road repairs	CFA	5	14/05/2002	21/05/2002
3	M42	J11-J10	Road repairs	3D	6	21/05/2002	21/05/2002
4	M62	J18-J20	Road repairs	3E	1	15/10/2002	20/12/2002
4	M62	J18-J20	Road repairs	CFA	2	07/01/2003	21/01/2003
4	M62	J18-J20	Road repairs	CFA	3	21/01/2003	31/01/2003
4	M62	J18-J20	Road repairs	CFA	4	07/02/2003	23/02/2003
4	M62	J18-J20	Road repairs	CFA	5	24/02/2003	05/03/2003
4	M62	J18-J20	Road repairs	CFA	6	07/03/2003	18/03/2003
4	M62	J18-J20	Road repairs	CFA	7	19/03/2003	29/03/2003
4	M62	J18-J20	Road repairs	CFA	8	30/03/2003	11/04/2003
4	M62	J18-J20	Road repairs	CFA	9	12/04/2003	24/04/2003
4	M62	J18-J20	Road repairs	CFA	10	25/04/2003	02/05/2003
4	M62	J18-J20	Road repairs	CFA	11	03/05/2003	27/05/2003
5	M42	J2-J3	Road repairs	3E	1	17/03/2003	18/03/2003
5	M42	J2-J3	Road repairs	CFA	2	19/03/2003	24/03/2003
5	M42	J2-J3	Road repairs	CFA	3	25/03/2003	30/03/2003
5	M42	J2-J3	Road repairs	CFA	4	31/03/2003	05/04/2003
5	M42	J2-J3	Road repairs	CFA	5	06/04/2003	09/04/2003
5	M42	J2-J3	Road repairs	3E	6	10/04/2003	12/04/2003
5	M42	J2-J3	Road repairs	CFA	7	25/04/2003	06/05/2003
6	M11	J8	Junction improvement	CFA	1	01/01/2002	09/03/2002
6	M11	J8	Junction improvement	CFA	2	10/03/2002	17/03/2002
6	M11	J8	Junction improvement	CFA	3	18/03/2002	22/08/2002
6	M11	J8	Junction improvement	2C	4	23/08/2002	16/10/2002
7	M62	J36-J38	Bridge works	3C	1	08/05/2002	19/10/2002
7	M62	J36-J38	Bridge works	CFA	2	20/10/2002	06/02/2003
7	M62	J36-J38	Bridge works	CFB	3	07/02/2003	16/03/2003
8	M5	J27-J28	Road repairs	3C/3B	1	08/04/2002	13/04/2002
8	M5	J27-J28	Road repairs	3F	2	14/04/2002	18/04/2002
8	M5	J27-J28	Road repairs	3G/3B	3	19/04/2002	24/04/2002
8	M5	J27-J28	Road repairs	3D/3B	4	25/04/2002	29/04/2002
8	M5	J27-J28	Road repairs	3B/3C	5	30/04/2002	05/05/2002
8	M5	J27-J28	Road repairs	3B/3F	6	06/05/2002	12/05/2002
8	M5	J27-J28	Road repairs	CFB	7	13/05/2002	26/05/2002

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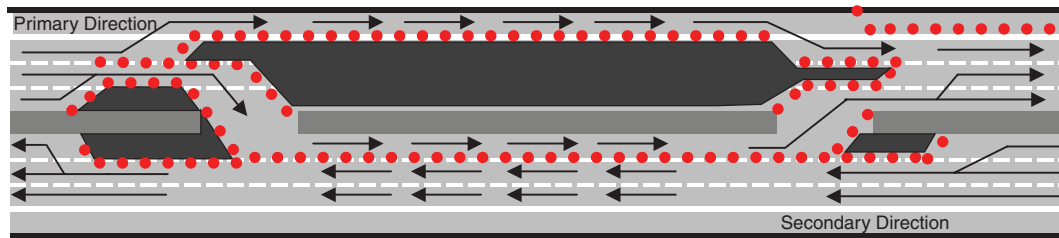
Table 2.2 (Continued) The 'with' road works period

Site No.	Motorway	Junction	Works	TM type	Phase	Works period	
						Start	End
9	M5	J30-J31	Junction improvement	3C	1	09/09/2002	18/11/2002
9	M5	J30-J31	Junction improvement	3B/3C	2	18/11/2002	19/12/2002
9	M5	J30-J31	Junction improvement	3B/3C	2	05/01/2003	23/02/2003
9	M5	J30-J31	Junction improvement	3C	3	24/02/2003	02/03/2003
9	M5	J30-J31	Junction improvement	3B/3F	4	03/03/2003	06/03/2003
9	M5	J30-J31	Junction improvement	3B/3C	5	07/03/2003	10/03/2003
9	M5	J30-J31	Junction improvement	3B/3F	4	10/03/2003	13/03/2003
10	M5	J9-J10	Road repairs	3C	1	11/11/2001	17/11/2001
10	M5	J9-J10	Road repairs	3C/3B	2	18/11/2001	28/11/2001
10	M5	J9-J10	Road repairs	CFA	3	29/11/2001	01/12/2001
11	M50	J1-J2	Bridge works	2B	1	18/11/2001	08/12/2001
11	M50	J1-J2	Bridge works	2B	2	09/12/2001	16/03/2002
11	M50	J1-J2	Bridge works	2B	3	17/03/2002	26/04/2002
11	M50	J1-J2	Bridge works	2B	4	27/04/2002	15/05/2002
12	M11	J6-J7	Road repairs	3D	1	05/02/2002	08/02/2002
12	M11	J6-J7	Road repairs	CFD	2	09/02/2002	26/02/2002
12	M11	J6-J7	Road repairs	CFD	3	01/03/2002	16/03/2002
12	M11	J6-J7	Road repairs	CFD	4	18/03/2002	27/03/2002
12	M11	J6-J7	Road repairs	CFD	4	02/04/2002	12/04/2002
12	M11	J6-J7	Road repairs	CFD	5	28/03/2002	01/04/2002
12	M11	J6-J7	Road repairs	3E	6	13/04/2002	14/04/2002
13	A1(M)	J63-J65	Road repairs	3E	4	23/01/2002	10/03/2002
14	M61	J1-J2	Bridge works	4A	1	02/04/2002	11/04/2002
14	M61	J1-J2	Bridge works	4A	2	11/04/2002	11/05/2002
14	M61	J1-J2	Bridge works	4C	3	05/06/2002	12/07/2002
14	M61	J1-J2	Bridge works	4C/4B	4	05/08/2002	16/08/2002
15	M6	J43	Bridge works	3F	1	18/02/2002	28/02/2002
16	M1	J25-J26	Bridge works	3B/3E	1	18/03/2002	17/04/2002
17	M180	J2	Concrete pavement overlay	3F	1	26/09/2002	27/09/2002
17	M180	J2	Concrete pavement overlay	3C	2	28/09/2002	10/10/2002
17	M180	J2	Concrete pavement overlay	3F	1	11/10/2002	13/10/2002
17	M180	J2	Concrete pavement overlay	3G	1	14/10/2002	24/11/2002
17	M180	J2	Concrete pavement overlay	3G	1	25/11/2002	26/11/2002
17	M180	J2	Concrete pavement overlay	3D	2	27/11/2002	08/12/2002
18	M3	J3-J4	Re-surfacing, drainage	3E	2	12/06/2002	15/06/2002
18	M3	J3-J4	Re-surfacing, drainage	CFA	3	16/06/2002	19/06/2002
18	M3	J3-J4	Re-surfacing, drainage	3E	4	20/06/2002	05/07/2002
18	M3	J3-J4	Re-surfacing, drainage	3E	5	06/07/2002	21/07/2002
18	M3	J3-J4	Re-surfacing, drainage	CFA	6	31/07/2002	22/08/2002
18	M3	J3-J4	Re-surfacing, drainage	CFA	7	27/08/2002	30/09/2002
19	M5	J19-J20	Lighting upgrade	3E	2	10/06/2002	10/07/2002
19	M5	J19-J20	Lighting upgrade	3E	3	10/07/2002	16/07/2002
20	M25	J21-J22	Concrete pavement overlay	3E	1	19/08/2002	13/09/2002
20	M25	J21-J22	Concrete pavement overlay	CFA	2	14/09/2002	17/09/2002
20	M25	J21-J22	Concrete pavement overlay	CFA	3	18/09/2002	01/10/2002
20	M25	J21-J22	Concrete pavement overlay	CFA	4	02/10/2002	23/10/2002
20	M25	J21-J22	Concrete pavement overlay	CFA	5	24/10/2002	07/11/2002
20	M25	J21-J22	Concrete pavement overlay	3E	6	08/11/2002	20/11/2002
20	M25	J21-J22	Concrete pavement overlay	3E	7	21/11/2002	27/11/2002
20	M25	J21-J22	Concrete pavement overlay	CFA	8	28/11/2002	05/12/2002
20	M25	J21-J22	Concrete pavement overlay	CFA	9	06/12/2002	12/12/2002
20	M25	J21-J22	Concrete pavement overlay	CFA	10	13/12/2002	18/12/2002
20	M25	J21-J22	Concrete pavement overlay	CFA	11	19/12/2002	20/12/2002

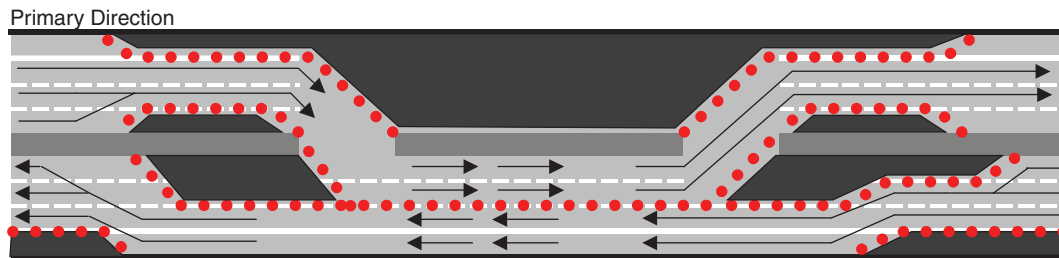
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Table 2.2 (Continued) The 'with' road works period

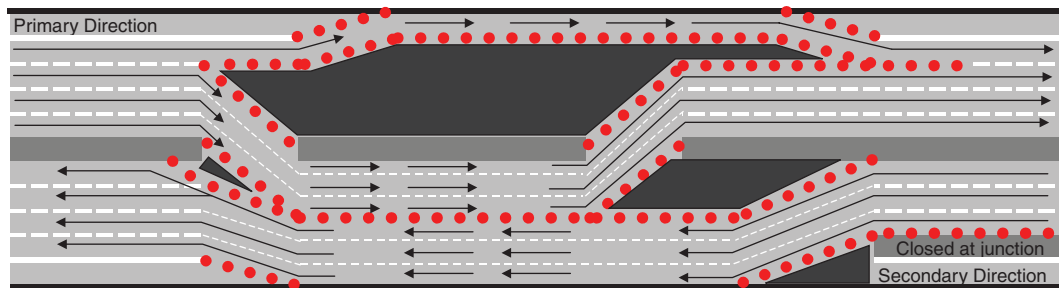
Site No.	Motorway	Junction	Works	TM type	Phase	Works period	
						Start	End
21	M4	J16-J17	Embankment works	3B/3C	1	02/10/2002	02/10/2002
21	M4	J16-J17	Embankment works	3C/3B	2	03/10/2002	28/10/2002
21	M4	J16-J17	Embankment works	3C/3B	3	29/10/2002	31/10/2002
21	M4	J16-J17	Embankment works	3B/3C	4	01/11/2002	23/11/2002
21	M4	J16-J17	Embankment works	3B/3C	5	24/11/2002	10/12/2002
22	M20	J10-J11	Road repairs	3F	1	29/07/2002	31/07/2002
22	M20	J10-J11	Road repairs	CFB	2	01/08/2002	07/08/2002
22	M20	J10-J11	Road repairs	CFB	3	08/08/2002	09/08/2002
22	M20	J10-J11	Road repairs	CFB	4	10/08/2002	14/08/2002
22	M20	J10-J11	Road repairs	CFB	5	15/08/2002	16/08/2002
22	M20	J10-J11	Road repairs	CFB	6	17/08/2002	25/08/2002
22	M20	J10-J11	Road repairs	CFB	7	26/08/2002	30/08/2002
22	M20	J10-J11	Road repairs	CFB	8	03/09/2002	09/09/2002
22	M20	J10-J11	Road repairs	CFB	9	10/09/2002	16/09/2002
22	M20	J10-J11	Road repairs	CFB	10	17/09/2002	21/09/2002
22	M20	J10-J11	Road repairs	CFB	11	22/09/2002	01/10/2002
22	M20	J10-J11	Road repairs	3C	12	02/10/2002	04/10/2002
23	M6	J20-J21A	Bridge works	CFC	1	17/07/2002	30/06/2003
24	M5	J26-J27	Concrete pavement overlay	3C	1	13/01/2003	15/01/2003
24	M5	J26-J27	Concrete pavement overlay	3C/3F	2	16/01/2003	26/01/2003
24	M5	J26-J27	Concrete pavement overlay	CFB	3	27/01/2003	19/02/2003
24	M5	J26-J27	Concrete pavement overlay	CFB	4	20/02/2003	19/03/2003
24	M5	J26-J27	Concrete pavement overlay	3C/3F	5	20/03/2003	20/03/2003
24	M5	J26-J27	Concrete pavement overlay	3C	6	21/03/2003	21/03/2003
25	M57	J2-J4	Concrete pavement overlay	3F	2	29/08/2002	11/09/2002
25	M57	J2-J4	Concrete pavement overlay	3F	3	12/09/2002	30/09/2002
25	M57	J2-J4	Concrete pavement overlay	CFA	4	01/10/2002	29/10/2002
25	M57	J2-J4	Concrete pavement overlay	CFA	5	30/10/2002	30/11/2002
25	M57	J2-J4	Concrete pavement overlay	CFA	6	12/01/2003	06/02/2003
25	M57	J2-J4	Concrete pavement overlay	CFA	7	07/02/2003	27/02/2003
26	M69	J2-M1 (J21)	Resurfacing	CFA	2	24/02/2003	16/03/2003
26	M69	J2-M1 (J21)	Resurfacing	CFA	3	17/03/2003	30/03/2003
26	M69	J2-M1 (J21)	Resurfacing	3C/3F	4	31/03/2003	13/04/2003
27	M42	J10	Road repairs	3D	1	21/03/2003	21/03/2003
27	M42	J10	Road repairs	CFA	2	22/03/2003	15/04/2003
27	M42	J10	Road repairs	3D	3	16/04/2003	17/04/2003
28	M6	J23-J25	Hybrid	3F	2	23/04/2003	20/05/2003
28	M6	J23-J25	Hybrid	CFA	3	28/05/2003	08/07/2003
29	M4	J5-J7	Road repairs	3B	1	28/04/2003	04/06/2003
29	M4	J5-J7	Road repairs	3B	2	05/06/2003	01/07/2003



CFA



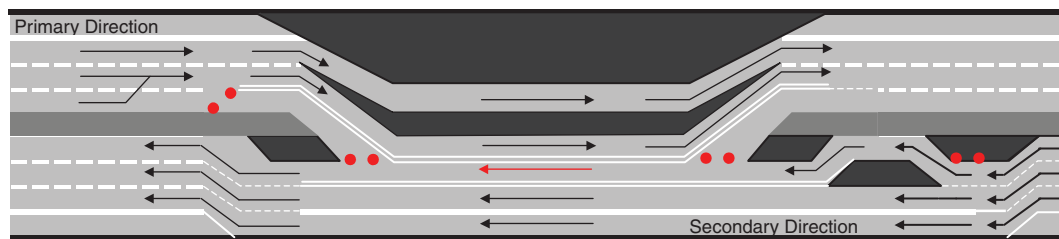
CFB



CFC



As in TA 64 Fig 9 (a)

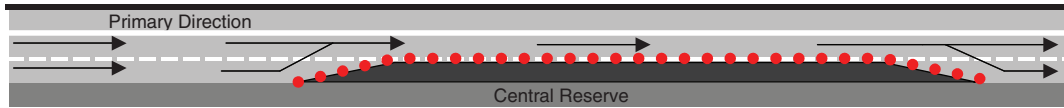


As in TA 64 Fig 9 (a)

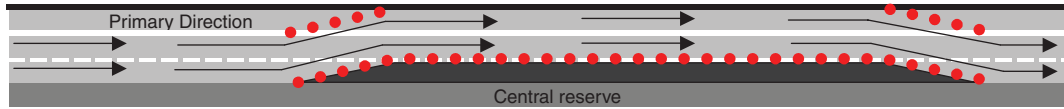
CFD

- Cone gates
- Buffer zone of cylinders & studs

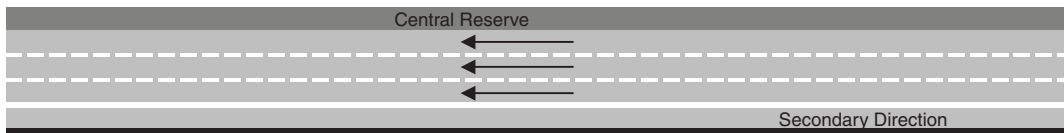
Figure 2 Standard traffic management layouts



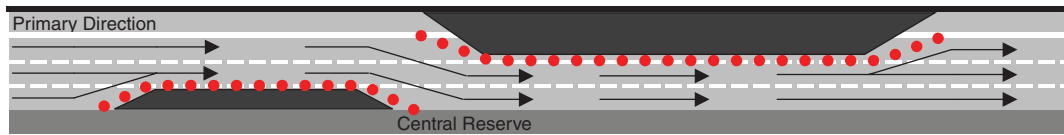
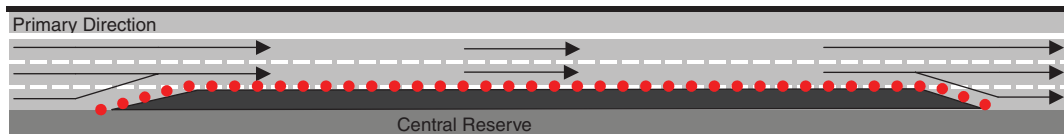
2B Lane 1 only running in the Primary direction is shown. Lane 2 only running is an alternative.



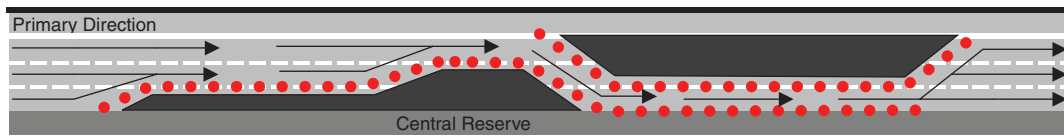
2C



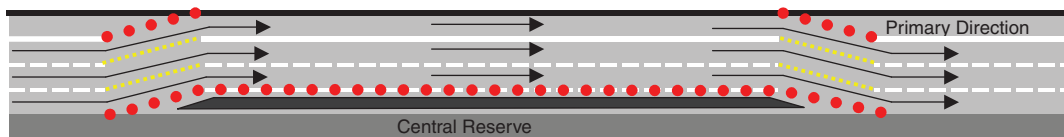
3B



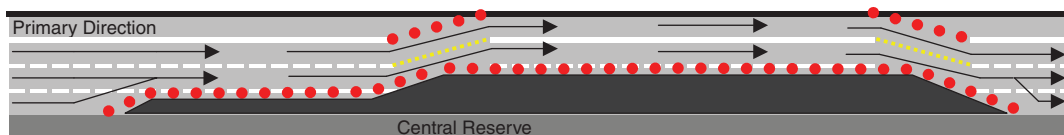
3C



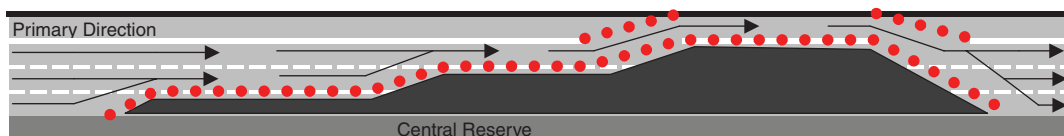
3D



3E



3F



3G

Figure 2 (Continued) Standard traffic management layouts

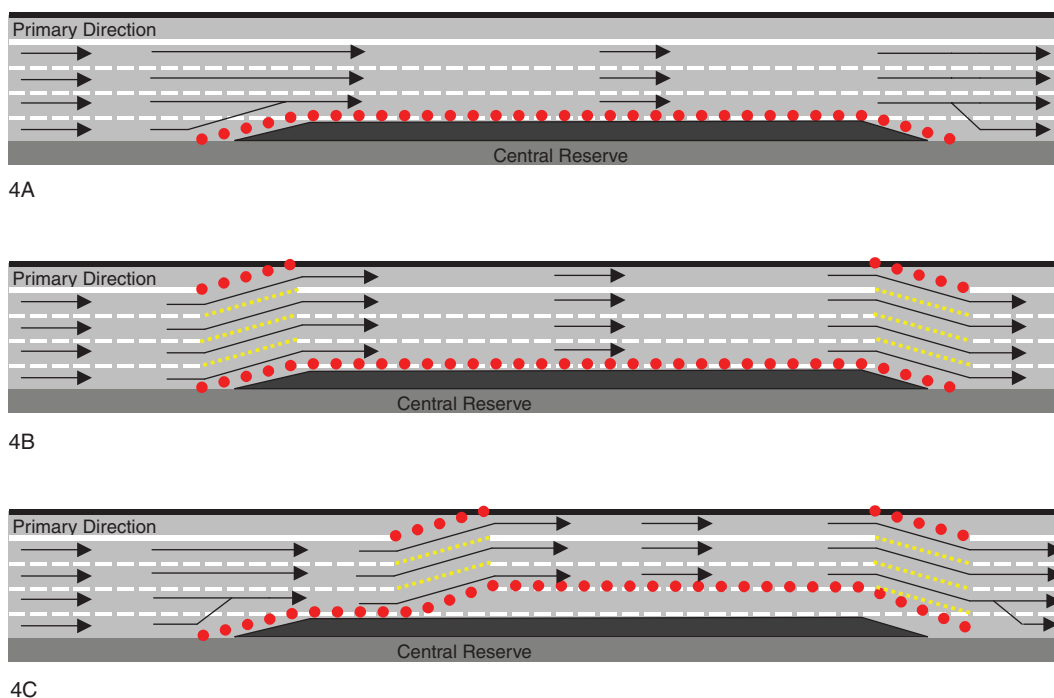


Figure 2 (Continued) Standard traffic management layouts

works. However, the results showed that the 6km distance was still applicable, see Section 3.5.11.

