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Sleep-Related Crashes on Sections of Different Road Types in the UK (1995–2001)

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CONTENTS

LIST OF TABLES 10
LIST OF FIGURES 12
EXECUTIVE SUMMARY 15
INTRODUCTION 17
METHOD 18
  Data collection 18
SECTION 1  PROPORTION OF ROAD TRAFFIC CRASHES CAUSED BY DRIVER SLEEPINESS 21
  Road traffic crashes 21
  Sleep-related crashes 21
  Severity and number of casualties 21
  Sex and age of drivers in crashes 22
  Vehicle type 24
SECTION 2  TIME OF DAY AND TRAFFIC DENSITY 25
  Day of week 30
  Month/season 31
SECTION 3  ROAD TRAFFIC CRASHES AND CAUSATION 33
SECTION 4  THE EFFECT OF NATURAL AND ARTIFICIAL LIGHTING 34
  Introduction 34
  Artificial lighting 34
  The effect of natural light 36
MAIN CONCLUSIONS 38
DISCUSSION

APPENDIX A
FATAL AND INJURY ROAD TRAFFIC CRASHES DUE TO DRIVER SLEEPINESS ON RURAL ROADS IN LINCOLNSHIRE, 1999–2000

INTRODUCTION

A1(T) DUAL CARRIAGEWAY

ROAD CHARACTERISTICS
General
Road surface
Lay-bys
Services

RESULTS
Roundabouts
Severity
Number of casualties
Causes of RTCs
Time of day/traffic flow
Location of SRCs
Sex and age of drivers in SRCs
Day of week for SRCs
Month/season
SRCs and vehicle type

A15(T) SINGLE CARRIAGEWAY

ROAD CHARACTERISTICS
General
Road surface
Lay-bys
Services
RESULTS 53
Severity 53
Number of casualties 53
Causes of RTCs 53
Time of day/traffic flow 54
Location of SRCs 55
Sex and age of drivers in SRCs 57
Day of week for SRCs 57
Month/season 57
SRCs and vehicle type 57

A52 SINGLE CARRIAGEWAY 58
ROAD CHARACTERISTICS 58
General 58
Road surface 58
Lay-bys 59
Services 59

RESULTS 60
Severity 60
Number of casualties 60
Causes of RTCs 60
Time of day/traffic flow 61
Location of SRCs 62
Sex and age of drivers in SRCs 64
Day of week for SRCs 64
Month 64
SRCs and vehicle type 64

B6403 SINGLE CARRIAGEWAY 65
ROAD CHARACTERISTICS 65
General 65
Day of week for SRCs 85
Month/season 86
SRCs and vehicle type 86

M20 87
Services 88

RESULTS 89
Severity 89
Number of casualties 89
Causes of RTCs 90
Time of day/traffic flow 90
Location of SRCs 91
Sex and age of drivers in SRCs 94
Day of week for SRCs 94
Month/season 95
Vehicle type 95

OVERALL CONCLUSIONS 96

DISCUSSION AND COMMENT 97

APPENDIX C
FATAL AND INJURY ROAD TRAFFIC CRASHES, 2000–2001, CAUSED BY DRIVER SLEEPINESS IN STAFFORDSHIRE ON SECTIONS OF THE M6 (a rural motorway with high traffic flow) AND THE A38 (a continuous section of a lit ‘A’ road) 98

INTRODUCTION 99

M6 101
Services 101

RESULTS 102
Severity 102
Number of casualties 102
Causes of RTCs 102
Sleep-Related Crashes on Sections of Different Road Types in the UK (1995–2001)

Time of day/traffic flow 103
Location of SRCs 104
Sex and age of drivers in SRCs 108
Day of week for SRCs 108
Month/season 109
SRCs and vehicle type 109

A38 110
Services 110
Lay-bys 110

RESULTS 111
Severity 111
Number of casualties 111
Causes of RTCs 111
Time of day/traffic flow 112
Location 113
Sex and age of drivers 113
Day of week and season 113
SRCs and vehicle type 113

OVERALL CONCLUSIONS 114

DISCUSSION AND COMMENT 115

APPENDIX D
FATAL AND INJURY ROAD TRAFFIC CRASHES CAUSED BY DRIVER SLEEPINESS ON THE NORTHAMPTONSHIRE SECTION OF THE M1, 2000–2001 (a lit rural motorway with high traffic flow) 116

INTRODUCTION 117
Services 119

RESULTS 121
Severity 121
Number of casualties 121
Causes of RTCs 121
Time of day/traffic flow 122
Location of SRCs 123
Sex and age of drivers in SRCs 127
Day of week for SRCs 127
Month/season 128
SRCs and vehicle type 128

OVERALL CONCLUSIONS 129

DISCUSSION AND COMMENT 130

REFERENCES 131

ACKNOWLEDGEMENTS 132
# LIST OF TABLES

## METHOD

*Table 1*  
Types of road

## SECTION 1

*Table 1.1*  
Severity of RTCs and SRCs  
*Table 1.2*  
Men and women in RTCs versus SRCs  
*Table 1.3*  
Vehicle types for RTCs and SRCs

## SECTION 2

*Table 2.1*  
Seasons and RTCs  
*Table 2.2*  
Seasons and SRCs

## SECTION 3

*Table 3.1*  
RTCs and causation

## APPENDIX A

*Table A1*  
Severity of RTCs and SRCs, A1(T) Lincolnshire, 1999–2000  
*Table A2*  
Causes of RTCs on the A1(T) Lincolnshire, 1999–2000  
*Table A3*  
Number of SRCs per month, A1(T) Lincolnshire, 1999–2000  
*Table A4*  
Severity of RTCs and SRCs, A15(T) Lincolnshire, 1999–2000  
*Table A5*  
Causes of RTCs on the A15(T) Lincolnshire, 1999–2000  
*Table A6*  
Number of SRCs per month, A15(T) Lincolnshire, 1999–2000  
*Table A7*  
Severity of RTCs and SRCs, A52 Lincolnshire, 1999–2000  
*Table A8*  
Causes of RTCs on the A52 Lincolnshire, 1999–2000  
*Table A9*  
Severity of RTCs and SRCs, B6403 Lincolnshire, 1999–2000
Table A10  
Causes of RTCs on the B6403 Lincolnshire, 1999–2000

APPENDIX B  
Table B1  
Severity of RTCs and SRCs, M25 Kent 1999–2000
Table B2  
Causes of RTCs on the M25 Kent, 1999–2000
Table B3  
Number of SRCs per month, M25 Kent 1999–2000
Table B4  
Severity of RTCs and SRCs, M20 Kent 1999–2000
Table B5  
Causes of RTCs on the M20 Kent, 1999–2000
Table B6  
Number of SRCs per month, M20 Kent 1999–2000

APPENDIX C  
Table C1  
Severity of RTCs and SRCs, M6 J11–16, 2000–2001
Table C2  
Table C3  
Number of SRCs per month, M6 J11–16, 2000–2001
Table C4  
Severity of RTCs and SRCs, A38 Staffordshire, 2000–2001
Table C5  
Causes of RTCs on the A38 Staffordshire, 2000–2001

APPENDIX D  
Table D1  
Severity of RTCs and SRCs, M1 Northamptonshire, 2000–2001
Table D2  
Causes of RTCs on the M1 Northamptonshire, 2000–2001
Table D3  
Number of SRCs per month, M1 Northamptonshire, 2000–2001
LIST OF FIGURES

SECTION 1

Figure 1.1  22
Sex and age of drivers in RTCs

Figure 1.2  23
Sex and age of drivers in SRCs

SECTION 2

Figure 2.1  25
Incidence of RTCs/SRCs and mean traffic flow, by time of day (all roads)

Figure 2.2  26
24h traffic density versus RTCs per mile per year for motorways and non-motorways

Figure 2.3  26
24h traffic density versus SRCs per mile per year for motorways and non-motorways

Figure 2.4  27
0200–0600h traffic density and RTCs per mile per year on motorways and non-motorways

Figure 2.5  28
0200–0600h traffic density and SRCs per mile per year on motorways and non-motorways

Figure 2.6  29
Traffic density and SRCs per 24h as a proportion of total RTCs on motorways and non-motorways

Figure 2.7  30
0200–0600h traffic density and SRCs as a proportion of total RTCs on motorways and non-motorways

Figure 2.8  31
RTCs and SRCs by day of week

Figure 2.9  32
Months and RTCs/SRCs

SECTION 4

Figure 4.1  35
RTCs for comparable lit versus unlit motorways at night (0000–0400h)

Figure 4.2  36
SRCs as a proportion of total crashes for lit versus unlit roads at night (0000–0400h)

Figure 4.3  37
RTCs and SRCs during 0530–0730h per mile/year during daylight and darkness
APPENDIX A

Figure A1  42
Map of Lincolnshire showing A1(T) (N/S Grantham), A15(T) (north of Lincoln), A52 (Boston to Skegness) and B6403 (bypass Grantham)

Figure A2  48
Incidence of RTCs/SRCs and mean summer and winter traffic flows on the A1(T) Lincolnshire, by time of day 1999–2000

Figure A3  49
Location of A1(T) n/bnd and s/bnd SRCs

Figure A4  55
Incidence of RTCs/SRCs and mean summer and winter traffic flows on the A15(T) Lincolnshire, by time of day

Figure A5  56
Location of A15(T) n/bnd and s/bnd SRCs

Figure A6  62
Incidence of RTCs/SRCs and mean summer and winter traffic flows on the A52 Lincolnshire, by time of day 1999–2000

Figure A7  63
Location of A52 n/bnd and s/bnd SRCs

Figure A8  69
Incidence of RTCs/SRCs and mean traffic flows on the B6403 Lincolnshire, by time of day 1999–2000

Figure A9  70
Location of B6403 n/bnd SRCs

APPENDIX B

Figure B1a  76
Map showing M25 Kent J2 to Clacket Services (J5/J6)

Figure B1b  77
Map showing M20 Kent J5 to J11A

Figure B2  82
Incidence of RTCs/SRCs and mean summer and winter traffic flows on the M25, by time of day 1999–2000

Figure B3a  83
Location of M25 (J2 to J4) clockwise and anticlockwise SRCs

Figure B3b  84
Location of M25 (south of J4 to Clacket Lane Services) clockwise and anticlockwise SRCs

Figure B4  85
Sex and age of drivers in SRCs on the M25 Kent, 1999–2000

Figure B5  86
SRCs and day of week, M25 Kent 1999–2000

Figure B6  91
Incidence of RTCs/SRCs and mean summer and winter traffic flows on the M20, by time of day 1999–2000
Figure B7a
Location of M20 (west) eastbound (coast) and westbound SRCs (London)

Figure B7b
Location of M20 (east) eastbound (coast) and westbound SRCs (London)

Figure B8
Sex and age of drivers in SRCs on the M20 Kent, 1999–2000

Figure B9
SRCs and day of week, M20 Kent 1999–2000

APPENDIX C
Figure C1
Map showing M6 J11 to J16 and A38 Lichfield-Burton upon Trent

Figure C2
Incidence of RTCs/SRCs and mean summer and winter traffic flows on the M6 J11–16, by time of day 2000–2001

Figure C3
Location of SRCs on M6

Figure C4
Sex and age of drivers in SRCs on the M6 J11 to J16, 2000–2001

Figure C5
SRCs and day of week, M6 J11–J16, 2000–2001

Figure C6
Incidence of RTCs/SRCs and mean summer and winter traffic flows on a lit section of the A38, by time of day 2000–2001

APPENDIX D
Figure D1
Map showing M1 Northamptonshire J14/J15 to J19

Figure D2
Incidence of RTCs/SRCs and mean summer and winter traffic flows on the M1 Northamptonshire, by time of day 2000–2001

Figure D3a
Location of M1 (northern section) n/bnd and s/bnd SRCs

Figure D3b
Location of M1 (mid-section) n/bnd and s/bnd SRCs

Figure D3c
Location of M1 (southern section) n/bnd and s/bnd SRCs

Figure D4
Sex and age of drivers in SRCs on the M1 Northamptonshire, 2000–2001

Figure D5
SRCs and day of week, M1 Northamptonshire, 2000–2001
EXECUTIVE SUMMARY

This report comprises an overview of the main findings from all our analyses (‘audits’) of sleep-related road crashes, including four new audits presented as appendices to this report. Also included in the overview are data from three earlier audits (Nos 1–3 below), previously described in Road Safety Research Report No. 22 (Reyner et al., 2001). The audits comprise detailed analyses of all crashes on sections of roads of differing types in order to establish the number of crashes resulting in injury and death that were sleep related. As sleep-related crashes (SRCs) tend to occur under monotonous driving conditions, we concentrated our audits on motorways that were both lit and unlit, that differed in traffic density and the number of lanes, and were urban and rural, including one to channel ports. However, audits were also carried out on monotonous ‘A’ trunk and (non-trunk) roads with dual and single carriageways, both lit and unlit, as well as on a ‘B’ single carriageway. The following roads were covered.

1. North Yorkshire sections of the A1(M), A1(T), A19(T)/A168(T) and A19(T) single carriageway. Two years of data from 1/1/1997. These roads are mostly unlit.

2. The illuminated section of the M5 in Worcestershire (Junctions 5–8). Two years of data from 1/1/1997.

3. The Warwickshire section of the M40. Two years of data from 1/1/1995. This road is unlit.

4. Rural roads in Lincolnshire. Two years of data from 1/1/1999 for the A1(T), A15(T), A52 and B6403.

5. An urban motorway, the M25, and the M20, a main arterial route to seaports in Kent. Two years of data from 1/1/1999.

6. The M6 and a lit section of the A38 in Staffordshire. Two years of data from 1/1/2000.

7. The M1 in Northamptonshire, being a lit section of a major motorway. Two years of data from 1/1/2000.

Overall, 17% of road traffic crashes (RTCs) resulting in injury or death were sleep related. Proportions varied between 3% and 30%, depending on the road type.

SRCs are more evident during the early hours of the morning, during the trough of the ‘body clock’, when people are naturally more sleepy at these times. Although increasing traffic density leads to increasing RTCs and SRCs per mile per year, both for 24h and during the early hours of the morning, the proportion of crashes that are SRCs increases as traffic volume increases on non-motorways, but for motorways
the opposite is true. That is, with increasing traffic volume, the proportion of RTCs that are SRCs decreases.

Artificial lighting during the hours of darkness marginally reduces RTCs on motorways having a high traffic density, and the proportion of these that are sleep related is also slightly reduced. On unlit motorways between 0530h and 0730h, it is naturally dark in the winter and light in the summer. In this situation, there are about half the RTCs in daylight than during the dark, however, the proportion of SRCs is marginally greater during these hours of daylight than darkness. Although this finding does take into consideration poor weather conditions, there are likely to be other seasonal factors.

Most (85%) of the drivers causing SRCs were men. 38% of all drivers causing SRCs were aged 30 or under. 67% of SRCs were caused by car drivers. A quarter of all crashes causing death or serious injury were SRCs. Given that 17% of RTCs are SRCs, this indicates that SRCs are about 50% more likely than the ‘average RTC’ to result in death or serious injury.

Clusters of SRCs were found on most of the roads we examined, indicating that certain sections of road facilitate these crashes.

Our audits were conservative. For example, RTCs during poor weather conditions were excluded from being SRCs even though sleepiness may have been the main cause. We are certain that a significant number of RTCs attributed to tyre blow-outs/deflation were tyre ‘blow-ins’, as a result of the crash, with the primary cause being sleep. Other crashes reportedly being caused by overweight vehicles were also excluded, although we suspected sleep often to be the cause.
INTRODUCTION

This report presents an overview of sleep-related crashes (SRCs) causing death or injury, based on analyses (‘audits’) of all road traffic crashes (RTC) from 15 sections of road, including four new audits presented as appendices to this report. Also included in the overview are data from three earlier audits (Nos 1–3 below), previously described in Road Safety Research Report No. 22 (Reyner et al., 2001). As SRCs tend to occur under monotonous driving conditions, we concentrated our audits on motorways that were both lit and unlit, that differed in traffic density and the number of lanes, and were urban and rural, including one to channel ports. However, audits were also carried out on monotonous ‘A’ trunk and (non-trunk) roads with dual and single carriageways, both lit and unlit, as well as on a ‘B’ single carriageway. The following roads were covered.

