FINAL REPORT

Route Safety Research

Prepared for

Transport Scotland

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Document History

This report has been prepared in accordance with the instructions of the client, Transport Scotland, for the client's sole and specific use.

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This document has been issued and amended as follows:

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Acronyms and Abbreviations

AADT	Annual Average Daily Traffic
ANPR	Automatic Number Plate Recognition
ASC	Average Speed Camera
ATC	Automatic Traffic Counter
D2AP	Dual 2 Lane All Purpose Carriageway
DfT	Department for Transport
DG	Directorate General
DMRB	Design Manual for Roads and Bridges
EFTA	European Free Trade Area
EU	European Union
Euro NCAP	European New Car Assessment Programme
HGV	Heavy Goods Vehicle
IRTAD	International Traffic Safety Data and Analysis Group
Kms	Kilometres
MSP	Member of the Scottish Parliament
NPRA	Norwegian Public Roads Administration
NUTS	Nomenclature of Territorial Units for Statistics
OECD	Organisation for Economic Co-operation and Development
PSQKM	Per Square Kilometre
RAP	Route Action Plan
RSA	Road Safety Audit
S2	Single 2 Lane Carriageway
STRIPE	Scottish Trunk Road Infrastructure Project Evaluation
TØI	Institute of Transport Economics
TPO	Transport Planning Objective
TRISS	Trunk Road Incident Support Service
TRL	Transport Research Laboratory
Vkms	Vehicle Kilometres
Vpd	Vehicles Per Day
WS2	Wide Single Carriageway
WS2+1	Wide Single 2+1 Lane Carriageway

Executive Summary

Introduction

Scotland has a well-developed road safety strategy and is ranked as one of the top performing nations globally. Transport Scotland commissioned CH2M to undertake a focussed research project to investigate whether there are any policies, strategies or mitigations adopted within Norway and Sweden which, historically, have a better record of road safety than Scotland that could influence road safety trends in Scotland.

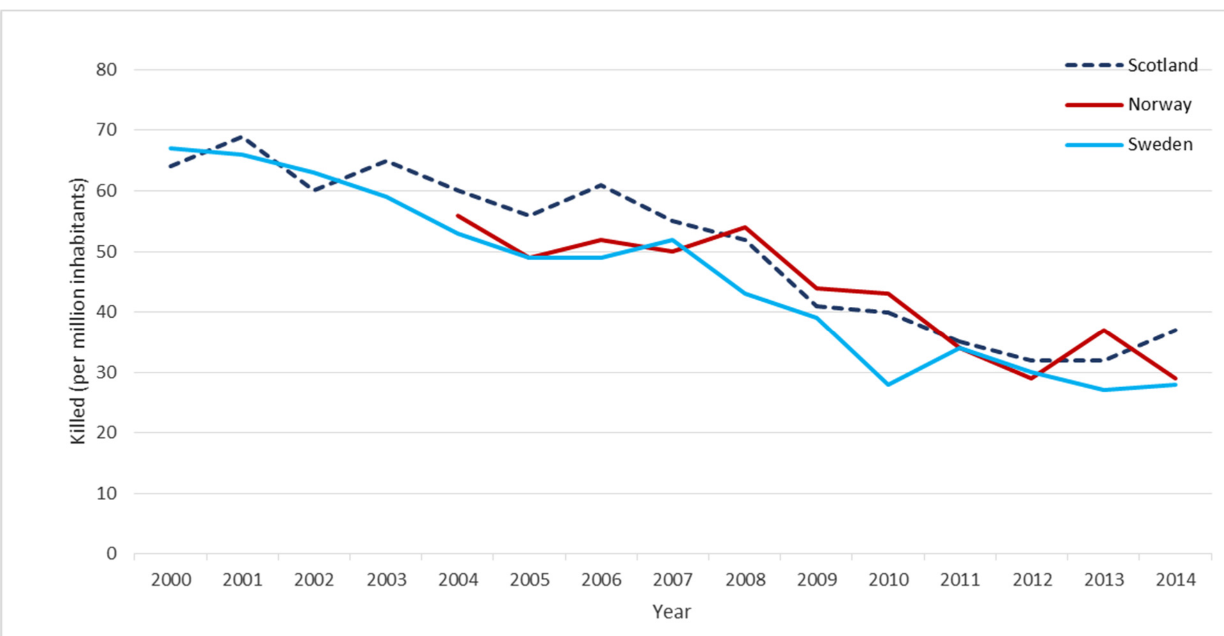
Rationale for International Comparison

Scotland, a northern European nation of some 5.37 million people in 2015, has an extensive and largely modern road network. The population density across the county varies significantly, from extensively urbanised areas of the central belt to the largely rural sparsely populated areas of the Highlands. The country's location at the northern periphery of Europe results in a predominantly maritime climate, with extensive periods of wet weather and not insignificant levels of snowfall over higher lying areas during the winter periods. Due to its northerly latitude, daylight hours vary significantly across the year. In considering these characteristics, commonalities between Scotland and its Northern European neighbours can be identified.

Given the characteristics discussed and their potential influence on road standards, driving conditions and, subsequently, road safety, the Scandinavian nations of Norway and Sweden are judged to provide suitable comparators with Scotland and a suitable basis on which to compare safety trends and statistics.

EuroStat collects data on transport safety for EU Member States, European Free Trade Area (EFTA) and candidate countries. The available Eurostat data compares the numbers killed per million inhabitants in Scotland, Norway and Sweden and is presented in the figure below.

Figure ES1 EuroStat Safety Statistics



The 2014 data suggested that while the numbers killed per million inhabitants in Norway and Sweden was broadly similar, the numbers killed in Scotland were somewhat higher and suggested that Sweden, in particular, has been outperforming Scotland in this respect over a number of years.

Scottish Case Studies

Three routes on which significant investment in targeted infrastructure improvements have been made in recent years have been considered; the A75 between Gretna and Stranraer, the A77 between Fenwick and Stranraer and the A9 between Dunblane and Inverness.

These routes have been considered due to the nature of the targeted improvements implemented and their relevance to this research. These include sections of WS2+1 carriageway, the aim of which is to improve and enhance overtaking opportunities and the implementation of safety camera systems, the aim of which is primarily to improve safety on routes where accident numbers and severities are greater than national average values.

The overarching findings from a review of four WS2+1 case studies indicated that there were notable reductions in the number and severity of accidents and casualties occurring following opening of two of the four projects examined. An increase in the number of accidents or severity of casualties were noted for two of the four projects examined. Examination of the available RSAs, however, suggested that accidents occurring post opening were not attributable to the design or layout of the project.

The overarching findings from a review of two safety camera system studies indicated that there were notable reductions in the number and severity of accidents and casualties occurring following opening of both of the projects examined. Available evidence also suggested that there notable reductions in the average speed of vehicles travelling on routes subject to speed camera systems following opening. Furthermore, notable reductions in the number of vehicles travelling at excessive speeds travelling on routes subject to speed camera systems were observed following opening,

International Context

Effective planning is considered to have played the biggest part in reducing accidents in Norway and Sweden. Roads in Sweden are built to prioritise safety over speed or convenience. Low urban speed limits, pedestrian zones and barriers that separate cars from bicycles and oncoming traffic have all contributed to the continued reduction in the number of accidents.

Construction of significant lengths of WS2+1 roads, particularly in Sweden, is considered to have contributed to significant road safety improvements over the first decade of Vision Zero. Provision of safer crossings (including pedestrian bridges and zebra crossings flanked by flashing lights, protected with speed bumps) are likely to have contributed to a significant reduction in the number of pedestrian deaths over the past five years. Strict policing has also played a contributory factor with less than 0.25% of drivers tested in Sweden over the alcohol limit. Furthermore, road deaths involving children under seven have reduced significantly in Sweden—in 2012 only one was killed, compared with 58 in 1970.

While effective planning is considered a major factor in reducing accidents in Norway and Sweden, research indicates that there is no single reason for the reductions in fatal casualties observed. A number of measures, however, were identified which could have contributed to this trend: These include:

- Road Safety Strategy - the adoption of “Vision Zero”
- Improvements in the car fleet i.e. increased proportion of car fleet with 5-star Euro NCAP ratings
- Reducing speed limits
- Conducting speeding campaigns

- Introduction of speed cameras resulting in reduced mean speed of traffic on high volume roads
- Provision of physical barriers to prevent head-on crashes on new motorways and two/three lane roads
- Running of seat belt campaigns resulting in increased use of seat belts

While a review of the available safety statistics indicates that road safety trends in Norway and Sweden are improving and may be linked to the policies, strategies and targeted measures identified within the preceding sections, cognisance of other factors which could contribute to the varying safety trends between Scotland, Norway and Sweden, should also be taken. These include:

- Signage strategies
- Speed limits
- Underlying driver behaviour
- Driver education (i.e. variations in driving test requirements)
- Regulations (i.e. requirements for snowchains in winter, headlights always on, drink driving limits)
- Targeted measures at reducing drink/drug driving

Summary and Conclusions

Examination of the information available at the time of this project suggests that, while there are similar approaches to road safety in Norway, Sweden and Scotland, differences in approach do exist that are worthy of further investigation. In terms of the design and delivery of infrastructure, while differences exist in the approaches taken, particularly in relation to the strategy adopted surrounding the delivery of WS2+1 schemes, it is considered unlikely that this factor alone accounts for the variation in road safety statistics between the three countries.

It is considered that differences in the approach to the enforcement of traffic violations and general differences in culture, attitudes and driving behaviour (such as the social unacceptability of drink driving) are likely to play a part. Furthermore, a range of other factors are considered likely to contribute to the accident trends observed in Norway and Sweden, such as the propensity of Euro NCAP 5 star rated vehicles within the vehicle fleet, the additional requisites needed to be able to obtain a driving license and traffic regulations related to winter driving, amongst others.

Each of the differing factors discussed within this report are likely to contribute, to varying degrees, to the safety statistics presented in Norway and Sweden. Research into each factor would be required to quantify their relative impacts on road safety.

Next Steps

Transport Scotland may wish to give consideration to undertaking further research into some of the specific factors outlined which may account for the variation in road safety statistics in Scotland, Norway and Sweden. This could include:

- Research into the impact of introducing and enforcing drug driving legislation in Scotland
- Research into the possibilities, implications and potential impacts of revising the requirements of the driving test and enhanced driver education
- A review of the design standard and approach to the delivery of WS2+1 schemes in Scotland
- Research into the impact of lowering speed limits, in both rural and urban areas

- Research into the potential for, implications and potential impacts of the installation of median barriers on both S2 and WS2+1 carriageways in Scotland

Furthermore, given the apparent success of the safety camera schemes currently operating in Scotland, Transport Scotland may wish to give consideration to undertaking an exercise to identify other routes which could benefit from the installation of similar systems, in order to improve driver behaviour and road safety.

Transport Scotland may also wish to give consideration to the findings and recommendations of other road safety research projects. In particular, the research undertaken by TRL relating to U.K. road safety, published in September 2016, posed a number of questions that Transport Scotland may wish to consider in a Scottish context, in more detail. An initial review of these questions, however, would require to be undertaken to establish the likely relevance of each of these areas to road safety in Scotland.

Finally, Transport Scotland should ensure that cognisance of up-to-date road safety statistics is taken when considering any future measures or research surrounding road safety trends. The latest available road safety data for Scotland (presented within '*Reported Road Casualties Scotland 2015'*, published in October 2016) indicates that the figures for all types of injury are the lowest since records began, suggesting that road safety in Scotland continues to improve. As a result it can be judged that the current approach to road safety in Scotland is contributing to a continuing improvement in road safety trends.

Introduction

1.1 Background

Scotland has a well-developed road safety strategy and is ranked as one of the top performing nations globally. Transport Scotland has commissioned CH2M to undertake a focussed research project to investigate whether there are any policies, strategies or mitigations adopted within Norway and Sweden which, historically, have a better record of road safety than Scotland that could influence road safety trends in Scotland.