At some sites it was necessary to truncate the data collection length as they would have extended beyond the end of the motorway. Table 2.3 lists the sites that were truncated and states the reason why. The data for truncated sites was not used to analyse the individual sections of the traffic management as they did not cover all the areas of interest.

2.4 PIA and traffic flow data

2.4.1 Personal Injury Accident (PIA) data

A full listing of all Personal Injury Accidents (PIAs) that occurred at each site during the works period was requested from the appropriate Police Authority.

For the period November 2001 to December 2002 PIA data was also obtained for each site from the Department for Transport's STATS19 PIA database. STATS19 accident report forms were obtained for PIAs that occurred at the sites that were in place in the period between January and July 2003.

STATS19 data was also obtained for the 5 years immediately prior to the road works commencement date. The data was used to determine PIAs at each site during an Equivalent Period (EP) when road works were not present.

The definition of the EP used in the study is as follows:

- Prev 1: the first available equivalent period prior to the calendar year that contained the works;
- Prev 2: the second available equivalent period prior to the calendar year that contained the works;
- Prev 3: the third available equivalent period prior to the calendar year that contained the works.

It was possible to define 3 equivalent periods for 27 sites and two for the remaining two sites. Table 2.4 shows the EP used for each site.

2.4.2 AADT traffic flow data

Annual Average Daily Total (AADT) traffic flow information was obtained for the works and equivalent period (EP) from the HA Travel Information Database (TRADS). Works and without works traffic flow information was requested from each study site. However, not all sites could provide data (see Table 2.5) and the detail and quality of the data varied considerably. Therefore, for consistency in the data set, it was decided to use the TRADS flow data collated for each site. This approach was validated by checking the TRADS flow data against the flow data collected.

Table 2.3 Major maintenance schemes with truncated sites

Site No.	Motorway	Junctions	Phase(s)	Truncation point	Reason for truncation
3	M42	J11-J10	1-3	MP 64.4	End of motorway
9	M5	J30-J31	All (1-5)	MP 261.9	Road changes from M5 to A38
13	A1(M)	J63-J65	4	MP 54.2	End of motorway
14	M61	J1-J2	All (1-4)	MP 0 & MP 2.7	End of motorway and motorway splits at J3
25	M57	J2-J4	All (1-8)	MP 19.5	End of motorway
26	M69	J2-M1 (J21)	All (1-4)	MP 125.0	End of motorway

Table 2.4 Works period start and end dates and equivalent sampling periods for previous years

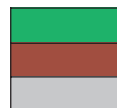
Site no	Location	Works period		Previous years				
		Start	End	Prev. 1	Prev. 2	Prev. 3	Prev. 4	Prev. 5
1	M5 J12	05/11/2001	10/10/2002	Green	Green	Green	Grey	Grey
2	M6 J6-7	07/07/2001	17/06/2002	Red	Green	Green	Green	Grey
3	M42 J11-10 S/B	12/04/2002	21/05/2002	Green	Green	Green	Grey	Grey
4	M62 J18-20	15/10/2002	27/05/2003	Green	Red	Green	Green	Grey
5	M42 J2-J3	17/03/2003	06/05/2003	Green	Green	Green	Grey	Grey
6	M11 J8	01/01/2002	16/10/2002	Red	Red	Green	Green	Green
7	M62 J36-38	08/05/2002	16/03/2003	Green	Green	Green	Grey	Grey
8	M5 J27-28	08/04/2002	26/05/2002	Green	Green	Green	Grey	Grey
9	M5 J31	09/09/2002	13/03/2003	Green	Green	Green	Grey	Grey
10	M5 J9-10	11/11/2001	01/12/2001	Green	Green	Green	Grey	Grey
11	M50 J1 to 2	18/11/2001	15/05/2002	Green	Green	Green	Grey	Grey
12	M11, J6-7 NB	05/02/2002	14/04/2002	Green	Green	Green	Grey	Grey
13	A1(M) J63-65	23/01/2002	10/03/2002	Green	Green	Green	Grey	Grey
14	M61 J1 to J2	02/04/2002	16/08/2002	Red	Green	Green	Green	Grey
15	M6 J43	18/02/2002	28/02/2002	Green	Green	Green	Grey	Grey
16	M1 J25 - J26	18/03/2002	17/04/2002	Green	Green	Green	Grey	Grey
17	M180, J2	26/09/2002	11/12/2002	Green	Green	Green	Grey	Grey
18	M3 J3-4	12/06/2002	30/09/2002	Green	Green	Green	Grey	Grey
19	M5, J19-20	10/06/2002	16/07/2002	Green	Red	Green	Green	Grey
20	M25 J21 - J22	19/08/2002	20/12/2002	Green	Red	Green	Green	Grey
21	M4 J16-17	02/10/2002	10/12/2002	Red	Red	Green	Red	Green
22	M20 J10-11	29/07/2002	04/10/2002	Green	Red	Green	Green	Grey
23	M6 J20-21	17/07/2002	30/06/2003	Green	Green	Green	Grey	Grey
24	M5, J26-27	13/01/2003	21/03/2003	Green	Green	Green	Grey	Grey
25	M57, J2-4	29/08/2002	27/02/2003	Green	Green	Green	Grey	Grey
26	M69, J2 to M1 J21	24/02/2003	13/04/2003	Green	Green	Green	Grey	Grey
27	M42 J10 N/B	21/03/2003	17/04/2003	Green	Green	Green	Grey	Grey
28	M6 J23-25	23/04/2003	08/07/2003	Red	Red	Red	Green	Green
29	M4 J5-7	28/04/2003	01/07/2003	Green	Green	Green	Grey	Grey

Key

Previous equivalent without works period used.

Previous equivalent without works period unsuitable due to presence of motorway road works.

Previous equivalent without works period not required.



2.5 Presentation of data

All data (traffic management, PIA and flow) collected in the study is contained within a Microsoft Excel spreadsheet. A front end application has been built into the spreadsheet to allow fast manipulation and analysis of the data. The spreadsheet application has been used to produce all the results described in the following section.

Table 2.5 Availability of traffic flow data for the with and without works period

Site No.	Motorway	Junction	Traffic data	
			Without works	With works
1	M5	J12	No	No
2	M6	J6-J7	Yes	No
3	M42	J11-J10	Yes	No
4	M62	J18-J20	Yes	No
5	M42	J2-J3	Yes	No
6	M11	J8	Yes	No
7	M62	J36-J38	Yes	No
8	M5	J27-J28	Yes	Yes
9	M5	J30-J31	No	No
10	M5	J9-J10	Yes	No
11	M50	J1-J2	Yes	No
12	M11	J6-J7	Yes	No
13	A1(M)	J63-J65	Yes	No
14	M61	J1-J2	Yes	No
15	M6	J43	No	No
16	M1	J25-J26	No	No
17	M180	J2	Yes	Yes
18	M3	J3-J4	Yes	No
19	M5	J19-J20	Yes	No
20	M25	J21-J22	Yes	No
21	M4	J16-J17	Yes	No
22	M20	J10-J11	Yes	No
23	M6	J20-J21A	No	No
24	M5	J26-J27	Yes	No
25	M57	J2-J4	Yes	No
26	M69	J2-M1 (J21)	Yes	No
27	M42	J10	Yes	No
28	M6	J23-J25	Yes	No
29	M4	J5-J7	Yes	No
Number of sites with data			24	2

3 Analysis

3.1 Composition of the study sample

This study has monitored 29 road work sites, and covered a total of 147 traffic management phases. Just under half of the phases used a contra-flow arrangement, with the remaining phases using lane closures or narrow lanes. Full details of the scope of the study are shown in Table 3.1 and details of the traffic management arrangements used can be found in Figure 2.

Annual Average Daily Traffic flow at the monitored sites varied from a minimum of 25,140 vehicles per day on the M50 to a maximum of 164,966 vehicles per day on the M6. The duration of road works sites varied from 11 days at junction 43 (J43) on the M6 to 348 days between J20 and J21 on the M6.

A total of 4,176 million vehicle kilometres were monitored and 423 Personal Injury Accidents (PIAs) recorded at the sampled road works sites. The sample control 'without works' period (equivalent period of time without road works in place for 3 previous years) contained 1,187 PIAs and 12,000 million vehicle kilometres.

Table 3.2 details the number of PIAs recorded at each road works site and PIAs for the Equivalent Period (EP). It can be seen the observed number of PIAs is often close to the average number of PIAs in the EP.

3.2 Overall Personal Injury Accident (PIA) rates

The overall Personal Injury Accident Rate for the study is estimated by combining the data from all traffic management arrangements across all sites monitored in the study. To compare with the 1982, 1987 and 1992 studies PIA information was recorded over a region of 6 kilometres either side of the central section of the works, as defined in Figure 3.

The overall with road works observed PIA rate was 0.101 PIA per million vehicle kilometres, which when compared with the equivalent non-works rate of 0.098 produces a ratio of with to without road works of 1.03. *The results showed that for this study there was no significant difference (5% level) between the works and non-works PIA rates.*

Table 3.3 details the overall PIA rates and shows that the rates observed are similar to the PIA rate on all motorways in Great Britain in 2002 (which includes the small percentage of PIAs and associated exposure that have occurred at road works).

The comparable rates observed for the previous studies were as follows:

	With road works PIA rate (PIA per million vehicle kilometres)	Without road works PIA rate (PIA per million vehicle kilometres)	Ratio of PIA rates	National motorway PIA rate (PIA per million vehicle kilometres)
2002	0.101	0.098	1.03	0.10
1992	0.174	0.076	2.29	0.11
1987	0.154	0.098	1.57	0.11
1982	0.161	0.111	1.45	0.14

Table 3.1 The scope of the study

Type of traffic management	Motorways involved	No. of roadworks phases	With road works		Without road works	
			Exposure	Accidents	Exposure	Accidents
			Veh. km (millions)	PIA	Veh. km (millions)	PIA
Contra-flow						
CFA	M6(2), M42(3), M62(2), M11, M5, M3, M25, M57, M69	47	1805.614	195	5219.579	510
CFB	M42, M62, M5(2), M20	16	115.917	8	321.181	29
CFC	M6	1	813.053	60	2361.526	213
CFD	M11	4	85.564	9	255.692	16
Non contra-flow						
<i>2-lane dual carriageways</i>						
2A						
2B	M50	4	53.674	2	152.845	5
2C	M11	1	66.329	4	187.380	14
<i>3-lane dual carriageways</i>						
3A						
3B	M4(2), M5(2), M1	13	163.940	25	457.257	74
3C	M5(5), M180, M69, M20, M57, M4, M62	22	443.642	43	1253.642	92
3D	M42(2), M11, M180	6	16.063	1	42.989	6
3E	M6, M62, M42, M11, A1(M), M3, M5, M25, M4, M1	16	438.827	59	1293.667	182
3F	M5(2), M6(2), M20, M57, M180	12	124.498	10	321.123	28
3G	M180	1	24.585	2	65.590	3
<i>4-lane dual carriageways</i>						
4A	M61	2	10.902	2	30.787	5
4B	M61	1	1.484	0	4.190	0
4C	M61	1	11.760	3	33.209	10
All layouts		147	4175.85	423	12000.66	1187

The number of sites is shown as M6(3) i.e. 3 sites on the M6.
See Figure 2 for definitions of the type of traffic management.

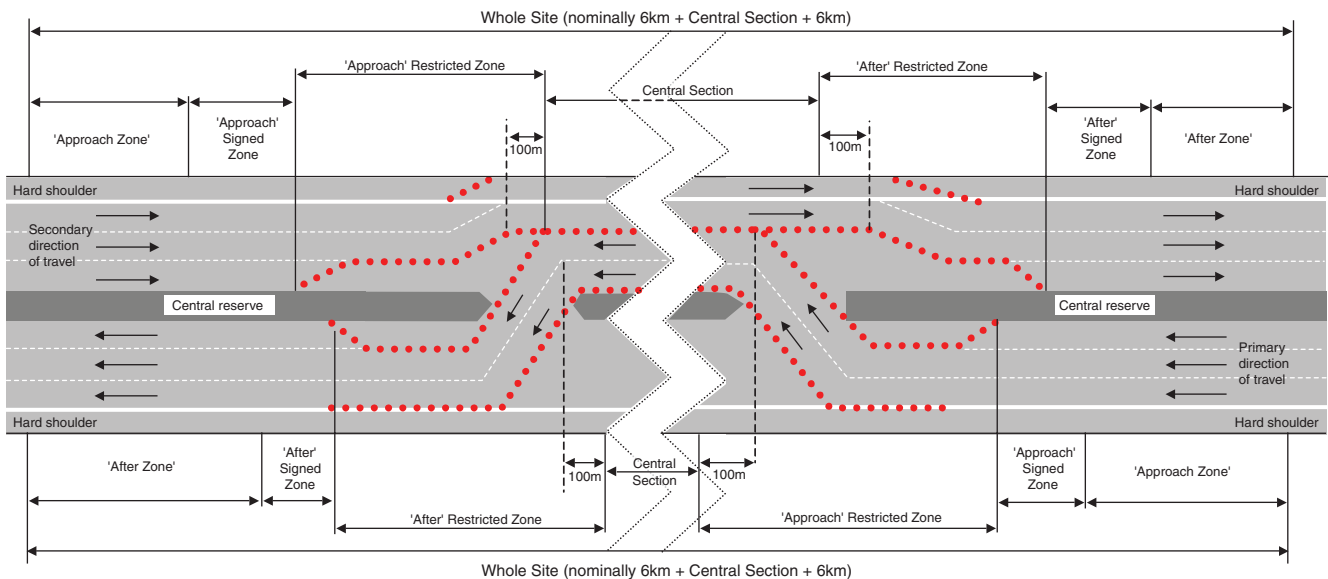


Figure 3 Definition of site sections

Table 3.2 Number of PIA by road works site, for the with and without road works periods

Site No.	Location	No. of PIA	Equivalent without road works periods No. of PIA				
			Average	Total	Prev. 1	Prev. 2	Prev. 3
1	M5 J12*	28	16.7	50	22	19	9
2	M6 J6-J7*	92	85.0	255	114	67	74
3	M42 J11-10	1	1.7	5	3	0	2
4	M62 J18-20	40	35.7	107	38	36	33
5	M42 J2-J3	2	3.3	10	3	5	2
6	M11 J8	21	20.7	62	28	19	15
7	M62 J36-38	10	11.7	35	13	10	12
8	M5 J27-28	2	2.3	7	2	2	3
9	M5 J30 & J31	2	3.7	11	8	1	2
10	M5 J9-10	7	0.3	1	1	0	0
11	M50 J1-2	2	1.7	5	1	2	2
12	M11, J6-7	10	5.7	17	2	6	9
13	A1(M) J63-65	6	2.7	8	2	3	3
14	M61 J1 to J2	5	5.0	15	4	6	5
15	M6 J43	0	0.0	0	0	0	0
16	M1 J25 - J26	1	2.3	7	1	2	4
17	M180, J2*	2	1.7	5	1	1	3
18	M3 J3-4	14	19.7	59	14	22	23
19	M5, J19-20	1	3.3	10	7	1	2
20	M25 J21-22	60	51.3	154	55	55	44
21	M4 J16-17	16	6.5	13	4	9	n/a
22	M20, J10-11	5	4.7	14	2	9	3
23	M6 J20-21	60	71.0	213	56	83	74
24	M5 J26-27	0	3.0	9	5	2	2
25	M57, J2-4	14	11.7	35	10	13	12
26	M69, J2 to M1 J21	4	0.7	2	0	2	0
27	M42 J10	0	1.7	5	1	1	3
28	M6 J23-25	1	3.5	7	3	4	n/a
29	M4 J5-7	17	22.0	66	22	22	22
Total		423		1187	422	402	363

* Includes HAWSAR accidents (see Section 3.5.13).

Figure 4 contains a plot of the above with and without road works PIA rates together with the PIA rate for all motorways over time. It can be seen that the ‘with’ works rate has converged with the national rate, which has remained fairly constant at approximately 0.1. It is thought that the reduction in the ‘with’ road works rate is due to the large number of safety initiatives that have taken place over the past decade. These will be discussed fully in Section 4.

Table 3.3 Overall PIA rates

	Personal injury accidents (mean number of)		Vehicle kilometres (mean number of [millions])		Personal injury accidents per million veh. km	
	With road works	Without road works	With road works	Without road works	With road works	3 year average EP
Whole sample	14.59	13.76	143.99	139.77	0.101	0.098
		Prev. 1 14.55		141.97		0.102
		Prev. 2 13.86		139.78		0.099
		Prev. 3 13.44		136.76		0.098
All motorways (GB) ¹	–	–	–	92,400 ¹	–	0.100 ²

¹ Source: Road Casualties Great Britain 2002 (Vehicle population, traffic and road length), Department of Transport, October 2003.

² Source: Road Casualties Great Britain 2002 (Table 3: Accidents and accident rates: by road class and severity: 1994-98 average, 1995-2002. (The National without road works accident rate is not strictly works-free, as it applies to the whole network which includes some road works).

3.2.1 Truncated sites

The effect of truncated sites on the works/non-works PIA ratio was tested by removing the sites listed in Table 2.3. The resulting works and without works PIA rates were 0.098 and 0.096 respectively, giving a ratio of 1.02. No statistical difference (5% level) was found between the two rates.

3.3 Ratios of personal injury accident rates by type of traffic management and by section

Figure 3 illustrates how the road works sites have been disaggregated into 7 zones: the approach zone, the approach signed zone, the approach restricted zone, the central section, the after restricted zone, the after signed zone and the after zone.

Table 3.4 shows the PIA rate by zone for primary, secondary and both directions for all traffic management layouts. The statistical significances of these values are given in Table 3.5.

Table 3.6 summarises the PIA ratios for each section of the traffic management as described in Figure 3. The largest ratios (typically 1.4, significant at the 90% confidence level) were found to be on the approach to the central works section. It is in these areas where conflicts between traffic are most likely and hence this result is as expected. The rate for the central works section was found to be significantly different from the without works period (5% level) giving a ratio of 1.27. For the zone after the works the ratios tended to be less than one (between 0.4 and 0.7) indicating that this area is more safe when road works are present.

3.4 PIA rates for use in QUADRO

Table 3.7 illustrates the derivation of accident rates suitable for use in the Department for Transport’s QUADRO program (Department for Transport, 2002b). Two rates are used in QUADRO: the ‘Site Presence Rate’ and the ‘Site Length Rate’. These rates are given separately in Table 3.7 for the primary and secondary direction. It should be noted that in this report the term ‘primary’ direction is used to mean the direction in which works activity is taking place and the ‘secondary’ direction the one unaffected by the works. See also Section 2.3.

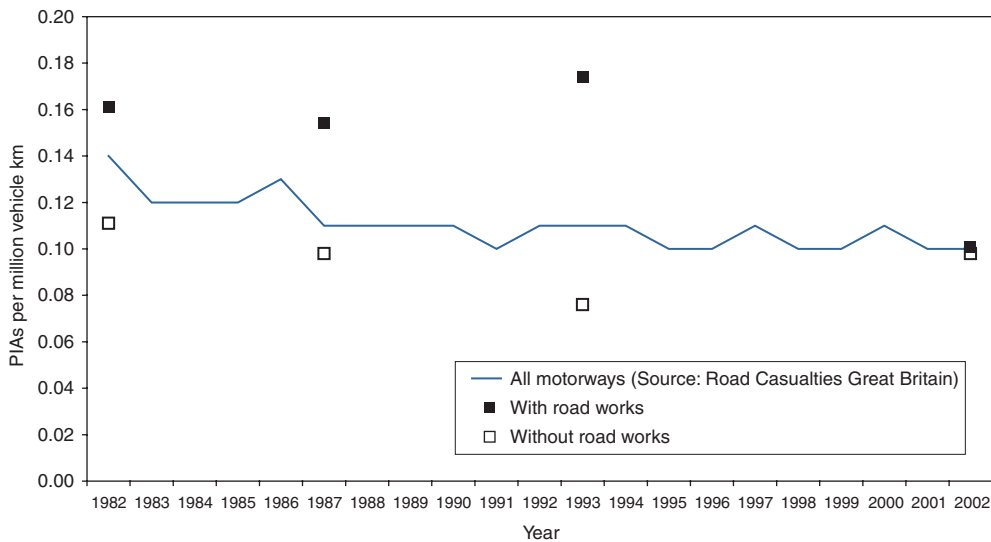


Figure 4 Comparison of PIA rates on motorways with and without road works 1982-2002

Site length rate

The site length rate corresponds to PIAs occurring along the works site itself, with the site length defined as that section of the road subject to a change in geometric standards due to the road works related traffic management. Thus referring to Figure 3, the site length corresponds to the Central Section.

The Site Length Rate is expressed conventionally in PIA per million vehicle-kilometres and is determined from the formula:

$$\text{Site length rate} = B_{cs} R_n$$

where B_{cs} = ratio of PIA rates on the Central Section, with road works over without road works;

and R_n = overall PIA rate without works (see Table 3.3) expressed in PIAs per million vehicle-kilometres. This corresponds to the study sample's Three-Year Averaged Equivalent Period without works PIA rate.

Site Presence Rate

The Site Presence Rate is independent of the length of the physical works, and is expressed in PIA per million vehicles. The rate is a measure of the extra PIAs associated with the presence of road works related features. It is effectively the extra PIAs in a given period divided by the total flow of traffic in that period. However, for the purpose of this study this is expressed more appropriately as:

$$\text{Site Presence Rate} = 12 R_n (B_o - 1)$$

Where 12 = nominal length of the approach plus after sections in kilometres (as shown in Figure 3);

B_o = ratio of PIA rates on the Whole Site excluding the Central Section, with road works over without road works;

and R_n = as defined above.

The Site Presence Rate for use in QUADRO is thus the excess PIA rate per million vehicle passes over and above the corresponding rate without works.