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4. Rural roads in Lincolnshire. Two years of data from 1/1/1999 for the A1(T), A15(T), A52 and B6403.

5. An urban motorway, the M25, and the M20, a main arterial route to seaports in Kent. Two years of data from 1/1/1999.

6. The M6 and a lit section of the A38 in Staffordshire. Two years of data from 1/1/2000.

7. The M1 in Northamptonshire, being a lit section of a major motorway. Two years of data from 1/1/2000.

We used our previously published criteria (Horne & Reyner, 1995) to establish the number and proportion of crashes that were SRCs, and to report on: the effect of traffic flow rates, the severity of injuries, the location of SRCs, the sex and age of the sleepy driver, the type of vehicle being driven, the effect of natural and artificial road lighting, and summary causations for all other RTCs.
METHOD

Different ‘types’ of roads (major and minor) with differing 24h traffic flows (Annual Average Daily Traffic Flows – AADTs) were selected. The types of roads covered are shown in Table 1.

<table>
<thead>
<tr>
<th>Table 1: Types of road</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MOTORWAYS</strong></td>
</tr>
<tr>
<td>• Lit and unlit</td>
</tr>
<tr>
<td>• 2 and 3 lanes</td>
</tr>
<tr>
<td>• Rural and urban</td>
</tr>
<tr>
<td>• Road to seaport</td>
</tr>
<tr>
<td>• Varying traffic density</td>
</tr>
<tr>
<td><strong>OTHER ROADS</strong></td>
</tr>
<tr>
<td>• ‘A’ trunk dual c/way</td>
</tr>
<tr>
<td>• ‘A’ dual c/way</td>
</tr>
<tr>
<td>• ‘A’ trunk single c/way</td>
</tr>
<tr>
<td>• ‘A’ single c/way</td>
</tr>
<tr>
<td>• ‘B’ single c/way</td>
</tr>
</tbody>
</table>

Data collection

We only report on data for RTCs resulting in injury and death, as the details collected by the attending police officers are far more extensive and informative than those involving ‘damage only’. Injury RTCs are reportable under Road Traffic Legislation (Section 170 of the Road Traffic Act 1988) and under the DfT STATS 19 system. STATS 19 casualty reporting identifies all those killed or injured in a road accident. This includes: persons who move quickly to avoid a vehicle but in doing so are injured, pedestrians injuring themselves on parked vehicles, and persons who fall from a vehicle and injure themselves. It excludes: death or injury to babies unborn up to the time of the accident, death due to natural causes (e.g. heart attack), confirmed suicides, persons who are merely shaken and who have no other injury, and accident witnesses (not directly involved) who suffer shock. STATS 19 casualty reporting indicates ‘Fatalities’ as being where death occurs in less than 30 days of the accident. ‘Serious Injury’ is identified as detention in hospital as an in-patient (either immediately or later), fracture, internal injury, burns (excluding friction burns), severe cuts, crushing, concussion, severe general shock requiring hospital treatment, and death occurring 30 days or more after the accident. ‘Slight Injury’ includes minor injuries not necessarily requiring medical attention, whiplash, sprains, bruises and cuts not judged to be severe, and slight shock requiring roadside attention (DfT, 1999).
The police forces responsible for each road were identified, and permission to collect data and produce reports for the DfT was sought from the appropriate Chief Constable. We liaised with traffic police officers at each of the constabularies, and with Accident Support Units and Criminal Justice Units.

Seven police forces were involved: Kent County Constabulary, Lincolnshire Police, West Mercia Constabulary, Northamptonshire Police, North Yorkshire Police, Staffordshire Police and Warwickshire Constabulary.

Data were collected for a two-year period for each of the 15 different sections of road.

Primary data were collected from the police Accident Report Forms completed by the officer attending the scene of an accident. Documentation that was also examined included: witness explanations and statements taken at the scene of the accident, postal questionnaires, and statements obtained by the police. The latter included statements by the driver deemed responsible for the accident, and from witnesses of the crash. Our evidence also included reports from the Accident Investigation Units, tachographs, photographs, sketch plans, and other correspondence relating to the crash. In addition, STATS 19 forms were consulted for information about the time of day, weather, sex and age of drivers and casualties. For each RTC we collected about 30 variables.

RTCs were categorised into ‘not an SRC’, ‘possible SRC’ or ‘probable SRC’ using previously published sleep-related criteria (Horne & Reyner, 1995), as shown below:

1. Good weather conditions and clear visibility.
2. Breathalyser/blood alcohol levels below the legal driving limit.
3. No mechanical defects to the vehicle.
4. Elimination of ‘speeding’ and ‘driving too close to the vehicle in front’.
5. Driver had no known medical disorder to cause the accident.
6. Vehicle either ran off the carriageway or ran into another vehicle that was clearly visible for several seconds beforehand – i.e. the incident was easily avoidable, and implying prolonged inattention.
7. No signs of pre-impact emergency swerving or braking, e.g. no skid marks before the impact.
8. The police officer at the scene suspected ‘sleepiness’.

If all criteria 1–7 applied, then the crash was a ‘possible SRC’. The inclusion of criterion 8 classified it as a ‘probable SRC’. The absence of this last criterion when criteria 1–7 is applied does not imply that the investigating officer excluded sleepiness.
Notes

Section 170 of the 1988 Road Traffic Act states that it is the duty of the driver to stop and report an accident and to give information or documents in cases where, owing to the presence of a motor vehicle on a road, an accident occurs on a main carriageway or highway where there is personal injury to a person other than the driver, or damage is caused to a vehicle other than that motor vehicle or trailer drawn by that motor vehicle, or, to an animal other than an animal in or on that motor vehicle or trailer drawn by that motor vehicle, or damage is caused to any other property constructed on, fixed to, growing in or otherwise forming part of the land on which the road in question is situated or land adjacent to such land.

‘Driver’ refers to the driver of Vehicle 1.

Traffic flow rates Average Annual Daily Traffic (AADT) flows and seasonal two hourly traffic flows were obtained for each section of road. Traffic flow rates were based on the mean of three summer months (June, July and August) and three winter months (October, November and December) unless otherwise stated.

Tyre ‘blow-ins’ differentiate from tyre ‘blow-outs’, and are used to describe tyre damage caused by the accident on impact.

Vehicle Type

HGV/LGV/MGV Some police records are not clear about vehicle type. ‘LGV’ can mean Light Goods Vehicles, those vehicles up to 3.5 tonnes maximum permissible gross vehicle weight, or Long Good Vehicle. ‘MGV’ refers to Medium Goods Vehicles, i.e. vehicles between 3.5 and 7.5 tonnes, and ‘HGV’ refers to Heavy Goods Vehicles, i.e. those vehicles over 7.5 tonnes maximum permissible gross vehicle weight. HGVs and MGVs are regulated vehicles and legally require tachographs. Note that ‘vans’ on police report forms may include vehicles of the van type constructed on a car chassis, or goods vehicles. ‘Other vehicles’ includes those such as motor caravans.
SECTION 1

PROPORTION OF ROAD TRAFFIC CRASHES CAUSED BY DRIVER SLEEPINESS

Road traffic crashes

- Data were obtained on a total of 1904 RTCs which occurred on the 15 different roads that resulted in death or serious or slight injury.
- Of these records, 76 files (4%) were missing or inadequate, being unavailable to view because they were at Court, or we were unable to identify causation owing to a lack of information.
- This left 1828 RTCs resulting in death or injury (96% of available data).

Sleep-related crashes

- Overall, 17% (316) of the RTCs were sleep related.
- The percentage of crashes caused by driver sleepiness varied between the road ‘types’, ranging from 3% (A19 single carriageway, North Yorkshire) to 30% (M40 Warwickshire).

Of these 316 crashes, 62% (197) were ‘possible’ and 38% (119) were ‘probable’ SRCs.

Severity and number of casualties

The severity of injuries as a result of SRCs on the 15 different roads is shown in Table 1.1. It should be noted that each RTC and SRC is identified by the worst outcome. That is, a fatal crash may also have involved serious and slight injuries which are not additionally identified.

<table>
<thead>
<tr>
<th>SEVERITY</th>
<th>All RTCs (%)</th>
<th>SRCs as % of all RTCs</th>
<th>‘Possible’ or ‘probable’ SRCs (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>54 (3%)</td>
<td>24%</td>
<td>13 (4%)</td>
</tr>
<tr>
<td>Serious</td>
<td>325 (18%)</td>
<td>24%</td>
<td>78 (25%)</td>
</tr>
<tr>
<td>Slight</td>
<td>1446 (79%)</td>
<td>15%</td>
<td>224 (71%)</td>
</tr>
<tr>
<td>Missing</td>
<td>3</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Total no.</td>
<td>1828 (100%)</td>
<td></td>
<td>316 (100%)</td>
</tr>
</tbody>
</table>
About one-quarter of all fatal crashes were caused by sleepy drivers. Similarly, one-quarter of all crashes resulting in serious injuries were SRCs.

The number of casualties in each RTC is not always recorded on police records, however, we have accurate data from several of the surveys. For motorways, there were 1729 casualties resulting in injury or death from 1117 RTCs, an average of 1.5 casualties per RTC. For SRCs, 292 casualties resulted from 205 SRCs, an average of 1.4 casualties per SRC, similar to RTCs. For non-motorways, there were 418 casualties resulting in injury or death from 258 RTCs, an average of 1.6 casualties per RTC. However, for SRCs, 107 casualties resulted from 30 SRCs, an average of 3.6 casualties per SRC, over twice the number for RTCs.

**Sex and age of drivers in crashes**

Data on sex and age were available for 14 of the 15 roads, and some records were incomplete, for age in particular. We can report on 86% (1645) of the full sample, where 82% (1343) of the RTCs were caused by men and 18% (302) by women. Figure 1.1 gives a further breakdown of these data.
36% (597) of these drivers were aged 30 or under (which includes three drivers under age, at 16 years of age). The number of crashes decreases as age increased.

For SRCs (278), 85% (236) were caused by men and 15% (42) by women. Further details can be seen in Figure 1.2.

![Figure 1.2: Sex and age of drivers in SRCs](chart)

38% (107) were drivers aged 30 or under. As with RTCs, the number of crashes decreased with age, although proportions were similar in the 31–40 and 41–50 age groups.

Young men are at a higher risk of having an SRC. This sample also shows that young women are at a higher risk of having SRCs than older women.

Table 1.2 gives a further breakdown of these proportions.

<table>
<thead>
<tr>
<th>Table 1.2: Men and women in RTCs versus SRCs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All RTCs</strong></td>
</tr>
<tr>
<td>• 82% men</td>
</tr>
<tr>
<td>• 18% women</td>
</tr>
<tr>
<td>• 35% of male drivers were aged 30 or under</td>
</tr>
<tr>
<td>• 43% of female drivers were aged 30 or under</td>
</tr>
</tbody>
</table>
Sex and age as predictors of crashes caused by driver sleepiness are similar to those for all causes.

**Vehicle type**

Data on vehicle type were unavailable for one road, the M40.

There was little difference between vehicle types for RTCs and SRCs. 67% of RTCs and SRCs were caused by car drivers. 23% of RTCs were caused by drivers of HGVs/LGVs/MGVs, compared to 26% in SRCs. If vans are included then these values rise to 29% and 33% respectively — see Table 1.3.

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>RTCs</th>
<th>SRCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>1142 (67%)</td>
<td>186 (67%)</td>
</tr>
<tr>
<td>Coach</td>
<td>7 (0.4%)</td>
<td>2 (0.7%)</td>
</tr>
<tr>
<td>Cycle</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>HGV/LGV</td>
<td>387 (23%)</td>
<td>73 (26%)</td>
</tr>
<tr>
<td>MGV</td>
<td>7 (0.4%)</td>
<td>1 (0.4%)</td>
</tr>
<tr>
<td>Van</td>
<td>98 (6%)</td>
<td>17 (6%)</td>
</tr>
<tr>
<td>Mcycle/Mscooter</td>
<td>35</td>
<td>0</td>
</tr>
<tr>
<td>Minibus</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Unavailable data</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1709</strong></td>
<td><strong>279</strong></td>
</tr>
</tbody>
</table>
SECTION 2

TIME OF DAY AND TRAFFIC DENSITY

Figure 2.1 compares traffic flow with the incidence of RTCs and SRCs in two hourly periods. Typically, flow is light during the early hours of the morning, whereas 32% (100) of the SRCs occurred then, compared to 12% for RTCs.

![Figure 2.1: Incidence of RTCs/SRCs and mean traffic flow, by time of day (all roads)](image)

In Figure 2.2 the total number of road crashes per mile per year for each road is plotted against 24h traffic density. Data are shown as motorways versus other roads (‘A’ and ‘B’ roads). As expected, RTCs rise as traffic volume increases. The incline is steeper for motorways. In both cases the correlation is significant at $r = 0.82$ (p < 0.02) for motorways and $r = 0.77$ (p < 0.02) for non-motorways.
Figure 2.2: 24h traffic density versus RTCs per mile per year for motorways and non-motorways

Figure 2.3 shows the comparable graph for SRCs.

Figure 2.3: 24h traffic density versus SRCs per mile per year for motorways and non-motorways
Here, SRCs rise as traffic density increases, as for the RTCs, however, the correlation for motorways is not significant \( r = 0.46 \) ns compared with the non-motorways \( r = 0.94, p < 0.001 \).

Given that SRCs are more likely to occur during the early hours of the morning, the next two figures show these data for 0200–0600h, beginning with Figure 2.4 for RTCs per mile per year, plotted against traffic density for the same period.

![Figure 2.4: 0200–0600h traffic density and RTCs per mile per year on motorways and non-motorways](image)

Here, the correlations are similar for both types of road \( r = 0.71, p < 0.05 \) for non-motorways and \( r = 0.86, p < 0.01 \) for motorways). However, for SRCs (Figure 2.5) the correlations are not significant \( r = 0.4 \) ns for non-motorways and \( r = 0.65 \) ns for motorways).
SRCs are linked to undemanding and monotonous driving conditions. However, if the two previous graphs are integrated to give SRCs as a proportion of RTCs, and again compared with traffic density, then there is an interesting outcome, as can be seen in Figure 2.6. Whereas for non-motorways the proportion of SRCs increases with traffic density to a significant extent ($r = 0.76$, $p < 0.03$), the reverse trend can be seen for motorways ($r = -0.79$, $p < 0.03$).
Figure 2.7 gives these data only for early morning (0200–0600h). Whilst the sample is too small for non-motorways and gives a random scatter, the negative association for motorways becomes stronger ($r = 0.98$, $p < 0.005$). Although the reasons for the latter are not clear, the most parsimonious explanation is that more vehicles on a motorway provide greater stimulation for drivers, which lessens the likelihood of sleepiness. With regard to the apparent opposite trend for non-motorways (Figure 2.6) we can only speculate; for example, that with increasing traffic density on these roads (which usually lack central crash barriers), a driver falling asleep and drifting across to the opposite lane is more likely to hit an oncoming vehicle.
Day of week

There is little clear trend for either RTCs or SRCs by day of week, although RTCs tend to peak on Friday (18%), as can be seen in Figure 2.8, whereas SRCs occurred least on Fridays (11%).
Month/season

Tables 2.1 and 2.2 show only minor seasonal changes for both RTCs and SRCs for the two groups of roads. 48% of all RTCs occurred in the six months of spring and summer, compared with 52% for SRCs.