1.2 Purpose of research

Road accident statistics published by the Department for Transport (DfT) indicates that Sweden and Norway are amongst the top performing countries in terms of road safety, and are outperforming Scotland. There are, however, some good examples of road safety in Scotland, including the safe system approaches adopted on the A9, A77 and A75, which can be examined alongside examples from Sweden and Norway.

The research objective for this project is:

- To identify the most successful **casualty reduction mitigation measures** and **strategies** adopted in various route safety strategies in Scotland, Norway and Sweden to inform future scheme development in Scotland.

It is hoped that improved and more sustained safety solutions can be developed and implemented in Scotland. The research will consider safety initiatives and strategies, and examine Wide Single 2+1 Lane Carriageways (WS2+1s) and safety camera systems as case studies.

The report is structured as follows:

The context and rationale for the study and the international comparisons undertaken in set out in **Chapter 2.**

Chapter 3 examines a number of Scottish ‘case studies’ focussing on WS2+1, safety camera projects and other mitigations.

The international context of the study is set out in **Chapter 4**, with an examination of the approach taken in Norway and Sweden relating to road safety.

Chapter 5 sets out the summary and conclusions of the report and examines the next steps which Transport Scotland may wish to consider.

Understanding the Context

2.1 Overview

This section outlines the road safety strategy in Scotland and presents a comparison of safety statistics for Scotland, Norway and Sweden to set the context of this research. Both Transport Scotland Road Safety Statistics and EuroStat have been examined to provide a range of analyses of the available road safety data.

2.1.1 Rationale for International Comparison

Scotland, a country with a population of some 5.37 million people[1] in 2015, has an extensive and largely modern road network covering the extent of the country. The population density across the county varies significantly, from extensively urbanised areas of the central belt (3,412 persons per square kilometre (psqkm) in the Glasgow City Council area) to the largely rural sparsely populated areas of the Highlands (9 persons psqkm in the Highland Council area)[2]. The country's location at the northern periphery of Europe results in a predominantly maritime climate, with extensive periods of wet weather and not insignificant levels of snowfall over higher lying areas during the winter periods. Due to its northerly latitude, daylight hours vary significantly across the year, from 17.5 hours of daylight during the summer period to approximately only 7 hours of daylight during the winter period[3], in central Scotland.

In considering these characteristics, commonalities between Scotland and its Northern European neighbours can be identified. Norway, a country with a population of some 5.18 million people in 2015[4] and Sweden, a country with a population of some 9.85 million people in 2015[5], similar to Scotland, also have extensive, largely modern road networks extending across each country. Further similarities with Scotland exist in relation to varying population densities – these vary significantly across Norway and Sweden, from the heavily urbanised population centres of Oslo, Bergen, Stockholm and Gothenburg to the rural, sparsely populated areas of both northern Norway and Sweden. The geographical location of both countries ensures commonalities between the climatic and daylight conditions with Scotland, with considerable rain and snowfall experienced in each country and significant variations in daylight hours across the year.

Given the characteristics discussed and their potential influence on road standards, driving conditions and, subsequently, road safety, the Scandinavian nations of Norway and Sweden are judged to provide suitable comparators with Scotland and a suitable basis on which to compare safety trends and statistics.

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1 http://www.nrscotland.gov.uk/statistics-and-data/statistics/stats-at-a-glance/infographics-and-visualisations#mid-year-2015

2 http://www.nrscotland.gov.uk/files/statistics/population-estimates/mid-2011/11mype-cahb-table9.pdf

3 http://www.scotlandinfo.eu/daylight-hours-sunrise-and-sunset-times/

4 https://www.ssb.no/en/befolkning/statistikker/folkemengde

5 http://www.scb.se/en_/Finding-statistics/Statistics-by-subject-area/Population/Population-composition/Population-statistics/Aktuell-Pong/25795/Yearly-statistics--The-whole-country/26040/

2.2 EuroStat

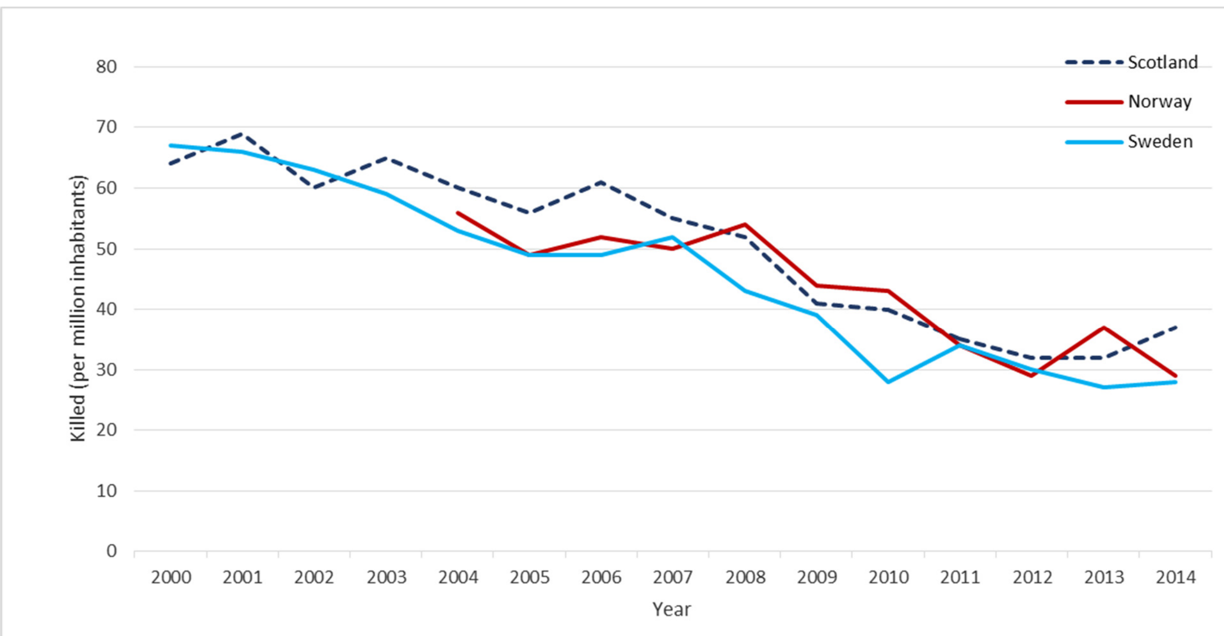
Eurostat is the statistical office of the European Union (EU) situated in Luxembourg. It was established in 1953 and is a Directorate-General (DG) of the European Commission. Eurostat is part of the portfolio of the Commissioner for Employment, Social Affairs, Skills and Labour mobility and its key role is to supply statistics to other DGs and supply the Commission and other European Institutions with data so they can define, implement and analyse Community policies.

EuroStat collects data on transport safety for EU Member States, European Free Trade Area (EFTA) and candidate countries. The data covers four transport modes: rail, road, inland waterways and air. As such, Eurostat provides a useful tool for comparing transport conditions across Europe. One such dataset collected by EuroStat is in relation to road safety. Accident and casualty is available for a number of European countries and provides a useful data source on which to carry out high level comparisons of accident numbers and trends across both EU and EFTA countries.

2.2.1 EuroStat Safety Statistics

A comparison of the numbers killed per million inhabitants in Scotland, Norway and Sweden is presented in **Figure 2.1** below.

Figure 2.1 EuroStat Safety Statistics (International Comparison)



As can be seen from the data presented in **Figure 2.1**, the general trend in numbers killed per million inhabitants is a reduction within Scotland, Norway and Sweden, across the period examined.

The 2014 data suggests that while the numbers killed per million inhabitants in Norway and Sweden was broadly similar (29 and 28 per million inhabitants respectively) the numbers killed in Scotland were somewhat higher at 37 killed per million inhabitants. While the data suggests that Sweden has been outperforming Scotland in this respect over a number of years, it should be noted that Scotland is one of the top performing nations globally and has a well-developed road safety system with a commitment to further improvement towards a vision of zero road deaths.

2014 Euro Stat Data:

- **37 killed** per million inhabitants in Scotland
- **29 killed** per million inhabitants in Norway
- **28 killed** per million inhabitants in Sweden

A recent update to the data available from Eurostat indicates that the numbers killed per million inhabitants in each of the three countries continues to fall. In 2015, the numbers killed in Scotland was 30 per million inhabitants. This compares with 23 per million inhabitants in Norway and 27 in Sweden. While the data continues to suggest that both Norway and Sweden are outperforming Scotland, the numbers killed per million inhabitants in Scotland continues to fall, notably by the largest absolute figure of any of the three countries. This suggests that the approach adopted to tackling road safety may be having a positive impact. Details are presented in **Appendix A**.

2.2.2 NUTS Statistical Regions

The Eurostat data is disaggregated into NUTS (Nomenclature of Territorial Units for Statistics) Level 2 statistical regions. There are four such regions covering Scotland, namely:

- UKM2 - Eastern Scotland
- UKM3 - South Western Scotland
- UKM5 - North Eastern Scotland
- UKM6 - Highlands and Islands

A graphical representation of the NUTS2 regions, and the numbers killed per million inhabitants across Europe at the NUTS2 level, is presented in **Appendix A**.

The NUTS2 regions are further subdivided, generally following local authority boundaries (or groups of local authority boundaries), which are classed as NUTS3 regions. To put into context the NUTS2 regions at a local authority level, the commonalities between NUTS2 regions and local authorities, at the estimated population at mid-2014[6], is presented in **Appendix A**. Based on the information presented in **Appendix A**, the population of the four NUTS2 regions, as of mid-2014, is as follows:

- UKM2 - Eastern Scotland - 2,053,610
- UKM3 - South Western Scotland – 2,316,990
- UKM5 - North Eastern Scotland – 489,450
- UKM6 - Highlands and Islands – 487,550

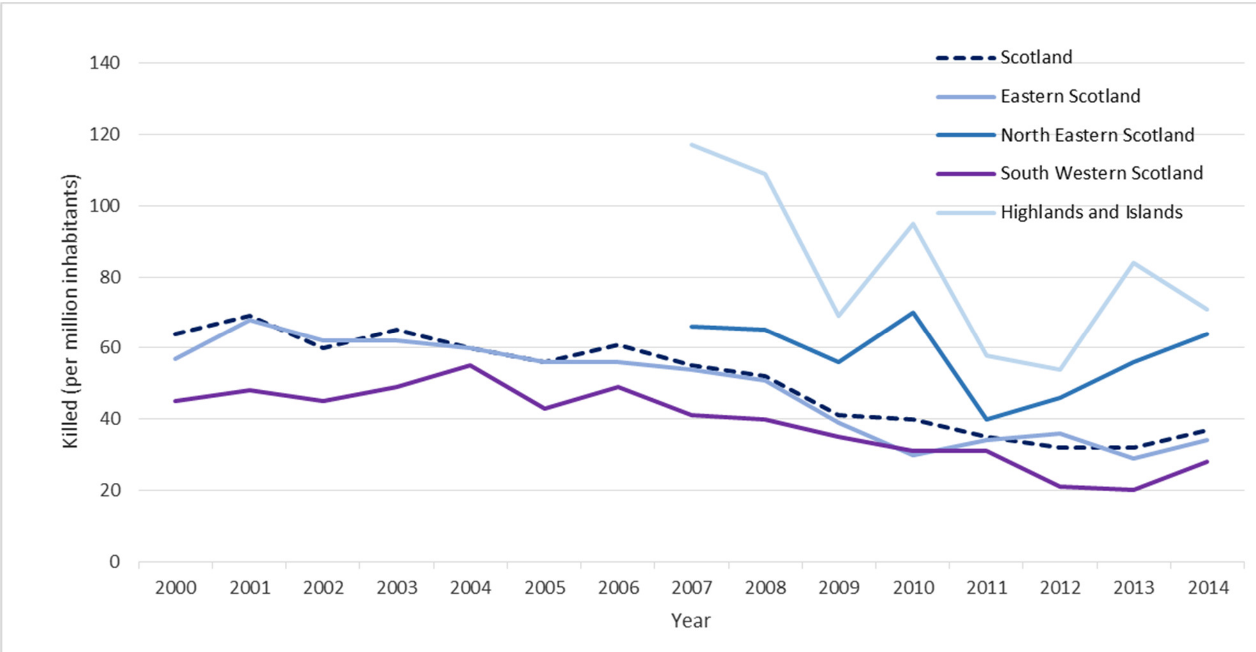
Given the population statistics noted above, it is evident that the total population across each of the four regions varies significantly. This reflects the fact that the geographical nature of each of the regions also varies significantly, from the South Western Scotland region (which covers both the densely

[6] http://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/population/population-estimates/mid-year-population-estimates/mid-2015-and-corrected-mid-2012-to-mid-2014/mid-2012-mid-2013-and-mid-2014-corrected-tables

populated central belt and more rural areas of Dumfries and Galloway) to the largely rural region of Highlands and Islands. Cognisance of this will be required to be taken account of when interpreting EuroStat statistics which are based on numbers killed per million inhabitants.