Values for use in QUADRO

Site Length Rate:

Based on the results of the study, the Site Length Rate for use in QUADRO for 2, 3 and 4 lane motorways are: 0.13 PIA/mvkm for the primary and 0.15 PIA/mvkm for the secondary direction.

Site Presence Rate:

Table 3.7 shows the values for the Site Presence Rate for the primary and secondary directions. The values are -0.11 PIA/mv for the primary and -0.14 PIA/mv for the secondary direction for use in QUADRO for 2, 3 and 4 lane motorways.

The figures for both the Site Length and Site Presence Rates are much lower than those currently used in QUADRO and reflect the main finding of this study that there is no significant difference (at the 5% level) between the works and non-works PIA rates. Given this finding, a negative value for the Site Presence Rate is to be expected if the value for the Site Length Rate, representing the risk on the Central Section, is greater than one.

The greatly reduced values for the two rates compared with those currently used have implications for the way PIAs are dealt with in QUADRO and it is recommended that Chapter 3 of Part 2 of the QUADRO manual that deals with the valuation of PIAs is reviewed before the values given above are used in QUADRO.

Table 3.4 PIA rates for each traffic management section, by direction of travel

Type of traffic management	With or without roadworks	Whole site	Traffic management zone							
			Approach	Approach signed zone	Approach restricted zone	Central section	After restricted zone	After signed zone	Approach and after	
All layouts primary direction										
Works	Number of PIAs	246	12	66	23	74	0	2	69	81
	Veh. km (millions)	2635.65	130.47	774.46	121.47	585.62	67.85	31.38	924.40	1054.88
	Mean PIA rate	0.09	0.10	0.09	0.19	0.13	0.00	0.06	0.07	0.08
Average 3 year EP PIA rate		0.10	0.07	0.08	0.11	0.11	0.16	0.05	0.10	0.09
Prev. 1	Number of PIAs	249	10	69	10	61	8	2	89	99
	Veh. km (millions)	2614.77	128.69	769.12	120.70	580.19	67.03	31.01	918.03	1046.72
	PIA rate	0.10	0.09	0.09	0.08	0.11	0.12	0.06	0.10	0.09
Prev. 2	Number of PIAs	254	7	62	11	68	10	1	95	102
	Veh. km (millions)	2545.80	125.86	748.09	116.41	567.71	65.24	30.31	892.17	1018.04
	PIA rate	0.10	0.06	0.08	0.09	0.12	0.15	0.03	0.11	0.10
Prev. 3	Number of PIAs	222	7	52	16	59	12	1	75	82
	Veh. km (millions)	2328.19	117.47	679.31	105.85	525.70	60.99	27.28	811.59	929.06
	PIA rate	0.10	0.06	0.08	0.15	0.11	0.20	0.04	0.09	0.09
Primary direction by contra-flow type										
CFA Works	Number of PIAs	72	4	14	6	23	0	1	24	28
	Veh. km (millions)	873.18	55.18	221.88	48.73	221.71	16.99	14.01	294.67	349.85
	Mean PIA rate	0.08	0.07	0.06	0.12	0.10	0.00	0.07	0.08	0.08
Average 3 year EP PIA rate		0.09	0.05	0.08	0.06	0.08	0.10	0.00	0.10	0.09
Prev. 1	Number of PIAs	77	4	21	1	18	1	0	32	36
	Veh. km (millions)	862.90	54.01	219.57	48.42	219.00	16.87	13.79	291.24	345.26
	PIA rate	0.09	0.07	0.10	0.02	0.08	0.06	0.00	0.11	0.10
Prev. 2	Number of PIAs	66	2	15	4	21	2	0	22	24
	Veh. km (millions)	838.10	53.16	212.70	46.41	213.65	16.27	13.52	282.39	335.54
	PIA rate	0.08	0.04	0.07	0.09	0.10	0.12	0.00	0.08	0.07
Prev. 3	Number of PIAs	69	2	17	3	14	2	0	31	33
	Veh. km (millions)	784.01	51.36	197.46	43.29	199.86	15.24	12.57	264.23	315.59
	PIA rate	0.09	0.04	0.09	0.07	0.07	0.13	0.00	0.12	0.10
CFB Works	Number of PIAs	5	2	1	0	0	0	0	2	4
	Veh. km (millions)	57.21	2.80	16.95	3.43	10.80	1.89	0.36	20.97	23.77
	Mean PIA rate	0.09	0.71	0.06	0.00	0.00	0.00	0.00	0.10	0.17
Average 3 year EP PIA rate		0.12	0.14	0.09	0.00	0.10	0.20	1.01	0.16	0.15
Prev. 1	Number of PIAs	8	1	2	0	1	0	0	4	5
	Veh. km (millions)	54.50	2.59	16.24	3.28	10.24	1.79	0.35	20.01	22.60
	PIA rate	0.15	0.39	0.12	0.00	0.10	0.00	0.00	0.20	0.22
Prev. 2	Number of PIAs	7	0	2	0	0	1	0	4	4
	Veh. km (millions)	51.14	2.41	15.26	3.09	9.60	1.67	0.32	18.79	21.20
	PIA rate	0.14	0.00	0.13	0.00	0.00	0.60	0.00	0.21	0.19
Prev. 3	Number of PIAs	4	0	0	0	2	0	1	1	1
	Veh. km (millions)	50.66	2.31	15.21	3.05	9.48	1.66	0.32	18.62	20.93
	PIA rate	0.08	0.00	0.00	0.00	0.21	0.00	3.10	0.05	0.05

These results do not include data from truncated sites.

Continued

Table 3.4 (Continued) PIA rates for each traffic management section, by direction of travel

Type of traffic management	With or without roadworks	Whole site	Traffic management zone								
			Approach	Approach signed zone	Approach restricted zone	Central section	After restricted zone	After signed zone	Approach and after		
CFC	Works	Number of PIAs	31	1	10	5	2	0	0	13	14
		Veh. km (millions)	392.64	26.27	134.28	14.60	42.33	26.27	2.92	145.96	172.23
		Mean PIA rate	0.08	0.04	0.07	0.34	0.05	0.00	0.00	0.09	0.08
	Average 3 year EP PIA rate		0.11	0.04	0.06	0.24	0.24	0.25	0.00	0.10	0.09
	Prev. 1	Number of PIAs	36	1	11	3	6	5	0	10	11
		Veh. km (millions)	384.94	25.76	131.65	14.31	41.50	25.76	2.86	143.10	168.86
		PIA rate	0.09	0.04	0.08	0.21	0.14	0.19	0.00	0.07	0.07
	Prev. 2	Number of PIAs	49	1	9	3	12	6	0	18	19
		Veh. km (millions)	377.39	25.25	129.07	14.03	40.69	25.25	2.81	140.29	165.55
		PIA rate	0.13	0.04	0.07	0.21	0.29	0.24	0.00	0.13	0.11
	Prev. 3	Number of PIAs	45	1	5	4	12	8	0	15	16
		Veh. km (millions)	374.70	25.07	128.15	13.93	40.39	25.07	2.79	139.29	164.36
PIA rate		0.12	0.04	0.04	0.29	0.30	0.32	0.00	0.11	0.10	
CFD	Works	Number of PIAs	5	0	1	3	0	0	0	1	1
		Veh. km (millions)	39.99	0.00	9.65	6.07	8.55	1.04	0.26	14.42	14.42
		Mean PIA rate	0.13	N/A	0.10	0.49	0.00	0.00	0.00	0.07	0.07
	Average 3 year EP PIA rate		0.08	N/A	0.10	0.17	0.08	0.00	0.00	0.02	0.02
	Prev. 1	Number of PIAs	0	0	0	0	0	0	0	0	0
		Veh. km (millions)	40.80	0.00	9.84	6.20	8.72	1.06	0.27	14.71	14.71
		PIA rate	0.00	N/A	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Prev. 2	Number of PIAs	5	0	1	2	2	0	0	0	0
		Veh. km (millions)	39.79	0.00	9.60	6.04	8.50	1.04	0.26	14.35	14.35
		PIA rate	0.13	N/A	0.10	0.33	0.24	0.00	0.00	0.00	0.00
	Prev. 3	Number of PIAs	4	0	2	1	0	0	0	1	1
		Veh. km (millions)	38.99	0.00	9.41	5.92	8.33	1.01	0.26	14.06	14.06
PIA rate		0.10	N/A	0.21	0.17	0.00	0.00	0.00	0.07	0.07	
Primary direction by non contra-flow type											
2B	Works	Number of PIAs	2	0	0	1	0	0	1	0	0
		Veh. km (millions)	53.67	0.00	15.18	4.62	14.08	0.96	1.68	17.16	17.16
		Mean PIA rate	0.04	N/A	0.00	0.22	0.00	0.00	0.59	0.00	0.00
	Average 3 year EP PIA rate		0.03	N/A	0.02	0.15	0.02	0.00	0.00	0.02	0.02
	Prev. 1	Number of PIAs	1	0	0	1	0	0	0	0	0
		Veh. km (millions)	52.62	0.00	14.88	4.53	13.80	0.94	1.65	16.82	16.82
		PIA rate	0.02	N/A	0.00	0.22	0.00	0.00	0.00	0.00	0.00
	Prev. 2	Number of PIAs	2	0	1	0	0	0	0	1	1
		Veh. km (millions)	51.59	0.00	14.59	4.44	13.53	0.92	1.62	16.49	16.49
		PIA rate	0.04	N/A	0.07	0.00	0.00	0.00	0.00	0.06	0.06
	Prev. 3	Number of PIAs	2	0	0	1	1	0	0	0	0
		Veh. km (millions)	48.63	0.00	13.54	4.16	12.75	0.86	1.53	15.78	15.78
PIA rate		0.04	N/A	0.00	0.24	0.08	0.00	0.00	0.00	0.00	

These results do not include data from truncated sites.

Continued

Table 3.4 (Continued) PIA rates for each traffic management section, by direction of travel

Type of traffic management	With or without roadworks	Whole site	Traffic management zone								
			Approach	Approach signed zone	Approach restricted zone	Central section	After restricted zone	After signed zone	Approach and after		
2C	Works	Number of PIAs	4	0	0	1	2	0	0	1	1
		Veh. km (millions)	66.33	2.33	19.56	2.41	17.74	1.42	1.10	21.77	24.10
		Mean PIA rate	0.06	0.00	0.00	0.42	0.11	0.00	0.00	0.05	0.04
	Average 3 year EP PIA rate		0.07	0.00	0.05	0.15	0.12	0.00	0.00	0.07	0.06
	Prev. 1	Number of PIAs	6	0	1	0	3	0	0	2	2
		Veh. km (millions)	66.50	2.36	19.60	2.39	17.80	1.43	1.09	21.83	24.19
		PIA rate	0.09	0.00	0.05	0.00	0.17	0.00	0.00	0.09	0.08
	Prev. 2	Number of PIAs	7	0	2	0	3	0	0	2	2
		Veh. km (millions)	61.04	2.09	18.01	2.27	16.28	1.30	1.04	20.03	22.13
		PIA rate	0.11	0.00	0.11	0.00	0.18	0.00	0.00	0.10	0.09
Prev. 3	Number of PIAs	1	0	0	1	0	0	0	0	0	
	Veh. km (millions)	59.84	2.05	17.66	2.22	15.96	1.27	1.02	19.64	21.70	
	PIA rate	0.02	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00	
3B	Works	Number of PIAs	25	0	6	1	12	0	0	6	6
		Veh. km (millions)	154.14	0.63	55.80	2.91	35.15	2.98	1.15	55.51	56.14
		Mean PIA rate	0.16	0.00	0.11	0.34	0.34	0.00	0.00	0.11	0.11
	Average 3 year EP PIA rate		0.17	0.00	0.18	0.41	0.14	0.12	0.00	0.17	0.17
	Prev. 1	Number of PIAs	22	0	10	0	7	0	0	5	5
		Veh. km (millions)	152.55	0.63	55.25	2.89	34.69	2.95	1.14	54.99	55.63
		PIA rate	0.14	0.00	0.18	0.00	0.20	0.00	0.00	0.09	0.09
	Prev. 2	Number of PIAs	30	0	8	1	4	1	0	16	16
		Veh. km (millions)	152.55	0.56	55.16	2.81	35.21	2.94	1.12	54.74	55.31
		PIA rate	0.20	0.00	0.15	0.36	0.11	0.34	0.00	0.29	0.29
Prev. 3	Number of PIAs	22	0	10	2	4	0	0	6	6	
	Veh. km (millions)	133.19	0.00	47.61	1.64	34.69	2.46	0.78	46.00	46.00	
	PIA rate	0.17	N/A	0.21	1.22	0.12	0.00	0.00	0.13	0.13	
3C	Works	Number of PIAs	41	3	16	4	9	0	0	9	12
		Veh. km (millions)	443.64	17.17	144.09	22.51	73.81	6.06	3.11	176.89	194.06
		Mean PIA rate	0.09	0.17	0.11	0.18	0.12	0.00	0.00	0.05	0.06
	Average 3 year EP PIA rate		0.06	0.10	0.05	0.11	0.05	0.00	0.00	0.07	0.08
	Prev. 1	Number of PIAs	37	2	8	3	5	0	0	19	21
		Veh. km (millions)	451.61	17.52	146.82	22.72	74.98	6.17	3.17	180.23	197.75
		PIA rate	0.08	0.11	0.05	0.13	0.07	0.00	0.00	0.11	0.11
	Prev. 2	Number of PIAs	28	2	7	1	5	0	0	13	15
		Veh. km (millions)	432.89	16.90	140.70	21.63	72.06	5.91	3.02	172.67	189.57
		PIA rate	0.06	0.12	0.05	0.05	0.07	0.00	0.00	0.08	0.08
Prev. 3	Number of PIAs	15	1	6	3	1	0	0	4	5	
	Veh. km (millions)	362.07	14.30	116.13	17.43	64.41	4.63	2.27	142.88	157.19	
	PIA rate	0.04	0.12	0.05	0.17	0.02	0.000	0.00	0.03	0.03	

These results do not include data from truncated sites.

Continued

Table 3.4 (Continued) PIA rates for each traffic management section, by direction of travel

Type of traffic management	With or without roadworks	Whole site	Traffic management zone								
			Approach	Approach signed zone	Approach restricted zone	Central section	After restricted zone	After signed zone	Approach and after		
3D	Works	Number of PIAs	1	0	0	0	0	0	0	1	1
		Veh. km (millions)	16.06	0.47	4.22	1.01	4.37	0.30	0.15	5.53	6.00
		Mean PIA rate	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.17
	Average 3 year EP PIA rate		0.13	0.00	0.25	0.00	0.16	0.00	0.00	0.06	0.06
	Prev. 1	Number of PIAs	2	0	1	0	0	0	0	1	1
		Veh. km (millions)	15.71	0.48	4.14	0.99	4.22	0.30	0.16	5.43	5.91
		PIA rate	0.13	0.00	0.24	0.00	0.00	0.00	0.00	0.18	0.17
	Prev. 2	Number of PIAs	1	0	0	0	1	0	0	0	0
		Veh. km (millions)	15.24	0.46	4.02	0.96	4.11	0.29	0.15	5.25	5.71
		PIA rate	0.07	0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.00
	Prev. 3	Number of PIAs	3	0	2	0	1	0	0	0	0
		Veh. km (millions)	14.86	0.44	3.93	0.93	4.04	0.28	0.15	5.10	5.54
PIA rate		0.20	0.00	0.51	0.00	0.25	0.00	0.00	0.00	0.00	
3E	Works	Number of PIAs	49	2	13	1	22	0	0	11	13
		Veh. km (millions)	403.59	19.03	112.49	8.83	126.74	7.03	5.33	124.14	143.17
		Mean PIA rate	0.12	0.11	0.12	0.11	0.17	0.00	0.00	0.09	0.09
	Average 3 year EP PIA rate		0.13	0.11	0.11	0.12	0.16	0.20	0.19	0.11	0.11
	Prev. 1	Number of PIAs	50	2	13	2	20	2	2	9	11
		Veh. km (millions)	397.83	18.84	110.68	8.73	125.08	6.90	5.24	122.36	141.19
		PIA rate	0.13	0.11	0.12	0.23	0.16	0.29	0.38	0.07	0.08
	Prev. 2	Number of PIAs	51	1	16	0	19	0	1	14	15
		Veh. km (millions)	394.49	18.55	109.53	8.64	124.75	6.83	5.18	121.01	139.56
		PIA rate	0.13	0.05	0.15	0.00	0.15	0.00	0.19	0.12	0.11
	Prev. 3	Number of PIAs	51	3	8	1	22	2	0	15	18
		Veh. km (millions)	381.10	18.06	105.88	8.36	120.08	6.61	5.03	117.07	135.13
PIA rate		0.13	0.17	0.08	0.12	0.18	0.30	0.00	0.13	0.13	
3F	Works	Number of PIAs	9	0	4	1	3	0	0	1	1
		Veh. km (millions)	110.61	5.65	33.80	4.59	22.55	2.34	1.13	40.55	46.20
		Mean PIA rate	0.08	0.00	0.12	0.22	0.13	0.00	0.00	0.02	0.02
	Average 3 year EP PIA rate		0.07	0.07	0.05	0.00	0.06	0.00	0.00	0.12	0.12
	Prev. 1	Number of PIAs	9	0	1	0	1	0	0	7	7
		Veh. km (millions)	112.15	5.61	34.37	4.63	22.93	2.35	1.15	41.10	46.71
		PIA rate	0.08	0.00	0.03	0.00	0.04	0.00	0.00	0.17	0.15
	Prev. 2	Number of PIAs	7	1	1	0	1	0	0	4	5
		Veh. km (millions)	109.68	5.61	33.55	4.52	22.32	2.33	1.13	40.22	45.83
		PIA rate	0.06	0.18	0.03	0.00	0.04	0.00	0.00	0.10	0.11
	Prev. 3	Number of PIAs	5	0	2	0	1	0	0	2	2
		Veh. km (millions)	58.66	3.03	18.55	3.37	8.79	1.39	0.43	23.11	26.14
PIA rate		0.09	0.18	0.11	0.00	0.11	0.00	0.00	0.09	0.08	

These results do not include data from truncated sites.

Continued

Table 3.4 (Continued) PIA rates for each traffic management section, by direction of travel

Type of traffic management	With or without roadworks	Whole site	Traffic management zone								
			Approach	Approach signed zone	Approach restricted zone	Central section	After restricted zone	After signed zone	Approach and after		
3G Works	Number of PIAs	2	0	1	0	1	0	0	0	0	
	Veh. km (millions)	24.58	0.94	6.56	1.75	7.80	0.55	0.16	6.83	7.77	
	Mean PIA rate	0.08	0.00	0.15	0.00	0.13	0.00	0.00	0.00	0.00	
	Average 3 year EP PIA rate		0.05	0.00	0.06	0.00	0.05	0.00	0.00	0.00	0.05
	Prev. 1	Number of PIAs	1	0	1	0	0	0	0	0	0
		Veh. km (millions)	22.66	0.90	6.07	1.62	7.22	0.51	0.15	6.19	7.09
		PIA rate	0.04	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00
	Prev. 2	Number of PIAs	1	0	0	0	0	0	0	0	1
		Veh. km (millions)	21.90	0.87	5.89	1.57	7.00	0.49	0.14	5.94	6.80
		PIA rate	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15
Prev. 3	Number of PIAs	1	0	0	0	1	0	0	0	0	
	Veh. km (millions)	21.48	0.85	5.79	1.54	6.89	0.48	0.14	5.79	6.64	
	PIA rate	0.05	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	
All layouts secondary direction											
Works	Number of PIAs	144	10	37	2	59	6	3	27	37	
	Veh. km (millions)	1442.43	99.06	384.12	39.59	395.91	32.54	21.23	469.98	569.04	
	Mean PIA rate	0.10	0.10	0.10	0.05	0.15	0.18	0.14	0.06	0.07	
Average 3 year EP PIA rate		0.09	0.07	0.08	0.11	0.10	0.15	0.11	0.10	0.09	
Prev. 1	Number of PIAs	150	6	35	6	47	6	5	45	51	
	Veh. km (millions)	1423.53	98.44	378.67	38.94	391.03	32.08	20.91	463.46	561.90	
	PIA rate	0.11	0.06	0.09	0.15	0.12	0.19	0.24	0.10	0.09	
Prev. 2	Number of PIAs	124	7	31	4	28	4	1	49	56	
	Veh. km (millions)	1390.26	93.60	369.76	37.98	382.47	31.39	20.49	454.58	548.18	
	PIA rate	0.09	0.07	0.08	0.11	0.07	0.13	0.05	0.11	0.10	
Prev. 3	Number of PIAs	120	7	27	3	38	4	1	40	47	
	Veh. km (millions)	1339.05	91.78	356.14	36.84	366.57	30.35	19.74	437.63	529.41	
	PIA rate	0.09	0.08	0.08	0.08	0.10	0.13	0.05	0.09	0.09	
Secondary direction by contra-flow type											
CFA Works	Number of PIAs	104	4	25	1	50	3	3	18	22	
	Veh. km (millions)	902.46	67.62	216.43	24.54	286.12	20.19	17.50	270.08	337.69	
	Mean PIA rate	0.12	0.06	0.12	0.04	0.17	0.15	0.17	0.07	0.07	
Average 3 year EP PIA rate		0.11	0.06	0.10	0.14	0.10	0.21	0.10	0.12	0.11	
Prev. 1	Number of PIAs	116	2	27	5	39	5	4	34	36	
	Veh. km (millions)	891.71	67.51	213.71	24.16	282.92	19.93	17.24	266.23	333.74	
	PIA rate	0.13	0.03	0.13	0.21	0.14	0.25	0.23	0.13	0.11	
Prev. 2	Number of PIAs	81	4	21	2	20	3	1	30	34	
	Veh. km (millions)	872.00	63.60	208.81	23.69	277.03	19.55	16.91	262.41	326.01	
	PIA rate	0.09	0.06	0.10	0.08	0.07	0.15	0.06	0.11	0.10	
Prev. 3	Number of PIAs	75	6	14	3	22	4	0	26	32	
	Veh. km (millions)	819.70	59.09	194.61	22.52	261.11	18.47	16.16	247.73	306.82	
	PIA rate	0.09	0.10	0.07	0.13	0.08	0.22	0.00	0.10	0.10	

These results do not include data from truncated sites.