<table>
<thead>
<tr>
<th>Month</th>
<th>RTCs Mways</th>
<th>RTCs non-Mways</th>
<th>Total RTCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring &amp; summer: April–September</td>
<td>627</td>
<td>256</td>
<td>883</td>
</tr>
<tr>
<td>Autumn &amp; winter: October–March</td>
<td>657</td>
<td>288</td>
<td>945</td>
</tr>
<tr>
<td><strong>Total no. of RTCs</strong></td>
<td><strong>1284</strong></td>
<td><strong>544</strong></td>
<td><strong>1828</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Month</th>
<th>SRCs Mways</th>
<th>SRCs non-Mways</th>
<th>Total SRCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring &amp; summer: April–September</td>
<td>128</td>
<td>37</td>
<td>165</td>
</tr>
<tr>
<td>Autumn &amp; winter: October–March</td>
<td>113</td>
<td>38</td>
<td>151</td>
</tr>
<tr>
<td><strong>Total no. of RTCs</strong></td>
<td><strong>241</strong></td>
<td><strong>75</strong></td>
<td><strong>316</strong></td>
</tr>
</tbody>
</table>
However, some difference can be seen for individual months, as can be seen in Figure 2.9. Motorway RTCs occurred most during October (11%) and December (12%). For SRCs it was October (12%) and August (11%). Noticeably, there were twice as many SRCs on non-motorways during the months of July, August and October compared with most other months.

Figure 2.9: Months and RTCs/SRCs

[Graph showing the number of RTCs and SRCs on motorways and non-motorways by month.]
SECTION 3

ROAD TRAFFIC CRASHES AND CAUSATION

The primary cause of each RTC is shown in Table 3.1. ‘Manoeuvre error’ includes lane swapping, overtaking and undertaking, ‘U’ turns and ‘pulling out’. ‘Speed’ includes driving too fast for the road and weather conditions. The ‘Shunt’ category includes too fast/too close for weather and road conditions and road layout. ‘Distraction’ includes attending to the radio/CD player, for example. ‘Other’ includes road rage, drivers leaning out of car windows to throw bottles or gum, etc.

RTCs for (all roads) were largely caused by driver impairment (79%). 28% were caused by manoeuvre error, and 24% by shunts and driving too close or too fast to the vehicle in front. 17% of RTCs were due to driver sleepiness (19% on motorways, 14% on non-motorways). 130 RTCs were attributed to tyre blow-outs or deflated tyres in the police crash report forms. However, some of these may well have been ‘blow-ins’ as a result of the crash rather than the cause. In addition, some RTCs were reported to be due to cars being overweight, e.g. carrying beer from seaports; some of these we suspect were due to sleepiness. We have excluded all these from being SRCs.

<table>
<thead>
<tr>
<th>CAUSE OF RTC</th>
<th>Motorways</th>
<th>Non-Motorways</th>
<th>Total RTCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep</td>
<td>241</td>
<td>75</td>
<td>316</td>
</tr>
<tr>
<td>Alcohol</td>
<td>42</td>
<td>20</td>
<td>62</td>
</tr>
<tr>
<td>Distraction</td>
<td>26</td>
<td>15</td>
<td>41</td>
</tr>
<tr>
<td>Driver illness</td>
<td>16</td>
<td>11</td>
<td>27</td>
</tr>
<tr>
<td>Drugs</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Maneouvre error</td>
<td>344</td>
<td>171</td>
<td>515</td>
</tr>
<tr>
<td>Excessive or inappropriate speed</td>
<td>321</td>
<td>111</td>
<td>432</td>
</tr>
<tr>
<td>Shunts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other, including too fast for road or weather conditions</td>
<td>12</td>
<td>37</td>
<td>49</td>
</tr>
<tr>
<td>SUB-TOTAL: DRIVER IMPAIRMENT</td>
<td>1004</td>
<td>442</td>
<td>1446</td>
</tr>
<tr>
<td>Insecure load/overweight vehicles/ debris on carriageway</td>
<td>32</td>
<td>15</td>
<td>47</td>
</tr>
<tr>
<td>Mechanical defect</td>
<td>11</td>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>Tyre blow-out/deflation</td>
<td>112</td>
<td>18</td>
<td>130</td>
</tr>
<tr>
<td>Weather</td>
<td>68</td>
<td>45</td>
<td>113</td>
</tr>
<tr>
<td>Other</td>
<td>57</td>
<td>14</td>
<td>71</td>
</tr>
<tr>
<td>SUB-TOTAL: NON-DRIVER IMPAIRMENT</td>
<td>280</td>
<td>102</td>
<td>382</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>1284</td>
<td>544</td>
<td>1828</td>
</tr>
</tbody>
</table>
SECTION 4
THE EFFECT OF NATURAL AND ARTIFICIAL LIGHTING

Introduction

A disproportionate number of crashes occur at night (when taking into account traffic flow), resulting in more severe injuries than during the daytime (Lay, 1998). It is claimed that road lighting can reduce the overall accident rate by 49% (Bruneau et al., 2001) and, more specifically, fatal crashes by 66% and all injury accidents by 25% (Lay, 1998). Extensive sections of rural motorways tend not to be lit.

Sleepy drivers are more prone to falling asleep at the wheel during the early hours of the morning at the circadian trough, when it is also dark. This section investigates the occurrence of SRCs with this factor in mind. In particular, we have undertaken two analyses:

1. Artificial lighting — RTCs and SRCs on comparable sections of lit and unlit motorways and other roads in the early morning 0000–0400h, when it is dark throughout the year.
2. Natural daylight versus darkness — On unlit motorways between 0530h and 0730h during the summer when it is naturally light and during the winter when it is naturally dark.

Artificial lighting

For the motorways in Study 1, two lit sections were ‘compared to’ two unlit sections, with one pair having average traffic flow rates and the other, heavy flow. The pairs were:

1. Rural motorways with average flow rates (around 80,000 vehicles/24h): the unlit section of the M40 in Warwickshire (AADT 78,115) and a lit section of the M5 in Worcestershire (AADT 81,294). Data were analysed for the period 0000h to 0400h when it is dark throughout the year.
2. Rural motorways with higher than average flow rates (around 100,000 vehicles/24h): the unlit section of the M6 in Staffordshire (AADT 103,507) and the lit section of the M1 in Northamptonshire (AADT 99,921).

Crashes (all causes and SRCs) per mile per year were calculated. The mean length of the motorway sections was 23 miles. Firstly, for RTCs, Figure 4.1 shows that lighting seems to have little effect in reducing RTCs on motorways with average
flows. A small improvement with lighting is seen with the high traffic flow motorways.

Lighting resulted in a more consistent but small reduction in the proportion of RTCs that were SRCs during these same hours (13% reduction for the motorways with average traffic flows and 6% for those with high traffic flow), as can be seen in Figure 4.2. However, as there was a reciprocal increase in non-sleepiness RTCs, it might be argued that lighting allows drivers to go faster because of the better visibility. In doing so they might be at greater risk of having a speed-related crash. Our data do not allow us to come to any conclusions over these possibilities.
The effect of natural light

We took data for 12 roads that had no artificial lighting, and compared the two, three month periods from May to July and November to January for the two hours 0530–0730h; i.e. hours when there was natural daylight or darkness. This time of day also falls within the trough of the 24h biological clock. These sections of roads were different types and comprised: motorways (M20, M25, M40 and M6), the A1(M), dual carriageways (A1(T) in North Yorkshire and in Lincolnshire the A19(T)/A168(T)), and single carriageways (A15(T), A19, A52 and the B6403).

Figure 4.3 shows more RTCs per mile per year during darkness compared with daylight hours. The opposite is true for SRCs, although to a lesser extent. As a proportion of RTCs, SRCs were 29% for daylight hours, compared with 11% for the dark. Of course, non-light related seasonal factors must have influenced these findings.
Figure 4.3: RTCs and SRCs during 0530–0730h per mile/year during daylight and darkness
MAIN CONCLUSIONS

1. Overall, 17% of RTCs resulting in injury or death were sleep-related (all road types). Proportions varied between 3% and 30%, depending on the road type. These are conservative values as we have excluded tyre blow-outs, likely SRCs in poor weather conditions, etc.

2. One-quarter of all crashes causing death or serious injury were SRCs.

3. Most (85%) of the drivers causing SRCs were men. 38% of all drivers causing SRCs were aged 30 years or under.

4. 67% of SRCs were caused by car drivers. 32% were caused by drivers of goods vehicles (HGVs/LGVs/MGVs and vans). Two SRCs were caused by coach drivers.

5. Whereas 12% of average daily RTCs occurred during the early hours of the morning (when traffic flow was low), 32% of daily SRCs occurred at this time.

6. The proportion of SRCs increases as traffic volumes increase on non-motorways. For motorways, the opposite is true where there is a significant negative correlation.

7. RTCs occurred most on Fridays, SRCs occurred least on Fridays and most on Mondays.

8. There was little seasonal change with RTCs and SRCs, although RTCs were more evident during October and December, whereas for SRCs this was during October and August.

9. 79% of all RTCs were caused by driver impairment.

10. When it is always dark throughout the year, i.e. between 0000h and 0400h, and when traffic flow and road distance are controlled for, artificial road lighting marginally reduced total RTCs on motorways and the proportion of crashes that were SRCs.

11. Comparing RTCs for the hours of 0530–0730h during the summer months, when the roads are naturally light, with the same hours during winter months, when the roads are naturally dark, there are notably less RTCs in daylight than in darkness. However, there is a marginally greater proportion of SRCs during natural daylight than during darkness.

12. There are clusters of SRCs on some sections of roads, to which we would like to draw attention (see Appendices A–D).
DISCUSSION

The proportion of RTCs caused by driver sleepiness varied depending on the road type.

In our sample of ‘A’ and ‘B’ roads, the greater the traffic density the greater the proportion of SRCs. On motorways, the opposite is true. The latter could be due to more vehicles on the road creating a less boring environment. The more vehicles there are on these roads, the more stimulation. However, other causes, such as manoeuvre error or speed including too fast/too close and shunts, are more evident.

A marginal reduction in the proportion of crashes that were SRCs on motorways when roads are artificially lit at night may be due to more stimulation for sleepy drivers. However, there are marginally more sleep crashes per mile per year when motorways are naturally light than in the dark. This could be due to drivers from different population groups driving on the roads in the summer during the early hours of the morning, perhaps holidaymakers less experienced at driving at this vulnerable time of the day.

Crashes occurring during poor weather conditions, or attributed on police records to tyre blow-outs or overweight vehicles, were all excluded from being an SRC. Thus, our analyses were conservative.
APPENDIX A

FATAL AND INJURY ROAD TRAFFIC CRASHES DUE TO DRIVER SLEEPINESS ON RURAL ROADS IN LINCOLNSHIRE, 1999–2000
INTRODUCTION

We undertook a comprehensive analysis of road traffic crash (RTC) data held by Lincolnshire Police for the following Lincolnshire roads, and for the two-year period 1999–2000:

- A1(T) dual carriageway
- A15(T) single carriageway
- A52 single carriageway
- B6403 single carriageway.

These roads were selected for being rural. The findings for the first two roads can also be compared with data from our earlier research (Reyner et al., 2001) for similar roads in North Yorkshire. The A1(T) in Lincolnshire is a major trunk road and can be compared with a more northerly section of this same road in North Yorkshire. Similarly, the A15(T) is a single carriageway road, which runs directly north/south from Lincoln to the M180, and can be compared with the A19(T) in North Yorkshire. The A52 in Lincolnshire is a ‘non-trunk’ single carriageway, ‘A’ class coastal road typical of the fens area. The B6403 (‘High Dyke’) is a ‘B’ class single carriageway which is particularly straight as it runs along the line of an old Roman road. Figure A1 shows the location of these roads.

The primary data were obtained from accident report files that included: accident report forms completed by the officer attending the scene of the accident, witness statements (including statements from drivers deemed responsible for the cause of the accidents), tachographs, photographs and all correspondence relating to the RTC. Data were from records held at Lincoln, Grantham and Boston Administrative Support Units located at various police stations.
Figure A1: Map of Lincolnshire showing A1(T) (N/S Grantham), A15(T) (north of Lincoln), A52 (Boston to Skegness) and B6403 (bypass Grantham)
A1(T) DUAL CARRIAGeway

The A1(T) in Lincolnshire comprises 21.5 miles of dual carriageway from the Lincolnshire/Nottinghamshire boundary in the north, to the Lincolnshire/Leicestershire boundary in the south. There are roundabouts 7.2 miles south of the Lincolnshire/Nottinghamshire border (Gonerby Moor roundabout) and at 18.5 miles south (Colsterworth roundabout).

Road Characteristics

From the north, southbound on the approach to Long Bennington bypass, the A1(T) is relatively straight and level for the first 2.5 miles. The road bends to the west of Long Bennington and is on an incline. The road declines beyond the bypass and rises again towards the crossroads at Foston village, located on a sweeping bend. Beyond the crossroads the road levels off and is relatively straight on the approach to Gonerby Moor roundabout. This section of the A1(T) is along the line of the Great North Road.

South of Gonerby Moor roundabout the road rises steadily, and sweeping bends form the Grantham Bypass. The road undulates and bends south of Grantham, towards Colsterworth roundabout.

South of Colsterworth roundabout to the county boundary (3 miles), the road is straight (with gradual inclines and declines), being set on the line of the old Roman road Ermine Street.

General

The A1(T) in Lincolnshire is unlit except at: Gonerby Moor roundabout, the Great Ponton area, and the Colsterworth roundabout to the junction with the B6403.

There are a number of crossroads and farm access roads that cross the central reservation. On the whole, main junctions are marked and have separate deceleration lanes within the central reservation or nearside verge. Farm access roads are unmarked and form gaps in the crash barrier. There are footpaths at Great Ponton (with a footbridge across the A1(T)) and north of Long Bennington (southbound).

Apart from cars, caravans and goods vehicles, there are slow moving agricultural vehicles, abnormal loads, coaches and pedal cycles. The A1(T) is also a bus route.

National speed limits apply. There are safety cameras on the southbound carriageway just north of Great Ponton, at Colsterworth crossroads and, on the northbound carriageway, just south of Great Ponton and Colsterworth roundabout.
Road surface

The road surface is hot-rolled asphalt, apart from a 2-mile section of concrete, 1.5 miles south of the county boundary with Nottinghamshire where there are warning signs (‘surface noise for 2 miles’) on both the northbound and southbound carriageways.

The width of each carriageway is 7.5 metres on average. There is a grassed central reservation which varies in width, with an Armco crash barrier (except where there is access for crossing the carriageway). The main carriageway is bordered on each side by a solid white reflective rumble strip with reflective cats eyes. There is a central white intermittent line with reflective cats eyes; these alternate between two standards to differentiate hazards. The hard shoulder is intermittent and infrequent.

Lay-bys

There are 29 lay-bys on the southbound carriageway and 31 on the northbound carriageway. They occur at intervals of about half a mile. The majority are unprotected, although a few follow the alignment of the old road and are protected by verge, trees, shrubs, etc. Some lay-bys have non-permanent tea/coffee vans.

The lay-bys are signed in advance, with blue/orange directional signs. Most have SOS phones. Regularly spaced marker posts on the nearside verge give directions to the nearest emergency phone.

Services

Services on the southbound carriageway are as follows:

- 6.0 miles – petrol filling station: facilities include 24h petrol, toilets, shop selling snacks, etc. There are no advance direction signs to this filling station.

- 7.3 miles – Gonerby Moor Services, located adjacent to Gonerby Moor roundabout and accessible for northbound and southbound traffic. Facilities include 24h petrol, toilets, accommodation and restaurant. There is a shop, but this is not open 24h. There is overnight parking, which is pay and display when one is parked for more than two hours. There are advance direction signs to this service area.

- 14.5 miles – McDonald’s restaurant: opening hours are from 7.30 am to 10.00 pm. There are no advance direction signs to this restaurant.

- 18.5 miles – Colsterworth Services, located adjacent to Colsterworth roundabout and accessible for northbound and southbound traffic. Facilities include 24h petrol, toilets and accommodation. There is a Little Chef which is open from 7.00 am to 10.00 pm and a Burger King, open from 10.00 am to
10.00 pm. There is a shop, but this is not open for 24h. There are advance direction signs to this service area.

- 21.1 miles – public house: open for usual opening hours with food and accommodation. There is also a separate Little Chef, open from 7.00 am until 10.00 pm. There are no advance direction signs to this restaurant.