A comparison of the numbers killed per million inhabitants within the four Scottish regions identified within the EuroStat data is presented in **Figure 2.2** below.

Figure 2.2 EuroStat Safety Statistics (Scottish Regions)



As can be seen from the data presented in **Figure 2.2**, the absolute numbers by year and trends in numbers killed per million inhabitants varies significantly between the four Scottish regions identified within the EuroStat dataset. While the data suggest general reductions in the numbers killed per million inhabitants over the periods examined within each of the four regions, the magnitude of the numbers killed in each of the regions varies significantly.

The data suggests that the numbers killed per million inhabitants in the Eastern and South Western Scotland regions closely track the Scottish total. This is likely due to the nature of the regions identified within the Eurostat data. The Eastern and South Western regions cover the major population centres of the central belt and as such, the numbers killed per million inhabitants at a Scotland wide level is likely to be weighed towards these regions.

2014 Euro Stat Data:

- **34 killed** per million inhabitants in the Eastern Scotland region
- **64 killed** per million inhabitants in the North Eastern Scotland region
- **28 killed** per million inhabitants in the South Western Scotland region
- **71 killed** per million inhabitants in the Highlands and Islands region

The numbers killed per million inhabitants in both the North Eastern Scotland and Highlands and Islands regions are somewhat higher than the Scottish average and are significantly higher than the Eastern Scotland and South Western Scotland regions. This is likely due to a number of factors including but not limited to; the more rural nature of the areas covered by these regions, prevailing weather conditions, particularly during winter months; lower levels of daylight hours during the winter months; and other geographical / social causes.

A recent update to the data available from Eurostat indicates that the numbers killed per million inhabitants in each of the four regions continues to fall. In 2015, the numbers killed in the Eastern and South Western Scotland regions was 30 and 23 per million inhabitants, respectively. The numbers killed in the North Eastern Scotland and Highlands and Islands regions continued to be somewhat higher at 51 and 47 per million inhabitants, respectively. This data indicates, however, that the numbers killed per million inhabitants has fallen significantly in each of these regions. Details are presented in **Appendix A**.

A further analysis of available Scottish transport and road safety statistics is presented in **Appendix B**.

2.3 Scotland's Road Safety Framework

Scotland has a well-established road safety system and is committed to further improvement towards a vision of zero road deaths. A key Scottish Government objective is to ensure safe road travel in Scotland for everyone. Scotland's Road Safety Framework[7], published in 2009, sets out the Framework for improving road safety in Scotland over the next decade, describes the road safety vision for Scotland, the aims and commitments, and the Scottish targets for reductions in road deaths and serious injuries to 2020.

An evidence-based mid-term review of the framework was undertaken in 2015/16. The review, which adopted a participatory approach, assessed the progress made since the framework was published in 2009 and identified three key Priority Focus Areas around Speed, Age and Vulnerable Road Users for further focus. The review report[8] was published in March 2016 and sets out an approach to ensure continued delivery of road safety outcomes towards 2020 casualty reduction targets and beyond.

Scotland's road safety vision is that there will be:

"A steady reduction in the numbers of those killed and those seriously injured, with the ultimate vision of a future where no-one is killed on Scotland's roads, and the injury rate is much reduced."

2.3.1 Road Safety Targets

The Framework set out a series of targets for improving road safety which are compared to the average Scottish figures for 2004 to 2008 and are as presented in **Table 2.1**.

Table 2.1. Scotland's Road Safety Framework – Road Safety Targets to 2020

Target	2015 Milestone (% Reduction)	2020 Target (% Reduction)
People Killed	30%	40%
People Seriously Injured	43%	55%
Children (aged <16) killed	35%	50%
Children (aged <16) Seriously Injured	50%	65%

The *'Reported Road Casualties Scotland*' series of publications sets out the progress made towards achieving these targets. The Scottish Government casualty reduction targets for 2020 are being met on

[7] http://www.gov.scot/resource/doc/274654/0082190.pdf

[8] http://www.transport.gov.scot/system/files/TS-%20Road%20Safety%20Framework%20-%20mid%20term%20review%20-%20March%202016.pdf

the trunk road network. Year on year reductions in terms of 'Killed and Serious Casualties' and 'Killed and Serious Child Casualties' tend to be below the current pro-rata target.

2.3.2 Framework Commitments

The Road Safety Framework sets out a number of commitments for delivery broken down into short term (one to two years), medium term (two to five years) and longer term (five to ten years). This covers a range of individual user groups / impacts areas.

In the context of this research, the measures targeted at trunk road users are particularly relevant.

The specific short, medium and long term measures identified within the framework are presented in **Table 2.2**.

Targeted Measures included:

- Children and Young People
- Pedestrians
- Motorcyclist
- Pedal Cyclists
- Pre-Drivers
- Drivers Aged 17-25
- People who Drive for Work
- Older Drivers
- Drivers from Abroad
- Rural Roads
- Impairment
- Seatbelts
- Speed
- Distraction
- Trunk Roads
- Local Roads
- Safer Vehicles

Table 2.2. Scotland's Road Safety Framework - Trunk Road Commitments

Commitments	Short Term	Medium Term	Long Term
Undertake Road Protection Score Surveys, for the remaining two-thirds of Scotland's trunk road network and determine how this information can complement the existing processes within the road safety engineering programme.	✓	✓	
Continue to consider and implement a range of proactive risk removal strategies to reduce the severity and frequency of impacts with hazards.	✓	✓	✓
Continue to invest in providing 2+1 overtaking opportunities.	✓	✓	✓
Consider the most appropriate barriers to protect vulnerable users such	✓	✓	✓
Continue to invest in junction improvement schemes.	✓	✓	✓
Rank the worst performing junctions on the trunk road network, by accident frequency and severity over the last ten years, and prepare a programme to improve selected locations.	✓		
Develop Route Safety Groups for each of the trunk road routes with participation from relevant road safety partners such as local authorities, police forces, emergency services, safety camera partnerships, etc.	✓	✓	
Examine the possibility for further rollout of TRISS.	✓	✓	
Implement Strategic Transport Projects Review including: – Transport Scotland's Strategic Road Safety Plan; – Road Safety Improvements in North and West of Scotland; – Route Management; – A82 targeted road improvements; – Road safety improvements in North and West Scotland; – A9 upgrade from Dunblane to Inverness; – A96 from Inverness to Nairn Upgrade; – Targeted Road Congestion/ Environmental Relief Schemes; and – Dundee Northern Relief Road.	✓	✓	✓

As can be seen from **Table 2.2**, a key commitment of the Road Safety Framework was the continued investment in WS2+1 overtaking opportunities in the short, medium and long term. Several WS2+1 schemes have been completed on a number of routes on the trunk road network, as detailed in **Figure C.1** in **Appendix C**. This type of targeted improvement will be the focus of this research and a number of 'case studies' will be examined.

The trunk road improvement projects completed by Transport Scotland over the period 2007 to 2016 are presented in **Appendix C**.

2.3.3 Other Documents

Transport Scotland has the responsibility for delivering The Scottish Government's Road Safety Framework. In doing so, a Strategic Road Safety Plan was published which sets out how Transport Scotland delivers road safety on the trunk road network.

The first Strategic Road Safety Plan was published in 2007 and supported delivery of the Road Safety Framework. The current Framework has reached the mid-point of its ten year period and has been reviewed in its own right. Transport Scotland, therefore, took the opportunity to update the Strategic Road Safety Plan in 2016[9] and to refocus on further reducing the numbers of accidents and casualties on the trunk road network.

The plan describes Transport Scotland's approach to implementing safe system principles through an action plan. This sets out how Transport Scotland intend to complement the traditional approach with more proactive methods in order to further improve the safety performance of the Scottish trunk road network. Twenty actions in total were identified, which sit under the following key headings:

- Safer Roads and Roadside
- Safer Users
- Safer Speeds
- Safer Management

Action 13 under the 'Safer Speeds' heading related to trunk road speed enforcement. It was considered that through targeted safety camera enforcement and improving driver behaviour, the purpose of the Scottish Safety Camera Programme is to contribute to Scotland's road safety vision and road safety targets as set out in the Scottish Government's Road Safety Framework to 2020.

Targeted safety camera enforcement has been trialled on the A77 between Bogend Toll and Ardwell Bay (implemented in 2005). A further system was installed on the A9 between Dunblane and Inverness in 2014. This type of targeted improvement has been examined as a 'case study' as part of the research.

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[9] http://www.transport.gov.scot/system/files/documents/reports/TS_Strategic_Road_Safety_Plan_2016_Digital_Sep_2016.pdf

Scottish Case Studies

3.1 Overview

For the purposes of this research, three routes (on which significant investment in targeted infrastructure improvements have been made in recent years) have been considered. These routes are as follows:

- A75 – Gretna to Stranraer
- A77 – Fenwick to Stranraer
- A9 – Dunblane to Inverness

These routes (or sections of routes) have been considered due to the nature of the targeted improvements implemented and their relevance to this research. In line with the objectives set out within the various routes' Route Action Plans (RAPs), targeted improvements to enhance both the level of service and safety of the routes have been delivered in recent years by Transport Scotland. These include providing sections of WS2+1 carriageway (to improve and enhance overtaking opportunities) and the implementation of safety camera systems, the aim of which is primarily to improve safety on routes where accident numbers and severities are greater than national average values.

The three routes selected have seen improvements of the nature of those described above in recent years and, as such, provide suitable 'case studies' on which to base this study. A description of the targeted improvements examined as part of this research (WS2+1s and Safety Camera Systems) and a detailed analysis of the impacts of each of the improvements identified is given in the **Appendix D**. A summary of the findings of each is presented below.

3.2 Case Study Findings

A total of six case studies were examined to identify the impacts and emerging safety trends following implementation. Relevant data was available for five of the six projects examined. The findings from the case studies are summarised below.

3.2.1 WS2+1s

The overarching findings from a review of the four WS2+1 case studies are as follows:

- The length of the WS2+1 projects examined varied between 0.9 kilometres to 2.9 kilometres.
- Three of the four WS2+1 projects facilitated overtaking for traffic travelling in one direction only (A75 Barfil to Bettyknowes, A75 Planting End to Drumflower & A9 Carrbridge).
- While the projects examined were developed as part of a wider route strategy, two of the four projects (A75 Barfil to Bettyknowes & A9 Carrbridge) were located somewhat distinctly from other overtaking sections.
- WS2+1 projects were implemented on routes with AADT flows of between 3,500 vpd to 9,500 vpd.
- WS2+1 projects were implemented on routes where the percentage of HGVs was between 8% and 11%.
- There were notable reductions in the number and severity of accidents and casualties occurring following opening of two of the four WS2+1 projects examined (A77 Park End to Bennane & A9 Carrbridge).

- An increase in the number of accidents or severity of casualties were noted for two of the four WS2+1 projects examined (A75 Barfil to Bettyknowes & A75 Planting End). Examination of the available RSAs, however, suggested that accidents occurring post opening were not attributable to the design or layout of the project.