Continued

Table 3.4 (Continued) PIA rates for each traffic management section, by direction of travel

Type of traffic management	With or without roadworks	Whole site	Traffic management zone								
			Approach	Approach signed zone	Approach restricted zone	Central section	After restricted zone	After signed zone	Approach and after		
CFB	Works	Number of PIAs	3	0	1	0	2	0	0	0	0
		Veh. km (millions)	58.71	5.80	14.97	3.37	11.05	1.38	0.40	21.75	27.55
		Mean PIA rate	0.05	0.00	0.07	0.00	0.18	0.00	0.00	0.00	0.00
	Average 3 year EP PIA rate		0.06	0.11	0.07	0.00	0.03	0.00	0.00	0.07	0.08
	Prev. 1	Number of PIAs	1	0	0	0	0	0	0	1	1
		Veh. km (millions)	58.24	5.70	14.72	3.29	10.80	1.35	0.39	21.99	27.69
		PIA rate	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.04
	Prev. 2	Number of PIAs	6	2	1	0	1	0	0	2	4
		Veh. km (millions)	54.19	5.27	13.72	3.03	10.10	1.25	0.36	20.45	25.72
		PIA rate	0.11	0.38	0.07	0.00	0.10	0.00	0.00	0.10	0.16
Prev. 3	Number of PIAs	3	0	2	0	0	0	0	1	1	
	Veh. km (millions)	52.45	7.73	13.31	2.97	9.69	1.22	0.35	17.18	24.90	
	PIA rate	0.06	0.00	0.15	0.00	0.00	0.00	0.00	0.06	0.04	
CFC	Works	Number of PIAs	29	4	9	1	5	0	0	10	14
		Veh. km (millions)	420.42	22.57	136.28	10.44	81.83	9.88	2.82	156.60	179.17
		Mean PIA rate	0.07	0.18	0.07	0.10	0.06	0.00	0.00	0.06	0.08
	Average 3 year EP PIA rate		0.07	0.03	0.06	0.10	0.09	0.07	0.12	0.07	0.06
	Prev. 1	Number of PIAs	20	0	6	1	4	1	0	8	8
		Veh. km (millions)	412.17	22.13	133.61	10.24	80.22	9.68	2.77	153.53	175.66
		PIA rate	0.05	0.00	0.04	0.10	0.05	0.10	0.00	0.05	0.05
	Prev. 2	Number of PIAs	34	1	8	2	7	1	0	15	16
		Veh. km (millions)	404.09	21.70	130.99	10.03	78.65	9.49	2.71	150.52	172.21
		PIA rate	0.08	0.05	0.06	0.20	0.09	0.11	0.00	0.10	0.09
Prev. 3	Number of PIAs	29	1	10	0	10	0	1	7	8	
	Veh. km (millions)	408.24	21.92	132.33	10.14	79.46	9.59	2.74	152.06	173.98	
	PIA rate	0.07	0.05	0.08	0.00	0.13	0.00	0.36	0.05	0.05	
CFD	Works	Number of PIAs	4	0	1	0	0	3	0	0	0
		Veh. km (millions)	45.57	2.08	13.19	0.82	13.09	0.82	0.27	15.29	17.38
		Mean PIA rate	0.09	0.00	0.08	0.00	0.00	3.66	0.00	0.00	0.00
	Average 3 year EP PIA rate		0.05	0.00	0.00	0.00	0.10	0.00	0.00	0.07	0.06
	Prev. 1	Number of PIAs	1	0	0	0	1	0	0	0	0
		Veh. km (millions)	46.49	2.12	13.46	0.84	13.35	0.84	0.28	15.60	17.73
		PIA rate	0.02	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
	Prev. 2	Number of PIAs	1	0	0	0	0	0	0	1	1
		Veh. km (millions)	45.26	2.07	13.10	0.81	13.00	0.81	0.27	15.19	17.26
		PIA rate	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.06
Prev. 3	Number of PIAs	5	0	0	0	3	0	0	2	2	
	Veh. km (millions)	44.36	2.03	12.84	0.80	12.74	0.80	0.27	14.89	16.91	
	PIA rate	0.11	0.00	0.00	0.00	0.24	0.00	0.00	0.13	0.12	

These results do not include data from truncated sites.

Continued

Table 3.4 (Continued) PIA rates for each traffic management section, by direction of travel

Type of traffic management	With or without roadworks	Whole site	Traffic management zone								
			Approach	Approach signed zone	Approach restricted zone	Central section	After restricted zone	After signed zone	Approach and after		
Secondary direction by non contra-flow type											
3E	Works	Number of PIAs	4	0	1	0	2	0	0	1	1
		Veh. km (millions)	15.27	0.99	3.25	0.43	3.82	0.29	0.24	6.26	7.25
		Mean PIA rate	0.26	0.00	0.31	0.00	0.52	0.00	0.00	0.16	0.14
Average 3 year EP PIA rate			0.50	1.35	0.43	0.00	0.55	0.00	1.46	0.40	0.53
	Prev. 1	Number of PIAs	12	4	2	0	3	0	1	2	6
		Veh. km (millions)	15.00	0.98	3.17	0.42	3.73	0.28	0.23	6.18	7.09
		PIA rate	0.80	4.07	0.63	0.00	0.80	0.00	4.29	0.32	0.85
	Prev. 2	Number of PIAs	2	0	1	0	0	0	0	1	1
		Veh. km (millions)	14.82	0.96	3.13	0.41	3.68	0.28	0.23	6.12	6.99
		PIA rate	0.13	0.00	0.32	0.00	0.00	0.00	0.00	0.16	0.14
	Prev. 3	Number of PIAs	8	0	1	0	3	0	0	4	4
		Veh. km (millions)	13.82	1.02	3.04	0.40	3.58	0.27	0.22	5.28	6.79
		PIA rate	0.58	0.00	0.33	0.00	0.84	0.00	0.00	0.76	0.59
All other non contra-flow layout types (2B, 2C, 3B, 3C, 3D, 3F and 3G) do not have a secondary direction											
All layouts both directions of travel											
	Works	Number of PIAs	390	22	103	25	133	6	5	96	118
		Veh. km (millions)	4078.08	229.53	1158.57	161.06	981.53	100.39	52.61	1394.38	1623.91
		Mean PIA rate	0.10	0.10	0.09	0.16	0.14	0.06	0.10	0.07	0.07
Average 3 year EP PIA rate			0.10	0.07	0.08	0.11	0.11	0.15	0.07	0.10	0.09
	Prev. 1	Number of PIAs	399	16	104	15	108	14	7	134	150
		Veh. km (millions)	4038.31	227.13	1147.79	159.64	971.22	99.11	51.92	1381.56	1608.62
		PIA rate	0.10	0.07	0.09	0.09	0.11	0.14	0.13	0.10	0.09
	Prev. 2	Number of PIAs	378	14	93	15	96	14	2	144	159
		Veh. km (millions)	3936.17	219.46	1117.85	154.39	950.18	96.63	50.80	1346.86	1567.10
		PIA rate	0.10	0.06	0.08	0.10	0.10	0.14	0.04	0.11	0.10
	Prev. 3	Number of PIAs	342	14	79	19	97	16	2	115	129
		Veh. km (millions)	3666.75	209.25	1035.44	142.69	892.27	91.35	47.03	1248.73	1458.47
		PIA rate	0.09	0.07	0.08	0.13	0.11	0.18	0.04	0.09	0.09
Both directions by contra-flow type											
CFA	Works	Number of PIAs	176	8	39	7	73	3	4	42	50
		Veh. km (millions)	1775.64	122.80	438.31	73.27	507.83	37.18	31.51	564.75	687.54
		Mean PIA rate	0.10	0.07	0.09	0.10	0.14	0.08	0.13	0.07	0.07
Average 3 year EP PIA rate			0.10	0.06	0.09	0.09	0.09	0.16	0.06	0.11	0.10
	Prev. 1	Number of PIAs	193	6	48	6	57	6	4	66	72
		Veh. km (millions)	1754.61	121.52	433.28	72.58	501.92	36.80	31.04	557.48	678.99
		PIA rate	0.11	0.05	0.11	0.08	0.11	0.16	0.13	0.12	0.11
	Prev. 2	Number of PIAs	147	6	36	6	41	5	1	52	58
		Veh. km (millions)	1710.11	116.76	421.52	70.10	490.68	35.83	30.43	544.79	661.55
		PIA rate	0.09	0.05	0.09	0.09	0.08	0.14	0.03	0.10	0.09
	Prev. 3	Number of PIAs	144	8	31	6	36	6	0	57	65
		(millions)	1603.72	110.45	392.07	65.81	460.96	33.72	28.73	511.96	622.42
		PIA rate	0.09	0.07	0.08	0.09	0.08	0.18	0.00	0.11	0.10

These results do not include data from truncated sites.

Continued

Table 3.4 (Continued) PIA rates for each traffic management section, by direction of travel

Type of traffic management	With or without roadworks	Whole site	Traffic management zone							
			Approach	Approach signed zone	Approach restricted zone	Central section	After restricted zone	After signed zone	Approach and after	
CFB Works	Number of PIAs	8	2	2	0	2	0	0	2	4
	Veh. km (millions)	115.92	8.60	31.92	6.80	21.85	3.27	0.76	42.72	51.32
	Mean PIA rate	0.07	0.23	0.06	0.00	0.09	0.00	0.00	0.05	0.08
Average 3 year EP PIA rate		0.09	0.12	0.08	0.00	0.07	0.11	0.48	0.11	0.11
Prev. 1	Number of PIAs	9	1	2	0	1	0	0	5	6
	Veh. km (millions)	112.74	8.29	30.96	6.56	21.05	3.14	0.73	42.00	50.29
	PIA rate	0.08	0.12	0.06	0.00	0.05	0.00	0.00	0.12	0.12
Prev. 2	Number of PIAs	13	2	3	0	1	1	0	6	8
	Veh. km (millions)	105.33	7.68	28.99	6.12	19.70	2.93	0.68	39.24	46.92
	PIA rate	0.12	0.26	0.10	0.00	0.05	0.34	0.00	0.15	0.17
Prev. 3	Number of PIAs	7	0	2	0	2	0	1	2	2
	Veh. km (millions)	103.11	10.03	28.52	6.03	19.17	2.88	0.67	35.80	45.83
	PIA rate	0.07	0.00	0.07	0.00	0.10	0.00	1.49	0.06	0.04
CFC Works	Number of PIAs	60	5	19	6	7	0	0	23	28
	Veh. km (millions)	813.05	48.85	270.57	25.04	124.15	36.15	5.74	302.56	351.41
	Mean PIA rate	0.07	0.10	0.07	0.24	0.06	0.00	0.00	0.08	0.08
Average 3 year EP PIA rate		0.09	0.04	0.06	0.18	0.14	0.20	0.06	0.08	0.08
Prev. 1	Number of PIAs	56	1	17	4	10	6	0	18	19
	Veh. km (millions)	797.11	47.89	265.26	24.55	121.72	35.44	5.63	296.63	344.51
	PIA rate	0.07	0.02	0.06	0.16	0.08	0.17	0.00	0.06	0.06
Prev. 2	Number of PIAs	83	2	17	5	19	7	0	33	35
	Veh. km (millions)	781.49	46.95	260.06	24.06	119.33	34.75	5.52	290.81	337.76
	PIA rate	0.11	0.04	0.07	0.21	0.16	0.20	0.00	0.11	0.10
Prev. 3	Number of PIAs	74	2	15	4	22	8	1	22	24
	Veh. km (millions)	782.93	46.99	260.48	24.07	119.85	34.66	5.53	291.35	338.34
	PIA rate	0.09	0.04	0.06	0.17	0.18	0.23	0.18	0.08	0.07
CFD Works	Number of PIAs	9	0	2	3	0	3	0	1	1
	Veh. km (millions)	85.56	2.08	22.84	6.89	21.64	1.86	0.54	29.72	31.80
	Mean PIA rate	0.11	0.00	0.09	0.44	0.00	1.61	0.00	0.03	0.03
Average 3 year EP PIA rate		0.06	0.00	0.04	0.15	0.09	0.00	0.00	0.05	0.04
Prev. 1	Number of PIAs	1	0	0	0	1	0	0	0	0
	Veh. km (millions)	87.29	2.12	23.30	7.03	22.07	1.90	0.55	30.32	32.44
	PIA rate	0.01	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00
Prev. 2	Number of PIAs	6	0	1	2	2	0	0	1	1
	Veh. km (millions)	85.05	2.07	22.70	6.86	21.51	1.85	0.53	29.54	31.60
	PIA rate	0.07	0.00	0.04	0.29	0.09	0.00	0.00	0.03	0.03
Prev. 3	Number of PIAs	9	0	2	1	3	0	0	3	3
	Veh. km (millions)	83.35	2.03	22.25	6.72	21.08	1.81	0.52	28.95	30.97
	PIA rate	0.11	0.00	0.09	0.15	0.14	0.00	0.00	0.10	0.10

These results do not include data from truncated sites.

Continued

Table 3.4 (Continued) PIA rates for each traffic management section, by direction of travel

Type of traffic management	With or without roadworks	Whole site	Traffic management zone							
			Approach	Approach signed zone	Approach restricted zone	Central section	After restricted zone	After signed zone	Approach and after	
Both directions by non contra-flow type										
2B Works	Number of PIAs	2	0	0	1	0	0	1	0	0
	Veh. km (millions)	53.67	0.00	15.18	4.62	14.08	0.96	1.68	17.16	17.16
	Mean PIA rate	0.04	N/A	0.00	0.22	0.00	0.00	0.59	0.00	0.00
Average 3 year EP PIA rate		0.03	N/A	0.02	0.15	0.02	0.00	0.00	0.02	0.02
Prev. 1	Number of PIAs	1	0	0	1	0	0	0	0	0
	Veh. km (millions)	52.62	0.00	14.88	4.53	13.80	0.94	1.65	16.82	16.82
	PIA rate	0.02	N/A	0.00	0.22	0.00	0.00	0.00	0.00	0.00
Prev. 2	Number of PIAs	2	0	1	0	0	0	0	1	1
	Veh. km (millions)	51.59	0.00	14.59	4.44	13.53	0.92	1.62	16.49	16.49
	PIA rate	0.04	N/A	0.07	0.00	0.00	0.00	0.00	0.06	0.06
Prev. 3	Number of PIAs	2	0	0	1	1	0	0	0	0
	Veh. km (millions)	48.63	0.00	13.54	4.16	12.75	0.86	1.53	15.78	15.78
	PIA rate	0.04	N/A	0.00	0.24	0.08	0.00	0.00	0.00	0.00
2C Works	Number of PIAs	4	0	0	1	2	0	0	1	1
	Veh. km (millions)	66.33	2.33	19.56	2.41	17.74	1.42	1.10	21.77	24.10
	Mean PIA rate	0.06	0.00	0.00	0.42	0.11	0.00	0.00	0.05	0.04
Average 3 year EP PIA rate		0.07	0.00	0.05	0.15	0.12	0.00	0.00	0.07	0.06
Prev. 1	Number of PIAs	6	0	1	0	3	0	0	2	2
	Veh. km (millions)	66.50	2.36	19.60	2.39	17.80	1.43	1.09	21.83	24.19
	PIA rate	0.09	0.00	0.05	0.00	0.17	0.00	0.00	0.09	0.08
Prev. 2	Number of PIAs	7	0	2	0	3	0	0	2	2
	Veh. km (millions)	61.04	2.09	18.01	2.27	16.28	1.30	1.04	20.03	22.13
	PIA rate	0.11	0.00	0.11	0.00	0.18	0.00	0.00	0.10	0.09
Prev. 3	Number of PIAs	1	0	0	1	0	0	0	0	0
	Veh. km (millions)	59.84	2.05	17.66	2.22	15.96	1.27	1.02	19.64	21.70
	PIA rate	0.02	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00
3B Works	Number of PIAs	25	0	6	1	12	0	0	6	6
	Veh. km (millions)	154.14	0.63	55.80	2.91	35.15	2.98	1.15	55.51	56.14
	Mean PIA rate	0.16	0.00	0.11	0.34	0.34	0.00	0.00	0.11	0.11
Average 3 year EP PIA rate		0.17	0.00	0.18	0.41	0.14	0.12	0.00	0.17	0.17
Prev. 1	Number of PIAs	22	0	10	0	7	0	0	5	5
	Veh. km (millions)	152.55	0.63	55.25	2.89	34.69	2.95	1.14	54.99	55.63
	PIA rate	0.14	0.00	0.18	0.00	0.20	0.00	0.00	0.09	0.09
Prev. 2	Number of PIAs	30	0	8	1	4	1	0	16	16
	Veh. km (millions)	152.55	0.56	55.16	2.81	35.21	2.94	1.12	54.74	55.31
	PIA rate	0.20	0.00	0.15	0.36	0.11	0.34	0.00	0.29	0.29
Prev. 3	Number of PIAs	22	0	10	2	4	0	0	6	6
	Veh. km (millions)	133.19	0.00	47.61	1.64	34.69	2.46	0.78	46.00	46.00
	PIA rate	0.17	N/A	0.21	1.22	0.12	0.00	0.00	0.13	0.13

These results do not include data from truncated sites.

Continued

Table 3.4 (Continued) PIA rates for each traffic management section, by direction of travel

Type of traffic management	With or without roadworks	Whole site	Traffic management zone								
			Approach	Approach signed zone	Approach restricted zone	Central section	After restricted zone	After signed zone	Approach and after		
3C	Works	Number of PIAs	41	3	16	4	9	0	0	9	12
		Veh. km (millions)	443.79	17.17	144.09	22.51	73.81	6.06	3.11	176.89	194.20
		Mean PIA rate	0.09	0.17	0.11	0.18	0.12	0.00	0.00	0.05	0.06
	Average 3 year EP PIA rate		0.06	0.10	0.05	0.11	0.05	0.00	0.00	0.07	0.08
	Prev. 1	Number of PIAs	37	2	8	3	5	0	0	19	21
		Veh. km (millions)	451.61	17.52	146.82	22.72	74.98	6.17	3.17	180.23	197.75
		PIA rate	0.08	0.11	0.05	0.13	0.07	0.00	0.00	0.11	0.11
	Prev. 2	Number of PIAs	28	2	7	1	5	0	0	13	15
		Veh. km (millions)	432.89	16.90	140.70	21.63	72.06	5.91	3.02	172.67	189.57
		PIA rate	0.06	0.12	0.05	0.05	0.07	0.00	0.00	0.08	0.08
Prev. 3	Number of PIAs	15	1	6	3	1	0	0	4	5	
	Veh. km (millions)	362.07	14.30	116.13	17.43	64.41	4.63	2.27	142.88	157.19	
	PIA rate	0.04	0.07	0.05	0.17	0.02	0.00	0.00	0.03	0.03	
3D	Works	Number of PIAs	1	0	0	0	0	0	0	1	1
		Veh. km (millions)	16.06	0.47	4.22	1.01	4.37	0.30	0.15	5.53	6.00
		Mean PIA rate	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.17
	Average 3 year EP PIA rate		0.13	0.00	0.25	0.00	0.16	0.00	0.00	0.06	0.06
	Prev. 1	Number of PIAs	2	0	1	0	0	0	0	1	1
		Veh. km (millions)	15.71	0.48	4.14	0.99	4.22	0.30	0.16	5.43	5.91
		PIA rate	0.13	0.00	0.24	0.00	0.00	0.00	0.00	0.18	0.17
	Prev. 2	Number of PIAs	1	0	0	0	1	0	0	0	0
		Veh. km (millions)	15.24	0.46	4.02	0.96	4.11	0.29	0.15	5.25	5.71
		PIA rate	0.07	0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.00
Prev. 3	Number of PIAs	3	0	2	0	1	0	0	0	0	
	Veh. km (millions)	14.86	0.44	3.93	0.93	4.04	0.28	0.15	5.10	5.54	
	PIA rate	0.20	0.00	0.51	0.00	0.25	0.00	0.00	0.00	0.00	
3E	Works	Number of PIAs	53	2	14	1	24	0	0	12	14
		Veh. km (millions)	418.86	20.02	115.74	9.26	130.55	7.32	5.57	130.40	150.42
		Mean PIA rate	0.13	0.10	0.12	0.11	0.18	0.00	0.00	0.09	0.09
	Average 3 year EP PIA rate		0.14	0.17	0.12	0.11	0.18	0.19	0.25	0.12	0.13
	Prev. 1	Number of PIAs	62	6	15	2	23	2	3	11	17
		Veh. km (millions)	412.75	19.82	113.85	9.15	128.81	7.18	5.47	128.54	148.28
		PIA rate	0.15	0.30	0.13	0.22	0.18	0.28	0.55	0.09	0.11
	Prev. 2	Number of PIAs	53	1	17	0	19	0	1	15	16
		Veh. km (millions)	409.30	19.52	112.66	9.05	128.43	7.11	5.41	127.13	146.55
		PIA rate	0.13	0.05	0.15	0.00	0.15	0.00	0.18	0.12	0.11
Prev. 3	Number of PIAs	59	3	9	1	25	2	0	19	22	
	Veh. km (millions)	394.91	19.08	108.93	8.76	123.66	6.88	5.25	122.35	141.92	
	PIA rate	0.15	0.16	0.08	0.11	0.20	0.29	0.00	0.16	0.16	

These results do not include data from truncated sites.