Services on the northbound carriageway are as follows:

- 0.1 miles – Little Chef and Travelodge. The Little Chef is open from 7.00 am until 10.00 pm. There are advance direction signs to this service area. Note that there is also access through the central reservation to the public house on the southbound carriageway.
- 2.5 miles – Colsterworth Services (see above).
- 5.7 miles – McDonald’s restaurant and petrol filling station. The latter is open 24h. McDonald’s is open from 7.30 am until 10.00 pm. There are advance direction signs to this service area.
- 7.3 miles – petrol filling station with shop selling snacks, etc. These facilities are not 24h. There are advance direction signs to this service area.
- 14.0 miles – Gonerby Moor Service Area (see above).
- 15.5 miles – access to the petrol filling station on the southbound carriageway (see above).
- 16.7 miles – Little Chef, open from 7.00 am until 10.00 pm, and petrol filling station, open from 6.30 am until 10.00 pm. There are advance direction signs to this service area.

In addition, there are café facilities available from caravans in some lay-bys.

At the junction with the A607, there are brown and white tourist direction signs to facilities at Grantham, and at South Witham there are signs to a public house which is open from 12 noon until 11.30 pm.
RESULTS

During the two-year period 1 January 1999 to 31 December 2000, Lincolnshire Police were called to 100 RTCs involving injury or death on this section of 21.5 mile A1(T) dual carriageway. One of these RTCs occurred on a slip road.

Thus, 99 RTCs occurred on the main carriageways of the A1(T) in Lincolnshire.

- 49% (49) of the 99 RTCs involved vehicles travelling northbound; 35% (35) were southbound. These numbers include four accidents when the vehicles were approaching or queuing at roundabouts. Thirteen of the 99 accidents occurred when the driver was entering or circumnavigating a roundabout (within the audit). Two files were unavailable to view (at Court).
- Of these 99 RTCs, 16% (16) were ‘possible’ or ‘probable’ SRCs.
- Of these 16 SRCs, 37% (6) were northbound and 62% (10) were southbound.
- Two of the 6 northbound SRCs were ‘probable’ and 4 were ‘possible’.
- Four of the 10 southbound SRCs were ‘probable’ and 6 were ‘possible’.

Roundabouts

Thirteen of the RTCs occurred when drivers were negotiating one of the two roundabouts situated within the audit area of the A1. Five were at the roundabout at Colsterwoth, and eight were at Gonerby Moor. The reasons for these accidents included: drivers being confused about direction, goods’ vehicles entering the roundabout too fast in high winds, alcohol, moving into the outside lane already occupied by another vehicle, no indication to move lanes, etc.

Severity

RTCs are identified as: fatal, serious injury and slight injury.

Table A1 shows that 50% of the RTCs we identified as possibly or probably sleep related resulted in serious injury (no fatal). This comprised 33% of the total number of all RTCs resulting in serious injury. The remaining 50% of the SRCs resulting in slight injury compares with 12% for all RTCs.

| Table A1: Severity of RTCs and SRCs, A1(T) Lincolnshire, 1999–2000 |
|-------------------|-----------------|-----------------|-----------------|
| SEVERITY          | All RTCs (%)    | SRCs as % of all RTCs | ‘Possible’ or ‘probable’ SRCs (%) |
| Fatal             | 7 (7%)          | 0                | 0               |
| Serious           | 24 (24%)        | 33%              | 8 (50%)         |
| Slight            | 66 (67%)        | 12%              | 8 (50%)         |
| Unknown/file unavailable | 2 (2%)       | 0                | 0               |
| Total no.         | 99 (100%)       | 16 (100%)        |                 |
Number of casualties

In total, 151 persons were injured in the 97 RTCs (where files were available to view and data entered), that is, 7 fatalities, 33 serious injuries and 111 slight injuries. Note that from the 16 SRCs resulting in injury, there were 28 injured persons: 10 were seriously injured and 18 slightly injured.

Causes of RTCs

Table A2 shows the causes of all RTCs. Classification under the category ‘manoeuvre error’ includes lane swapping, overtaking and undertaking. ‘Distraction’ includes attending to the radio, for example. Table A2 shows that RTCs on the A1(T) in Lincolnshire were caused largely by driver impairment, with 27% of those RTCs due to manoeuvre error. 16% were caused by sleepiness, and 17% were as a result of shunts.

<table>
<thead>
<tr>
<th>CAUSE OF RTC</th>
<th>A1(T) LINCOLNSHIRE NORTHBOUND RTCs</th>
<th>A1(T) LINCOLNSHIRE SOUTHBOUND RTCs</th>
<th>A1(T) TOTAL NO. OF RTCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep</td>
<td>6</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>Manoeuvre error, including overtaking and errors at roadworks</td>
<td>20</td>
<td>7</td>
<td>27</td>
</tr>
<tr>
<td>Excessive or inappropriate speed</td>
<td>Shunts</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Other, including too fast for road or weather conditions</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Distraction</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Driver illness/medical</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Alcohol</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Drugs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SUB-TOTAL: DRIVER IMPAIRMENT</td>
<td>44</td>
<td>25</td>
<td>69</td>
</tr>
<tr>
<td>Tyre blow-outs/deflation</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Mechanical defect</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Insecure load/debris on road/animal on road</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Weather</td>
<td>0</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>SUB-TOTAL: NON-DRIVER IMPAIRMENT</td>
<td>5</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>49</td>
<td>35*</td>
<td>84*</td>
</tr>
</tbody>
</table>

* Note that 13 RTCs occurred on, or negotiating, a roundabout. Two files were unavailable to view.
Time of day/traffic flow

Mean traffic flow rates on the A1(T) were measured at site 9401 Barrowby for northbound traffic, and site 9402 Barrowby for southbound traffic. Summer flows are represented from mean weekly flow data (Monday to Sunday) collected during June to August 2000, and winter flows are represented from mean weekly traffic flows (Monday to Sunday) collected during the period 30 October 2000 to 24 December 2000.

Figure A2: Incidence of RTCs/SRCs and mean summer and winter traffic flows on the A1(T) Lincolnshire, by time of day 1999–2000

Mean 24h summer traffic flow (both directions) was 39,251 vehicles and mean 24h winter traffic flow (both directions) was 37,261 vehicles. As usual, traffic flow was low during the night/early morning. 31% of SRCs occurred between midnight and 0800h, compared with 21% for all RTCs.

Location of SRCs

Figure A3 shows the location of SRCs. There was a cluster of three SRCs (two southbound and one northbound) just north of Long Bennington, and two SRCs (one northbound and one southbound) occurred at exactly the same location on the straight section of the A1(T) just north of Grantham.
Sex and age of drivers in SRCS

75% of these drivers were men (N = 12), and 50% of all these drivers were aged 40 or under. The age for one driver was unknown.

Day of week for SRCS

Notably, 31% of SRCS occurred on a Saturday. 44% of SRCS occurred during the weekend, compared with 28% of all RTCs.

Month/season

There was no obvious seasonal difference with SRCS, as can be seen in Table A3 for the A1(T).

<table>
<thead>
<tr>
<th>Table A3: Number of SRCS per month, A1(T) Lincolnshire 1999–2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month 1999–2000</td>
</tr>
<tr>
<td>Spring &amp; summer: April–September</td>
</tr>
<tr>
<td>Autumn &amp; winter: October–March</td>
</tr>
<tr>
<td>Total no. of SRCS</td>
</tr>
</tbody>
</table>

SRCs and vehicle type

69% (11) of the 16 SRCS were caused by cars registered for private use. 31% (5) were caused by HGVs/LGVs and a pick-up truck, all of which were registered for business use.
A15(T) SINGLE CARRIAGEWAY

The A15(T) runs north/south through Lincolnshire, from the M180 in the north to the A46(T) ring-road around the city of Lincoln. RTCs at the roundabout with the A46(T) ring-road have been excluded from the audit to match with audits of roads in North Yorkshire. There is a roundabout along the section of road within the audit at Caenby Corner, 10 miles north of Lincoln.

This rural trunk route comprises 14.7 miles of single carriageway.

ROAD CHARACTERISTICS

The A15(T) is straight, along the line of the old Roman road, Ermine Street, except for a sweeping bend where the road bypasses the runway area of RAF Scampton. On this bend there are crossroads with a right turn facility (to Hackthorn and Brattleby village). There are slight inclines and declines.

General

The A15(T) is primarily unlit. There are sections of lighting from the Lincoln bypass to just north of RAF Scampton, and at Caenby Corner roundabout.

There are a number of junctions and farm accesses along the A15(T). Generally, the junctions are marked with standard ‘give way’ markings and have either/or/and advance warning signs, advance direction signs and local flag signs (located directly opposite or in the mouth of junctions). A number of the junctions south of Caenby Corner roundabout have right turn facilities.

Traffic also includes slow moving agricultural vehicles, coaches, pedal cycles, etc. The A15(T) is also a bus route.

There is a 50 mph speed limit from Lincoln bypass to north of RAF Scampton, after which the route is very rural, with no lighting, no footpath, and is derestricted.

There are safety cameras on the northbound carriageway at the showground north of Lincoln within the 50 mph speed limit, and on the southbound carriageway at Snitterby.

There are roadside footpaths northwards from Lincoln bypass to RAF Scampton, and at Caenby Corner.

There are parking restrictions for RAF Cranwell, extending north to Hackthorn crossroads. There are ‘low flying aircraft’ warning signs.
Road surface

South of Caenby Corner roundabout, the road surface of the A15(T) is mainly hot-rolled asphalt. North of Caenby Corner, the road has thin surfacing (a relatively new type of surfacing that is noticeably quieter when driven on).

The average width of the carriageway is 7 m. Each carriageway is edged with a solid white reflective line. South of Caenby Corner roundabout there is mostly a metre strip between this edgeline and the edge of the carriageway; there is no metre strip north of Caenby Corner.

Generally, there is a central single white intermittent line that alternates between two standards to differentiate hazards. There are also lengths of double white lines along the route. Reflective catseyes are within the white centre lines.

Lay-bys

There are two lay-bys on the southbound carriageway, one at Hackthorn crossroads, 4.7 miles from the Lincoln bypass, and one at Snitterby, 11.5 miles north of the Lincoln bypass. On the northbound carriageway, there is one lay-by at Spridlington, 6.2 miles from the Lincoln bypass. All lay-bys on this section of the A15 are unprotected.

Services

There is a service area at Caenby Corner roundabout. Facilities include a Little Chef, Truck Stop café and 24hr petrol. There are no advance direction signs to this service area.
RESULTS

During the two-year period from 1 January 1999 to 31 December 2000, Lincolnshire Police were called to 41 RTCs on this section of the A15(T) single carriageway.

- 53.6% (22) of these 41 RTCs were northbound; 41.5% (17) were southbound.

The carriageway location was unknown for one RTC. One accident file was unavailable to view.

- Of these 41 RTCs, 17% (7) were ‘possible’ or ‘probable’ SRCs.
- Four of these seven SRCs were northbound, and three southbound.
- Three of the northbound SRCs were ‘probable’, and one ‘possible’.
- Two of the southbound SRCs were ‘probable’, and one ‘possible’.

Severity

Table A4 shows that 33% of RTCs resulting in fatalities were possibly or probably sleep related. 43% of all SRCs resulted in death or serious injury.

<table>
<thead>
<tr>
<th>SEVERITY</th>
<th>All RTCs (%)</th>
<th>SRCs as % of RTCs</th>
<th>‘Possible’ or ‘probable’ SRCs (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>6 (15%)</td>
<td>33%</td>
<td>2 (29%)</td>
</tr>
<tr>
<td>Serious injury</td>
<td>10 (24%)</td>
<td>10%</td>
<td>1 (14%)</td>
</tr>
<tr>
<td>Slight injury</td>
<td>24 (59%)</td>
<td>16%</td>
<td>4 (57%)</td>
</tr>
<tr>
<td>Unknown</td>
<td>1 (2%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total no.</td>
<td>41 (100%)</td>
<td></td>
<td>7 (100%)</td>
</tr>
</tbody>
</table>

Number of casualties

There were 7 fatalities and 72 injured persons as a result of the 41 RTCs. 24 of the injuries were serious and 48 were slight.

There were three fatalities and 11 injuries as a result of the SRCs. Two of the latter were serious and nine were slight.

Causes of RTCs

Table A5 shows the causes of all RTCs. Most (31) RTCs on the A15(T) were caused by driver error; 29% (12) due to shunts, which included vehicles being driven into the back of stationary vehicles waiting to turn off the road, and drivers approaching Caenby Corner roundabout too fast.
Mean traffic flows on the A15(T) were measured at sites 9405 (northbound vehicles) and 9406 (southbound vehicles), Caenby Corner. The incidence of RTCs and SRCs, with mean traffic flow by time of day, are shown in Figure A4.

Mean 24 hr summer traffic flow was 9,542 vehicles and mean 24 hr winter traffic flow was 9,104 vehicles. As expected, traffic flow was light during the night and early hours of the morning. 29% of SRCs occurred between 0000h and 0600h, compared with 13% of all RTCs.

### Table A5: Causes of RTCs on the A15(T) Lincolnshire, 1999–2000

<table>
<thead>
<tr>
<th>CAUSE OF RTC</th>
<th>A15(T) LINCOLNSHIRE NORTHBOUND RTCs</th>
<th>A15(T) LINCOLNSHIRE SOUTHBOUND RTCs</th>
<th>A15(T) TOTAL NO. OF RTCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Manoeuvre error, including overtaking and errors at roadworks</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Excessive or inappropriate speed</td>
<td>Shunts</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Other, including too fast for road or weather conditions</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Distraction</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Driver illness/medical</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Alcohol</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Drugs</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>SUB-TOTAL: DRIVER IMPAIRMENT</strong></td>
<td>18</td>
<td>13</td>
<td>31</td>
</tr>
<tr>
<td>Tyre blow-outs/deflation</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Weather</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>SUB-TOTAL: NON-DRIVER IMPAIRMENT</strong></td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td>22</td>
<td>17</td>
<td>39*</td>
</tr>
</tbody>
</table>

* Note that the direction was incomplete on the accident record form for one RTC (causation, Alcohol), and that one file was unavailable to view.

**Time of day/traffic flow**

Mean traffic flows on the A15(T) were measured at sites 9405 (northbound vehicles) and 9406 (southbound vehicles), Caenby Corner. The incidence of RTCs and SRCs, with mean traffic flow by time of day, are shown in Figure A4.

Mean 24 hr summer traffic flow was 9,542 vehicles and mean 24 hr winter traffic flow was 9,104 vehicles. As expected, traffic flow was light during the night and early hours of the morning. 29% of SRCs occurred between 0000h and 0600h, compared with 13% of all RTCs.
Location of SRCs

Figure A5 shows the location of SRCs on the A15(T).
Sex and age of drivers in SRCs

All of the drivers in SRCs on the A15(T) were men, and over half were 40 years of age or under.

Day of week for SRCs

Three SRCs occurred during the weekend. Eleven of the 41 RTCs occurred during the weekend.

Month/season

Table A6 shows the season when SRCs occurred on the A15(T).

<table>
<thead>
<tr>
<th>Month 1999–2000</th>
<th>SRCs A15(T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring and summer: April–September</td>
<td>3</td>
</tr>
<tr>
<td>Autumn and winter: October–March</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total no. of SRCs</strong></td>
<td><strong>7</strong></td>
</tr>
</tbody>
</table>

SRCs and vehicle type

71% (5) of the SRCs involved cars. One SRC involved a van used for business, and one SRC involved an HGV.
A52 SINGLE CARRIAGEWAY

The A52 runs northeast/southwest along the eastern side of Lincolnshire from Boston to Skegness on the coast. It forms the coast route for visitors to the area from the south. This rural route comprises 20 miles of two-way single carriageway.

ROAD CHARACTERISTICS

The A52 is relatively flat as it lies in the ‘fens’ area of Lincolnshire. The area to the east is mainly mud flats. There are infrequent straight lengths of road as the road mostly winds through minor coastal villages. Skegness is the only seaside resort.