3.2.2 Safety Camera Systems

The overarching findings from a review of the two safety camera system studies are as follows:

- The length of the sections of carriageway over which the schemes were implemented varied between 60 kilometres and 220 kilometres.
- The schemes covered both dual and single carriageway sections.
- The routes on which safety camera schemes were implemented had AADT flows varying between 6,500 vpd and 35,000 vpd.
- Safety camera schemes were implemented on routes where the percentage of HGVs was between 8% and 17% of the total traffic observed.
- There were notable reductions in the number and severity of accidents and casualties occurring following opening of both of the projects examined.
- There were notable reductions in the average speed of vehicles travelling on routes subject to speed camera systems following opening, where data is available.
- There were notable reductions in the number of vehicles travelling at excessive speeds travelling on routes subject to speed camera systems following opening, where data is available.
- Detailed statistics of the number and severity of accidents and casualties and vehicle speed data was unavailable for one project (A77 Bogend Toll to Ardwell Bay).

While detailed statistics were unavailable at the time of writing for the A77 Bogend Toll to Ardwell Bay safety camera system, the A77 scheme has now been in operation for over 10 years, and as such, a considerable amount of data has been collected. The latest headline figures covering the last three years to July 2015 indicate that there has been a 77% reduction in fatal casualties and a 74% reduction in serious casualties compared with the original baseline published in 2005. This suggests the system has been successful in its aim of contributing to improvements in road safety.

3.3 Other Mitigations

In addition to the WS2+1 and safety camera schemes examined, Transport Scotland continue to invest in the trunk road network to improve road safety. In recent years, a number of individual junction improvements, such as the A9 Ballinluig and A9 Bankfoot junctions have been upgraded to mitigate specific safety issues at these locations. Several bypass schemes have been delivered, including the A68 Dalkeith Bypass and the A82 Crianlarich Bypass, providing significant safety benefits for communities through the removal of strategic trunk road traffic.

Evaluations undertaken by Transport Scotland confirm that bypass and targeted junction improvement projects are likely to have the most significant impact on road safety, with the greatest reduction in accidents observed following their construction. It can be concluded, therefore, that continued investment in the trunk road network is contributing to improving safety and is aiding in reducing the number of fatal and serious accidents occurring. Details of Transport Scotland's evaluation programme can be found at http://www.transport.gov.scot/road/project-evaluation.

Dualling of the major routes between Scotland's cities is a key Scottish Government transport commitment. Transport Scotland is pressing ahead with the dualling of the A9 between Perth and

Inverness, with both construction and design work currently ongoing on several sections. Design work is also progressing on the dualling of the A96.

Transport Scotland also has a strong record of applying other innovative techniques and using emerging technologies to reduce casualties and positively influence driver behavior. Innovations have varied from route strategies to single location improvements to address site specific issues, including:

- Introduction of intelligent road studs at Sheriffhall Roundabout on the A720 to the south of Edinburgh
- Installation of speed activated traffic signals on the A78 at Fairlie, in Ayrshire

In the case of Sheriffhall Roundabout and the introduction of intelligent road studs, an evaluation undertaken[10] following their installation suggests that the studs have a positive impact on driver behaviour when in the context of a spiral marked roundabout. The lane discipline of vehicles is likely to be improved and the probability of vehicle conflicts is reduced.

Transport Scotland continues to monitor specific sites where issues are observed and will assess the need for innovative solutions to address operational concerns.

10 http://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=10&ved=0ahUKEwj2vNyXoerSAhUnj1QKHXDXDjgQFghDMAk&url=http%3A%2F%2Fabstracts.aetransport.org%2Fpaper%2Fdownload%2Fid%2F4577&usg=AFQjCNEGOI5Z0Zw6fjIV4IWRxzfPrGQO4Q

International Context

4.1 Overview

As outlined in **Section 2**, it is clear that while road safety in Scotland has been generally improving over the past decade, the available statistics indicate that Norway and Sweden, two countries of comparable geography, climate and population to Scotland, perform markedly better in regard to the safety performance of their primary road networks.

This section examines the international research that has been undertaken surrounding road safety trends with a focus on the Norwegian and Swedish context. A focus on specific targeted road improvement measures in both Norway and Sweden is also discussed. An examination of other relevant road safety research has also been undertaken.

4.2 Background to International Research

The International Traffic Safety Data and Analysis Group (IRTAD)[11] is a permanent working group of the International Transport Forum at the Organisation for Economic Co-operation and Development (OECD). The working group comprises road safety experts and statisticians from renowned safety research institutes, national road and transport administrations, international organisations, universities, automobile associations, the automobile industry, and others from both OECD and non-OECD countries.

IRTAD's Road Safety Annual Report series[12] provides a yearly overview of road safety performance in member and observer countries. It presents a synthesis of the latest trends in member countries as well as detailed reports for each country, outlining the crash data collection process, the road safety strategies and targets in place. It also provides detailed safety data by road user, location and age together with information on recent trends in speeding, drink-driving and other aspects of road user behaviour.

IRTAD's main objectives are to contribute to international co-operation on safety data and its analysis. Its key outputs are the IRTAD Database (that currently publishes safety data from 32 countries) and its annual report on road safety performance. It also conducts regular research and analysis on topics related to safety data analysis including forecasting, relationship between speed and crash risks, road safety and economic developments.

The IRTAD Road Safety Annual Report includes specific analysis of road safety trends, strategies and targets for both Norway and Sweden. These are examined in more detail in the following sections.

[11] http://www.itf-oecd.org/IRTAD

[12] http://www.oecd-ilibrary.org/transport/road-safety-annual-report_23124571

4.3 The Norwegian Context

4.3.1 Overview

The Norwegian Public Roads Administration (NPRA) - Statens Vegvesen - is responsible for the planning, construction and operation of the national and county road networks. On matters pertaining to national roads, the NPRA is under the direction of the Ministry of Transport and Communications. The NPRA is under the leadership of the Directorate of Public Roads, which is an autonomous agency of the Ministry of Transport and Communication.

The NPRA's vision in relation to road safety is :

"A vision of no road fatalities or road accidents causing lifelong injury is set out for the long term road safety effort"

The Norwegian road network, as of 2010, comprised 92,000 kilometres of public roads, of which 10,000 kilometres were classed as national roads with a further 44,000 classed as county roads. Municipal roads comprised 38,000 kilometres with approximately 300 km of multilane motorways and 450 kilometres of 2-lane motorways.

In Norway, traffic safety policy is co-ordinated by the NPRA. Main national stakeholders include the NPRA, the police, the public health and education administrations, together with leading non-governmental organisations. At regional and local levels, counties and municipalities play a very important role. Norwegian road safety policy relies on a broad and collaborative approach, a common and shared strategy and co-ordination among all stakeholders.

4.3.2 International Research Findings

IRTAD's Road Safety Annual Report, 2015 edition, presents 2014 road safety data for Norway along with provisional data from 2015. The report examines trends in traffic and road safety from the years 1990 to 2015 and road user behaviour patterns. This included data on speed, drink driving, drugs and driving, distracted driving, fatigue and seat belt usage. The report also puts the findings into the context of Norway's road safety strategy and national targets to 2024 and comments on the progress achieved thus far. A review of recently implemented safety measures is also undertaken. These are examined in more detail below.

4.3.2.1 Norwegian Road Safety Strategies and Targets

The IRTAD report identified the current road safety strategies (2014 - 2024) and targets. The Road Safety Strategy (2014 - 2024) is informed by a Vision Zero strategy adopted by the Norwegian Parliament in 2001. The Norwegian Vision Zero involves all modes of transport and the main focus is to reduce crashes that can lead to fatalities and serious injuries. The highest priority is given to the reduction of head-on crashes, single vehicle crashes and collisions with cyclists and pedestrians. Special attention is also paid to high-risk road users, such as young drivers, elderly road users and motorcyclists.

A National Plan of Action for Road Traffic safety is published every fourth year. The current plan covers the period 2014-17[13] and is embedded in the National Transport Plan 2014-2024. The plan highlights the current road safety challenges in Norway and describes the measures that will be implemented from 2014-17 to move towards the national target of no more than 500 fatalities and severe injuries by 2024.

13 http://www.vegvesen.no/_attachment/646945/binary/968554?fast_title=National+Plan+of+Action+for+Road+Traffic+Safety+2014%E2%80%93 2017.+Short+version.pdf

The specific goal of the plan was initially to halve the number of killed and seriously injured by 2024, when compared to the average for the period 2008-11. A modelling exercise based on existing knowledge shows that it is possible to reach 630 fatalities and seriously injured by 2024. By taking into account the fact that it is not possible to assess the effect of all measures and that new technology may bring additional benefits, a new target was set of no more than 500 fatalities and seriously injured by 2024.

The NPRA continuously monitors developments concerning fatalities and the seriously injured, in addition to a set of safety performance indicators, related to speed, seat belt wearing and heavy vehicle safety standards.

4.3.2.2 Recently Implemented Safety Measures

The IRTAD report identified a number of recent safety measures introduced over the period 2013 to 2016. These included:

- Road user education and awareness.
- An ongoing speed campaign has been updated with a focus on young drivers. The campaign of sharing the road (cyclists and cars) is ongoing and the seat belt campaign is updated with wearing seat belts in buses.
- The NPRA use of a camera system for ANPR as a tool to carry out inspection tasks. The system is one of many measures adopted in order to achieve inspection objectives more efficiently. In 2015, the NPRA started a pilot project aiming to enforce compliance with the new requirement of an electronic toll payment tag for business vehicles. The requirement applies to both Norwegian and foreign vehicles on Norwegian roads.

4.3.2.3 Recent and Ongoing Research

The IRTAD report identified a number of recent and ongoing research projects. These included:

- A 5-year (2013-17) research programme Better Safety in Traffic being carried out by the NPRA, the purpose of which is to assess the potential for reducing the numbers of fatal and serious injuries and identify areas where the greatest returns can be made in the coming years. *In 2015, there was specific research and analysis on all cyclist accidents registered by the emergency centre of Oslo. A similar study will be undertaken in 2016 for pedestrians*.
- A study on crashes, driving behaviour and safety attitudes among novice drivers published by the Institute of Transport Economics (TØI) in 2013 (TØI report 1287/2013), demonstrating that novice drivers who received their license in 2011-12 had more positive road safety attitudes, better driving behaviour, and lower crash involvement risk during the first months of solo driving, compared to drivers who obtained their license in 2004.
- A study on the crash effects of speed cameras, published in 2014 (TØI report 1384/2014) demonstrating that speed cameras have a general positive impact on the number of injury accidents occurring, considering differing lengths of road between camera locations.
- A study on trends on the risk of apprehension for traffic offences, published in 2014 (TØI report 1361/2014) suggesting measures to reduce traffic violations included; installation of feedback signs for motorists, increasing conventional police enforcement and increasing the use of section control by speed cameras.
- An evaluation report on the crash effects of road section control by average speed cameras, published in 2014 (TØI report 1339/2014), demonstrating that significant reductions in injury accidents by up to 21%.

4.3.2.4 IRTAD Report Conclusions

The IRTAD report concluded that, in terms of road safety, the long term trend showed an improvement, with the number of road deaths decreasing by 43% between 2010 and 2015. It was suggested that there was no single reason for this trend and instead, was as a result of a systematic, long term and fact based approach to tackling road safety. The report did highlight that positive developments on indicators, such as vehicle speed, seatbelt wearing, lane barriers and other key factors with known impacts on severe traffic accidents were observed with important measures introduced, including:

- The adoption of a "Vision Zero" road safety strategy.
- penetration of vehicles into the car fleet with 5-star EuroNCAP ratings for top levels of both passive and active safety measures.
- reduced speed limits, a speeding campaign, and speed cameras resulting in reduced mean speed of traffic on high volume roads.
- new motorways and two/three lane roads with physical barriers to prevent head-on crashes.
- seat belt campaigns resulting in increased use of seat belts.

4.3.3 Consultation with Norwegian Roads Authority

As part of this research, consultation with the NPRA (Statens Vegvesen) has been undertaken via e-mail and telephone conversations with a road safety specialist. Relevant documents and studies from Norway have been shared to inform this research.

The consultation gave input to this project for three categories, namely:

- General Road Safety / Other Information;
- WS2+1 roads; and
- Safety Cameras.