Continued

Table 3.4 (Continued) PIA rates for each traffic management section, by direction of travel

Type of traffic management	With or without roadworks	Whole site	Traffic management zone							
			Approach	Approach signed zone	Approach restricted zone	Central section	After restricted zone	After signed zone	Approach and after	
3F Works	Number of PIAs	9	0	4	1	3	0	0	1	1
	Veh. km (millions)	110.61	5.65	33.80	4.59	22.55	2.34	1.13	40.55	46.20
	Mean PIA rate	0.08	0.00	0.12	0.22	0.13	0.00	0.00	0.02	0.02
Average 3 year EP PIA rate		0.07	0.07	0.05	0.00	0.06	0.00	0.00	0.12	0.12
Prev. 1	Number of PIAs	9	0	1	0	1	0	0	7	7
	Veh. km (millions)	112.15	5.61	34.37	4.63	22.93	2.35	1.15	41.10	46.71
	PIA rate	0.08	0.00	0.03	0.00	0.04	0.00	0.00	0.17	0.15
Prev. 2	Number of PIAs	7	1	1	0	1	0	0	4	5
	Veh. km (millions)	109.68	5.61	33.55	4.52	22.32	2.33	1.13	40.22	46.71
	PIA rate	0.06	0.18	0.03	0.00	0.04	0.00	0.00	0.10	0.11
Prev. 3	Number of PIAs	5	0	2	0	1	0	0	2	2
	Veh. km (millions)	58.66	3.03	18.55	3.37	8.79	1.39	0.43	23.11	26.14
	PIA rate	0.09	0.00	0.11	0.00	0.11	0.00	0.00	0.09	0.08
3G Works	Number of PIAs	2	0	1	0	1	0	0	0	0
	Veh. km (millions)	24.58	0.94	6.56	1.75	7.80	0.55	0.16	6.83	7.77
	Mean PIA rate	0.07	0.00	0.15	0.00	0.13	0.00	0.00	0.00	0.00
Average 3 year EP PIA rate		0.05	0.00	0.06	0.00	0.05	0.00	0.00	0.00	0.05
Prev. 1	Number of PIAs	1	0	1	0	0	0	0	0	0
	Veh. km (millions)	22.66	0.90	6.07	1.62	7.22	0.51	0.15	6.19	7.09
	PIA rate	0.04	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00
Prev. 2	Number of PIAs	1	0	0	0	0	0	0	0	1
	Veh. km (millions)	21.90	0.87	5.89	1.57	7.00	0.49	0.14	5.94	6.80
	PIA rate	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15
Prev. 3	Number of PIAs	1	0	0	0	1	0	0	0	0
	Veh. km (millions)	21.48	0.85	5.79	1.54	6.89	0.48	0.14	5.79	6.64
	PIA rate	0.05	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00

These results do not include data from truncated sites.

Table 3.5 Statistical significance of the differences, between the with and without road works PIA rates

Type of traffic management	With road works		Without road works		z-Statistic	% change in accident rates as a result of road works	2-sided confidence level at which the difference is significant	With road works 95% confidence interval		Without road works 95% confidence interval	
	Mean PIA rate	Vehicle kilometres (millions)	3 year average EP PIA rate	Vehicle kilometres (millions)				Lower	Upper	Lower	Upper
All sections, both directions											
Whole sample, all layouts, both directions	0.10	4078.08	0.10	11641.61	0.08	0.00	0.93	0.09	0.11	0.09	0.10
CFA	0.10	1775.64	0.10	5068.43	0.42	0.04	0.67	0.09	0.11	0.09	0.10
CFB	0.07	115.92	0.09	321.18	0.72	-0.24	0.47	0.03	0.14	0.06	0.13
CFC	0.07	813.05	0.09	2361.53	1.44	-0.18	0.15	0.06	0.09	0.08	0.10
CFD	0.11	85.56	0.06	255.69	1.11	0.68	0.27	0.05	0.20	0.04	0.10
2B	0.04	53.67	0.03	152.84	0.15	0.14	0.88	0.00	0.13	0.01	0.08
2C	0.06	66.33	0.08	187.38	0.54	-0.25	0.59	0.02	0.15	0.04	0.13
3B	0.16	154.14	0.17	438.29	0.18	-0.04	0.86	0.10	0.24	0.13	0.21
3C	0.09	443.64	0.06	1246.57	1.80	0.46	0.07	0.07	0.13	0.05	0.08
3D	0.06	16.06	0.12	45.82	0.76	-0.50	0.44	0.00	0.35	0.04	0.27
3E	0.13	418.86	0.14	1217.35	0.81	-0.12	0.42	0.10	0.17	0.12	0.17
3F	0.08	110.61	0.08	280.49	0.04	0.02	0.97	0.04	0.15	0.05	0.12
3G	0.07	24.58	0.05	66.04	0.48	0.64	0.63	0.00	0.26	0.01	0.13
Approach section											
<i>Primary</i>											
CFA	0.07	55.18	0.05	158.53	0.55	0.44	0.59	0.02	0.19	0.02	0.10
CFB	0.71	2.80	0.14	7.30	1.10	4.21	0.27	0.09	2.58	0.00	0.76
CFC	0.04	26.27	0.04	76.08	0.03	-0.03	0.98	0.00	0.21	0.01	0.12
CFD	0.00	0.00	0.00	0.00	~	~	~	~	~	~	~
2B	0.00	0.00	0.00	0.00	~	~	~	~	~	~	~
2C	0.00	2.33	0.00	6.51	~	~	~	~	~	~	~
3B	0.00	0.63	0.00	1.20	~	~	~	~	~	~	~
3C	0.17	17.17	0.10	48.72	0.65	0.70	0.52	0.04	1.05	0.03	0.24
3D	0.00	0.47	0.00	1.37	~	~	~	~	~	~	~
3E	0.11	19.03	0.11	55.45	0.04	-0.03	0.97	0.01	0.38	0.04	0.24
3F	0.00	5.65	0.07	14.25	~	~	~	~	~	0.00	0.39
3G	0.00	0.94	0.00	2.61	~	~	~	~	~	~	~
All layouts	0.10	130.47	0.07	372.03	1.06	0.48	0.29	0.05	0.17	0.04	0.10
<i>Secondary</i>											
CFA	0.06	67.62	0.06	190.20	-0.11	-0.06	1.09	0.02	0.15	0.03	0.11
CFB	0.00	5.80	0.11	18.69	~	~	~	~	~	0.01	0.39
CFC	0.18	22.57	0.03	65.74	1.61	4.83	0.11	0.05	0.45	0.00	0.11
CFD	0.00	2.08	0.00	6.22	~	~	~	~	~	~	~
3E	0.00	0.99	1.35	2.97	~	~	~	~	~	0.28	3.45
All layouts	0.10	99.06	0.07	283.82	0.86	0.43	0.39	0.05	0.19	0.04	0.11
<i>Both directions</i>											
CFA	0.07	122.80	0.06	348.73	0.30	0.14	0.77	0.03	0.13	0.04	0.09
CFB	0.23	8.60	0.12	26.00	0.66	1.01	0.51	0.03	0.84	0.02	0.34
CFC	0.10	48.85	0.04	141.83	1.39	1.90	0.17	0.03	0.24	0.01	0.08
CFD	0.00	2.08	0.00	6.22	~	~	~	~	~	~	~
2B	0.00	0.00	0.00	0.00	~	~	~	~	~	~	~
2C	0.00	2.33	0.00	6.51	~	~	~	~	~	~	~
3B	0.00	0.63	0.00	1.20	~	~	~	~	~	~	~
3C	0.17	17.17	0.10	48.72	0.65	0.70	0.51	0.04	0.51	0.03	0.24
3D	0.00	0.47	0.00	1.37	~	~	~	~	~	~	~
3E	0.10	20.02	0.17	58.42	-0.80	-0.42	1.58	0.01	0.36	0.08	0.31
3F	0.00	5.65	0.07	14.25	~	~	~	~	~	0.00	0.39
3G	0.00	0.94	0.00	2.61	~	~	~	~	~	~	~
All layouts	0.10	229.53	0.07	655.85	1.27	0.43	0.21	0.06	0.15	0.05	0.09

~ Denotes that the subgroup had no accidents in the with and/or without road works period.
Table excludes truncated sites.

Continued

Table 3.5 (Continued) Statistical significance of the differences, between the with and without road works PIA rates

Type of traffic management	With road works		Without road works		z-Statistic	% change in accident rates as a result of road works	2-sided confidence level at which the difference is significant	With road works 95% confidence interval		Without road works 95% confidence interval	
	Mean PIA rate	Vehicle kilometres (millions)	3 year average EP PIA rate	Vehicle kilometres (millions)				Lower	Upper	Lower	Upper
Approach signed section											
<i>Primary</i>											
CFA	0.06	221.88	0.08	629.74	1.03	-0.25	0.30	0.03	0.11	0.06	0.11
CFB	0.06	16.95	0.09	46.72	0.37	-0.31	0.71	0.00	0.33	0.02	0.22
CFC	0.07	134.28	0.06	388.87	0.38	0.16	0.70	0.04	0.14	0.04	0.09
CFD	0.10	9.65	0.10	28.85	0.00	0.00	1.00	0.00	0.58	0.02	0.30
2B	0.00	15.18	0.02	43.01	~	~	~	~	~	0.00	0.13
2C	0.00	19.56	0.05	55.28	~	~	~	~	~	0.01	0.16
3B	0.11	55.80	0.18	158.02	1.26	-0.39	0.21	0.04	0.23	0.12	0.26
3C	0.11	144.09	0.05	403.65	1.97	1.13	0.05	0.06	0.18	0.03	0.08
3D	0.00	4.22	0.25	12.09	~	~	~	~	~	0.05	0.73
3E	0.12	112.49	0.11	326.09	0.06	0.02	0.95	0.06	0.20	0.08	0.16
3F	0.12	33.80	0.05	86.47	1.13	1.56	0.26	0.03	0.30	0.01	0.12
3G	0.15	6.56	0.06	17.75	0.59	1.71	0.55	0.00	0.85	0.00	0.31
All layouts	0.09	774.46	0.08	2196.52	0.16	0.02	0.88	0.07	0.11	0.07	0.10
<i>Secondary</i>											
CFA	0.12	216.43	0.10	617.13	0.57	0.15	0.57	0.07	0.17	0.08	0.13
CFB	0.07	14.97	0.07	41.75	-0.06	-0.07	1.05	0.00	0.37	0.01	0.21
CFC	0.07	136.28	0.06	396.94	0.22	0.09	0.82	0.03	0.13	0.04	0.09
CFD	0.08	13.19	0.00	39.40	~	~	~	0.00	0.42	~	~
3E	0.31	3.25	0.43	9.35	-0.32	-0.28	1.25	0.01	1.72	0.12	1.10
All layouts	0.10	384.12	0.08	1104.56	0.67	0.14	0.50	0.07	0.13	0.07	0.10
<i>Both directions</i>											
CFA	0.09	438.31	0.09	1246.87	-0.20	-0.04	1.16	0.06	0.12	0.08	0.11
CFB	0.06	31.92	0.08	88.47	-0.31	-0.21	1.24	0.00	0.23	0.03	0.16
CFC	0.07	270.57	0.06	785.81	0.43	0.13	0.67	0.04	0.11	0.05	0.08
CFD	0.09	22.84	0.04	68.25	0.65	0.99	0.51	0.01	0.32	0.01	0.13
2B	0.00	15.18	0.02	43.01	~	~	~	~	~	0.00	0.13
2C	0.00	19.56	0.05	55.28	~	~	~	~	~	0.01	0.16
3B	0.11	55.80	0.18	158.02	-1.28	-0.39	1.80	0.04	0.23	0.12	0.26
3C	0.11	144.09	0.05	403.65	1.98	1.13	0.05	0.06	0.18	0.03	0.08
3D	0.00	4.22	0.25	12.09	~	~	~	~	~	0.05	0.73
3E	0.12	115.74	0.12	335.44	-0.03	-0.01	1.03	0.07	0.20	0.09	0.17
3F	0.12	33.80	0.05	86.47	1.15	1.56	0.25	0.03	0.30	0.01	0.12
3G	0.15	6.56	0.06	17.75	0.59	1.71	0.55	0.00	0.85	0.00	0.31
All layouts	0.09	1158.57	0.08	3301.08	0.53	0.06	0.60	0.07	0.11	0.07	0.09

~ Denotes that the subgroup had no accidents in the with and/or without road works period.
Table excludes truncated sites.

Continued

Table 3.5 (Continued) Statistical significance of the differences, between the with and without road works PIA rates

Type of traffic management	With road works		Without road works		z-Statistic	% change in accident rates as a result of road works	2-sided confidence level at which the difference is significant	With road works 95% confidence interval		Without road works 95% confidence interval	
	Mean PIA rate	Vehicle kilometres (millions)	3 year average EP PIA rate	Vehicle kilometres (millions)				Lower	Upper	Lower	Upper
Approach restricted section											
<i>Primary</i>											
CFA	0.12	48.73	0.06	138.12	1.21	1.13	0.23	0.05	0.27	0.03	0.11
CFB	0.00	3.43	0.00	9.42	~	~	~	~	~	~	~
CFC	0.34	14.60	0.24	42.27	0.62	0.45	0.53	0.11	0.80	0.11	0.44
CFD	0.49	6.07	0.17	18.16	1.09	1.99	0.27	0.10	1.44	0.03	0.48
2B	0.22	4.62	0.15	13.13	0.27	0.42	0.79	0.01	1.21	0.02	0.55
2C	0.42	2.41	0.15	6.88	0.62	1.86	0.54	0.01	2.31	0.00	0.81
3B	0.34	2.91	0.41	7.34	-0.16	-0.16	1.13	0.01	1.91	0.08	1.19
3C	0.18	22.51	0.11	61.78	0.66	0.57	0.51	0.05	0.45	0.05	0.23
3D	0.00	1.01	0.00	2.88	~	~	~	~	~	~	~
3E	0.11	8.83	0.12	25.73	-0.03	-0.03	1.02	0.00	~	0.02	0.34
3F	0.22	4.59	0.00	12.53	~	~	~	0.01	1.21	~	~
3G	0.00	1.75	0.00	4.73	~	~	~	~	~	~	~
All layouts	0.19	121.47	0.11	342.96	1.89	0.76	0.06	0.12	0.28	0.08	0.15
<i>Secondary</i>											
CFA	0.04	24.54	0.14	70.37	-1.69	-0.71	1.91	0.00	0.23	0.06	0.25
CFB	0.00	3.37	0.00	9.30	~	~	~	~	~	~	~
CFC	0.10	10.44	0.10	30.41	-0.03	-0.03	1.02	0.00	0.53	0.02	0.29
CFD	0.00	0.82	0.00	2.45	~	~	~	~	~	~	~
3E	0.00	0.43	0.00	1.24	~	~	~	~	~	~	~
All layouts	0.05	39.59	0.11	113.76	-1.35	-0.56	1.82	0.01	0.18	0.06	0.19
<i>Both directions</i>											
CFA	0.10	73.27	0.09	208.49	0.22	0.11	0.82	0.04	0.20	0.05	0.14
CFB	0.00	6.80	0.00	18.72	~	~	~	~	~	~	~
CFC	0.24	25.04	0.18	72.68	0.56	0.34	0.58	0.09	0.52	0.10	0.31
CFD	0.44	6.89	0.15	20.61	1.09	1.99	0.27	0.09	1.27	0.03	0.43
2B	0.22	4.62	0.15	13.13	0.27	0.42	0.79	0.01	1.21	0.02	0.55
2C	0.42	2.41	0.15	6.88	0.62	1.86	0.54	0.01	2.31	0.00	0.81
3B	0.34	2.91	0.41	7.34	-0.16	-0.16	1.13	0.01	1.91	0.08	1.19
3C	0.18	22.51	0.11	61.78	0.66	0.57	0.51	0.05	0.45	0.05	0.23
3D	0.00	1.01	0.00	2.88	~	~	~	~	~	~	~
3E	0.11	9.26	0.11	26.96	-0.03	-0.03	1.02	0.00	0.60	0.02	0.33
3F	0.22	4.59	0.00	12.53	~	~	~	0.01	1.21	~	~
3G	0.00	1.75	0.00	4.73	~	~	~	~	~	~	~
All layouts	0.16	161.06	0.11	456.72	1.39	0.45	0.16	0.10	0.23	0.08	0.14
<i>Primary</i>											
CFA	0.10	221.71	0.08	632.50	0.82	0.24	0.41	0.07	0.16	0.06	0.11
CFB	0.00	10.80	0.10	29.32	~	~	~	~	~	0.02	0.30
CFC	0.05	42.33	0.24	122.58	-3.58	-0.81	2.00	0.00	0.17	0.17	0.35
CFD	0.00	8.55	0.08	25.56	~	~	~	~	~	0.00	0.28
2B	0.00	14.08	0.03	40.09	~	~	~	~	~	0.00	0.14
2C	0.11	17.74	0.12	50.05	-0.08	-0.06	1.06	0.01	0.41	0.04	0.26
3B	0.34	35.15	0.14	104.60	1.88	1.38	0.06	0.18	0.60	0.08	0.24
3C	0.12	73.81	0.05	211.45	1.61	1.34	0.11	0.06	0.23	0.03	0.09
3D	0.00	4.37	0.16	12.37	~	~	~	~	~	0.01	0.58
3E	0.17	126.74	0.16	369.91	0.20	0.05	0.84	0.11	0.26	0.13	0.21
3F	0.13	22.55	0.06	54.04	0.95	1.40	0.34	0.03	0.39	0.01	0.16
3G	0.13	7.80	0.05	21.11	0.59	1.71	0.55	0.00	0.71	0.00	0.26
All layouts	0.13	585.62	0.11	1673.60	0.84	0.12	0.40	0.10	0.16	0.10	0.13

~ Denotes that the subgroup had no accidents in the with and/or without road works period.
Table excludes truncated sites.

Continued

Table 3.5 (Continued) Statistical significance of the differences, between the with and without road works PIA rates

Type of traffic management	With road works		Without road works		z-Statistic	% change in accident rates as a result of road works	2-sided confidence level at which the difference is significant	With road works 95% confidence interval		Without road works 95% confidence interval	
	Mean PIA rate	Vehicle kilometres (millions)	3 year average EP PIA rate	Vehicle kilometres (millions)				Lower	Upper	Lower	Upper
<i>Secondary</i>											
CFA	0.17	286.12	0.10	821.06		0.77	1.00	0.13	0.23	0.08	0.12
CFB	0.18	11.05	0.03	30.59	1.13	4.54	0.26	0.02	0.65	0.00	0.18
CFC	0.06	81.83	0.09	238.33	-0.81	-0.31	1.58	0.02	0.14	0.05	0.13
CFD	0.00	13.09	0.10	39.10	~	~	~	0.00	0.28	0.03	0.26
3E	0.52	3.82	0.55	10.99	-0.05	-0.04	1.04	0.03	1.89	0.20	1.19
All layouts	0.15	395.91	0.10	1140.07	2.33	0.50	0.02	0.11	0.19	0.08	0.12
<i>Both directions</i>											
CFA	0.14	507.83	0.09	1453.57	2.78	0.56	0.01	0.11	0.18	0.08	0.11
CFB	0.09	21.85	0.07	59.92	0.34	0.37	0.73	0.01	0.33	0.02	0.17
CFC	0.06	124.15	0.14	360.90	-2.94	-0.60	2.00	0.02	0.12	0.11	0.19
CFD	0.00	21.64	0.09	64.66	~	~	~	~	~	0.03	0.20
2B	0.00	14.08	0.03	40.09	~	~	~	~	~	0.00	0.14
2C	0.11	17.74	0.12	50.05	-0.08	-0.06	1.06	0.01	0.41	0.04	0.26
3B	0.34	35.15	0.14	104.60	1.88	1.38	0.06	0.18	0.60	0.08	0.24
3C	0.12	73.81	0.05	211.45	1.61	1.34	0.11	0.06	0.23	0.03	0.09
3D	0.00	4.37	0.16	12.37	~	~	~	~	~	0.01	0.58
3E	0.18	130.55	0.18	380.90	0.18	0.05	0.85	0.12	0.27	0.14	0.22
3F	0.13	22.55	0.06	54.04	0.95	1.40	0.34	0.03	0.39	0.01	0.16
3G	0.13	7.80	0.05	21.11	0.59	1.71	0.55	0.00	0.71	0.00	0.26
All layouts	0.14	981.53	0.11	2813.67	2.16	0.27	0.03	0.11	0.16	0.10	0.12
<i>After restricted section</i>											
<i>Primary</i>											
CFA	0.00	16.99	0.10	48.38	~	~	~	~	~	0.03	0.24
CFB	0.00	1.89	0.20	5.13	~	~	~	~	~	0.00	1.09
CFC	0.00	26.27	0.25	76.08	~	~	~	~	~	0.15	0.39
CFD	0.00	1.04	0.00	3.11	~	~	~	~	~	~	~
2B	0.00	0.96	0.00	2.72	~	~	~	~	~	~	~
2C	0.00	1.42	0.00	4.00	~	~	~	~	~	~	~
3B	0.00	2.98	0.12	8.36	~	~	~	~	~	0.00	0.67
3C	0.00	6.06	0.00	16.72	~	~	~	~	~	~	~
3D	0.00	0.30	0.00	0.86	~	~	~	~	~	~	~
3E	0.00	7.03	0.20	20.35	~	~	~	~	~	0.05	0.50
3F	0.00	2.34	0.00	6.07	~	~	~	~	~	~	~
3G	0.00	0.55	0.00	1.49	~	~	~	~	~	~	~
All layouts	0.00	67.85	0.16	193.26	~	~	~	~	~	0.10	0.22
<i>Secondary</i>											
CFA	0.15	20.19	0.21	57.96	-0.56	-0.28	1.43	0.03	0.43	0.11	0.36
CFB	0.00	1.38	0.00	3.83	~	~	~	~	~	~	~
CFC	0.00	9.88	0.07	28.76	~	~	~	~	~	0.01	0.25
CFD	3.66	0.82	0.00	2.45	~	~	~	0.76	10.70	~	~
3E	0.00	0.29	0.00	0.82	~	~	~	~	~	~	~
All layouts	0.18	32.54	0.15	93.82	0.41	0.24	0.68	0.07	0.40	0.08	0.25
<i>Both directions</i>											
CFA	0.08	37.18	0.16	106.34	-1.32	-0.50	1.81	0.02	0.24	0.09	0.26
CFB	0.00	3.27	0.11	8.95	~	~	~	~	~	0.00	0.62
CFC	0.00	36.15	0.20	104.85	~	~	~	~	~	0.12	0.31
CFD	1.61	1.86	0.00	5.56	~	~	~	0.33	4.72	~	~
2B	0.00	0.96	0.00	2.72	~	~	~	~	~	~	~
2C	0.00	1.42	0.00	4.00	~	~	~	~	~	~	~
3B	0.00	2.98	0.12	8.36	~	~	~	~	~	0.00	0.67
3C	0.00	6.06	0.00	16.72	~	~	~	~	~	~	~
3D	0.00	0.30	0.00	0.86	~	~	~	~	~	~	~
3E	0.00	7.32	0.19	21.17	~	~	~	~	~	0.05	0.48
3F	0.00	2.34	0.00	6.07	~	~	~	~	~	~	~
3G	0.00	0.55	0.00	1.49	~	~	~	~	~	~	~
All layouts	0.06	100.39	0.15	287.09	-2.81	-0.61	2.00	0.02	0.13	0.11	0.21

~ Denotes that the subgroup had no accidents in the with and/or without road works period.
Table excludes truncated sites.