General

The A52 is lit at specific areas along the route. These are: Boston, Freiston, Butterwick, Benington, Leverton, Old Leake, Wrangle, Wainfleet St Mary and Skegness.

There are no major junctions along the A52. There are numerous minor junctions and farm accesses. Junctions are generally marked with standard give way markings, and are signed out of the villages with junction warning signs and local flag signs. Some busier junctions also have an advance direction sign.

This section of the A52 carries varied traffic, including caravans, slow moving agricultural vehicles, coaches, pedal cycles, etc. The A52 is also a bus route.

There are short lengths of road that generally have 40 mph speed limits, with street lighting and footpaths.

There is a safety camera on the northbound carriageway at Freiston, and one on the southbound carriageway at Wrangle.

Road surface

Most of the road surface is surface dressed (road surface sprayed with tar and covered with chippings to increase skid resistance). There are occasional lengths of hot-rolled asphalt and thin surfacing (quieter surface).

The average road width is 6.5m. Generally, the carriageway has a central single white intermittent line that alternates between two standards to differentiate hazards. There are occasional lengths of double white lines. There are reflective catseyes within the white centre lines, except for street lit sections.
Lay-bys

There are lay-bys northbound at Boston, Leverton and Friskney, and southbound at Wrangle, Wainfleet and Croft. All these lay-bys are accessible from both directions.

Services

There are numerous facilities along this section of the A52, although none of them are open for 24h. Services include the following.

- Boston – two public houses, one with a restaurant, the other selling food. There is a café at a garden centre.
- Freiston – inn, providing food and accommodation.
- Benington – public house, and village stores.
- Leverton – public house, picnic site with toilets and shop (signed in advance), village stores, and garage selling petrol.
- Wrangle – public house selling food, tea room, village stores, and garage selling petrol.
- Friskney – public house.
- Croft – petrol filling station, and numerous static/touring caravan sites.

Facilities at Wainfleet are signed from the A52, with brown and white facility signs.
RESULTS

During the two-year period, Lincolnshire Police were called to 88 RTCs involving injury or death on this section of the A52 single carriageway from Boston to Skegness.

Four files were unavailable to view.

- 54% (48) of the 88 RTCs occurred on the A52 towards Skegness (in an easterly or northerly direction); 41% (36) occurred towards Boston (in a westerly or southerly direction). The direction was unknown for the four vehicles where the files were unavailable for viewing.

- Of these 88 RTCs, 4% (4) were ‘possible’ or ‘probable’ SRCs.

- Three of these SRCs were northbound, and one was southbound.

- One of the northbound SRCs was ‘probable’, the other two were ‘possible’.

- The southbound SRC was ‘possible’.

Severity

Table A7 shows that all of the SRCs resulted in death or serious injury. 40% of all RTCs resulting in fatal injuries were possibly or probably sleep related.

<table>
<thead>
<tr>
<th>SEVERITY</th>
<th>All RTCs (%)</th>
<th>SRCs as % of RTCs</th>
<th>‘Possible’ or ‘probable’ SRCs (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>5 (5.7%)</td>
<td>40%</td>
<td>2 (50%)</td>
</tr>
<tr>
<td>Serious injury</td>
<td>13 (14.8%)</td>
<td>15%</td>
<td>2 (50%)</td>
</tr>
<tr>
<td>Slight injury</td>
<td>66 (75%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Files unavailable to view</td>
<td>4 (4.5%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total no.</td>
<td>88 (100%)</td>
<td>0</td>
<td>4 (100%)</td>
</tr>
</tbody>
</table>

Number of casualties

Six people were killed and 131 people were injured (22 serious) in these 84 RTCs. Two people were killed, one person seriously injured, and five people slightly injured from one of the SRCs. In the four SRCs, three people died, four were seriously injured, and five received slight injuries; making a total of 12 casualties.

Causes of RTCs

Table A8 shows that most (67) RTCs on the A52 were caused by driver error. 16% (14) were caused by vehicles travelling too fast for the road, on bends and for the
road surface condition, with an additional 20% (18) involving shunts, including vehicles running into the back of stationary vehicles waiting to turn. 25% (22) were caused by manoeuvre error, such as overtaking.

<table>
<thead>
<tr>
<th>CAUSE OF RTC</th>
<th>A52 LINCOLNSHIRE NORTH/EASTBOUND RTCs</th>
<th>A52 LINCOLNSHIRE SOUTH/WESTBOUND RTCs</th>
<th>A52 TOTAL NO. RTCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Manoeuvre error, including overtaking</td>
<td>11</td>
<td>11</td>
<td>22</td>
</tr>
<tr>
<td>Excessive or inappropriate speed</td>
<td>10</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>Shunts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other, including too fast for road or weather conditions</td>
<td>8</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Distraction</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Driver illness/medical</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Alcohol</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td><strong>SUB-TOTAL: DRIVER IMPAIRMENT</strong></td>
<td>40</td>
<td>27</td>
<td>67</td>
</tr>
<tr>
<td>Mechanical defect</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Insecure load/substance on road/animal on road</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Weather</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>SUB-TOTAL: NON-DRIVER IMPAIRMENT</strong></td>
<td>8</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td>48</td>
<td>36</td>
<td>84*</td>
</tr>
</tbody>
</table>

* Note that four files were unavailable to view.

**Time of day/traffic flow**

Mean traffic flows on the A52 were measured at sites just south of Skegness, in both directions, towards Skegness and towards Boston.

Figure A6 shows the incidence of RTCs/SRCs and mean summer (weeks during June to August 2000) and winter (weeks during October to December 2000) traffic flows for an average day, Monday to Sunday, by time of day.
Mean 24h summer traffic flow rates (both directions) was 10,875 vehicles. Traffic flow during the winter months was 30% lower than during the summer, at 7,684 vehicles per 24h (both directions). 31% of SRCs occurred between 0000h and 0800h, compared with 21% of all RTCs.

**Location of SRCs**

Figure A7 shows the location of SRCs.

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**Figure A6: Incidence of RTCs/SRCs and mean summer and winter traffic flows on the A52 Lincolnshire, by time of day 1999–2000**

[Graph showing RTCs and SRCs along with mean traffic flow rates by time of day]
Sex and age of drivers in SRCs

Two of the drivers in the SRCs were women, both aged 18; the men were aged 26 and 78.

Day of week for SRCs

There was one SRC on a Wednesday, Thursday, Friday and Sunday. 31% of all RTCs occurred during the weekend.

Month

Two SRCs occurred during August, one during September, and one during November.

SRCs and vehicle type

All of these four drivers were driving cars.
The B6403 runs north/south through the southwest quadrant of Lincolnshire, between the A17(T) (Byard’s Leap) in the north and the A1(T) (Colsterworth) in the south, to the east of Grantham. This rural route comprises 15.9 miles of two-way single carriageway. Northwards, there is a roundabout 5.9 miles on the B6403/A52 to Grantham, and indicated crossroads 12 miles north at the junction with the A153.

**ROAD CHARACTERISTICS**

The B6403 runs along the line of the old Roman road *Ermine Street*, and is known as ‘High Dyke’.

Northbound, the first 5.9 miles to the roundabout controlled junction with the A52 is undulating and bends frequently. At 2.7 miles there is a decline towards the railway bridge. The road bends sharply to the right before the bridge and then sharply to the left beyond the bridge. The road continues straight, but undulates with the contours of the land; thus there are dips in the road. There are traffic signals at Ancaster village, 6.1 miles from the A52/B6403 roundabout. The final stretch northbound from Ancaster is straight (3.9 miles).

**General**

The B6403 is *unlit* except at the junction with the A1(T), the roundabout at the A52, the right turn facility into RAF Barkston, Ancaster village and the junction with the A17(T).

There are a number of junctions, farm accesses and public footpaths/bridleways along this rural route. Generally, the junctions are marked with standard give way markings and have either/or/and advance warning signs, advance direction signs and local flag signs.

The B6403 carried varied traffic, including cars and caravans, slow moving agricultural vehicles, coaches, pedal cycles, etc. The B6403 is also a bus route.

There is infrequent roadside development along this road. Apart from Ancaster, any development consists of farm buildings and small hamlets.

Ancaster village is subject to a 30 mph speed limit. Otherwise, the route is derestricted.

Southwards from the junction with the A17(T), the *Viking Way* footpath runs along the B6403, for approximately 1.5 miles (not visible from the highway).
Road surface

Most of the road is surface dressed. There are occasional sections of hot-rolled asphalt and thin surfacing. The average road width is 6.5 m. On the whole, the carriageway has a central single white intermittent line that alternates between two standards to differentiate hazards. There are also sections of road with double white lines. There are reflective catseyes within the white lines, except on the section of road through Ancaster village where there is street lighting.

Lay-bys

There are no designated lay-bys.

Services

There are no specified areas along this route. There are various facilities within the village of Ancaster that front the B6403, including village stores and petrol (not 24h). There is a café at the junction with the A17(T).
RESULTS

During the two-year period 1 January 1999 to 31 December 2000, Lincolnshire Police were called to 32 RTCs involving injury or death on the B6403 east of Grantham, between the A1(T) at Colsterworth and the A17(T) at Cranwell.

- 62.5% (20) of the 32 RTCs were northbound; 34.4% (11) were southbound. The direction was unknown for one RTC.
- Of these 32 RTCs, 6% (2) were ‘possible’ SRCs.
- Both these SRCs were north/northeastbound.

Severity

Table A9 shows the severity of RTCs and SRCs on the B6403. 8% of all RTCs resulted in serious injury; all of which were possibly or probably sleep related.

<table>
<thead>
<tr>
<th>SEVERITY</th>
<th>All RTCs (%)</th>
<th>SRCs as % of RTCs</th>
<th>‘Possible’ or ‘probable’ SRCs (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>1 (3%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Serious injury</td>
<td>13 (41%)</td>
<td>8%</td>
<td>1 (50%)</td>
</tr>
<tr>
<td>Slight injury</td>
<td>18 (56%)</td>
<td>5%</td>
<td>1 (50%)</td>
</tr>
<tr>
<td>Total no.</td>
<td>32 (100%)</td>
<td></td>
<td>2 (100%)</td>
</tr>
</tbody>
</table>

Number of casualties

There was one fatality, and 45 people were injured in the 32 RTCs. Sixteen of the latter were seriously injured.

Causes of RTCs

Table A10 shows that 41% of RTCs were caused by manoeuvre error. This included overtaking, turning into the path of other vehicles, etc.
Mean traffic flows on the B6403 were measured 250 m south of Welby junction, near Ancaster. Hourly traffic flow data for summer and winter periods 1999–2000 were unavailable.

Figure A8 shows the incidence of RTCs and when the two SRGs occurred, together with the mean Monday to Sunday traffic flow from a one-week period during October 2001 (23–29 October), by time of day. The daily average flow (Monday to Sunday) was 5801 vehicles (northbound plus southbound).
Location of SRCs

Figure A9 shows the location of SRCs.
Sex and age of drivers in SRCs
The drivers in the SRCs were a 23-year-old woman, and a 50-year-old man.

Day of week for SRCs
One of the SRCs occurred on a Sunday, the other on a Monday. 22% of all RTCs occurred during the weekend.

Month
Both of the SRCs occurred during the month of July.

SRCs and vehicle type
One of the SRCs was caused by a car, the other by an HGV.
OVERALL CONCLUSIONS

1. 16% of RTCs on the A1(T) dual carriageway were possibly or probably caused by driver sleepiness.

2. 17% of RTCs on the A15(T) single carriageway were possibly or probably caused by driver sleepiness.

3. 33% of RTCs on the A1(T) involving serious injuries were sleep related, 33% of fatal RTCs on the A15(T) were SRCs, and 40% of fatal RTCs on the A52 were possibly or probably sleep related.

4. Most of the drivers in SRCs were men, and on the A1(T) and the A15(T) 50% were 40 years of age or under.

5. 41% of the SRCs occurred during the weekend compared with 28% of all RTCs.

6. 52% of the SRCs occurred during the spring and summer months. 48% occurred during the autumn and winter months.

7. 73% of the SRCs were caused by drivers in cars, 24% were caused by HGV/ LGV drivers (one SRC was caused by a van driver).
DISCUSSION AND COMMENT

1. In comparison with our road crash audit of the A19(T) single carriageway in North Yorkshire, the percentage of SRCs occurring on the A15(T) in Lincolnshire is high: 17% on the A15(T) compared with 3% on the A19(T) (Reyner et al., 2001). However, the number of RTCs (all causes) was higher on the A19(T) (73) than the A15(T) (41). The higher number of SRCs on the A15(T) in Lincolnshire might be associated with it being straight, except for a sweeping bend around RAF Scampton. It is a Roman road, and runs north/south from Lincoln to the M180. Note that the traffic flow is much lower on the A15(T) than the A19(T) (9323 versus 48,688 vehicles).

2. The percentage of accidents due to sleepiness on the A1(T) is similar to our findings from our road crash audit for the A1(T) in North Yorkshire.

3. The A52 is a ‘non-trunk’ single carriageway road through fenland, with infrequent straight sections of road. There were more RTCs caused by alcohol than sleep on this coastal route (six RTCs due to alcohol, and four due to sleep).

4. The B6403, or ‘High Dyke’, runs along the line of an old Roman road. The number of SRCs on this rural route was low. 41% of RTCs were caused by manoeuvre error.

5. One of these roads is a possible cause for particular concern; the section of the A15(T). It seems to have a higher than average occurrence (16%) of SRCs for its road type (note it has a relatively low traffic flow). Most of the SRCs on this road were ‘probable’. Furthermore, 30% were fatal (33% of all the fatal RTCs on this road were SRCs). 14 people were injured as a result of these SRCs. However, our study was only over a period of two years, and we have reported on relatively small numbers. Ideally, data should be collected for a further one or two years.
APPENDIX B

FATAL AND INJURY ROAD TRAFFIC CRASHES CAUSED BY DRIVER SLEEPINESS ON SECTIONS OF THE M25 (an urban motorway with high traffic flow) AND THE M20 (a motorway to channel ports) IN KENT, 1999–2000
INTRODUCTION

We undertook a comprehensive data collection and analysis of injury and death road traffic crash (RTC) records held by Kent County Constabulary for the two-year period 1999–2000 on sections of the M25 and the M20.

The M25 was selected because it is an ‘urban’ motorway with high traffic flow. The M20 is the major route from London to the coastal ports of Dover and Folkestone, and the channel tunnel at Ashford.

Figure B1 shows the location of these roads.

The primary data were from files which included crash report forms completed by the officer attending the scene, witness statements (including statements from the drivers deemed responsible for the crash), tachographs, photographs, and all correspondence relating to the RTC. Data were obtained from records held at Ashford and Gravesend Police Administration and Processing Units.
Figure B1a: Map showing M25 Kent J2 to Clacket Services (J5/J6)

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M25

The M25 is the main strategic orbital route around Greater London, connecting with all the major trunk roads and motorways which radiate from London. The M25 forms a hub of the national trunk road network; local, long distance and international traffic use this motorway as a London bypass. It carries about 14% of all motorway traffic, although it accounts for about 6% of mileage of the motorway network. At peak times, the M25 as a whole, can be at capacity with congestion occurring at any time during the day. The section of the M25 considered for this audit, however, does not have the highest volume. Daily flow rates vary on the M25 from 125,000 at the Dartford River Crossing (start of the audit) to 185,000 between Junctions 13 and 14 near Heathrow.

The length of road considered for this audit was between Junction 2 and Clacket Lane Services; a distance of 34.4 km (21.4 miles).

This section of the M25 is a three lane motorway, except for a two lane section of about 1–1.5 miles. Clockwise at Junction 5 the motorway is two lane, where the A21 splits off until the other side of Junction 5. Anticlockwise, where the M26 joins, the motorway is four lanes (i.e. two lanes each M26 to M25) then three lanes.

This section of motorway is unlit, except for lighting at Junction 5, the M26 link.