4.3.3.1 General Road Safety / Other Information

The consultation confirmed that Statens Vegvesen is basing the approach to road safety in Norway on Vision Zero. This approach has been adopted, primarily with the aim of:

- reducing the number of single vehicle accidents;
- reducing head-on collisions; and
- reducing accidents with pedestrians and cyclists.

These aims are studied in periods of 4 years. Half way through this period, a report is released that presents the progress against 122 actions that are undertaken by Statens Vegvesen to improve road safety.

The consultation exercise indicated that there were a number of reasons for improving road safety in Norway. It was judged that a number of key reasons were likely to include: many high profile road safety campaigns and the high number of seatbelt users. It was also considered that, due to the fact that the NPRA has responsibility for driver education and licencing, vehicle registration and control, road planning, building and maintenance (and is therefore able to devise a 'joined up' strategy across its field of responsibility), this may have a positive impact on road safety.

Through the consultation process, it was highlighted that where accidents have occurred which involved vehicles leaving the carriageway (or there was a perceived or actual risk that this could occur) road studs are being installed on the edges of the road to better highlight to drivers that boundaries of the carriageway.

4.3.3.2 WS2+1 Roads

The consultation highlighted that Norway currently has approximately 300 km of WS2+1 roads. As part of the National Transport Plan, it is planned that all roads with an AADT between 6,000 vpd and 12,000 vpd will be upgraded to WS2+1 standard with all roads with an AADT over 12,000 vpd upgraded to dual carriageway standard. The feedback provided indicated that "*it's just a matter of time and money. The roads in Norway are usually slim, thereby it is quite expensive to upgrade them into 2+1 or 2+2 roads*"

The current approach to the implementation of WS2+1 roads is based on Swedish studies that have proven that WS2+1 roads improve road safety. The Swedish research has been validated by Norwegian and Irish studies, where 15 kilometres of WS2+1 roads have been examined and have been observed to reduce accidents for cars by approximately 60%; a reduction in fatal and serious accidents of 50% – 60% was also observed. Vehicles travelling on the WS2+1 sections with a speed limit of 90 km/h was observed to have increased average speed by 2 km/h. No notable change in average speed was observed on WS2+1 roads with a speed limit of 110 km/h. This indicates that while WS2+1 roads may have resulted in minor increases in observed vehicle speeds, they have reduced bottlenecks for traffic owing to the fact that they facilitate overtaking manoeuvres. Furthermore, increases in vehicle speeds are not deemed to have resulted in a negative impact on safety, with significant reductions in the number of fatal and serious accidents occurring.

It is considered more problematic to convert Norwegian S2 roads into WS2+1 roads than it is in Sweden given that Norwegian roads tend to be narrower; to widen S2 roads, including space for a median wire barrier, would also be much more expensive. It was also highlighted that, on sections of carriageway where there is the possibility of head-on collisions occurring, central barriers are either implemented where none previously existed, or strengthened where an existing barrier was in place, to improve safety for road users.

4.3.3.3 Safety Cameras

Through the consultation process, it was highlighted that Norway has 300 cameras installed over 25 sections of road. These sections are determined over different criteria such as routes with high speed and areas where more than normal number of serious accidents occur. Research has found that the effect from stationed speed cameras is that the speed of the vehicles are slowing down by the cameras and that the speed is affected about 3 kilometres after the camera by an average reduced speed of 3.5%. The Norwegian Road Authorities predict that this has given a reduction of 13% of fatal and serious accidents on that 3 kilometre route. It was also noted that on routes with a speed limit of 80 km/h that have average speed cameras, an average speed reduction of 11% was observed. Given the reduction in vehicle speeds, the Norwegian Road Authorities estimate that this may have resulted in an average reduction of fatal and serious accidents of 39%.

4.3.4 Other Relevant Projects

As part of this research, recent projects contributing to improvements in road safety have been identified and examined. One such project, delivered by the NPRA was the E6 Øyer to Lillehammer, which is discussed below.

Based on the information provided through the consultation process, it has become apparent that the NPRA does not undertake before and after monitoring evaluations of individual schemes in the same way as these are undertaken in Scotland. As such, before and after information relating to specific schemes that is comparable with the Scottish 'Case Studies' presented in **Section 3** does not appear to be widely available.

Road Safety Lillehammer – towards Vision Zero

Between 2003 and 2006, Statens Vegvesen undertook a project together with Trygg Trafik[14], the Police and Public Road Administrations with the aim of resolving a safety problem on the E6 between Øyer and Lillehammer. An additional aim of the project was to demonstrate how coordinated measures can have an influence on the traffic safety situation in a greater geographical area. It was hoped that the outcome of this project would inspire other administrations in other parts of the country to implement traffic safety measures on order to prevent serious accidents.

The project comprised various elements including; a survey of residents and road users of the area to identify their experience, attitude and knowledge surrounding road safety, various measures to educate children and adolescents about road safety and the testing of a new means of control and surveillance by the Police that it was envisioned would lead to reduced speeds.

The main target of this project was to provide knowledge about Vision Zero and, more generally, road safety to inhabitants within the project area and to enhance knowledge of Vision Zero and road safety across the country. The survey undertaken of inhabitants and road users demonstrated that there was a good background knowledge surrounding traffic control and surveillance and actions for younger drivers. From the survey, it was demonstrated that the knowledge surrounding the implementation and actions taken for younger drivers was less well pronounced within that younger age group. The survey highlighted that the actions taken for kindergartens and lower schools was the area least understood by the survey respondents.

As part of the project, a traffic safety centre was established to tackle gaps in inhabitants and road user's knowledge of road safety. The Road Safety Centre was established at the Norwegian Road Museum, located in Lillehammer. In addition, a short story competition for younger members of the community, relating to road safety, was undertaken.

At the Norwegian Road Museum, an obstacle course was constructed that focused on road safety which had the aim of teaching children traffic rules. During the duration of this project, all local schools participated in some or all of the activities ran by Trygg Trafik. The organisation focused on disseminating information to schools, teachers and parents in relation to road safety. This focussed on traffic rules for walking, biking, usage of reflectors, usage of biking helmet and how to properly ride the bike. Additionally, the Norwegian Road Museum devised a special educational curriculum for kindergarten and school age children in cooperation with school teachers from the area and Trygg Trafik.

A survey was undertaken of visitors to the Road Safety Centre at the Norwegian Road Museum to establish the success, or otherwise, of the measures undertaken. The results demonstrated a mostly positive response with a grade of 4.9 on a 1-6 scale (where 6 is the best). It was considered that females were generally more positive to the exhibition than males. The age span of the respondents to the survey was primarily in the 16 and 54 year old age bracket. This indicated that younger people who were considered to be the most important target group were most affected by the exhibition with road safety than older people. It was noted, however, that the response rate to the survey was particularly low (this was completed by 248 of the over 33 thousand visitors to the museum) and it did not measure how many visitors had the opportunity to fill in the survey.

An exhibition of 280 pair of shoes at the Norwegian Road Museum (representing people killed in car accidents the previous year) formed the basis for a short story competition. 75 students participated in the competition. The members of the judging panel that selected the winner of this competition saw the result of this competition as potentially leading to a change in the student's understanding and

[14] Trygg Trafikk is an umbrella organization for the voluntary road safety work and serves as a link between voluntary associations and the road safety authorities. The organisation is given a special responsibility for promoting traffic education in kindergarten and school and providing information and knowledge about road safety

appreciation of road safety. The winning short story was published in several local newspapers and on several websites.

It was concluded that the project was deemed to have met its defined aims. Training and education for young people was undertaken, with traffic safety and education measures carried out. The control and surveillance measures tested were considered to result in reduced speed and fewer situations with dangerous overtaking. Opening of the traffic safety centre at the Norwegian Road Museum enabled the visualisation of traffic safety, potential counter measures and, more generally, the Vision Zero approach. It was noted, however, that while the measures developed may be replicated across the country and may contribute to reducing the accident rate, the project did not provide quantitative evidence as to which factors could be significant and why that may be the case.

4.4 The Swedish Context

4.4.1 Overview

The Swedish Transportation Administration (Trafikverket) is the national authority assigned the overall sectoral responsibility for the entire road transport system in Sweden. Trafikverket is responsible for drawing up and applying road transport regulations, in addition to the planning, construction, operation and maintenance of the state roads.

The Swedish road network, as of 2011, comprised approximately 578,000 kilometres of public roads of which approximately 1,900 kilometres were motorway[15]. Several agencies in Sweden support the government in the field of road safety. Authorities co-operate with each other but have specific tasks within the road transport system. The three main governmental agencies are:

Trafikverket, the Swedish Transport Administration, is responsible for long-term planning of the transport system for all types of traffic, as well as for building, operating and maintaining public roads and railways. The Swedish Transport Administration is also responsible for administering the theoretical and practical driving tests needed for a driving licence for both professional and private drivers.

Transportstyrelsen, the Swedish Transport Agency, whose goal is to offer good accessibility and high-quality, secure and environmentally friendly rail, air, sea and road transport. The Agency has overall responsibility for drawing up regulations and ensuring that authorities, companies, organisations and citizens comply with them.

Trafikanalys, Transport Analysis, which reviews the bases for decisions, assesses measures and is responsible for statistics.

Sweden is divided into 290 municipalities and 20 county councils. These municipalities and counties have responsibility for local road safety. Local government has a long tradition in Sweden. The country's municipalities, county councils and regions are responsible for providing a significant proportion of all public services, including road safety. They have a considerable degree of autonomy, as well as independent powers of taxation, local self-government and the right to levy taxes are stipulated in the Instrument of

> The Swedish road transport system is to be designed so that no one is killed or seriously injured in traffic.
>
> The ambition is that it will gradually be designed to reflect human ability and the level of external violence that the human body can withstand.
>
> The road safety policy adopted emphasises that the agencies' work in this field is based on protecting human life and well-being.

[15] http://www.oecd-ilibrary.org/docserver/download/9713051ec020.pdf?expires=1490265518&id=id&accname=guest&checksum=4662ED01E8CE35E93AA838ED208B7375

Government, one of the four pillars of the Swedish Constitution.

In 1997, a Road Traffic Safety Bill founded on "Vision Zero" was passed by a large majority in the Swedish Parliament. This represented an entirely new way of thinking with respect to road traffic safety. Vision Zero is conceived from the ethical base that it can never be acceptable that people are killed or seriously injured when moving within the road transport system. This centres on an explicit goal and develops into a highly pragmatic and scientifically-based strategy which challenges the traditional approach to road safety. The long term goal is that no-one will be killed or seriously injured within the Swedish road transport system.

4.4.2 International Research Findings

IRTAD's Road Safety Annual Report, 2015 edition presents 2014 road safety data for Sweden along with provisional data from 2015. The report examines trends in traffic and road safety from the years 1990 to 2015 and road user behaviour patterns. This included data on speed, drink driving, drugs and driving, distracted driving, fatigue and seat belt usage. The report also puts the findings into the context of Sweden's road safety strategy and national targets to 2024 and comments on the progress achieved thus far. A review of recently implemented safety measures is also undertaken.

4.4.2.1 Swedish Road Safety Strategies and Targets

The IRTAD report identified the current road safety strategies (2011 – 2020) and targets. The basis of Swedish road safety work is Vision Zero, a strategic approach towards a safe system, whereby no-one is at risk of being fatally or severely injured while using road transport. There is no safety plan in a traditional sense.

The current interim safety targets were adopted by the Swedish Parliament in 2009 and specify that the number of road fatalities should be halved between 2007 and 2020. That translates into a maximum of 220 road deaths in 2020. The number of seriously injured on the roads is to be reduced by a quarter. In addition to the current national target, there is an interim target at the EU level, for halving the number of road deaths between 2010 and 2020. This corresponds to a more stringent interim target of a maximum of 133 road deaths in 2020. No decision has yet been made to adjust the Swedish target to this level, and so the interim target of no more than 220 road deaths remains. The target level and the monitoring process for reaching this target are being revised during 2015-2016 in order to make sure that the target levels and the indicators are as relevant as possible.