Continued

Table 3.5 (Continued) Statistical significance of the differences, between the with and without road works PIA rates

Type of traffic management	With road works		Without road works		z-Statistic	% change in accident rates as a result of road works	2-sided confidence level at which the difference is significant	With road works 95% confidence interval		Without road works 95% confidence interval	
	Mean PIA rate	Vehicle kilometres (millions)	3 year average EP PIA rate	Vehicle kilometres (millions)				Lower	Upper	Lower	Upper
After signed section											
<i>Primary</i>											
CFA	0.07	14.01	0.00	39.88	~	~	~	0.00	0.40	~	~
CFB	0.00	0.36	1.01	0.99	~	~	~	~	~	0.03	5.63
CFC	0.00	2.92	0.00	8.45	~	~	~	~	~	~	~
CFD	0.00	0.26	0.00	0.78	~	~	~	~	~	~	~
2B	0.59	1.68	0.00	4.80	~	~	~	0.00	3.31	~	~
2C	0.00	1.10	0.00	3.16	~	~	~	~	~	~	~
3B	0.00	1.15	0.00	3.04	~	~	~	~	~	~	~
3C	0.00	3.11	0.00	8.46	~	~	~	~	~	~	~
3D	0.00	0.15	0.00	0.46	~	~	~	~	~	~	~
3E	0.00	5.33	0.19	15.45	~	~	~	~	~	0.04	0.57
3F	0.00	1.13	0.00	2.70	~	~	~	~	~	~	~
3G	0.00	0.16	0.00	0.43	~	~	~	~	~	~	~
All layouts	0.06	31.38	0.05	88.61	0.37	0.41	0.71	0.01	0.23	0.01	0.12
<i>Secondary</i>											
CFA	0.17	17.50	0.10	50.32	0.67	0.73	0.50	0.04	0.50	0.03	0.23
CFB	0.00	0.40	0.00	1.10	~	~	~	~	~	~	~
CFC	0.00	2.82	0.12	8.22	~	~	~	~	~	0.00	0.68
CFD	0.00	0.27	0.00	0.82	~	~	~	~	~	0.00	4.52
3E	0.00	0.24	1.46	0.69	~	~	~	~	~	0.04	8.11
All layouts	0.14	21.23	0.11	61.14	0.29	0.23	0.77	0.03	0.41	0.05	0.24
<i>Both directions</i>											
CFA	0.13	31.51	0.06	90.20	1.05	1.29	0.29	0.03	0.33	0.02	0.13
CFB	0.00	0.76	0.48	2.09	~	~	~	~	~	0.01	2.67
CFC	0.00	5.74	0.06	16.67	~	~	~	~	~	0.00	0.33
CFD	0.00	0.54	0.00	1.60	~	~	~	~	~	~	~
2B	0.59	1.68	0.00	4.80	~	~	~	0.00	3.31	~	~
2C	0.00	1.10	0.00	3.16	~	~	~	~	~	~	~
3B	0.00	1.15	0.00	3.04	~	~	~	~	~	~	~
3C	0.00	3.11	0.00	8.46	~	~	~	~	~	~	~
3D	0.00	0.15	0.00	0.46	~	~	~	~	~	~	~
3E	0.00	5.57	0.25	16.13	~	~	~	~	~	0.07	0.63
3F	0.00	1.13	0.00	2.70	~	~	~	~	~	~	~
3G	0.00	0.16	0.00	0.43	~	~	~	~	~	~	~
All layouts	0.10	52.61	0.07	149.75	0.45	0.29	0.65	0.03	0.22	0.04	0.13
After section											
<i>Primary</i>											
CFA	0.08	294.67	0.10	837.86	-1.01	-0.20	1.69	0.05	0.12	0.08	0.13
CFB	0.10	20.97	0.16	57.42	-0.73	-0.39	1.54	0.01	0.34	0.07	0.30
CFC	0.09	145.96	0.10	422.69	-0.44	-0.12	1.34	0.05	0.15	0.07	0.14
CFD	0.00	14.42	0.00	43.12	~	~	~	~	~	~	~
2B	0.00	17.16	0.02	49.09	~	~	~	~	~	0.00	0.11
2C	0.05	21.77	0.07	61.51	-0.34	-0.29	1.27	0.00	0.26	0.02	0.17
3B	0.11	55.51	0.17	155.74	-1.19	-0.38	1.77	0.04	0.24	0.11	0.25
3C	0.05	176.89	0.07	495.79	-1.05	-0.30	1.71	0.02	0.10	0.05	0.10
3D	0.18	5.53	0.06	15.78	0.61	1.85	0.54	0.00	1.01	0.00	0.35
3E	0.09	124.14	0.11	360.43	-0.53	-0.16	1.41	0.04	0.16	0.07	0.14
3F	0.02	40.55	0.12	104.43	-2.47	-0.80	1.99	0.00	0.14	0.07	0.21
3G	0.00	6.83	0.00	17.92	~	~	~	~	~	~	~
All layouts	0.07	924.40	0.10	2621.79	-2.24	-0.24	1.97	0.06	0.09	0.09	0.11

~ Denotes that the subgroup had no accidents in the with and/or without road works period.
Table excludes truncated sites.

Continued

Table 3.5 (Continued) Statistical significance of the differences, between the with and without road works PIA rates

Type of traffic management	With road works		Without road works		z-Statistic	% change in accident rates as a result of road works	2-sided confidence level at which the difference is significant	With road works		Without road works	
	Mean PIA rate	Vehicle kilometres (millions)	3 year average EP PIA rate	Vehicle kilometres (millions)				95% confidence interval		95% confidence interval	
								Lower	Upper	Lower	Upper
<i>Secondary</i>											
CFA	0.07	270.08	0.12	776.37	-2.50	-0.43	1.99	0.04	0.11	0.09	0.14
CFB	0.00	21.75	0.07	59.62	~	~	~	~	~	0.02	0.17
CFC	0.06	156.60	0.07	456.11	-0.08	-0.03	1.07	0.03	0.12	0.04	0.09
CFD	0.00	15.29	0.07	45.68	~	~	~	~	~	0.01	0.19
3E	0.16	6.26	0.40	17.59	-1.10	-0.60	1.73	~	~	0.16	0.82
All layouts	0.06	469.98	0.10	1355.36	-2.98	-0.42	2.00	0.04	0.08	0.08	0.12
<i>Both directions</i>											
CFA	0.07	564.75	0.11	1614.23	-2.43	-0.31	1.99	0.05	0.10	0.09	0.13
CFB	0.05	42.72	0.11	117.04	-1.45	-0.58	1.85	0.00	0.17	0.06	0.19
CFC	0.08	302.56	0.08	878.79	-0.38	-0.08	1.30	0.05	0.11	0.07	0.10
CFD	0.03	29.72	0.05	88.80	-0.28	-0.25	1.22	0.00	0.19	0.01	0.12
2B	0.00	17.16	0.02	49.09	~	~	~	~	~	0.00	0.11
2C	0.05	21.77	0.07	61.51	-0.34	-0.29	1.27	0.00	0.26	0.02	0.17
3B	0.11	55.51	0.17	155.74	-1.19	-0.38	1.77	0.04	0.24	0.11	0.25
3C	0.05	176.89	0.07	495.79	-1.05	-0.30	1.71	0.02	0.10	0.05	0.10
3D	0.18	5.53	0.06	15.78	0.61	1.85	0.54	0.00	1.01	0.00	0.35
3E	0.09	130.40	0.12	378.02	-0.85	-0.23	1.60	0.05	0.16	0.09	0.16
3F	0.02	40.55	0.12	104.43	-2.47	-0.80	1.99	0.00	0.14	0.07	0.21
3G	0.00	6.83	0.00	17.92	~	~	~	~	~	~	~
All layouts	0.07	1394.38	0.10	3977.15	-3.51	-0.30	2.00	0.06	0.08	0.09	0.11
<i>Approach and after section</i>											
<i>Primary</i>											
CFA	0.08	349.85	0.09	996.39	-0.75	-0.14	1.54	0.05	0.12	0.08	0.11
CFB	0.17	23.77	0.15	64.73	0.14	0.09	0.89	0.04	0.43	0.07	0.28
CFC	0.08	172.23	0.09	498.77	-0.43	-0.12	1.33	0.04	0.14	0.07	0.12
CFD	0.07	14.42	0.02	43.12	0.63	1.99	0.53	0.00	0.39	0.00	0.13
2B	0.00	17.16	0.02	49.09	~	~	~	~	~	0.00	0.11
2C	0.04	24.10	0.06	68.01	-0.34	-0.29	1.27	0.00	0.23	0.02	0.15
3B	0.11	56.14	0.17	156.93	-1.21	-0.38	1.77	0.04	0.23	0.11	0.25
3C	0.06	194.06	0.08	544.51	-0.64	-0.18	1.48	0.03	0.11	0.05	0.10
3D	0.17	6.00	0.06	17.16	0.62	1.86	0.54	0.00	0.93	0.00	0.32
3E	0.09	143.17	0.11	415.89	-0.51	-0.14	1.39	0.05	0.16	0.08	0.14
3F	0.02	46.20	0.12	118.68	-2.65	-0.82	1.99	0.00	0.12	0.06	0.20
3G	0.00	7.77	0.05	20.53	~	~	~	~	~	0.00	0.27
All layouts	0.08	1054.88	0.09	2993.81	-1.75	-0.19	1.92	0.06	0.09	0.08	0.11
<i>Secondary</i>											
CFA	0.07	337.69	0.11	966.57	-2.34	-0.38	1.98	0.04	0.10	0.09	0.13
CFB	0.00	27.55	0.08	78.31	~	~	~	~	~	0.03	0.17
CFC	0.08	179.17	0.06	521.85	0.72	0.27	0.47	0.04	0.13	0.04	0.09
CFD	0.00	17.38	0.06	51.90	~	~	~	~	~	0.01	0.17
3E	0.14	7.25	0.53	20.86	-1.87	-0.74	1.94	0.00	0.77	0.26	0.94
All layouts	0.07	569.04	0.10	1639.49	-2.21	-0.30	1.97	0.05	0.09	0.08	0.11
<i>Both directions</i>											
CFA	0.07	687.54	0.10	1962.96	-2.15	-0.27	1.97	0.05	0.10	0.09	0.11
CFB	0.08	51.32	0.11	143.04	-0.72	-0.30	1.53	0.02	0.20	0.06	0.18
CFC	0.08	351.41	0.08	1020.62	0.19	0.04	0.85	0.05	0.12	0.06	0.10
CFD	0.03	31.80	0.04	95.02	-0.28	-0.25	1.22	0.00	0.18	0.01	0.11
2B	0.00	17.16	0.02	49.09	~	~	~	~	~	0.00	0.11
2C	0.04	24.10	0.06	68.01	-0.34	-0.29	1.27	0.00	0.23	0.02	0.15
3B	0.11	56.14	0.17	156.93	-1.21	-0.38	1.77	0.04	0.23	0.11	0.25
3C	0.06	194.06	0.08	544.51	-0.64	-0.18	1.48	0.03	0.11	0.05	0.10
3D	0.17	6.00	0.06	17.16	0.62	1.86	0.54	0.00	0.93	0.00	0.32
3E	0.09	150.42	0.13	436.75	-1.10	-0.26	1.73	0.05	0.16	0.09	0.16
3F	0.02	46.20	0.12	118.68	-2.63	-0.82	1.99	0.00	0.12	0.06	0.19
3G	0.00	7.77	0.05	20.53	~	~	~	~	~	0.00	0.27
All layouts	0.07	1623.91	0.09	4633.31	-2.62	-0.22	1.99	0.06	0.09	0.09	0.10

~ Denotes that the subgroup had no accidents in the with and/or without road works period.
Table excludes truncated sites.

Table 3.6 Ratios of PIA rates, by section

Type of traffic management	Approach section	Approach signed zone	Approach restricted zone	Central section	After restricted zone	After signed zone	After section	Approach ¹ and after
Primary								
CFA	<i>*[1.44]</i>	0.75	2.12	1.24	–	–	0.80	0.86
CFB	<i>*[5.21]</i>	<i>*[0.69]</i>	–	–	–	–	<i>*[0.61]</i>	<i>*[1.09]</i>
CFC	<i>*[0.97]</i>	1.16	<i>*[1.45]</i>	<i>*[0.19]</i>	–	–	0.87	0.88
CFD	–	<i>*[1.00]</i>	<i>*[2.99]</i>	–	–	–	<i>*[2.99]</i>	<i>*[3.00]</i>
2B	–	–	<i>*[1.42]</i>	–	–	–	–	–
2C	–	–	<i>*[2.86]</i>	<i>*[0.94]</i>	–	–	<i>*[0.71]</i>	<i>*[0.71]</i>
3B	–	0.61	<i>*[0.84]</i>	2.38	–	–	0.62	0.62
3C	<i>*[1.70]</i>	2.13	<i>*[1.58]</i>	2.35	–	–	0.70	0.82
3D	–	–	–	–	–	–	<i>*[2.85]</i>	<i>*[2.86]</i>
3E	<i>*[0.97]</i>	1.02	<i>*[0.97]</i>	1.05	–	–	0.84	0.86
3F	–	<i>*[2.57]</i>	–	<i>*[2.38]</i>	–	–	<i>*[0.20]</i>	<i>*[0.19]</i>
3G	–	<i>*[2.73]</i>	–	<i>*[2.72]</i>	–	–	–	–
All layouts	1.48	1.02	1.76	1.12	–	<i>*[1.41]</i>	0.74	0.81
Secondary								
CFA	<i>*[0.94]</i>	1.15	<i>*[0.29]</i>	1.77	<i>*[0.72]</i>	<i>*[1.73]</i>	0.57	0.62
CFB	–	<i>*[0.93]</i>	–	<i>*[5.48]</i>	–	–	–	–
CFC	<i>*[5.83]</i>	1.09	<i>*[0.97]</i>	0.69	–	–	0.97	1.27
CFD	–	–	–	–	–	–	–	–
3E	–	<i>*[0.71]</i>	–	<i>*[0.96]</i>	–	–	<i>*[0.40]</i>	<i>*[0.26]</i>
<i>All other non contra-flow layout types (2B, 2C, 3B, 3C, 3D, 3F and 3G) do not have a secondary direction.</i>								
All layouts	1.43	1.14	<i>*[0.44]</i>	1.50	<i>*[1.24]</i>	<i>*[1.23]</i>	0.58	0.69
Both directions								
CFA	1.14	0.97	1.12	1.57	<i>*[0.51]</i>	<i>*[2.31]</i>	0.69	0.74
CFB	<i>*[2.01]</i>	<i>*[0.80]</i>	–	<i>*[1.37]</i>	–	–	<i>*[0.42]</i>	<i>*[0.70]</i>
CFC	<i>*[2.9]</i>	1.13	<i>*[1.34]</i>	0.40	–	–	0.92	1.04
CFD	–	<i>*[2.00]</i>	<i>*[2.98]</i>	–	–	–	<i>*[0.75]</i>	<i>*[0.74]</i>
2B	–	–	<i>*[1.42]</i>	–	–	–	–	–
2C	–	–	<i>*[2.86]</i>	<i>*[0.94]</i>	–	–	<i>*[0.71]</i>	<i>*[0.71]</i>
3B	–	0.61	<i>*[0.84]</i>	2.38	–	–	0.62	0.62
3C	<i>*[1.70]</i>	2.13	<i>*[1.58]</i>	2.35	–	–	0.70	0.82
3D	–	–	–	–	–	–	<i>*[2.85]</i>	<i>*[2.86]</i>
3E	<i>*[0.58]</i>	0.99	<i>*[0.97]</i>	1.05	–	–	0.77	0.74
3F	–	<i>*[2.57]</i>	–	<i>*[2.38]</i>	–	–	<i>*[0.20]</i>	<i>*[0.19]</i>
3G	–	<i>*[2.73]</i>	–	<i>*[2.72]</i>	–	–	–	–
All layouts	1.43	1.06	1.45	1.27	0.39	<i>*[1.29]</i>	0.70	0.77

¹ Ratio is defined as the PIA rate with road works divided by the PIA rate without road works.

² See Figure 2 for definitions of the traffic management layout.

³ See Figure 3 for definitions of sections.

* Figures shown in italics (in brackets) are derived from samples with less than 30 million vehicle - kilometres and / or less than 5 personal injury accidents during the works period, or an average of 5 personal injury accidents over the previous 3 years.

Table 3.7 PIA rate ratios for use in QUADRO

		<i>Classification: Motorways</i>						
			95% confidence level lower	Works direction (primary)	95% confidence level upper	95% confidence level lower	Direction without works (secondary)	95% confidence level upper
Site Length Rate ratio								
Number of PIAs	With road works			74			59	
	Without road works	Aggregate		188			113	
		<i>Prev. 1</i>		61			47	
		<i>Prev. 2</i>		68			28	
		<i>Prev. 3</i>		59			38	
Vehicle - kilometres (millions)	With road works			583.09			390.55	
	Without road works	Aggregate		1664.53			1128.84	
		<i>Prev. 1</i>		578.69			387.66	
		<i>Prev. 2</i>		564.15			379.70	
		<i>Prev. 3</i>		521.69			361.48	
PIA rate	With road works		0.10	0.13	0.16	0.11	0.15	0.19
	Without road works	Average 3 year EP	0.10	0.11	0.13	0.08	0.10	0.12
		<i>Prev. 1</i>		0.11			0.12	
		<i>Prev. 2</i>		0.12			0.07	
		<i>Prev. 3</i>		0.11			0.11	
Site Length Rate Ratio				1.12			1.51	
<i>(Study site length rate (PIA/mvkm))</i>				0.11			0.15	
QUADRO site length rate (PIA/mvkm)				0.13			0.15	
Site Presence Rate Ratio								
Number of PIAs	With road works			172			85	
	Without road works	Aggregate		537			281	
		<i>Prev. 1</i>		188			103	
		<i>Prev. 2</i>		186			96	
		<i>Prev. 3</i>		163			82	
Vehicle - kilometres (millions)	With road works			2032.30			1025.00	
	Without road works	Aggregate		5749.32			2966.30	
		<i>Prev. 1</i>		2025.23			1018.56	
		<i>Prev. 2</i>		1951.72			996.34	
		<i>Prev. 3</i>		1772.38			951.40	
PIA rate	With road works		0.072	0.085	0.098	0.066	0.083	0.103
	Without road works	Average 3 year EP	0.086	0.093	0.102	0.084	0.095	0.106
		<i>Prev. 1</i>		0.093			0.101	
		<i>Prev. 2</i>		0.095			0.096	
		<i>Prev. 3</i>		0.092			0.086	
Site Presence Rate ratio				0.91			0.88	
<i>(Study Site Presence Rate (PIA/mv))</i>				-0.11			-0.15	
QUADRO Site Presence Rate (PIA/mv)				-0.11			-0.14	

*Primary and Secondary directions are those with the works and without works respectively. Truncated sites have been excluded.
Study Site Length Rate and Study Site Presence Rate are calculated using overall without road works PIA rates from the study sample.
Site Length Rate is based on the central section.
Site Presence Rate is based on the Whole Site excluding the Central Section.*

3.5 PIA risk factors

3.5.1 PIA rates in daylight and darkness

The analysis of the PIA rate by lighting condition required the proportions of the daily traffic flow which occurred during darkness and daylight. Darkness was defined as the period from half an hour after sunset to half an hour before sunrise.

Figure 5 shows the ratio of the daily traffic flow which occurred during darkness for each month of the year for a sample of three sites in the study. An average of this ratio was then calculated for each month and the proportion of the traffic flow in darkness was estimated for the period of the works for each site in the study. The proportion of the traffic flow in darkness ranged from 15 per cent for works in the summer months to 53% for works that took place in November and December. The figure for those sites that lasted 12 months was 31%.

Table 3.8 outlines the numbers and rates of PIAs in daylight and darkness. For the whole site, all layouts, the proportions of PIAs in daylight are similar (76% and 73% for with and without road works respectively). The proportion is also similar to the National figure of 72% for all motorways (Department for Transport, 2002a). The 'with' road works figure for the present study is also similar to those obtained in the 1982 and 1987 studies (77% and 78% respectively). The figure for the previous study in 1992 was 70%. No significant difference was observed between the works and without works PIA rates for both daylight and darkness conditions.

3.5.2 PIA severity, casualty severity and PIA costs

Accidents involving personal injury often have more than one casualty. The severity of a personal injury accident is classified by the highest category of casualty severity that occurred as a result of the incident.

3.5.2.1 PIA severity

Table 3.9 shows the severity of PIAs (number and percentage) in the works and without works periods,

together with the latest National average. The results show that the distribution of severity classification for the works and without works period is similar to that of the National figures.

When comparing the works and without works figures it can be seen that there is a reduction of approximately 17% in the number of Killed or Seriously injured accidents (KSI = Fatal + Serious accidents) and an increase of 11% in the number of slight accidents. This is suspected to be due to the lower average speed of traffic travelling through works.

3.5.2.2 Casualty severity

Table 3.10 shows the number and classification of casualties per personal injury accident for the works and without works periods, together with the National statistics. The results show that the without works and National figures are comparable. However, the effect of the presence of road works appears to reduce the likelihood of a fatal and/or serious casualty in an accident. This finding is in keeping with accident severity figures.

Table 3.11 shows the distribution of casualty severity by road user type. The results show that comparing PIAs at works and the non-works situation, there was a 27% decrease in Driver/Rider Fatal and Serious injury casualties. There was also a 3% decrease in both Passenger and Pedestrian Fatal and Serious Driver/Rider casualties. The percentage of Fatal and Serious Driver/Rider casualties was higher than the National average in the both the works and without works periods.

3.5.2.3 PIA costs

The values for the prevention of fatal, serious and slight injury accidents include the following elements of cost:

- Loss of output due to injury.
- Ambulance costs and cost of hospital treatment.