The M25 is relatively straight and flat, running in and out of cuttings and embankments. There are noticeable curves and gradients just before, at and after Junction 5, and anticlockwise just before and at Junction 4. Clockwise, the gradient is uphill just before the Junction 3 slip-off, and just after the Junction 4 slip-off. The gradient is downhill just before and at the Junction 4 slip-on, and after/before Junction 5.

All lanes are standard 3.65 m wide with 3.3 m hard-shoulders. Standard reflective rumble strips are in place throughout the length. Catseyes meet the standard design criteria, and are of the stick-on type rather than the Halifax type.

There is a concrete V-drain on a short section of the motorway and a ditch on two short sections.

The central reservation is the standard minimum. This is not the case at Junction 5 where the links separate. There is a standard armco barrier, mainly tension corrugated beam and, in places, open box beam.

The surface of the road is hot-rolled asphalt with ‘surface dressing’ or a ‘thin wearing course system’ in parts, the latter particularly from Junction 5 to Clacket Lane Services.
There are emergency telephones.

The road is subject to the national speed limit, which for cars and light goods vehicles is 70 mph, and for goods vehicles exceeding 7.5 tonnes is 60 mph.

**Services**

Clacket Lane Services is at the beginning/end of the audit. 24h facilities are available. Accommodation is on the west side only (clockwise), but there is access from the east side. HGV overnight parking is available on both sides.

The only other services on the M25 are at Junction 23 (A1), and between Junction 30 and Junction 31 (Thurrock).
RESULTS

During the two-year period 1 January 1999 to 31 December 2000, Kent County Constabulary were called to 233 RTCs causing injury or death on the Kent section of the M25, from Junction 2 to Clacket Lane Services in-between Junctions 5 and 6. Of these RTCs, 28 occurred on slips and roundabouts at slips. 

Thus, 205 RTCs occurred on the main carriageway of the M25 in Kent.

Three files were unavailable to view and 14 files were unclassified. When allocating causation factors to each collision, including whether collisions were possibly or probably sleep related, we were unable to classify some RTCs as it was unclear from the collision report forms what actually happened. These 17 files amounted to 8.3% of the total number of collisions occurring on the main carriageway, and were deleted from the final number of RTCs.

Thus, ‘possible’ and ‘probable’ SRCs were determined from 188 RTCs.

- 48% (91) were clockwise; 52% (97) were anticlockwise.
- 12% (22) were ‘possible’ or ‘probable’ SRCs.
- Of these 22 SRCs, 41% (9) were clockwise; 59% (13) were anticlockwise.
- Two of the clockwise SRCs were ‘probable’ and seven were ‘possible’.
- Two of the anticlockwise SRCs were ‘probable’ and 11 were ‘possible’.

Severity

Table B1 shows the severity of injury in those crashes we were able to comment on. 14% of SRCs resulted in serious injury; 86% in slight injury. These were similar proportions to injuries in all collisions (10% and 90% respectively).

<table>
<thead>
<tr>
<th>SEVERITY</th>
<th>All RTCs (%)</th>
<th>SRCs as % of all RTCs</th>
<th>‘Possible’ or ‘probable’ SRCs (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serious</td>
<td>18 (10%)</td>
<td>17%</td>
<td>3 (14%)</td>
</tr>
<tr>
<td>Slight</td>
<td>170 (90%)</td>
<td>11%</td>
<td>19 (86%)</td>
</tr>
<tr>
<td>Total no.</td>
<td>188 (100%)</td>
<td></td>
<td>22 (100%)</td>
</tr>
</tbody>
</table>

Number of casualties

28 casualties resulted from the 22 SRCs; 264 from the 188 RTCs.
Causes of RTCs

Table B2 shows the causes of all RTCs. Almost all (92%) of the crashes on this section of the M25 were caused by driver error. 12% were caused by driver sleepiness.

<table>
<thead>
<tr>
<th>CAUSE OF RTC</th>
<th>M25 KENT CLOCKWISE RTCs</th>
<th>M25 KENT ANTICLOCKWISE RTCs</th>
<th>M25 KENT TOTAL NO. OF RTCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep</td>
<td>9</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>Manoeuvre error</td>
<td>36</td>
<td>42</td>
<td>78</td>
</tr>
<tr>
<td>Excessive or inappropriate speed</td>
<td>Shunts</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>27</td>
<td>62</td>
</tr>
<tr>
<td>Other, including too fast for road or weather</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Distraction</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Medical</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Alcohol</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Drugs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>SUB-TOTAL: DRIVER IMPAIRMENT</strong></td>
<td><strong>83</strong></td>
<td><strong>90</strong></td>
<td><strong>173</strong></td>
</tr>
<tr>
<td>Tyre blow-outs/deflation</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Mechanical defect</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Insecure load/debris on road</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Weather – road surface water</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><strong>SUB-TOTAL: NON-DRIVER IMPAIRMENT</strong></td>
<td><strong>8</strong></td>
<td><strong>7</strong></td>
<td><strong>15</strong></td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td><strong>91</strong></td>
<td><strong>97</strong></td>
<td><strong>188</strong></td>
</tr>
</tbody>
</table>

Time of day/traffic flow

Mean AADTs (Annual Average Daily Traffic flows, Monday to Sunday) varied on this section of the M25 from 94,364 in the winter and 102,691 in the summer, between Junctions 4 and 5, to 124,982 in the winter and 134,104 in the summer between Junctions 2 and 3. Figure B2 shows the incidence of RTCs and SRCs over the time of day, with mean seasonal traffic flows between Junctions 2 and 3 and Junctions 4 and 5. Flow rates are clockwise and anticlockwise.
45% (10) of SRCs occurred between 0000h and 0600h when traffic flow was light, whereas 8% (15) of all RTCs occurred during the same period. Note that the latter includes the 10 SRCs. Thus, only 3% of collisions not related to sleep occurred during these hours.

**Location of SRCs**

Figure B3 shows the location of SRCs. A cluster of two clockwise and two anticlockwise SRCs were located just south of Junction 3. A further cluster of four anticlockwise SRCs and one clockwise SRC was located between Junctions 4 and 5.
Sex and age of drivers in SRCs

Figure B4 shows the sex and age of drivers who caused the crash. 73% (16) were men. 36% (8) of the drivers were aged 30 or under.

![Figure B4: Sex and age of drivers in SRCs on the M25 Kent, 1999–2000](image)

Day of week for SRCs

Figure B5 shows the incidence of SRCs by day of week. SRCs occurred most on a Monday (23%), and least on a Friday and on a Saturday (4% each day). 23% of SRCs occurred at the weekend, compared with 28% for all RTCs.
Month/season

Table B3 shows in which seasons SRCs occurred on the M25. Crashes caused by driver sleepiness occurred least during the autumn and winter months.

<table>
<thead>
<tr>
<th>Month 1999–2000</th>
<th>SRCs M25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring and summer: April–September</td>
<td>13</td>
</tr>
<tr>
<td>Autumn and winter: October–March</td>
<td>9</td>
</tr>
<tr>
<td>Total no. of SRCs</td>
<td>22</td>
</tr>
</tbody>
</table>

SRCs and vehicle type

59% (13) of the 22 SRCs were caused by cars, 23% (5) by HGVs, and 18% (4) by LGVs including vans.
The M20 is one of the main arterial motorway routes between London and the channel ports of Dover, Folkestone and Ramsgate and also the Channel Tunnel. It carries 20% of HGVs at its eastern end. Congestion occurs regularly around Maidstone.

The length of road considered for this audit was between Junction 5 and Junction 11A, a distance of 51 km (31.7 miles).

The M20 is a three lane motorway running along relatively flat land close to the foot of the North Downs. This section of the M20 undulates slightly, but there are no gradients steeper than the normal 3% maximum. The motorway snakes slightly through the length of road between Junctions 5 and 7, but is almost straight for much of the length between Junctions 7 and 8. The road ‘kinks’ more sharply just before/after Junction 9. Between Junctions 9 and 10 the M20 is on the edge of the urban area of Ashford; the road links the towns of Ashford to the southeast with Maidstone to the northwest.

This section of the motorway runs in and out of cuttings/embankments. Some considerable tree planting has taken place along the side of the motorway. Southbound, there is a length of timber noise-dampening fence between Junctions 6 and 7. Northbound, between Junctions 7 and 8, there is considerable earth bunding as a result of the construction of the Channel Tunnel Rail Link. Some lengths of high-noise dampening fencing have been erected to both sides of the M20 between Junctions 10 and 11.

Between Junctions 5 and 6, the M20 is three lanes with two lane collector/distributor roads along each side. Between Junctions 6 and 7 the motorway has four lanes, and between Junctions 7 and 8 it is three lane.

The M20 is lit from Junction 5 to just west of Junction 7 and between Junctions 11 and 11A.

All lanes are standard 3.65 m with 3.3 m hard-shoulders. There is significant hatching of hardened central reserves where these have been widened for visibility on curves. There is a central reservation with standard Armco barrier. The central reservation is of standard 4 m width throughout, with some minor localised visibility widening on some curves. There are standard Armco safety barriers throughout.

There are standard reflective rumble strips along the edge of each carriageway. There are standard Highways Agency approved white, red, green and yellow road studs. A standard grass verge applies along the whole length. There is a standard
grass verge along this whole section of motorway, although there is a hard strip and
noise barrier immediately behind the London-bound hard-shoulder between
Junctions 10 and 11 for a distance of 2 km because of the Channel Tunnel Rail Link
work.

The road surface from Junctions 5 to 8 is blacktop, and concrete from Junctions 8 to
9. Between Junctions 9 and 10 the original concrete surface has been overlaid with
thin blacktop as a noise-reducing measure. Between Junctions 10 and 11A the
surface is concrete, although much of this is shortly to be overlaid with thin
blacktop.

There are emergency phones along the motorway at one mile intervals.

The national speed limit of 70 mph applies. Goods vehicles over 7.5 tonnes
maximum laden weight are subject to a maximum speed of 60 mph.

**Services**

Services are at Junction 8 (Maidstone), situated on a roundabout just off the
motorway. There are 24h facilities with HGV overnight parking.
RESULTS

During the two-year period 1 January 1999 to 31 December 2000, Kent County Constabulary were called to 191 RTCs causing injury or death on the Kent section of the M20 between Junctions 5 and 11A. We viewed files of three RTCs which occurred on slip roads. Thus, 188 RTCs occurred on the main carriageway of the M20 in Kent.

Three files were unavailable to view. Fourteen files were unable to be classified for crash causation owing to insufficient information. These 17 files amounted to 9% of the total number of crashes occurring on the main carriageway, and we deleted them from the final number of RTCs.

Thus, ‘possible’ and ‘probable’ SRCs were determined from 171 RTCs.

- 53% (90) of these RTCs were caused by vehicles travelling eastbound; 47% (81) were westbound.
- Of the 171 RTCs on the main carriageway, 22% (37) were ‘possible’ or ‘probable’ SRCs.
- Of these SRCs, 70% (26) were eastbound and 30% (11) were westbound.
- Five of the eastbound SRCs were ‘probable’ and 21 were ‘possible’.
- Two of the westbound SRCs were ‘probable’ and nine were ‘possible’.

Severity

Table B4 shows the severity of injury for those crashes we were able to comment on. 16% of SRCs resulted in serious injury and 84% in slight injury. These were similar proportions to injuries in all RTCs (12% and 86% respectively).

<table>
<thead>
<tr>
<th>SEVERITY</th>
<th>All RTCs (%)</th>
<th>SRCs as % of all RTCs</th>
<th>‘Possible’ or ‘probable’ SRCs (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>3 (2%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Serious</td>
<td>21 (12%)</td>
<td>29%</td>
<td>6 (16%)</td>
</tr>
<tr>
<td>Slight</td>
<td>147 (86%)</td>
<td>21%</td>
<td>31 (84%)</td>
</tr>
<tr>
<td>Total no.</td>
<td>171 (100%)</td>
<td></td>
<td>37 (100%)</td>
</tr>
</tbody>
</table>

Number of casualties

48 casualties resulted from the 37 SRCs; 243 from the 171 RTCs in total.
Causes of RTCs

Table B5 shows the causes of RTCs. 65% were caused by driver impairment. 22% were caused by driver sleepiness. Notably, 37% of non-driver impairment crashes were due to the weather, in particular road surface water. This may be because of the part concrete surface of the road. ‘Other’ included crashes caused by: the bonnet of vehicle ‘flew up’, drunk pedestrian on carriageway, casualty falling off back of dumper truck, police operation to retrieve stolen vehicle, handbrake applied whilst vehicle in motion.

### Table B5: Causes of RTCs on the M20 Kent, 1999–2000

<table>
<thead>
<tr>
<th>CAUSE OF RTC</th>
<th>M20 KENT EASTBOUND RTCs</th>
<th>M20 KENT WESTBOUND RTCs</th>
<th>M20 KENT TOTAL NO. OF RTCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep</td>
<td>26</td>
<td>11</td>
<td>37</td>
</tr>
<tr>
<td>Manoeuvre error</td>
<td>24</td>
<td>30</td>
<td>54</td>
</tr>
<tr>
<td>Excessive or inappropriate speed</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Shunts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other, including too fast for road or weather conditions</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Distraction</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Medical</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Alcohol</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Drugs</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>SUB-TOTAL: DRIVER IMPAIRMENT</strong></td>
<td><strong>63</strong></td>
<td><strong>49</strong></td>
<td><strong>112</strong></td>
</tr>
<tr>
<td>Tyre blow-outs/deflation</td>
<td>7</td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td>Mechanical defect</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Insecure load/overweight vehicle/debris on road</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Weather, including road surface water</td>
<td>12</td>
<td>10</td>
<td>22</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td><strong>SUB-TOTAL: NON-DRIVER IMPAIRMENT</strong></td>
<td><strong>27</strong></td>
<td><strong>32</strong></td>
<td><strong>59</strong></td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td><strong>90</strong></td>
<td><strong>81</strong></td>
<td><strong>171</strong></td>
</tr>
</tbody>
</table>

Time of day/traffic flow

Mean AADTs (Annual Average Daily Traffic flows) varied on this section of the M20 from 110,140 (winter) and 116,496 (summer) between Junctions 5 and 6 to 50,224 (winter) and 54,004 (summer) between Junctions 9 and 10. Figure B6 shows the incidence of RTCs and SRCs with mean seasonal traffic flows for Junctions 5 to 6 and Junctions 9 to 10. Flows are eastbound (coast-bound) and westbound (London-bound).
35% (13) of SRCs occurred between 0000h and 0600h when traffic flow was light. 15% (26) of all RTCs occurred during the same period.

**Location of SRCs**

Figure B7 shows the location of eastbound and westbound SRCs on the M20. There were several clusters of mostly eastbound SRCs: three eastbound SRCs just after Maidstone motorway service area to Harrietsham; four eastbound and four westbound SRCs between Lenham and Charing Heath, a distance of just over 2 miles; three eastbound SRCs were apparent at Westwell Leacon before Junction 9; three more eastbound SRCs at Junction 9; and, noticeably, seven eastbound SRCs just east of Junction 10, Ashford. These clusters may be some cause for concern.
Sex and age of drivers in SRCs

Figure B8 shows the sex and age of drivers causing SRCs. Most (84%) were men. 41% (15) of all the drivers were aged 30 or under (the age was unknown for one man).

Day of week for SRCs

Figure B9 shows the incidence of SRCs by day of week. Most SRCs occurred on a Monday (22%) and least on a Tuesday (3%). 32% of SRCs occurred at the weekend, which is similar to the 30% for all RTCs.
Month/season

Table B6 shows when SRCs occurred on the M20. There were more during the spring and summer months than during the autumn and winter.