The Swedish Transport Administration regularly publishes progress reports towards the 2020 road safety objectives. The latest report was published in April 2015 "*Analysis of road safety trends 2014. Management by objectives for road safety work towards the 2020 interim targets*". To achieve the road safety targets, road safety work is managed by objectives and targets that have been set for a number of performance indicators.

4.4.2.2 Recently Implemented Safety Measures

The IRTAD report identified a number of recent safety measures introduced over the period 2013 to 2016. These included:

- ***Speed Management*** - There are around 1,100 speed cameras on the rural network in Sweden. During 2014, only a few new cameras were introduced, but for the period 2015-20, yearly additions of about 200 new cameras are planned. This is expected to have a significant impact on speed compliance.
- ***Vehicles*** - The development of ABS as standard equipment on motorcycles has moved quickly over the last three years. From being standard with only one manufacturer and an expensive option with the others, ABS has become a natural piece of standard equipment on the majority

of the major motorcycle models. The percentage of traffic volume of motorcycles fitted with ABS increased from 9% in 2007 to 44% in 2015. The goal for 2020 is 70%.

4.4.2.3 Recent and Ongoing Research

The IRTAD report identified a number of recent and ongoing research projects. These included:

- A study related to the public health consequences of road traffic injuries, published in Transportation Research Part F 38 - 2016
- A study considering the impact of winter weather on injuries in single pedestrian accidents, published in VTI report 868 – 2015.
- An evaluation of alcohol, drugs and medicine use among killed drivers of passenger cars between 2005-2013, published in VTI-notat 11-2015
- A study of the involvement of young moped riders in accidents, published in VTI Report 856 – 2015
- A traffic safety evaluation of measures including; rumble strips on S2 carriageway and motorways and 2+1 roads, in 2013 and 2014, published in VTI-notat 7-2016, which suggested that all measures examined have positive traffic safety effects and reduce the number of fatal and serious accidents.
- A study of the long term traffic safety effects of new speed limits in Sweden, published in VTI Report 860 – 2015, which indicated around 17 lives per year had been saved due to changes in speed limits. Specifically focusing on 2+1 routes, where speed limits were reduced from 110km/h to 100 km/h, injury accidents decreased by around 10 per year. On 2+1 roads where speed limits were increased from 90km/h to 100km/h, injury accidents increased by around 19 per year.

4.4.2.4 IRTAD Report Conclusions

The IRTAD report concluded that, in terms of road safety, between 1990 and 2015, the number of road fatalities decreased by 66%, while the number of injury crashes between 1990 and 2014 was reduced by only 22%. The report concluded that this variation was explained by better reporting of injury crashes in recent years and by a strong focus on reducing the most severe crashes.

The report also suggested that the overall positive trend could partly be explained by gradual improvements in infrastructure, vehicle fleet, an increased focus on injury prevention and reduced speeds.

- Reduction in fatalities of 66% (1990 – 2015)
- Reduction in injury crashes of 22% (1990 – 2014)
- Gradual improvements in infrastructure
- Gradual improvements in Vehicle Fleet
- Increased focus on injury prevention
- Increased focus on Reduced Speeds
- Introduction of median barriers

It was noted that both the safe national road indicators and safe vehicle indicators were improving, and road design has long embraced greater safety. It was also noted that Sweden has experienced a substantial drop in injured occupants of passenger cars since 2003. The report highlighted that the reduction in serious injuries has been so significant that, since 2011, more cyclists than car occupants have been seriously injured. It was concluded that this could mainly be attributed to safer cars, lower speeds and the introduction of median barriers.

4.4.3 Consultation with Swedish Roads Authority

Consultation with the Swedish Transportation Administration (Trafikverket) was handled through email conversation and a physical meeting in November 2016. Discussions were held with a senior employee with expertise in road safety in Sweden and internationally, focussing primarily in the following three topics:

- General Road Safety / Other Information;
- WS2+1 Roads; and
- Speed Cameras.

4.4.3.1 General Road Safety / Other Information

Sweden has a vision to eliminate any serious or fatal accidents on the Swedish road network. Trafikverket want to ideally have all roads where there is a risk of collision by opposing traffic segregated to avoid any frontal collision. It is also working to eliminate the 'human factor' by upgrading roads so it will be somewhat impossible for serious or fatal accidents to occur.

Evidence suggest that most of the serious and fatal accidents that occur on Sweden's motorways and WS2+1 roads can be attributed to older / poorly maintained heavy goods vehicles which tend to originate in central or southern Europe, travelling to Sweden without appropriate consideration of the varying conditions i.e. the installation of winter tyres and the inability of drivers to handle the Swedish winter conditions.

A current key focus is in relation to removing the 'human factor' and improving road safety with autonomous vehicles. Trafikverket is currently supporting Volvo in developing this technology. In 2017, Volvo will start a test run with 100 autonomous cars in Gothenburg, Sweden as a pilot. Following the pilot, this will be expanded and will be trialled in London and locations in China to ensure autonomous vehicles are capable of responding and coping with different traffic environments. With this project and other initiatives, much of the ongoing work in terms of road safety is to improve the vehicle itself.

In Sweden, the government controls the distribution of alcoholic beverages that have over 3.5% alcoholic measure through the state controlled store, Systembolaget. Trafikverket previously had significant cooperation with Systembolaget for marketing regarding driving under the influence of alcohol and the potential impacts. It is considered that the level of this type of marketing has reduced significantly. This owes to the fact that it was considered by Trafikverket at that time that this wasn't an effective approach to promoting road safety. Instead, Trafikverket now increasingly works on clarifying this during driving courses and particularly to younger people. The most noticeable marketing collaboration between Trafikverket and Systembolaget is the introduction of warning labels on all alcoholic beverages that states that the beverage should not be combined with driving. From discussions with Trafikverket, it is now of the view that too much marketing surrounding road safety has been removed. It is now considered that it would be beneficial for enhanced marketing to be reintroduced to improve road safety.

4.4.3.2 WS2+1 Roads

In terms of WS2+1 design, Trafikverket are using both median and side barriers to avoid head-on collisions and to reduce the risk of leaving the road (due to driver fatigue or mobile phone use etc.). It is considered that median cable barriers have an elastic effect to make sure that vehicles are kept within their own driving field, avoiding frontal collision. Median cable barriers, however, are not popular with motorcyclists as their design includes poles and strings that can cause injury if motorcyclists crash into the barrier. It is considered that motorcyclists prefer hard steel median barriers that don't have the elastic effect and strings, however, these are not considered to be as safe for other road users.

A study of three different types of median barriers that are used in Sweden was undertaken by Trafikverket. The three types of barrier were considered as follows: cable barrier (flexible), steel barrier (semi flexible) and concrete barrier (rigid). This study indicated that some flexibility of the barrier is necessary in order to ensure that vehicles involved in a collision with the barrier aren't unacceptably damaged. It was considered that a concrete barrier may be used in areas where deflection of the barrier isn't permitted and where the combination of expected collision angles and speed doesn't create a situation where the risk of getting hurt is high. The study suggested that steel barriers provided good results in testing and may, from a safety perspective, be possible to use as median barrier. It was judged that the cable barrier demonstrated better potential in many complex situations and was considered more suitable in the mitigation of several types of collisions. The cable barrier, therefore, has been used widely across the Swedish road network and it has been estimated that the installation of these median cable barriers have prevented around 30 deaths and 120 serious injuries between 1998 and 2005.

It was the personal opinion of a road safety expert at Trafikverket that it would not make any difference what type of barrier was in place for motorcyclists due to the speed at which they are usually travelling when accidents are most likely to occur.

Based on research undertaken by a Trafikverket analysis group, concerns have been raised that WS2+1 schemes implemented post 2011 has been of a lower standard than those previously constructed. Furthermore, it was noted that there has not been any extensive reductions in speed limits from 90 km/h to 80 km/h. The analysis group considers achievement of safety targets possible. To achieve this, however, the analysis group underlined the importance of securing a high level of ambition both for conversion from S2 to WS2+1 roads and the need for reductions in speed limits (from 90 km/h to 80 km/h) on roads that are not planned to be converted to WS2+1 roads.

4.4.3.3 Safety Cameras

On roads where there is no median barriers and there is opposing traffic, Trafikverket is using an Intelligent Speed Adaption (ISA) system (a type of speed camera) that is used to lower the speed limit. Research has shown that the speed within the vicinity of the speed camera has reduced significantly, in addition to reductions in the speeds observed in between the cameras. The average speed on roads on which speed cameras have been implemented has reduced by 5%. It has been calculated that, following this reduction in speed that a subsequent reduction in the amount of fatal accidents on the roads by 20-30% and serious and fatal accidents by 20% has been witnessed.

If any fatal accidents occur on the Swedish road network, Trafikverket makes an in depth analysis to find out causes of accidents and how accidents could be prevented. From analysis, it was the expert opinion of the Trafikverket employee consulted that speed has been considered a factor in most of the cases examined.

Trafikverket is using speed cameras in an effort to enforce lower speed limits and reduce vehicle speeds on roads where drivers exceed the existing speed limits. A research project focusing on the effect of speed and road safety with speed cameras was undertaken by Trafikverket and the national police in 2006. The project indicated that on routes where an accident rate of more than 0.08 fatal and serious accidents per km per year was observed and the average speed exceeded 5 km/h over the assigned speed limit, the installation of speed cameras would be considered.

Research was conducted from 2006 to 2008 that measured the effect of speed cameras on specific routes by measuring the average speed before the implementation of speed cameras and then the speed one year after the speed cameras had been in place. These measurements were made from 82 locations within the vicinity of the camera locations, more than 100 locations between the cameras and locations where signage was present indicating that speed cameras were present on the route.

The data gathered indicated that speed cameras reduced the average speed and number of vehicles that exceed the speed limit, which is considered to have led to a reduction in fatal accidents by 20% to 30% and fatal and serious accidents by 20%.

Reductions in average speed have been observed on the routes upon which speed cameras have been implemented. It is noted, however, that the average reduction differs depending on the prevailing speed limits. As would have been expected, the reduction in vehicle speed is most notable within the vicinity of the camera locations - at locations between the cameras there is a slightly lower reduction in speed, but still a visible reduction.

- Average speed reduction of 1.4% (50km/h roads)
- Average speed reduction of 5.8% (70km/h roads)
- Average speed reduction of 3.9% (90km/h roads)

The reduction in the number of vehicles that greatly exceed the speed limit is significant on routes where speed cameras have been implemented. A reduction of some 34% was noted within the vicinity of and in between camera locations. It was noted, however, that there was a significant difference in the amount of vehicles that greatly surpass the speed limits within the vicinity of the speed cameras and in between the camera locations. The findings suggested that a reduction of up to 76% was observed within the vicinity of the cameras compared to a 5% reduction in between the camera locations. This is believed to be due to road users who slow down only within the vicinity of the camera itself and then speed back up again.

Research suggested that implementation of speed cameras could reduce the average speed observed on 90km/h roads from 92km/h to 88km/h, (a 4% reduction) which would result in a 20% reduction in fatal accidents. Following analysis of the observed speed data and accident statistics, it was confirmed that the reduction of fatal accidents proved to be 20%.

4.4.4 Other Relevant Projects

As part of this research, recent projects contributing to improvements in road safety have been identified and examined. One such project, delivered by Trafikverket, was the Gävle to Axmartavlan section of the E4, north of Stockholm.

4.4.4.1 Gävle to Axmartavlan

Many road engineers considered that, for many years, to keep roads safer, roads should be constructed wider and straighter to avoid crashes. The implication of this is that this led to increased vehicle speeds. The Vision Zero initiative was initially presented in 1995, with some radical suggestions, including; upgrading at grade junctions to roundabouts, construction of WS2+1 roads and ensuring all roads over a certain speed had a median barrier or equivalent installed to separate opposing streams of traffic. At that time, these recommendations were not well received as it was considered that motorways should be the future approach adopted for road upgrades. Road managers were of the opinion that WS2+1 roads were more dangerous for the road user and could see no reasoning for the introduction of median barriers, as this approach had not been adopted elsewhere, at that time.