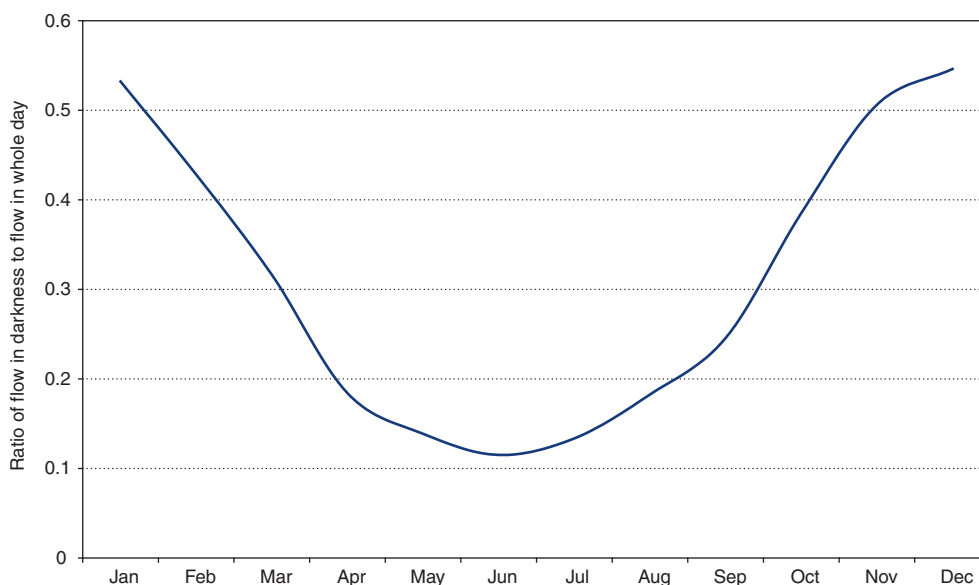


Figure 5 Proportion of daily flow occurring in darkness

Table 3.8 Numbers and rates of PIAs in daylight and darkness

	<i>Daylight (whole site, all layouts)</i>	<i>Darkness (whole site, all layouts)</i>	<i>All lighting conditions</i>
Number of PIAs			
With road works	321 [145]	102 [61]	423 [206] ¹
Without road works	862	325	1187
Aggregate			
<i>Prev. 1</i>	309	113	422
<i>Prev. 2</i>	295	107	402
<i>Prev. 3</i>	258	105	363
Percentage of total			
With road works	76% [70%]	24% [30%]	100%
Without road works	73%	27%	100%
Aggregate			
<i>Prev. 1</i>	73%	27%	100%
<i>Prev. 2</i>	73%	27%	100%
<i>Prev. 3</i>	71%	29%	100%
All motorways ²	72%	28%	100%
Vehicle kilometres (millions)			
With road works	2881.34	1294.51	4175.85
Without road works	8280.08	3720.03	12000.11
Aggregate			
<i>Prev. 1</i>	2840.84	1276.32	4117.16
<i>Prev. 2</i>	2797.02	1256.63	4053.65
<i>Prev. 3</i>	2642.22	1187.08	3829.30
PIA per million vehicle kilometres			
With road works	0.111	0.079	0.101
Without road works	0.104	0.087	0.099
Average 3 year equivalent works period			

¹ The figures in square brackets [] are the results of the 1992 study (TRL Project Report PR81).

² Source: Road Casualties Great Britain 2002. Table 17. The Stationery Office. October 2003.

Table 3.9 Numbers of PIAs and percentage of total by PIA severity class

	<i>Number of PIAs</i>			<i>Total number of PIA</i>
	<i>Fatal</i>	<i>Serious</i>	<i>Slight</i>	
Number of PIAs				
With road works	5 [0]	40 [28]	378 [178]	423 [206]
Without road works				
Aggregate	30	133	1023	1187
<i>Prev. 1</i>	12	53	357	422
<i>Prev. 2</i>	9	38	355	402
<i>Prev. 3</i>	10	42	311	363
Percentage of total				
With road works	1.18% [-]	9.46% [14%]	89.36% [86%]	100% [100%]
Without road works				
Aggregate	3%	11%	86%	100%
<i>Prev. 1</i>	3%	13%	85%	100%
<i>Prev. 2</i>	2%	9%	88%	100%
<i>Prev. 3</i>	3%	12%	86%	100%
Number of PIAs				
All motorways (GB) ¹	175	987	7,780	8,942
Percentage of total				
	2%	11%	87%	100%

The figures in square brackets [] are the results of the 1992 study (TRL Project Report PR81).

¹ Source: Road Casualties Great Britain 2002 (Table 3 Accidents and accident rates: by road type and severity: Average 1994-98, 1995-2002).

Table 3.10 Number of casualties per PIA by casualty severity

	<i>Fatal injury</i>		<i>Serious injury</i>		<i>Slight injury</i>		<i>All casualties</i>	
	<i>Number of casualties</i>	<i>Number of casualties per PIA</i>	<i>Number of casualties</i>	<i>Number of casualties per PIA</i>	<i>Number of casualties</i>	<i>Number of casualties per PIA</i>	<i>Number of casualties</i>	<i>Number of casualties per PIA</i>
At road works	5 [0]	0.01 [-]	51 [47]	0.12 [0.23]	638 [252]	1.51 [1.22]	694 [299]	1.64 [1.45]
Without road works								
Aggregate	33	0.03	175	0.15	1662	1.40	1870	1.58
<i>Prev. 1</i>	13	0.03	70	0.17	586	1.39	669	1.59
<i>Prev. 2</i>	9	0.02	48	0.12	536	1.33	593	1.48
<i>Prev. 3</i>	11	0.03	57	0.15	540	1.49	608	1.68
All motorways ¹	224	0.03	1,283	0.14	12,763	1.43	14,270	1.60

¹ Source: Road Casualty Great Britain 2002 (Tables 3 and 4c), Department for Transport.

Table 3.11 Casualty frequency by casualty severity and person type

	<i>Fatal and serious injury</i>						<i>Slight injury</i>			<i>All injuries</i>			
	<i>Driver/rider</i>		<i>Passenger</i>		<i>Pedestrian</i>		<i>Driver /rider</i>	<i>Passenger</i>	<i>Pedestrian</i>	<i>Driver /rider</i>		<i>Passenger</i>	<i>Pedestrian</i>
	<i>F</i>	<i>S</i>	<i>F</i>	<i>S</i>	<i>F</i>	<i>S</i>				<i>F</i>	<i>S</i>		
	<i>F</i>	<i>S</i>	<i>F</i>	<i>S</i>	<i>F</i>	<i>S</i>	<i>F</i>	<i>S</i>	<i>F</i>	<i>S</i>	<i>F</i>	<i>S</i>	
Number of casualties													
With road works	4	31	1	16	0	4	408	230	0	443	247	4	
Without road works													
Aggregate	21	122	7	49	5	4	1072	583	7	1215	639	16	
<i>Prev. 1</i>	9	47	3	22	1	1	388	194	4	444	219	6	
<i>Prev. 2</i>	6	39	1	7	2	2	365	169	2	410	177	6	
<i>Prev. 3</i>	6	36	3	20	2	1	319	220	1	361	243	4	
Percentage of total injury type													
With road works	63%		30%		7%		64%	36%	–	63.8%	35.6%	0.6%	
Without road works	69%		27%		4%		65%	35%	0%	65%	34%	1%	
Aggregate													
<i>Prev. 1</i>	67%		30%		2%		66%	33%	1%	66%	33%	1%	
<i>Prev. 2</i>	79%		14%		7%		68%	32%	0%	69%	30%	1%	
<i>Prev. 3</i>	62%		34%		4%		59%	41%	0%	59%	40%	1%	
Percentage of all road users accounted for by driver/rider													
Motorways (GB) ¹	58%		–		–		–	–	–	60%	–	–	

¹ Source: Road Casualty Great Britain 2002 (Table 8 Casualty rates: by road user type and severity: 1992 - 2002).

- Human costs, based on Willingness To Pay values, which represent grief, pain and suffering to the casualty, relatives and friends, and, for fatal accidents, the intrinsic loss of enjoyment of life over and above the consumption of goods and services.
- Damage to vehicles and property.
- Police and the administrative costs of accident insurance.

The cost of a PIA is larger than the cost of a casualty as on average there is more than one casualty in any given PIA.

The costs associated with PIAs used in this study have been extracted from the latest Highways Economic Note No. 1 (October 2003) and are based on 2002 national data. Cost estimates are given for June 2002 prices and values. As the majority of the sample is based within this financial year the figures have been directly taken from Table 4a which are as follows:

Cost of a Motorway Fatal PIA	=	£1,698,940
Cost of a Motorway Serious PIA	=	£190,740
Cost of a Motorway Slight PIA	=	£21,990

These figures were used to calculate the mean total cost of PIAs per site in the works period, which equates to £842,639. The same cost figure for the without works period was £1,135,499. Therefore, the presence of road works resulted in a reduction in cost of £292,860.

Table 3.12 shows the costs associated with each traffic management layout monitored in the study. However, due to the small number of phases monitored for certain traffic management types, and the lack of consistent change in cost within types, little significance can be given to these results.

3.5.3 Effect of road surface condition

The road surface condition at the time of each PIA in the works and without works periods is shown in Table 3.13. 66% of the road works accidents occurred under dry road surface conditions. This figure is between the without works period (61%) and the National average (71%) and suggests that the road surface condition does not contribute to additional PIAs at road works.

3.5.4 Effect of weather conditions

The weather conditions at the time of the PIA for the works and without works PIA figures are shown in Table 3.14. The percentage of PIAs that occur in fine conditions is similar for the works and without works periods. The figures are also similar to the National average.

3.5.5 PIA types

This road works accident study has covered a wide range of road work sites and the sample is felt to be more representative than in previous studies. As a result the classification of PIA types has been changed to enable the additional detail obtained, such as junction PIAs, to be analysed. The new PIA categories and results are shown in Table 3.15.

The results show that the majority of the PIAs fall within 3 accident categories Multiple Shunt (53% with works, 54% without works), Multiple Vehicle [Lane Changing Error] (22% with, 20% without) and Single Vehicle [hit other object] (8% with, 13% without). The 1992 study showed a 30% increase in shunt PIAs when comparing with (48%) and without (18%) works period. This finding was

Table 3.12 Change in PIA costs, with and without road works by traffic management type

<i>TM type</i>	<i>Site No.</i>	<i>Phase</i>	<i>Works</i>	<i>Prev. 1</i>	<i>Prev. 2</i>	<i>Prev. 3</i>	<i>Average 3 year EP</i>	<i>Change in average cost (£)</i>	<i>% change in cost (as a result of road works)</i>
2B	11	1	43980	21990	43980	43980	36650 <i>Average 2B</i>	7,330 7,330	20%
2C	6	4	256710	1977640	491430	21990	830353 <i>Average 2C</i>	-573,643 -573,643	-69%
3B	29	1	542580	2498230	2835730	3173230	2835730 <i>Average 3B</i>	-2,293,150 -2,293,150	-81%
3B/3C	8	5	0	190740	0	21990	70910	-70,910	-100%
3B/3C	9	2	21990	43980	0	0	14660	7,330	50%
3B/3C	21	1	388650	234720	87960	0	107560 <i>Average 3B/3C</i>	281,090 72,503	261%
3B/3E	16	1	21990	190740	43980	87960	107560 <i>Average 3B/3E</i>	-85,570 -85,570	-80%
3B/3F	8	6	21990	0	0	0	0	21,990	-
3B/3F	9	4	0	0	0	0	0 <i>Average 3B/3F</i>	0 10,995	-
3C	1	3	2476240	2263510	601380	1852870	1572587	903,653	57%
3C	7	1	43980	3720560	153930	491430	1455307	-1,411,327	-97%
3C	9	1	21990	131940	190740	43980	122220	-100,230	-82%
3C	10	1	256710	190740	0	0	63580	193,130	304%
3C	17	2	0	0	0	234720	78240	-78,240	-100%
3C	22	12	0	0	0	0	0	0	-
3C	24	1	0	0	21990	0	7330 <i>Average 3C</i>	-7,330 -71,478	-100%
3C/3B	8	1	0	0	0	0	0	0	-
3C/3B	10	2	1720930	0	0	0	0	1,720,930	-
3C/3B	21	2	300690	21990	3632600	0	1218197 <i>Average 3C/3B</i>	-917,507 267,808	-75%
3C/3F	24	2	0	21990	0	21990	14660	-14,660	-100%
3C/3F	26	4	0	0	21990	0	7330 <i>Average 3C/3F</i>	-7,330 -10,995	-100%
3D	3	1	0	0	0	0	0	0	-
3D	12	1	0	21990	0	0	7330	-7,330	-100%
3D	17	2	0	0	0	0	0	0	-
3D	27	1	0	0	0	0	0 <i>Average 3D</i>	0 -1,833	-
3D/3B	8	4	0	0	0	0	0 <i>Average 3D/3B</i>	0 0	-
3E	2	2	278700	256710	278700	109950	215120	63,580	30%
3E	4	1	373830	395820	454620	410640	420360	-46,530	-11%
3E	5	1	0	0	0	0	0	0	-
3E	12	6	21990	0	0	0	0	21,990	-
3E	13	4	1808890	43980	65970	65970	58640	1,750,250	2985%
3E	18	2	300690	21990	1896850	322680	747173	-446,483	-60%
3E	19	2	21990	153930	21990	1720930	632283	-610,293	-97%
3E	20	1	630540	1180770	2476240	1034010	1563673 <i>Average 3E</i>	-933,133 -25,078	-60%

Continued

Table 3.12 (Continued) Change in PIA costs, with and without road works by traffic management type

<i>TM type</i>	<i>Site No.</i>	<i>Phase</i>	<i>Works</i>	<i>Prev. 1</i>	<i>Prev. 2</i>	<i>Prev. 3</i>	<i>Average 3 year EP</i>	<i>Change in average cost (£)</i>	<i>% change in cost (as a result of road works)</i>
3F	1	2	322680	1911670	322680	21990	752113	-429,433	-57%
3F	8	2	0	0	21990	0	7330	-7,330	-100%
3F	15	1	0	0	0	0	0	0	-
3F	17	1	43980	21990	21990	0	14660	29,320	200%
3F	22	1	0	0	0	0	0	0	-
3F	25	2	21990	43980	21990	1764910	610293	-588,303	-96%
3F	28	2	0	212730	234720	0	149150	-149,150	-100%
							<i>Average 3F</i>	<i>-163,557</i>	
3G	17	1	0	0	0	0	0	0	-
							<i>Average 3G</i>	<i>0</i>	
3G/3B	8	3	0	0	0	0	0	0	-
							<i>Average 3G/3B</i>	<i>0</i>	
4A	14	1	43980	21990	43980	43980	36650	7,330	20%
							<i>Average 4A</i>	<i>7,330</i>	
4C	14	3	43980	65970	65970	65970	65970	-21,990	-33%
							<i>Average 4C</i>	<i>-21,990</i>	
4C/4B	14	4	21990	0	21990	0	7330	14,660	200%
							<i>Average 4C/4B</i>	<i>14,660</i>	
CFA	2	3	6110780	6120850	5561030	4544260	5408713	702,067	13%
CFA	3	2	21990	234720	0	43980	92900	-70,910	-76%
CFA	4	2	843270	608550	2520220	2498230	1875667	-1,032,397	-55%
CFA	5	2	43980	403470	109950	43980	185800	-141,820	-76%
CFA	6	1	1048830	4681430	432630	645360	1919807	-870,977	-45%
CFA	7	2	491430	43980	65970	87960	65970	425,460	645%
CFA	10	3	21990	0	0	0	0	21,990	-
CFA	18	3	344670	2131570	432630	520590	1028263	-683,593	-66%
CFA	20	2	1532610	3393130	1591410	946050	1976863	-444,253	-22%
CFA	25	4	454620	513420	263880	344670	373990	80,630	22%
CFA	26	2	256710	0	21990	0	7330	249,380	3402%
CFA	27	2	0	21990	21990	1911670	651883	-651,883	-100%
CFA	28	3	21990	21990	21990	0	14660	7,330	50%
							<i>Average CFA</i>	<i>-185,306</i>	
CFB	7	3	21990	212730	0	190740	134490	-112,500	-84%
CFB	8	7	21990	21990	21990	1720930	588303	-566,313	-96%
CFB	22	2	447450	43980	197910	1911670	717853	-270,403	-38%
CFB	24	3	0	425460	21990	21990	156480	-156,480	-100%
							<i>Average CFB</i>	<i>-276,424</i>	
CFC	23	1	2331900	3583390	4514620	2471010	3523007	-1,191,107	-34%
							<i>Average CFC</i>	<i>-1,191,107</i>	
CFD	12	2	366660	21990	469440	704160	398530	-31,870	-8%
							<i>Average CFD</i>	<i>-31,870</i>	

Table 3.13 Personal Injury Accident frequency by road surface condition

	Road surface condition		
	Dry	Other	Total
Number of PIAs			
With road works	278 [126] ¹	145 [80] ¹	423 [206] ¹
Without road works			
Aggregate	727	460	1187
Prev. 1	254	168	422
Prev. 2	251	151	402
Prev. 3	222	141	363
Percentage of total			
With road works	66% [61%] ¹	34% [39%] ¹	100% [100%] ¹
Without road works			
Aggregate	61%	39%	100%
Prev. 1	60%	40%	100%
Prev. 2	62%	38%	100%
Prev. 3	61%	39%	100%
All motorways (GB)²			
Percentage of total	71%	29%	100%

¹ The figures in square brackets [] are the results of the 1992 study (TRL Project Report PR81).

² Source : Road Casualties Great Britain 2002 (Table 14a - Accidents: by daylight and darkness, road surface condition, built-up and non built-up roads and severity: 2002, Department for Transport).

Table 3.14 Personal Injury Accident frequency by weather condition

	Weather conditions		
	Dry	Other	Total
Number of PIAs			
With road works	339 [154] ¹	84 [52] ¹	423 [206] ¹
Without road works			
Aggregate	907	280	1187
Prev. 1	323	99	422
Prev. 2	308	94	402
Prev. 3	276	87	363
Percentage of total			
With road works	80% [75%] ¹	20% [25%] ¹	100% [100%] ¹
Without road works			
Aggregate	76%	24%	100%
Prev. 1	77%	23%	100%
Prev. 2	77%	23%	100%
Prev. 3	76%	24%	100%
All motorways (GB)²			
Percentage of total	76%	24%	100%

¹ The figures in square brackets [] are the results of the 1992 study (TRL Research Report RR81).

² Source: Road Casualties Great Britain 2002 (Table 15a - Accidents: by daylight and darkness, weather condition, built-up and non built-up roads and severity: 2002, Department for Transport).

Table 3.15 Personal Injury Accident frequency by type of PIA

	Type of PIA														
	PJ off	MJ off	SJ off	PJ on	MJ on	SJ on	P	MC	MO	MS	MOT	SR	SOO	SOT	All PIAs
Number of accidents															
With road works	1	9	8	0	7	2	3	92	21	224	7	5	32	12	423
Without road works															
Aggregate	0	5	15	0	10	10	15	242	46	643	1	0	156	44	1187
Prev. 1	0	3	8	0	4	5	5	91	19	221	0	0	48	18	422
Prev. 2	0	2	2	0	3	3	5	73	15	230	0	0	55	14	402
Prev. 3	0	0	5	0	3	2	5	78	12	192	1	0	53	12	363
Percentage of total injury type															
With road works	0%	2%	2%	0%	2%	0%	1%	22%	5%	53%	2%	1%	8%	3%	100%
Without road works															
Aggregate	0%	0%	1%	0%	1%	1%	1%	20%	4%	54%	0%	0%	13%	4%	100%
Prev. 1	0%	1%	2%	0%	1%	1%	1%	22%	5%	52%	0%	0%	11%	4%	100%
Prev. 2	0%	0%	0%	0%	1%	1%	1%	18%	4%	57%	0%	0%	14%	3%	100%
Prev. 3	0%	0%	1%	0%	1%	1%	1%	21%	3%	53%	0%	0%	15%	3%	100%

Types:

PJ off = pedestrian junction error - off.

MJ off = Multiple vehicle junction error - off.

SJ off = Single vehicle junction error - off.

PJ on = Pedestrian junction error - on.

MJ on = Multiple vehicle junction error - on.

SJ on = Single vehicle junction error - on.

P = Pedestrian accident.

MC = Multiple vehicle changing lane.

MO = Multiple vehicle overtaking error.

MS = Multiple vehicle shunt.

MOT = Multiple vehicle other.

SR = Single vehicle hit road works.

SOO = Single vehicle hit other object.

SOT = Single vehicle other.

comparable with the 1987 and 1982 studies. This suggests that the occurrence of shunts in normal motorway driving conditions is increasing and the level of shunts at road works is consistent over time. The rise in shunts in the without works period, when compared with the previous studies, may be due to the significant increase in traffic levels and congestion over the past decade.

3.5.5.1 Number of vehicles involved in PIAs

The number of vehicles involved in each PIA in the study is shown in Table 3.16. The results show that the distribution of the number of vehicles involved in the road works PIAs is comparable with the without works and National distributions.

3.5.5.2 PIA involvement by vehicle type

The frequency of vehicle involvement by class of vehicle is shown in Table 3.17. The results show that the distribution of vehicle involvement is similar to the 1992 study and the national figures. This suggests that vehicle type does not have any significant effect on the type of PIAs that occur at road works.

3.5.6 The effect of speed camera enforcement

Speed camera enforcement, with the appropriate signing, was used at 17 of the 29 sites monitored in the study. Of these sites 10 were monitored using analogue cameras, 5 were monitored using digital cameras and the remaining two sites used patrol cars and speed traps. The analogue speed cameras present during this study are those that measure spot speeds of vehicles at a single location.

Digital cameras described in this study measure the average speed of vehicles over a distance between two cameras using number plate recognition software.

The study data was split into sites with and without speed camera enforcement to determine their respective with/without works ratios. The ratios found for both sets of data were found to be not significantly different from 1.0, see Table 3.18. However it should be noted that it appears in general sites with speed cameras were chosen as they were thought to have a high accident risk. Table 3.18 shows that the non-works PIA rate is significantly (5% level) higher for the sites with speed cameras than the rate for sites without.