<table>
<thead>
<tr>
<th>Month 1999–2000</th>
<th>SRCs M20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring and summer: April–September</td>
<td>22</td>
</tr>
<tr>
<td>Autumn and winter: October–March</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total no. of SRCs</strong></td>
<td><strong>37</strong></td>
</tr>
</tbody>
</table>

Vehicle type

65% (24) of the SRCs were caused by cars. One SRC was caused by a coach driver, 21% (8) by HGVs, and 11% (4) by LGVs, including vans.
OVERALL CONCLUSIONS

1. 12% of RTCs on the M25 were possibly or probably caused by driver sleepiness.
2. 22% of RTCs on the M20 were possibly or probably caused by driver sleepiness.
3. For crashes causing serious injuries, 17% on the M25 and 29% on the M20 were sleep related.
4. 45% of SRCs on the M25 occurred between 0000h and 0600h. Only 3% of crashes not related to sleep occurred during the same period. 35% of SRCs on the M20 occurred during these hours.
5. Most of the drivers in SRCs were men (73% of drivers on the M25 and 85% on the M20). Almost half of the drivers were 30 years of age or under (36% on the M25 and 41% on the M20).
6. Crashes caused by driver sleepiness occurred most during the spring and summer months.
7. Just over half (59%) of the SRCs on the M25 were due to car drivers. For the M20 this was 65%.
DISCUSSION AND COMMENT

1. In comparison with our earlier road crash audit of the M5 (Junctions 5 to 8) and the M40 (Warwickshire), the percentage of SRCs occurring on the M25 is low (Reyner et al., 2001). This low number might be associated with high traffic flow on the M25 (possibly due to short journeys on this London orbital motorway and more stimulation for drivers). Shunts and driving too fast/too close for conditions amounted to 35% of the total number of crashes, and 41% of crashes were caused by manoeuvre error (blindspots, HGV drivers).

2. In comparison with our other road crash audits, the percentage of SRCs occurring on this section of the M25 ‘fits’ a trend for motorways, whereby sleep crashes as a proportion of all crashes decrease as traffic volume increases.

3. A number of crashes could not be attributed causes because it was unclear what happened from the crash report form, or there were no driver explanations or statements. These were excluded from our analysis.

4. On the M20 there were twice the number of SRCs coast-bound (eastbound) than London-bound (westbound). This finding is similar to the results from our preliminary analysis of SRCs on the M180/A180 in Humberside (Horne & Reyner, 1996), which is also a main arterial road to a coastal port.

5. There were a number of crashes attributed to tyre blow-outs/deflations and overweight vehicles. Some of these on the M20 were attributed to the vehicle being overweight from carrying beer from the ports. However, some also had the characteristics of an SRC, but we excluded them from being so.

6. There are a number of clusters of SRCs on the M20, particularly eastbound, to which we would like to draw attention.
APPENDIX C

FATAL AND INJURY ROAD TRAFFIC CRASHES, 2000–01, CAUSED BY DRIVER SLEEPINESS IN STAFFORDSHIRE ON SECTIONS OF THE M6 (a rural motorway with high traffic flow) AND THE A38 (a continuous section of a lit ‘A’ road)
INTRODUCTION

We undertook comprehensive data collection and analysis of injury and death road traffic crash (RTC) records held by Staffordshire Police for sections of the M6 and A38 over the two-year period 2000–2001.

The M6 was selected because it is a rural motorway with high traffic flows, and the A38 because it is a lit dual carriageway.

Figure C1 shows the location of the sections of the M6 and the A38 where we collected data for this road audit.

The primary data were from crash report files which included: crash report forms completed by the officer attending the scene of the collision, witness statements (including statements from drivers deemed responsible for the cause of the collisions), tachographs, photographs, and all correspondence relating to the RTC. Data were collected from records held at Staffordshire Police Traffic and Process Office, Hednesford.
Figure C1: Map showing M6 J11 to J16 and A38 Lichfield-Burton upon Trent

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The M6 is the main north/south route through Birmingham.

The section considered for this audit was between Junction 11, Shareshill (Cannock), north of the Hilton Park Services and the M54, and Junction 16, Barthomley (Stoke-on-Trent), giving a distance of 54.5 km (34 miles).

It is a three lane motorway, primarily unlit. The surface material is mainly hot-rolled asphalt and chippings. In parts there is a concrete or ‘quieter surfacing’. The road undulates and snakes gently in a northwest direction. Between Junctions 13 and 14 the road firmly bends to the western side of Stafford, continues to snake and undulate gently. There is a steepish bank south of Junction 15. The road sweeps round to the west of Newcastle-under-Lyme/Stoke-on-Trent. From 1 mile north of Junction 15 there is a 4% gradient up to Keele Services and for approximately 1 mile north of Keele a 5–6% gradient down.

All lanes are standard 3.65 m wide with 2.8–3.2 m hard-shoulders. The central reservation is approximately 4 m throughout. Road studs meet the standard criteria and are mainly adhesive Stimsonite or similar.

There is no concrete drainage channel. Verge fencing is intermittent for obstructions and deep embankments are as per standard requirements.

There are emergency telephones at regular one mile intervals.

The road is subject to the national speed limit, which for cars and LGVs is 70 mph, and for goods vehicles exceeding 7.5 tonnes is 60 mph.

Services

There are two motorway service areas located on this section of the M6. Stafford Services are situated between Junctions 14 and 15, and Keele Services are between Junctions 15 and 16. Both service areas have cafés and restaurants, overnight parking for goods vehicles, and offer 24h facilities. Stafford Services has overnight accommodation whereas Keele Services does not. The next service areas are: northwards, Sandbach (Junctions 16 to 17) and, southwards, Hilton Park (Junctions 10a to 11).
RESULTS

During the two-year period 1 January 2000 to 31 December 2001, Staffordshire Police were called to 499 RTCs causing injury or death on the M6 between Junction 11 and Junction 16. Of these, 44 occurred on slips and roundabouts at slips. Two RTCs were caused by animals found dead at the scene and these RTCs were not included. Note that three files were unavailable to view, as were three files we were unable to classify; these six were still included in the total RTCs.

Thus, ‘possible’ and ‘probable’ SRCs were determined from 453 RTCs.

- 47% (215) of the RTCs were caused by vehicles travelling northbound; 52% (235) were southbound.

- Of the 453 RTCs on the main carriageway, 16.1% (73) were ‘possible’ or ‘probable’ SRCs.

- Of these 73 SRCs, 60% (44) were northbound and 40% (29) southbound.

- Ten of the northbound SRCs were ‘probable’ SRCs, and 34 were ‘possible’ SRCs.

- Nine of the southbound SRCs were ‘probable’ SRCs and 20 were ‘possible’ SRCs.

Severity

Table C1 shows the severity of injury for RTCs and SRCs. A quarter of all fatal crashes were sleep related, as were those resulting in serious injury. The proportion of SRCs resulting in death and serious injury was higher than for RTCs (all causes).

<table>
<thead>
<tr>
<th>SEVERITY</th>
<th>All RTCs (%)</th>
<th>SRCs as % of all RTCs</th>
<th>‘Possible’ or ‘probable’ SRCs (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>8 (2%)</td>
<td>25%</td>
<td>2 (3%)</td>
</tr>
<tr>
<td>Serious</td>
<td>38 (8%)</td>
<td>26%</td>
<td>10 (14%)</td>
</tr>
<tr>
<td>Slight</td>
<td>404 (90%)</td>
<td>15%</td>
<td>61 (83%)</td>
</tr>
<tr>
<td>Total no.</td>
<td>450 (100%)</td>
<td></td>
<td>73 (100%)</td>
</tr>
</tbody>
</table>

Number of casualties

116 casualties resulted from the 73 SRCs, and 767 people were injured as a result of 450 RTCs.
Causes of RTCs

Table C2 shows the causes of RTCs. 80% were due to driver error. 32% were caused by excessive or inappropriate speed, including shunts and driving too fast/too close for the road or weather conditions. 25% of RTCs were caused by driver manoeuvre error. 16% were caused by driver sleepiness. Three additional drivers admitted to falling asleep at the wheel but are included in the 13 collisions caused by drivers impaired by alcohol. ‘Other’ included, for example, suicide.

<table>
<thead>
<tr>
<th>CAUSE OF RTC</th>
<th>M6 STAFFS NORTHBOUND RTCs</th>
<th>M6 STAFFS SOUTHBOUND RTCs</th>
<th>M6 STAFFS TOTAL NO. OF RTCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep</td>
<td>44</td>
<td>29</td>
<td>73</td>
</tr>
<tr>
<td>Manoeuvre error</td>
<td>48</td>
<td>64</td>
<td>112</td>
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<tr>
<td>Excessive or inappropriate speed</td>
<td></td>
<td></td>
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<tr>
<td>Shunts</td>
<td>61</td>
<td>80</td>
<td>141</td>
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<tr>
<td>Other, including too fast for road or weather conditions</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Distraction</td>
<td>6</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Medical</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Alcohol</td>
<td>6</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Drugs</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>SUB-TOTAL: DRIVER IMPAIRMENT</strong></td>
<td><strong>172</strong></td>
<td><strong>187</strong></td>
<td><strong>359</strong></td>
</tr>
<tr>
<td>Tyre blow-outs/deflation</td>
<td>19</td>
<td>16</td>
<td>35</td>
</tr>
<tr>
<td>Mechanical defect</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Insecure load/debris on road</td>
<td>2</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>Weather, including road surface water</td>
<td>11</td>
<td>11</td>
<td>22</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
<td>8</td>
<td>16</td>
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<tr>
<td>Unclassified</td>
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<td><strong>SUB-TOTAL: NON-DRIVER IMPAIRMENT</strong></td>
<td><strong>43</strong></td>
<td><strong>47</strong></td>
<td><strong>91</strong></td>
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<tr>
<td><strong>TOTAL:</strong></td>
<td><strong>215</strong></td>
<td><strong>236</strong></td>
<td><strong>450</strong></td>
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</tbody>
</table>

* Note that 3 files were unavailable for viewing.

Time of day/traffic flow

Mean AADTs (Annual Average Daily Traffic flows, Monday to Sunday) were taken from sites between Junctions 13 and 14 on the northbound and southbound carriageways for summer months (1 May to 31 July 2000) and winter months (1 January to 31 March 2000). Figure C2 shows the incidence of RTCs/SRCs by time of day, with mean traffic flows (both directions).
29% (21) of SRCs occurred between 0000h and 0600h, which compares with 11% (50) of all RTCs during the same period. Note that this includes the 21 SRCs. Thus, only 6% of crashes not related to sleep occurred during these hours.

### Location of SRCs

Figure C3 shows the location of SRCs by markerpost, from number 207/5 at the northbound entry slip at Junction 11 to number 262 at Junction 16. Note that SRCs are shown to the nearest 500 km, although some are shown within an approximate 1 km distance. Noticeably, there were nine northbound and three southbound SRCs between markerposts 234 and 238/5, a distance of 4.5 km (2.8 miles). All these crashes (except one) occurred at, or north of Stafford North MSA. Five northbound and one southbound SRCs occurred at markerpost 219, just before Junction 3, and there were five northbound SRCs within a kilometre of each other, between markerposts 245 and 246 at Junction 15.
<table>
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<th>Markerpost</th>
<th>N/bnd SRCs</th>
<th>S/bnd SRCs</th>
<th>Note: specific location unavailable for 3 SRCs</th>
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<td>* Shown to nearest km</td>
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<td>* Shown to nearest km</td>
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<td>259</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>259/5</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>260</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>260/5</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>261</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>261/5</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>262</td>
<td></td>
<td></td>
<td>Junction 16 S/bnd Exit</td>
</tr>
</tbody>
</table>
Sex and age of drivers in SRCs

Figure C4 shows the sex and age of drivers who caused the crash. Note that the age was unknown for one male driver. 88% (64) were men. One-third of the drivers (34%) were aged 30 or younger (men and women).

![Figure C4: Sex and age of drivers in SRCs on the M6 J11 to J16, 2000–2001](image)

Day of week for SRCs

Figure C5 shows the incidence of SRCs by day of week. SRCs occurred least on a Friday (8%), whereas RTCs occurred most on a Friday (19%). 27% (20) of SRCs occurred during the weekend, which is similar to the overall rate for the RTCs during the weekend.
Month/season

Table C3 shows in which season SRCs occurred on the M6.

<table>
<thead>
<tr>
<th>Month 2000–2001</th>
<th>SRCs M6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring and summer: April–September</td>
<td>38</td>
</tr>
<tr>
<td>Autumn and winter: October–March</td>
<td>35</td>
</tr>
<tr>
<td>Total no. of SRCs</td>
<td>73</td>
</tr>
</tbody>
</table>

There was no seasonal difference here.

SRCs and vehicle type

78% (57) of the SRCs were caused by cars; 22% (16) by goods vehicles (13 vehicles were 7.5 tonnes and over; two were between 3.5 tonnes and 7.5 tonnes; and one was up to 3.5 tonnes).
The A38 runs from the South West to the North Midlands at Mansfield. We were interested to see whether roadside lighting has any bearing on the number and location of SRCs. The lit section of road selected was just north of Lichfield at Hilliard’s Cross up to the junction with the A5121 (Branston) at Burton upon Trent. This section of road is approximately 12 km (7.5 miles).

It is a dual carriageway and the surface material is hot-rolled asphalt and chippings. The road undulates and snakes gently, along the floodplain. At Barton Turn there is a chevron-marked bend, after which there is a slight climb out of the floodplain. At Branston there is a chevron-marked bend.

The carriageways consist of two lanes. Each lane is 3.65 m wide. Carriageways are kerbed with grass verges. There is a central reservation which is approximately 2.5 to 3.5 m wide. Road studs on the centre line are mainly the adhesive type. Safety fencing is mainly double-sided tensioned corrugated beam in the centre reserve, with open box beam at structures or other obstructions. Verge fencing is intermittent (for obstructions and deep embankments) as per standard requirements. There are no emergency telephones.

The road is subject to the national speed limit, which for cars and light goods vehicles is 70 mph, and for goods vehicles exceeding 7.5 tonnes is 60 mph.

Services

Northbound, there is a petrol station between the Fradley Park turn off and the A513. There is a Little Chef after the B5016 turn off. There is a mobile café at one of the lay-bys.

Southbound there is a Little Chef just after the B5016 turn off and another, with a petrol station, between the Fradley Park turn off and Hilliard’s Cross. Petrol is available at an additional site between the A513 Tamworth turn off and the Fradley Park turn off. There is a hotel at the turn off to Fradley Park.

Lay-bys

There are three unprotected lay-bys northbound and seven southbound (some are shared with bus stops).
RESULTS

During the two-year period 1 January 2000 to 31 December 2001, Staffordshire Police were called to 66 RTCs causing injury or death on this lit section of the A38. Of these 66 RTCs, 18 occurred on slips, roundabouts at slips or service roads (we were unable to classify three files).

Thus, ‘possible’ and ‘probable’ SRCs were determined from 48 RTCs.

- 44% (21) of the RTCs were caused by vehicles travelling northbound; 56% (27) were southbound.
- Of the RTCs considered on the main carriageway, 16.6% (8) were ‘possible’ or ‘probable’ SRCs.
- Of these 8 SRCs, 25% (2) were northbound (both ‘probable’) and 75% (6) were southbound (two ‘probable’ and four ‘possible’).

Severity

Table C4 shows the severity of injury for RTCs and SRCs.

<table>
<thead>
<tr>
<th>SEVERITY</th>
<th>All RTCs (%)</th>
<th>SRCs as % of RTCs</th>
<th>‘Possible’ or ‘probable’ SRCs (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serious</td>
<td>5 (10%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Slight</td>
<td>43 (90%)</td>
<td>19%</td>
<td>8 (100%)</td>
</tr>
<tr>
<td>Total no.</td>
<td>48 (100%)</td>
<td></td>
<td>8 (100%)</td>
</tr>
</tbody>
</table>

Number of casualties

Eleven casualties resulted from the eight SRCs; 80 people were injured as a result of 48 RTCs.

Causes of RTCs

Table C5 shows the causes of RTCs. 79% of all crashes on this section of the A38 were caused by driver error. 40% were caused by manoeuvre error. 16.6% were caused by driver sleepiness.
Mean AADTs (Annual Average Daily Traffic flows, Monday to Sunday) were taken from sites on the A38 just north of the A513 for the summer months (1 June to 31 August 2001) and winter months (1 October to 31 December 2001). Figure C6 shows the incidence of RTCs/SRCs over time of day, with mean traffic flows (both directions).