After campaigning for WS2+1 roads, the traffic safety manager received the support of the General Director and Sweden's first implementation of a WS2+1 road was opened in 1998 between Gävle and Axmartavlan, on the E4, north of Stockholm. This trial road received a significant amount of critique and was said by many politicians, road safety administrations, as well as the public, that this was going to result in significant safety issued where road users transitioned from a motorway to a different road standard. It was also considered that the median cable barrier would result in fatalities in instances where drivers made an error when carrying out an overtaking manoeuvre.

The first accident on the section occurred one week after the inauguration of the road, where a driver lost control due to a distraction in their vehicle and crashed into the median barrier. It was noted that there was traffic on the opposing carriageway at the time. The median barrier took the impact of the car and it was judged that it most likely saved the driver's life. After that story was released by the media, opinions started to change surrounding WS2+1 roads and median barriers.

Evidence suggested that the trial section between Gävle and Axmartavlan was performing very successfully. The available statistics following opening demonstrated a fall in the number of fatal accidents on the road and demonstrated good value for money given WS2+1 roads in Sweden cost approximately 1/10th of the investment in a new dual carriageway. With the emerging benefits of WS2+1 roads confirmed, this helped to convince stakeholders and the Swedish public of the merits of the increased usage of WS2+1 roads.

4.5 Other Relevant Research

The Transport Research Laboratory (TRL) carried out a research project surrounding U.K. road safety on behalf of PACTS (a registered charity and an associate Parliamentary Group), published in September 2016[16]. The research compared the U.K.'s performance, in terms of road safety, with that of other high performing countries, including Norway and Sweden.

The study confirmed that the U.K. does have one of the best overall safety records, however, it was flagged that the safety of some individual road user groups compared less well. It was suggested that there appeared to be fewer vehicle occupant deaths per head in Britain than in other countries, however, there appears to be more vulnerable road user deaths per head in Britain.

Pedestrians, cyclists and motorcyclists constitute almost half of Britain's road deaths but fewer than two-fifths in Sweden. The likelihood of a pedal cyclist being killed per distance travelled in the U.K. is approximately twice that in Norway. 18-24 year olds are more at risk of being killed on the road in most countries than the average person, however this risk is proportionately higher on British roads than roads in Sweden.

The proportion of new cars which have a Euro NCAP 5 star rating is smaller in the U.K. than Sweden. In addition, the average pedestrian protection scores on new cars is lower in the U.K. than across the E.U. as whole and lower than in Norway and Sweden.

The study recommended that the following areas be considered:

The study suggested that:

- A greater proportion of British road deaths are on roads with speed limits of 60mph or more;
- Britain has more deaths per unit length of motorway, though not necessarily per vehicle kilometre, than the average motorway in the EU;
- Deaths on roads in urban areas are more likely to be male in Britain, and in rural area more likely to be female, than in other countries;
- Road deaths are more likely to be recorded as occurring at junctions in Britain; and
- In rural areas in Britain, pedestrians constitute a larger proportion of road deaths and car/taxi occupants a smaller proportion.

16 http://www.pacts.org.uk/wp-content/uploads/sites/2/PPR796-Understanding-the-Strengths-and-Weaknesses-of-Britains-Road-Safety-Performance-1.pdf

- Reviewing the safety records of roads with speed limits of 60mph and above, including motorways;
- Further investment in motorway safety;
- Ensuring that junctions are designed as safely as possible, particularly in respect of vulnerable road users;
- Implementing measures to improve the safety of pedestrians, pedal cyclists and motorcyclists;
- Implementing further measures to improve the safety of young drivers;
- Modernising the car fleet in the UK, replacing the oldest cars with today's highest Euro NCAP performing cars;
- Implementing higher standards of protection for vulnerable road users in vehicle safety regulation and Euro NCAP; and
- Obtaining and classifying casualty and exposure data in more consistent ways in different countries to enable more robust international comparison and evaluation.

The study set out a number of questions for further investigation. Those questions relevant to this study are as follows:

- Why are there proportionally more road deaths on roads with higher speed limits in Britain than in other countries?
- Why do Britain's motorways have more deaths per unit length than motorways in other countries?
- Why are there proportionally more vulnerable road user deaths in Britain than in other countries?
- Why are there proportionally more fatalities among 18-24 year olds in Britain than in other countries?
- How many collisions could be prevented and how many casualties mitigated, particularly among vulnerable road users, if cars on Britain's roads have higher Euro NCAP star ratings?

While this research has been carried out at a U.K. wide level, a number of the questions posed are relevant to road safety in Scotland and warrant further consideration.

4.6 Other Considerations

While every care has been taken to select routes and projects within Norway and Sweden that can be deemed comparable with the Scottish routes and projects examined as part of this research, it should be recognised that a range of factors, other than road design, can contribute to enhancements in road safety. This may mean that, while examples of Norwegian and Swedish best practice can be considered in a Scottish context, a range of other factors could contribute to similar measures implemented in Scotland having a differing impact, to varying degrees.

A number of other factors which are deemed to influence road safety are as follows:

- Signage strategies
- Speed limits
- Underlying driver behaviour
- Driver education (i.e. variations in driving test requirements)

- Regulations (i.e. requirements for snowchains in winter, headlights always on, drink driving limits)
- Targeted measures at reducing drink/drug driving

In Norway, it is considered that driving under the influence of drugs or alcohol represents an important risk factor for traffic accidents – it has been estimated that intoxication from alcohol, drugs or medication is a probable contributing factor in 24% of all fatal collisions in Norway[17]. The number of roadside police checks in Norway is one of the highest in Europe and systematic testing for driving under the influence has been introduced in all police checks. Sanctions imposed for non-compliance are proportional to the offender's monthly salary and escalate as the level of alcohol and/or drug concentration levels increase, ranging from a fine for being just over the limit to the withdrawal of a driver's license and imprisonment. Since February 2012, legislative limits were introduced for non-alcohol related drugs and it is an offence to be over the impairment levels considered for varying drug types.

A similar approach has been adopted in Sweden. The SMADIT programme (United Action Against Alcohol and Drugs on Roads) is a cooperative effort of several local authorities, the Swedish Transport Administration and Swedish Police (among others). Individuals reported for drink and / or drug driving are offered professional help promptly with the aim of reducing impaired driving and offering options for individuals to handle their addictions. All local authorities work according to SMADIT, though the programme is flexible enough that a varying, tailored approach is taken in different parts of the country.

Differing underlying behaviours between Scotland, Norway and Sweden, such as the approach taken in Scandinavian countries to winter driving, can contribute to the varying safety levels highlighted within the Eurostat data discussed earlier in this report. Identification and quantification of the varying impacts of other underlying factors would require further detailed research.

It is out-with the scope of this research to attempt to review the impacts of areas such as those noted above that could contribute to the variation in road safety statistics observed when comparing Scotland to both Norway and Sweden. Further research will be required to qualify any impacts of these areas.

4.7 International Context Conclusions

Effective planning is considered to have played the biggest part in reducing accidents in Norway and Sweden. Roads in Sweden are built to prioritise safety over speed or convenience. Low urban speed limits, pedestrian zones and barriers that separate cars from bicycles and oncoming traffic have all contributed to the continued reduction in the number of accidents.

Construction of significant lengths of WS2+1 roads, particularly in Sweden, is considered to have contributed to significant road safety improvements over the first decade of Vision Zero. Provision of safer crossings (including pedestrian bridges and zebra crossings flanked by flashing lights, protected with speed bumps) are likely to have contributed to a significant reduction in the number of pedestrian deaths over the past five years. Strict policing has also played a contributory factor with less than 0.25% of drivers tested in Sweden over the alcohol limit. Furthermore, road deaths involving children under seven have reduced significantly in Sweden—in 2012 only one was killed, compared with 58 in 1970.

While effective planning is considered a major factor in reducing accidents in Norway and Sweden, the available IRTAD reports indicated that there was no single reason for the reductions in fatal casualties observed. The reports did identify, however, a number of measures which could have contributed to this trend: These included:

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17 https://www.regjeringen.no/globalassets/upload/sd/vedlegg/brosjyrer/sd_ruspavirket_kjoring_net.pdf

- Road Safety Strategy - the adoption of “Vision Zero”
- Improvements in the car fleet i.e. increased proportion of car fleet with 5-star Euro NCAP ratings
- Reducing speed limits
- Conducting speeding campaigns
- Introduction of speed cameras resulting in reduced mean speed of traffic on high volume roads
- Provision of physical barriers to prevent head-on crashes on new motorways and two/three lane roads
- Running of seat belt campaigns resulting in increased use of seat belts

While a review of the available safety statistics indicates that road safety trends in Norway and Sweden are improving and may be linked to the policies, strategies and targeted measures identified within the preceding sections, cognisance of the other factors which could contribute to the varying safety trends between Scotland, Norway and Sweden, outlined in the preceding section, should also be taken.

While a range of other potential factors have been identified, this list should not be considered exhaustive. It is out-with the scope of this research to investigate or quantify the impacts of these factors on the varying safety trends between Scotland, Norway and Sweden.

Summary, Conclusions and Next Steps

5.1 Summary and Conclusions

While Scotland has a well-developed road safety strategy and is ranked as one of the top performing nations globally, historically Norway and Sweden have a better record of road safety than Scotland. This study focuses on the comparison of road safety statistics and trends in Scotland with those of Norway and Sweden to ascertain whether there are any policies, strategies or mitigations adopted within Norway and Sweden which could influence road safety trends in Scotland.

A comparison of factors contributing to road safety in Scotland, Norway and Sweden has been undertaken. The findings of this comparison is set out under the following headings:

- Road Safety Strategy
- Infrastructure
- Enforcement
- Other Factors and Considerations

5.1.1 Road Safety Strategy

Scotland, Norway and Sweden all have well developed road safety strategies, with numerous polices covering a range of impact areas and user types. Both Norway and Sweden have adopted “Vision Zero” road safety polices – that is ‘a vision of no road fatalities or road accidents causing lifelong injury’.

In Sweden, Vision Zero was first introduced in 1995 and has resulted in major changes both in terms of views on road safety and in the approach adopted to achieve it. The Swedish Parliament passed a resolution in 1997 when Vision Zero became the foundation for road safety in Sweden. Since then, the parliament in 2009 passed a new intermediate objective for fatal and serious casualties. Vision Zero has focused on a range of areas, including:

- Safer Road Environments
- Safer Vehicles
- Safer Transports (Freight)
- In-depth studies of fatal collisions
- Seat Belt reminders
- Alcohol Ignition Interlock
- Road Safety Cameras
- Cycle Helmets
- Road Safety – A Work Environment Issue
- Closer Cooperation on Road Safety

Road infrastructure improvements have seen roundabouts become more commonplace at intersections in urban areas. This is due to the perception that consequences of a collision are deemed to be less severe than at a priority junction. Since 2000, the construction of WS2+1 roads with median barriers has accelerated. The Vision Zero strategy also permitted municipal authorities to establish 30km/h speed limits in built up areas, which have now been implemented on a relatively large scale. Speed limits were also reviewed in order to ensure they reflect the standard of the road. As a result, there are now few sections of road with a speed limit of 110km/h that do not have a median barrier.