When comparing the results for Analogue and Digital camera enforcement it should be noted that the PIA ratio for the digital camera sites is less than 1.

Table 3.19 shows the proportion and severity of PIAs at sites with and without speed camera enforcement. There was a 1% decrease in the proportion of fatal and serious PIAs at sites with speed cameras. However, it should be noted that installing speed cameras at road works is expensive and they are generally only used at sites where it is thought that the works are likely to have a significant impact on safety at the site. Although these numbers are small it should be remembered that the respective cost of a fatal and serious PIA are £1,698,940 and £190,740.

3.5.7 The effect of narrow lanes

Table 3.20 shows the number of PIAs at sites with and without narrow lane traffic management arrangements. The results show that PIA rate for the sites using narrow lanes was less when road works were in operation, when

Table 3.16 Number of vehicles per Personal Injury Accident

	Number of vehicles per PIA						
	1	2	3	4	5	6	>6
Number of PIAs							
With road works ¹	58 [32]	216 [79]	96 [50]	38 [26]	9 [12]	2 [7]	4 [—]
Without road works							
Aggregate	241	567	227	86	34	14	18
Prev. 1	83	210	77	32	8	4	8
Prev. 2	80	194	82	28	15	2	1
Prev. 3	78	163	68	26	11	8	9
Percentage of total							
With road works ¹	14% [16%]	51% [38%]	23% [24%]	9% [13%]	2% [6%]	0% [3%]	1% [—%]
Without road works							
Aggregate	20%	48%	19%	7%	3%	1%	2%
Prev. 1	20%	50%	18%	6%	2%	50%	2%
Prev. 2	20%	48%	20%	7%	4%	200%	0%
Prev. 3	21%	45%	19%	7%	3%	89%	2%
All motorways (GB)²							
Percentage of total	22%	50%	17%	11% ³	—	—	—

¹ The numbers in brackets [] are the results of the 1992 study.

² Source: Road Casualties Great Britain 2002 (Table 20 Accidents: by number of vehicles involved, road class and severity), Department for Transport.

³ 11% of PIAs involved 4 or more vehicles.

3.17 Frequency of vehicle involvement in Personal Injury Accidents by class of vehicle

	Vehicle class							Total number of vehicles
	C	LGV	MGV	HGV	PSV	MC	OV	
Number of PIAs								
With road works	756	60	16	154	14	25	23	1048
Without road works								
Aggregate	2115	111	43	260	18	52	247	2846
Prev. 1	755	48	18	148	6	11	22	1008
Prev. 2	678	44	19	82	6	20	92	941
Prev. 3	682	19	6	30	6	21	133	897
Percentage of total								
With road works	72%	6%	2%	15%	1%	2%	2%	100%
	[76%]	[4%] ¹		[15%] ²	[1%]	[3%]	[1%]	
Without road works								
Aggregate	74%	4%	2%	9%	1%	2%	9%	100%
Prev. 1	75%	5%	2%	15%	1%	1%	2%	100%
Prev. 2	72%	5%	2%	9%	1%	2%	10%	100%
Prev. 3	76%	2%	1%	3%	1%	2%	15%	100%
% of total veh. km on all motorways (GB)³								
	75%	11%	13% ⁴		1%	<1%	–	100%

Class:

C = Car.

LGV = Light goods vehicle, maximum gross weight 1.5 tonne or less.

MGV = Medium goods vehicle, maximum gross weight greater than 1.5 tonne and under 7.5 tonne.

HGV = Heavy goods vehicle, maximum gross weight 7.5 tonne or over.

PSV = Public service vehicle.

MC = Motorcycle.

OV = Other vehicles (including minibus and taxi).

¹ In 1992 study, LGV defined as light goods vehicle, unladen weight 1.5 tonne or less.

² In 1992 study, OGV defined as other goods vehicle, unladen weight greater than 1.5 tonne. OGV is equivalent to MGV + HGV in the current study.

³ Source: Transport Statistics Great Britain 2002 (Table 4.9) The Stationery Office, October 2002.

⁴ All vehicles over 3.5 tonnes gross vehicle weight (MGV + HGV).

The figures in square brackets [] are the results of the 1992 study (TRL Project Report PR81).

veh km is vehicle kilometres (millions).

Table 3.18 The influence of speed cameras on PIA rates

PIAs (mean number of)		Million vehicle kilometres (mean number of)				PIAs				Ratio				
Without speed cameras		With speed cameras		Without speed cameras		With speed cameras		Without speed cameras		With speed cameras		Without speed cameras	With speed cameras	
Non-Works	Non-works	Works	Non-works	Works	Non-works	Works	Non-works	Works	Non-works	Works	Non-works			
6.42	6.17	Aggregate	20.35	19.12	71.80	69.03	194.96	189.70	0.089	0.089 ¹	0.104	0.101 ¹	1.000	1.036
		Digital	39.60	39.97			428.05	420.31			0.093	0.095		0.973
		Analogue	13.60	11.12			98.89	94.73			0.138	0.117		1.172
		Other	6.00	7.00			92.59	88.03			0.065	0.080		0.815

¹ The non-works with speed camera PIA rate is significantly greater than the without speed camera rate (5% level).

Table 3.19 Numbers of PIAs and percentage of total by accident severity class

Number of PIAs	Number of accidents			Total number of PIA
	Fatal	Serious	Slight	
Without speed cameras	2 [3.33] 3%	7 [9] 9%	68 [61.7] 88%	77 [73] 100%
With speed cameras	3 [7] 1% [2%]	33 [35.33] 10% [11%]	310 [279.33] 90% [87%]	346 [321.66]
Digital	2 [2.67]	14 [17.67]	177 [176.67]	193 [197.01]
Analogue	1 [3.33]	17 [15.67]	123 [91.67]	141 [110.67]
Other	0 [1]	2 [2]	10 [11]	12 [14]

The figures in square brackets [] are the average number of PIAs in the equivalent non-works period.

compared to the without works PIA rate. However, when tested the works/ without works ratio for both sites with and without narrow lanes were found not to be significantly different from 1.

Table 3.20 shows that, as with the sites with speed cameras, sites where narrow lanes were chosen tended to have a significantly (5% level) higher PIA risk when no road works are present

3.5.8 The effect of site flow level

In order to determine any effects that flow level may have on PIAs, each site was categorised into one of the following:

- 1 Low (AADT less than 60,000 vehicles).
- 2 Medium (AADT greater than 60,000, but less than 100,000 vehicles).
- 3 High (AADT greater than 100,000 vehicles).

Table 3.21 shows the breakdown of results by the above three categories. It can be seen that for the low and high flow sites that the PIA rate is reduced when road works were present. However, for the medium flow sites the PIA ratio is approximately 1.5 times higher, but this result was not found to be significant at the 95% level.

3.5.9 The effect of works duration

The effect of works duration on PIA rates was investigated by separating the sites into the following categories:

- 1 Less than 2 months.
- 2 between 2-5 months.
- 3 greater than 5 months.

Table 3.20 Personal Injury Accident frequency by narrow lanes

Number of PIAs	Narrow lanes		Total
	Used	Not used	
With road works	281	142	42
Mean	20.07	6.45	14.59
Without road works			
Aggregate	849	338	1187
Mean	20.30	5.17	13.76
Prev. 1	298	124	422
Prev. 2	287	115	402
Prev. 3	264	99	363
Percentage of total			
With road works	66%	34%	100%
Without road works			
Aggregate	72%	28%	100%
Prev. 1	71%	29%	100%
Prev. 2	71%	29%	100%
Prev. 3	73%	27%	100%
Vehicle kilometres (millions)			
With road works			
Mean	194.53	66.05	143.99
Without road works			
Mean	190.34	63.15	139.77
PIA rate per million vehicle kilometres			
With road works	0.103	0.098	0.101
Without road works	0.107 ¹	0.082 ¹	0.098
PIA works / no works ratio			
	0.963	1.190	1.029

¹ The non-works with narrow lanes PIA rate is significantly greater than the without narrow lane rate (5% level).

Table 3.22 displays the PIA number and rates for these categories. The results show that there is no significant difference between the PIA works/ without works ratios.

3.5.10 Temporary Vertical Barriers (TVBs)

Only 2 of the 29 sites in the study used Temporary Vertical Barriers (TVBs) to separate opposing traffic through the works. It was therefore not possible to analyse the effect on safety at road works.

3.5.11 The zone of influence

As part of this study it was decided to investigate PIAs that occurred outside the area monitored in the previous studies to see whether the zone of influence of a road works site extended further upstream or downstream than the designated 6 kilometre area (perhaps as a result of the increased traffic flow on the network). To achieve this PIA details were collected for a further 4 kilometres up and down stream of the works.

The PIAs recorded in the extended zone were analysed for both the works and without works periods. The results did not provide any clear evidence that there was an increase of PIAs that could be caused by queuing

Table 3.21 Personal Injury Accident frequency by traffic flow

	AADT flow*			Total
	Medium		High	
	Low	> 60,000 &		
	< 60,000	< 100,000	> 100,000	
Number of sites	12	8	9	29
Number of PIAs				
With road works	42	90	291	423
Mean	3.50	11.25	32.33	14.59
Without road works				
Aggregate	133	168	886	1187
Mean	3.69	7.42	32.81	13.76
Prev. 1	46	69	307	422
Prev. 2	43	61	298	402
Prev. 3	44	38	281	363
Percentage of total				
With road works	10%	21%	69%	100%
Without road works				
Aggregate	11%	14%	75%	100%
Prev. 1	11%	16%	73%	100%
Prev. 2	11%	15%	74%	100%
Prev. 3	12%	10%	77%	100%
Vehicle kilometres (millions)				
With road works				
Mean	43.95	122.82	296.22	143.99
Without road works				
Mean	41.20	118.96	289.68	139.77
PIA rate per million vehicle kilometres				
With road works	0.080	0.092	0.109	0.101
Without road works	0.090	0.062	0.113	0.098
PIA works / no works ratio				
	0.888	1.469	0.964	1.029

* Combined flow for both carriageways.

associated with the works (shunts and lane changing error) and it was therefore decided that the 6 kilometre zone of influence was still applicable for the current traffic levels.

3.5.12 PIA time trends associated with the introduction of works

There is a concern that a large number of accidents occur when a road works site is first introduced on a motorway. To help quantify this, a plot of PIA against time duration was produced for each site. The graphs did not show any clear trends of PIAs over time and therefore evidence to support the concern could not be found. However, it should be noted that this study has only investigated PIAs and there may be a trend for damage only accidents.

3.5.13 Workforce accidents

The HA HAWSAR records were provided for the works sites. There were 4 reported workforce accidents at the 29 sites. Three of the accidents involved vehicles from the public highway and hence were included in the 423 PIAs collected for the study. The other accident

Table 3.22 Personal Injury Accident frequency by works duration

	Works duration			Total
	> 2 months &		> 5 months	
	< 2 months	< 5 months		
Number of sites	11	10	8	29
Number of PIAs				
With road works	35	133	255	423
Mean	3.18	13.30	31.88	14.55
Without road works				
Aggregate	84	365	738	1187
Mean	2.55	12.50	30.75	13.72
Prev. 1	24	118	280	422
Prev. 2	29	136	237	402
Prev. 3	31	111	221	363
Percentage of total				
With road works	8%	31%	60%	100%
Without road works				
Aggregate	7%	31%	62%	100%
Prev. 1	6%	28%	66%	100%
Prev. 2	7%	34%	59%	100%
Prev. 3	9%	31%	61%	100%
Vehicle kilometres (millions)				
With road works				
Mean	32.36	93.83	360.20	143.55
Without road works				
Mean	30.71	91.07	350.59	139.35
PIA rate per million vehicle kilometres				
With road works	0.098	0.142	0.088	0.101
Without road works	0.083	0.137	0.088	0.098
PIA works / no works ratio				
	1.186	1.033	1.009	1.029

involved an operative injuring their lower back whilst loading drainage ironwork on to a vehicle. This accident has not been included in the study as road traffic was not involved.

3.6 Risk factors

It is not possible based on this single study to assign detailed risk factors. The data collected only permits a first order of ranking for the various traffic management elements by zone. For any Scheme Risk Assessment (SRA) the risk factor ranking provided should be used with caution and where necessary adjusted to take account of unusual site and traffic conditions. In addition the assessor should undertake a sensitivity assessment to ensure that the SRA calculated is robust.

Appendix B lists the risk factors, together with the 95% confidence intervals, calculated using the study data.

4 Summary

4.1 Summary of main findings

The safety performance of traffic management arrangements at road works sites has been periodically monitored by the Highways Agency since 1982. The last study was conducted in 1992. Since this date there have been a number of safety initiatives that have been introduced to reduce the number of accidents on motorways, particularly when road works are present. Some of these measures include:

- The introduction of Chapter 8 of the Traffic signs Manual (1991).
- The increased use of speed cameras at road works and the introduction of digital speed enforcement zones (2000).
- The introduction of sector scheme traffic management training.
- The increased use of narrow lane traffic management layouts due to capacity demand on the network.
- Speed limiter settings lowered to 65mph for new buses and coaches and to 56mph for HGVs. (1994).
- Introduction of the Driving Theory test for car and motorcycle learners (1996).
- Kill your speed campaigns (1999).
- Think! Road safety campaign which included road works in 2002.

This study is based on a sample of 29 road work sites and PIA details were collected for a total exposure of 4,176 million vehicle kilometres. For this exposure, 423 PIAs were recorded at the work sites and, for control, data was also collected for 1187 PIAs over the previous 3 years at the sites when no road works were present.

This large sample is approximately 3.5 times greater than the samples in the previous study. The study has covered a large representative range of traffic management layouts that are currently being used at road work sites.

4.1.1 Overall Personal Injury Accident (PIA) rates

The study showed that there was no significant increase in the rate of PIAs when road works were present on the motorway. The reason for the finding is that the PIA rate for the works situation has decreased from 0.174 in the 1992 study to 0.101. The rate for the without works period was 0.098 which is comparable to the National figure of 0.1 (Department for Transport 2002a). The national PIA rate figure for motorways has remained almost constant at 0.1 over the last decade (Department for Transport 2002a). It is therefore considered that the safety measures mentioned above have led to a significant reduction to the rate of PIAs at road works.

4.1.2 Effects of speed camera enforcement

The study monitored 17 sites that used speed camera enforcement. Of these sites 10 used analogue cameras (spot speed measurement), 5 used digital cameras (average

speed measurement) and 2 used patrol cars and speed traps. No significant difference was observed in the PIA rate for sites with and without cameras. However, there was a 1% decrease in the proportion of Fatal and Serious PIAs recorded at the sites with speed cameras when compared to the without works period. It should also be noted that the sites with speed camera enforcement had a significantly higher (see Table 3.18) without works ratio than sites that did not use camera enforcement.

4.1.3 PIA and casualty severity

The 2002 study showed that when compared with the 'without' works figured, there was a 17% reduction in the number of fatal and serious PIAs. When compared with the National and without works period the study also showed a reduction in the likelihood of a fatal or serious casualty in a PIA occurring at a road works site (see Tables 3.9 and 3.10).

4.1.4 PIA costs

The reduction in fatal and serious PIAs at the works sites in the 2002 study when compared to the equivalent without works periods produced an accumulative reduction in PIA cost of £292,860.

4.1.5 PIA types

The top three accident types that were observed across the 29 works sites were Multiple Vehicle Shunts (53%), Multiple Vehicle [changing lane errors] (22%) and Single Vehicle [hit other object] (8%). These types and proportions were comparable to the previous studies.

4.1.6 Workforce accidents

A review of the Highways Agency's HAWSAR records indicate that there have been very few reported workforce accidents associated with the 29 road work sites.

4.1.7 Other factors

Other factors such as weather, road conditions, number of vehicles involved and lighting conditions were analysed. All of these factors were shown not to have an increased impact on the safety performance of motorways when road works are introduced.

5 Study conclusion

It can be concluded from the evidence produced by this study, that due to the increased number of safety measures and practices over the past decade, the risk when road works are present is now similar to the risk when no road works are present. However, it should be noted that this assessment is only associated with Personal Injury Accidents and there is no evidence to suggest that the effect is the same for damage only accidents. The inclusion of damage only accidents in a study such as this would be practically impossible as no adequate and formal records of damage only accidents on the roads are recorded.

6 Acknowledgements

The authors of this report would like to thank all the people associated with the works sites detailed in Table 2.1 for their help and co-operation with this study. TRL would also like to acknowledge the help and support provided by the HA area support teams and the client team for this contract.

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Appendix A: Details of information requested from each site

Traffic flow

- Average Annual Daily Total flow (AADT), split by carriageway, through the site during the works period.
- AADT flows, split by carriageway, through the site for the 3 most recent preceding years without road works in place.
- Proportion of Heavy Goods Vehicles (HGV) in the traffic flow.

Street lighting

- Lit section? (part?/all?).
- Lights in working order?
- Traffic Management (TM) signs lit?
- Type of lighting.
- Presence of temporary lighting.
- Crossover Lighting?
- Height of lighting columns.
- Position of lighting columns.

Special features

- Speed cameras?
- Type.
- Location.
- Threshold speeds (for Live and dummy cameras).
- No. of cameras.
- No. of dummy units (No. with and without flash units).
- Markings only
- Prosecution/Offenders information (if available).
- Police Speed Check signing?
- No. and location of Police speed check signs.
- Date & Time of Police spot checks.
- Method(s) of detection (e.g. Unmarked cars, Hand held device).
- Prosecution/Offenders information (if available).
- Temporary Vertical Barriers.
- Location.
- Type.
- Will CCTV cameras be in operation?
- Will permanent or temporary Variable Message Signs (VMS) be used at the site?
- Site photographs (only if available).

Appendix B: Risk factors

The following tables contain risk factors and their associated 95% confidence intervals for use in the risk assessment aspects of traffic management design and operations. The tables have been produced using the following assumptions:

- 1 Personal Injury Accidents are Poisson distributed.
- 2 There is no error associated with exposure measures.
- 3 There is no correlation between works and no works.

Traffic management type

TM type	Works/ no works	95% confidence interval		Works			No works (previous 3 years)		
	Ratio	Lower	Upper	PIAs	Exposure	Rate	PIAs	Exposure	Rate
Tidal contra-flow	1.681	0.308	3.054	9	85.564	0.105	16	255.692	0.063
Non contra-flow (all types)	1.021	0.831	1.212	151	1355.704	0.111	419	3842.679	0.109
Partial contra-flow (2x1, 4x3)	1.021	0.875	1.167	255	2618.667	0.097	723	7581.105	0.095
Full contra-flow (2x2)	0.764	0.166	1.363	8	115.917	0.069	29	321.181	0.090

Of the 272 contra-flow PIAs, 5 (1.8%) were head on collisions between opposing traffic in the central section of the works, and 3 (1.1%) were PIAs at cross-overs within the approach restricted zone (2 rear shunt and 1 lane changing PIA at the start of the cross-over).

Traffic management zone

TM zone	Works/ no works	95% confidence interval		Works			No works (previous 3 years)		
	Ratio	Lower	Upper	PIAs	Exposure	Rate	PIAs	Exposure	Rate
Approach	1.429	0.697	2.160	22	229.532	0.096	44	655.848	0.067
Approach signed	1.063	0.823	1.304	103	1158.573	0.089	276	3301.082	0.084
Approach restricted	1.447	0.750	2.144	25	161.064	0.155	49	456.721	0.107
Central	1.267	1.008	1.525	133	981.532	0.136	301	2813.668	0.107
After restricted	0.390	0.057	0.723	6	100.392	0.060	44	287.085	0.153
After signed*	1.294	-0.074	2.662	5	52.607	0.095	11	149.748	0.073
After	0.697	0.541	0.852	96	1394.381	0.069	393	3977.149	0.099

* Figures shown in italics are derived from samples with less than 30 million veh - km and / or less than 5 PIAs during the works period or an average of 5 accidents over the previous 3 years.

Narrow lanes

	Works/ no works	95% confidence interval		Works			No works (previous 3 years)		
	Ratio	Lower	Upper	PIAs	Exposure	Rate	PIAs	Exposure	Rate
Narrow lanes	0.958	0.829	1.087	281	2723.374	0.103	849	7882.086	0.108
No narrow lanes	1.191	0.958	1.425	142	1453.104	0.098	338	4120.266	0.082

Reduction in number of lanes

	Works/ no works	95% confidence interval		Works			No works (previous 3 years)		
	Ratio	Lower	Upper	PIAs	Exposure	Rate	PIAs	Exposure	Rate
Lane drop	1.265	1.002	1.529	128	1322.416	0.097	286	3738.609	0.076
No lane drop	0.948	0.823	1.073	295	2853.436	0.103	901	8261.502	0.109

Speed cameras

	Works/ no works	95% confidence interval		Works			No works (previous 3 years)		
	Ratio	Lower	Upper	PIAs	Exposure	Rate	PIAs	Exposure	Rate
Speed cameras	1.031	0.905	1.158	346	3314.309	0.104	963	9515.018	0.101
No speed cameras	0.992	0.735	1.248	77	861.543	0.089	224	2485.094	0.090

Abstract

This report reviews the fourth motorway safety performance study carried out on behalf of the Highways Agency. Previous studies were carried out in 1982, 1987 and 1992 and have provided the Agency with key information on the safety of traffic management at major road works.

This study has monitored 29 major motorway road works sites and has recorded Personal Injury Accident details for an exposure of 4,176 million vehicle kilometres over the period November 2001 to July 2003. The study showed that there was no significant difference in the rate of Personal Injury Accidents when road works were present.

Related publications

Temporary traffic management on high speed roads - good working practice. 2002 (price £25, code AAX)

Guidance for safer temporary traffic management. 2002 (price £35, code H)

PR81 *A study of the safety performance of major motorway roadwork layouts* by M R Hayes, P J Taylor and H C R Bowman. 1994 (price £50, code N)

PR37 *A review of the accident risk associated with major roadworks on all-purpose dual carriageway roads* by M R Hayes and P J Taylor. 1993 (price £50, code N)

RR223 *A study of the safety of major motorway roadworks in 1987* by M Marlow and R D Coombe. 1989 (price £20, code B)

RR42 *Safety performance of traffic management at major roadworks on motorways in 1982* by I Summersgill. 1985 (price £20)

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