### Table C5: Causes of RTCs on the A38 Staffordshire, 2000–2001

<table>
<thead>
<tr>
<th>CAUSE OF RTC</th>
<th>A38 STAFFS NORTHBOUND RTCs</th>
<th>A38 STAFFS SOUTHBOUND RTCs</th>
<th>A38 STAFFS TOTAL NO. OF RTCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep</td>
<td>2</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Manoeuvre error</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excessive or inappropriate speed</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Shunts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other, including too fast for road or weather conditions</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Distraction</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Medical</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Alcohol</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>SUB-TOTAL: DRIVER IMPAIRMENT</td>
<td>15</td>
<td>23</td>
<td>38</td>
</tr>
<tr>
<td>Tyre blow-outs/deflation</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Weather including road surface water</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Unclassified</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>SUB-TOTAL: NON-DRIVER IMPAIRMENT</td>
<td>6</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>21</td>
<td>27</td>
<td>48</td>
</tr>
</tbody>
</table>

### Time of day/traffic flow

Mean AADTs (Annual Average Daily Traffic flows, Monday to Sunday) were taken from sites on the A38 just north of the A513 for the summer months (1 June to 31 August 2001) and winter months (1 October to 31 December 2001). Figure C6 shows the incidence of RTCs/SRCs over time of day, with mean traffic flows (both directions).
Location

Six of the SRCs occurred on the southbound carriageway between Branston and Barton. Two occurred on the northbound carriageway between Wychnor and Barton.

Sex and age of drivers

Seven of the drivers in SRCs were men. All except one of the drivers were under 45 years of age.

Day of week and season

Five of the eight SRCs occurred between Friday and Sunday. Four occurred during the spring and summer months (April to September) and three occurred during the autumn and winter months (October to March).

SRCs and vehicle type

Six of the SRCs were caused by cars and two by vans.
OVERALL CONCLUSIONS

1. 16% of RTCs on the M6 (Junctions 11 to 16) were possibly or probably caused by driver sleepiness. 17% of RTCs on the section of the A38 were possible or probable SRCs.

2. A quarter of all fatal crashes were sleep related, as were those resulting in serious injuries. The proportion of SRCs resulting in death or serious injuries was higher than for RTCs (all causes). All of the SRCs on the A38 resulted in slight injuries.

3. 29% of SRCs on the M6 occurred between 0000h and 0600h when traffic flow was light. Only 6% of crashes that were not related to sleep occurred during the same period.

4. There were clusters of SRCs on the M6. Noticeably, there were six SRCs close to Junction 13, five SRCs close to Junction 15, and nine SRCs within a distance of under three miles at, or north of, Stafford North motorway service area.

5. Most (88%) of the drivers in SRCs on the M6 were men. One-third of the drivers (men and women) were 30 years of age or under. Seven out of the eight drivers in SRCs on the A38 were men.

6. Most (78%) of the SRCs were caused by car drivers. Six out of the eight SRCs on the A38 were caused by car drivers.
DISCUSSION AND COMMENT

This section of the M6 had a high crash rate (451 over 34 miles — all causes), compared with similar sections of roads within our other road crash audits.

In comparison with our other audits, the percentage of SRCs occurring on this section of the M6 ‘fits’ a trend for motorways, whereby SRCs as a proportion of all crashes decrease as traffic volume increases. This could be due to more stimulation for the driver, with other causes such as shunts, too fast/too close, or manoeuvre error being evident with higher traffic volumes.

The A38 ‘fits’ a similar trend for non-motorways. Conversely, the proportion of SRCs increases as traffic volumes increase. We are considering the reasons for this.

Northbound, there are clusters of RTCs just before Junction 13 and at, or just after, Stafford motorway service area, and at Junction 15 before Keele Services. This indicates that too few drivers are stopping to take a break here.

There was little difference in the proportion of RTCs that were sleep related on this lit section of the A38, compared with an unlit section of an ‘A’ road we looked at in one of our previous road audits (Reyner et al., 2001). However, the dataset for the A38 was small.

We were unable to plot the location of the SRCs on the A38 due to insufficient information.
APPENDIX D

FATAL AND INJURY ROAD TRAFFIC CRASHES CAUSED BY DRIVER SLEEPINESS ON THE NORTHAMPTONSHIRE SECTION OF THE M1, 2000–01 (a lit rural motorway with high traffic flow)
INTRODUCTION

We carried out comprehensive data collection and analysis of injury and death road traffic crash (RTC) records held by Northamptonshire Police for the M1 in Northamptonshire over the two-year period 2000–01.

The M1 was selected because it is a busy, lit major rural motorway with an average 24h traffic flow of 100,000 vehicles.

Figure D1 shows the location of this section of the M1.

The primary data were from crash report files which included: crash report forms completed by the officer attending the scene of the crash, witness statements (including statements from drivers deemed responsible for the cause of the crashes), tachographs, photographs, and all correspondence relating to the RTC. Data were collected from records held at Northamptonshire Police headquarters in Northampton.
Figure D1: Map showing M1
Northamptonshire J14/J15 to J19

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The M1 is the main north/south route through the country.

The road considered for this audit was just south of Junction 15 (Northamptonshire county boundary to Junction 19 (Leicestershire county boundary), giving a distance of 24.4 miles (39.3 km).

This section of road is primarily a three-lane motorway, with two lanes only between the exit and entry slips at Junction 19. The entire section of the M1 in Northamptonshire is lit. The majority of the lighting is in the central reserve. At junctions and at multi-purpose crossovers the lighting columns are situated in the verge. The type of lighting is all SON.

On the northbound carriageway, the surface material is mainly hot-rolled asphalt but there is surface dressing from Whilton to Junction 18. The southbound road surface is mainly a thin-wearing course of various types, but from Whilton to Junction 15 the surface is hot-rolled asphalt. There are a number of inclines and declines along the motorway, the incline immediately north of Watford Gap Services is problematic in that it has a history of accidents. Concerning curvature of the road, the only major bend is in the vicinity of Whilton.

Generally, all lanes are standard 3.65 m wide with 2.8–3.2 m hard-shoulders, and approximately a 4 m central reserve, but there is some variation throughout the length. There is a vehicular safety fence throughout the length of the central reserve, and on the verge where protection is required, such as structures, large signs, embankments, etc. Road studs on the northbound carriageway are depressible cast Halifax or similar. On the southbound carriageway, they are depressible cast Halifax or similar, adhesive non-depressible Stimsonite or similar, or non-depressible in casting Stimsonite type.

There is a cast in-situ concrete drainage channel in the central reserve from markerpost 94 to Junction 18 markerpost 126/3.

There are emergency telephones at intervals of 900 m to 1400 m, depending on junction locations, etc.

There are some ‘Check your distance’ chevrons between Junctions 16 and 17.

The road is subject to the national speed limit, which for cars and light goods vehicles is 70 mph, and for goods vehicles exceeding 7.5 tonnes is 60 mph.

**Services**

There are two motorway service areas located on this section of the M1. Rothersthorpe Services are situated at Junction 15A, and Watford Gap Services are just south of Junction 17. Both service areas have cafés and restaurants, overnight
parking for goods vehicles, and offer 24h facilities. Both service areas have overnight accommodation. The next motorway service areas are: northwards, Leicester Forest East at Junction 21, and, southwards, Newport Pagnell, north of Junction 14.
RESULTS

During the two-year period 1 January 2000 to 31 December 2001, Northamptonshire Police were called to 206 RTCs causing injury or death on the M6 between Junctions 14/15 and 19. Of these, six occurred on slips. Note that four files were unavailable to view, and two files could not be classified; all six were included in the total RTC data.

Thus, ‘possible’ and ‘probable’ SRCs were determined from 200 RTCs.

- 47% (93) of the RTCs were caused by vehicles travelling northbound; 51% (103) were southbound.
- Of the 200 RTCs on the main carriageway, 18% (36) were ‘possible’ or ‘probable’ SRCs.
- Of these 36 SRCs, 47% (17) were northbound and 53% (19) southbound.
- Six of the northbound SRCs were ‘probable’ SRCs, and 11 were ‘possible’ SRCs.
- Seven of the southbound SRCs were ‘probable’ SRCs, and 12 were ‘possible’ SRCs.

Severity

Table D1 shows the severity of injury for RTCs and SRCs. 67% of all fatal crashes were sleep-related. The percentages of SRCs resulting in death and serious injury were higher for SRCs (31%) than RTCs (19%).

<table>
<thead>
<tr>
<th>SEVERITY</th>
<th>All RTCs (%)</th>
<th>SRCs as % of all RTCs</th>
<th>‘Possible’ or ‘probable’ SRCs (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>6 (3.1%)</td>
<td>67%</td>
<td>4 (11.1%)</td>
</tr>
<tr>
<td>Serious</td>
<td>32 (16.3%)</td>
<td>22%</td>
<td>7 (19.4%)</td>
</tr>
<tr>
<td>Slight</td>
<td>157 (80.1%)</td>
<td>15%</td>
<td>24 (66.7%)</td>
</tr>
<tr>
<td>Incomplete</td>
<td>1 (0.5%)</td>
<td></td>
<td>1 (2.8%)</td>
</tr>
<tr>
<td>Total no.</td>
<td>196 (%)</td>
<td></td>
<td>36 (100%)</td>
</tr>
</tbody>
</table>

Number of casualties

51 casualties resulted from the 36 SRCs, and 314 people were injured as a result of 196 RTCs.
Causes of RTCs

Table D2 shows the causes of RTCs. 78% of all crashes on this section of the M1 were due to driver error. 18% were caused by driver sleepiness. Noticeably, 33% were caused by excessive or inappropriate speed, including shunts and driving too fast/too close for road or weather conditions. 20% were caused by manoeuvre error.

‘Other’ included, for example, a driver ‘undertaking’ in a stolen vehicle, a provisional licence holder driving on the motorway.

<table>
<thead>
<tr>
<th>CAUSE OF RTC</th>
<th>M1 NORTHANTS NORTHBOUND RTCs</th>
<th>M1 NORTHANTS SOUTHBOUND RTCs</th>
<th>M1 NORTHANTS TOTAL NO. OF RTCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep</td>
<td>17</td>
<td>19</td>
<td>36</td>
</tr>
<tr>
<td>Manoeuvre error</td>
<td>19</td>
<td>21</td>
<td>40</td>
</tr>
<tr>
<td>Excessive or inappropriate speed</td>
<td>39</td>
<td>25</td>
<td>64</td>
</tr>
<tr>
<td>Shunts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other, including too fast for road or weather conditions</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Distraction</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Medical</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Alcohol</td>
<td>4</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>SUB-TOTAL: DRIVER IMPAIRMENT</td>
<td>81</td>
<td>74</td>
<td>155</td>
</tr>
<tr>
<td>Tyre blow-outs/deflation</td>
<td>5</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>Mechanical defect</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Insecure load/debris on road</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Weather including road surface water</td>
<td>1</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Unclassified</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>SUB-TOTAL: NON-DRIVER IMPAIRMENT</td>
<td>12</td>
<td>29</td>
<td>41</td>
</tr>
<tr>
<td>TOTAL:</td>
<td>93</td>
<td>103</td>
<td>196</td>
</tr>
</tbody>
</table>

Time of day/traffic flow

Mean AADTs (Annual Average Daily Traffic flows, Monday to Sunday) were taken from sites between Juncions 18 and 19 on the northbound and southbound carriageways for the summer months (June to August 2001) and winter months (November 2001 to January 2002). Figure D2 shows the incidence of RTCs/SRCs for time of day and mean traffic flows (both directions).
42% (15) of SRCs occurred between 0000h and 0600h. This compares with 18% (36) of all RTCs during the same period (this includes the SRCs). Thus, only 11% of crashes not related to sleep occurred during these hours. There was a noticeable seasonal difference in traffic flows, with an increase in vehicles in the summer mornings.

**Location of SRCs**

Figure D3 shows the location of SRCs. There were three SRCs at Crick Lodge, just north of Junction 18 (one northbound and two southbound), four SRCs close to Junction 17, just north of Watford Gap Services, a cluster of three southbound and one northbound SRCs just north of Junction 16 and a similar cluster at Junction 16, with two further southbound SRCs between the two clusters. There were six northbound and three southbound SRCs between Junctions 15a and 15, south of Rothersthorpe Services, Northampton. The remainder were from Junction 15 southwards to the county boundary, northbound at Crick and at Rothersthorpe, and one SRC at the northern edge of the audit, Junction 19.
Figure D3c: Location of M1 (southern section) n/bnd and s/bnd SRCs

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Sex and age of drivers in SRCs

Figure D4 shows the sex and age of drivers who caused the crash. 83% (30) were men. 42% (15) of drivers were aged 30 or younger (men and women). Age was unknown for two of the men.

Day of week for SRCs

Figure D5 shows the incidence of SRCs by day of week. There was little difference here.
Month/season

Table D3 shows when SRCs occurred on the M1. There was no seasonal difference.

### Table D3: Number of SRCs per month, M1 Northamptonshire, 2000–2001

<table>
<thead>
<tr>
<th>Month 2000–2001</th>
<th>SRCs M1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring and summer: April to September</td>
<td>18</td>
</tr>
<tr>
<td>Autumn and winter: October to March</td>
<td>18</td>
</tr>
<tr>
<td><strong>Total no. of SRCs</strong></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</table>

**SRCs and vehicle type**

53% (19) of the SRCs were caused by cars; 36% (13) by HGVs. 8% (3) SRCs by vans, and one by a coach.
OVERALL CONCLUSIONS

1. 18% of RTCs on the M1 in Northamptonshire were possibly or probably caused by driver sleepiness.

2. 31% of SRCs resulted in serious or fatal injuries, compared with 19% of all crashes.

3. Almost 80% of all crashes on this section of the M1 were caused by driver error.

4. 42% of SRCs on the M1 occurred between 0000h and 0600h when traffic flow was light. 18% of all crashes (including sleep) occurred during the same period.

5. There seems to be clusters of SRCs on the M1 in Northamptonshire.

6. Most (83%) of the drivers in SRCs were men. 42% of all drivers were aged 30 or under.

7. Just over half (53%) of the SRCs on the M1 were caused by car drivers.
DISCUSSION AND COMMENT

In comparison with our other road crash audits, the percentage of SRCs occurring on this section of the M1 ‘fits’ a trend for motorways, whereby sleep crashes as a proportion of all crashes decrease as traffic volume increases. This could be due to more driver stimulation, with other causes such as shunts, too fast/too close or manoeuvre error being more evident with higher traffic volumes.

When compared to another unlit section of motorway with similar traffic flows, there is a marginal increase in the proportion of RTCs that are sleep related on this section of the M1. However, when comparing these two sections of roads and the effect of artificial lighting, the number of RTCs and SRCs per mile per year on this lit section of the M1 were slightly lower than for the unlit motorway.

There were a number of crashes attributed to tyre blow-outs/deflations. However, some also had the characteristics of an SRC, but we excluded them from being so.
REFERENCES


ACKNOWLEDGEMENTS

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We would also like to thank:

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- staff at Lincolnshire police Accident Support Units at Grantham, Boston and Lincoln
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- Kent County Constabulary and Police Administration & Process Units at Ashford and Gravesend
- Babtie for traffic flow
- Mouchel Consulting Ltd for supplying information about the road characteristics of the M25
- WS Atkins Transportation Engineering for supplying information about the road characteristics of the M20
- GIS Unit, Planning & Land Use Statistics, Office of the Deputy Prime Minister for mapping tiles.
- The assistance of Staffordshire Police is gratefully acknowledged, in particular the Traffic and Process Office, Central Prosecutions Department, Cannock.
- Our thanks to W. S. Atkins for providing traffic flow data and to Optima Infrastructure Management for information about road characteristics of the M6 and A38 Staffordshire.
- The assistance of Northamptonshire Police is gratefully acknowledged, in particular the Central Accident Bureau at Northamptonshire Police headquarters.
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We also wish to thank Martin Boddy for his assistance.