In Norway, the approach to road safety strategy is highly collaborative, with the current National Plan of Action for Road Traffic Safety 2014-2017 having been compiled by the NPRA in conjunction with the police, the Norwegian Directorates of Health and Education & Training, the Norwegian Council for Road Safety, county administrations and city municipalities and other non-governmental organisations. The plan sets out several measures, including:

- Road Safety Campaigns and information dissemination
- Road User Training
- Development of driver training and the practical driving test
- Measures targeting youths, senior citizens, motorcycle riders, immigrants and professional drivers
- Assessment of road safety rules concerning user behaviour
- Enforcement and control
- Vehicle Inspections
- Penalties and Sanctions
- ITS systems in vehicles and on roads
- Road network investment
- Operation and maintenance
- Speed Limits

In terms of investment in the road network, the plan set out an anticipated spend over the period 2014-17 of 40 billion NOK (approx. £4 billion at today's exchange rates) on new roads. This included:

- 107km of new 4-lane road with median safety barriers
- Installation of median barriers on 141km of 2 and 3 lane national roads
- Establishment of rumble strips on designated road sections
- Development and employment of a recording scheme to identify measures to prevent serious accidents where vehicles leave the carriageway
- Adaption of 175km of national road for pedestrians and cyclists (47km in urban areas)

In Scotland the current Road Safety Framework was published in 2009 and updated in 2016. The updated document committed to a 'Vision Zero' approach similar to Norway and Sweden. The strategy focussed on three priority areas which were:

- Speed and motorcyclists
- Pre-drivers, Drivers aged 17-25 and older drivers
- Cyclists and pedestrians

The framework contains many elements of the "safe system" approach to road safety. This recognises that road users are fallible and will make mistakes. A key part of the safe system approach requires that the road system be designed to take account of user error and vulnerabilities so that the chances of serious or fatal injury are reduced. This is in line with the principles of the Target Zero approach.

The approach to road safety strategy in Scotland in recent years has moved towards the approaches adopted in Norway and Sweden. The impact of the current approach on road safety trends may take a number of years to materialise.

5.1.2 Infrastructure

The sourcing of pre and post opening data for road schemes in Norway and Sweden comparable with the Scottish Case Studies set out in **Section 3** has proven difficult. Before and after monitoring of specific road schemes of the nature covered within this report do not appear to be undertaken to the same extent in Norway and Sweden as in Scotland. The monitoring and evaluation of specific road schemes in Scotland, therefore, appears to be better developed in Scotland, with adoption of formal road scheme evaluation in 2012. While direct comparisons of specific schemes cannot be made, a review of other associated information, impacts and findings has been considered.

While Norway and Sweden have observed success in reducing the number of accidents through the implementation of median barriers, this approach has been undertaken over fairly extensive lengths of carriageway. This differs somewhat from the approach undertaken in Scotland to date. WS2+1 schemes in Scotland tend to be in the order of 1km to 3km in length, do not include a median barrier and primarily provide overtaking opportunities in a single direction of travel. The available data from the WS2+1 schemes examined as part of the Scottish cases studies indicates that head-on collisions have not been witnessed within the vicinity of the WS2+1 sections. This suggests that implementation of median barriers over the extents of the WS2+1 schemes constructed in Scotland are unlikely to have a significant impact on road safety, albeit that the risk of a head-on collision would be mitigated over a short length of carriageway.

Given the variation in standards and the approach to delivering WS2+1s in Scotland, Norway and Sweden, it is difficult to draw any firm conclusions regarding their relative impacts. What can be deduced, however, is that the approach taken in Norway and Sweden, with longer sections of back to back WS2+1s being provided (with a continuous median barrier separating opposing carriageways) appears to result in more significant improvements in safety than the approach currently adopted in Scotland.

The successful impact of safety camera schemes implemented in Scotland is mirrored in the impact of those implemented in both Norway and Sweden. Significant reductions in fatal and serious casualties, in addition to reductions in average observed vehicle speeds, have been observed following installation of safety camera systems in each of the three countries. Given the available evidence, it would appear that this type of mitigation, if applied appropriately, can result in significant improvements in road safety through the reduction of vehicle speeds and the propensity for vehicles to exceed the speed limit.

5.1.3 Enforcement

Common traffic fines in Norway and Sweden are, generally, significantly greater than in Scotland[18]. Fines for prohibited overtaking and traffic signal offences are much greater than the comparable fines within Scotland. As a result, road users are generally more likely to avoid illegal practices, which can often lead to accidents.

Historically, penalties for usage of a mobile device while driving in Norway were much more severe than in Scotland. A recent change in the law in the U.K., effective as of 1st March 2017, however, has increased the penalty for using a mobile device while driving from 3 penalty points and a £100 fine to 6 penalty points and a £200 fine. This change is significant, particularly for younger drivers, who have recently passed their test. One offence could result in new drivers losing their driving license, with a

[18] http://www.speedingeurope.com/theburger/

maximum of 6 penalty points permitted for drivers in their first 2 years after passing their driving test. This change in the law, therefore, is likely to act as a significant deterrent against using mobile devices given the resulting penalties. Data to indicate the impact of this change in regulation on road safety will become available over the coming years. It is noted that in Sweden, there is currently no formalised penalty for usage of a mobile device while driving, although recent changes to Swedish law advises that while drivers can still use mobile devices, they are no longer permitted to use them in any manner that could be deemed "detrimental" to their driving. An evaluation of the new policy will be completed in Spring 2017.

The Scottish Government introduced legislation to reduce the blood alcohol drink driving, which came into force in December 2014. This reduced the legal limit of alcohol in the blood stream from 80mg (as per the rest of the U.K.) to 50mg per 100ml of blood. This is still somewhat higher than the limits in place in Norway and Sweden (20mg per 100ml of blood) which are among the strictest limits in Europe. The number of convictions in Scotland falling within the band between the new and old limits has been fairly low to date, which suggests that a change in culture or 'unacceptability' surrounding drink driving among a proportion of drivers, who may be more inclined to drink and drive, may take longer to materialise. The stricter limits in place in both Norway and Sweden essentially take a 'zero tolerance' approach to drink driving, leaving the driver with little doubt as to the acceptable limit of alcohol than can be consumed prior to driving.

Norway and Sweden have well established drug driving policies, with criminally enforceable limits and a high level of roadside police and systematic testing. Presently, there is no roadside testing or criminal limits in relation to drug driving in Scotland. Strict drug drive laws introduced in England and Wales in 2015 have resulted in a four-fold increase in the number of motorists charged with driving under the influence since the law was introduced, while the successful conviction rate has nearly doubled from 52% in 2012 to, more recently, 95%. The Scottish Government is in on-going discussions with Police Scotland, the Scottish Police Authority and the Crown Office & Procurator Fiscal Service on the operational requirements, including how roadside testing can be put in place. Ministers intend to lay regulations by the end of 2017 for approval by Members of the Scottish Parliament (MSPs), with implementation, including the need to have the necessary testing equipment in place, expected in 2019.

5.1.4 Other Factors / Considerations

Evidence suggests that the vehicle fleet in Norway and Sweden may play a role in the road safety trends observed in both countries. The propensity of Euro NCAP 5 star rated vehicles within the vehicle fleet is somewhat greater in Norway and Sweden when compared to Scotland. There are a variety of potential reasons for this, including the types of vehicles generally purchased, consumer purchasing power etc.

The available evidence suggests that the requirement to obtain a driving license may be more stringent in Norway and Sweden than in Scotland (and the wider U.K.). Using Norway as an example, there are a number of mandatory stages that are required to be completed prior to advancing to the final practical examination. These include:

- A night-time driving demonstration
- A safety course on a closed circuit testing driving skills in slippery conditions (oil and water mixture applied to circuit surface)
- Motorway Driving Course
- Long Distance Driving Course

These requirements provide new drivers with the full range of skills required to ensure safety driving techniques are adhered to. The current driving test requirement in Scotland (and the wider U.K.) are not as stringent and do not cover such a wide range of areas. As such, new drivers may not be fully equipped with the skills and knowledge to deal with all scenarios they could encounter. This, in turn, is likely to contribute to the higher ranking of Norway and Sweden, in terms of road safety, in comparison to Scotland.

It is judged that drivers in Norway and Sweden are likely to be much more accustomed to driving in adverse weather conditions, particularly winter conditions including ice and snow, than drivers in Scotland. Severe weather requires drivers to adjust their driving style accordingly to suit the conditions. Anecdotal evidence suggests that a proportion of drivers in Scotland are inherently poor at dealing with unusual weather conditions, such as heavy snow fall, which can result in road safety issues. This is related to the driver education issue discussed earlier, with drivers perhaps not receiving adequate tuition in how to deal with driving in inclement weather.

Vehicles in Norway and Sweden are required to have headlights on at all times. This is likely to aid visibility of drivers and other road users, both during the low light conditions in the winter but also during the summer. There is no such requirement in Scotland. The impact on safety of this requirement in Norway and Sweden cannot be quantified, however, it is reasonable to assume that with an increase in visibility would come a subsequent improvement in road safety.

Over the winter period in both Norway and Sweden, all cars are required by law to have either studded tyres or un-studded winter friction tyres. Outside this period, winter tyres may be used if the roads are considered to be in "winter conditions" by the local police. Foreign registered cars are also required to meet this requirement. Similar to the above, the impact on safety of this requirement in Norway and Sweden cannot be quantified, however, it is reasonable to assume that installation of appropriate tyres for winter weather conditions is likely to result in a subsequent improvement in road safety.

5.1.5 Summary

The study has highlighted that, while there are similar approaches to road safety in the three countries, differences in approach do exist that are worthy of further investigation. While differences exist in the approach to the design and delivery of infrastructure, particularly in relation to the strategy adopted surrounding the delivery of WS2+1 schemes, it is considered unlikely that this factor alone accounts for the variation in road safety statistics between the three countries.

Instead, differences in the approach to the enforcement of traffic violations, general differences in attitudes and driving behaviour (such as the social unacceptability of drink driving) are likely to play a part. Furthermore, a range of other factors are considered likely to contribute to the accident trends observed in Norway and Sweden, such as the propensity of Euro NCAP 5 star rated vehicles within the vehicle fleet, the additional requisites needed to be able to obtain a driving license and traffic regulations related to winter driving, as discussed in the preceding section.

Each of these differing factors discussed are likely to contribute, to varying degrees, to the safety statistics presented in Norway and Sweden. Research into each factor will be required to quantify their relative impacts on road safety.

5.2 Next Steps

Following this review, Transport Scotland may wish to give consideration to undertaking further research into some of the specific factors outlined which may account for the variation in road safety statistics in Scotland, Norway and Sweden. This could include:

- Research into the impact of introducing and enforcing drug driving legislation in Scotland
- Research into the possibilities, implications and potential impacts of revising the requirements of the driving test and enhanced driver education

- A review of the design standard and approach to the delivery of WS2+1 schemes in Scotland
- Research into the impact of lowering speed limits, in both rural and urban areas
- Research into the potential for, implications and potential impacts of the installation of median barriers on both S2 and WS2+1 carriageways in Scotland

Furthermore, given the apparent success of the safety camera schemes currently operating in Scotland, Transport Scotland may wish to give consideration to undertaking an exercise to identify other routes which could benefit from the installation of similar systems, in order to improve driver behaviour and road safety.

The TRL research project surrounding U.K. road safety, published in September 2016 , as discussed in **Section 4**, posed a number of questions that are worthy of further investigation. While this study was undertaken at a U.K. wide level, there are specific areas that Transport Scotland may wish to consider in a Scottish context, in more detail. These are as follows:

- Investigation into the reasons why there are proportionally more road deaths on roads with higher speed limits in Britain than in other countries.
- Investigation into the reasons why Britain's motorways have more deaths per unit length than motorways in other countries.
- Investigation into the reasons why there are proportionally more vulnerable road user deaths in Britain than in other countries.
- Investigation into the reasons why there are proportionally more fatalities among 18-24 year olds in Britain than in other countries.
- Investigation into how many collisions could be prevented and how many casualties mitigated, particularly among vulnerable road users, if cars on Britain's roads have higher Euro NCAP star ratings.

As noted above, the TRL report considered road safety at a U.K. level and an initial review would require to be undertaken to establish the likely relevance of each of these areas to road safety in Scotland.

Cognisance of up-to-date road safety statistics should be made, however, when considering any future measures or research surrounding road safety trends. The latest available data for Scotland, presented within '*Reported Road Casualties Scotland 2015'*[19], published in October 2016, indicates that the figures for all types of injury are the lowest since records began, suggesting that road safety in Scotland continues to improve. It can be judged, therefore, that the current approach to road safety in Scotland is contributing to a continuing improvement in road safety trends.

19 http://www.transport.gov.scot/sites/default/files/documents/rrd_reports/uploaded_reports/j452722/j452722.pdf

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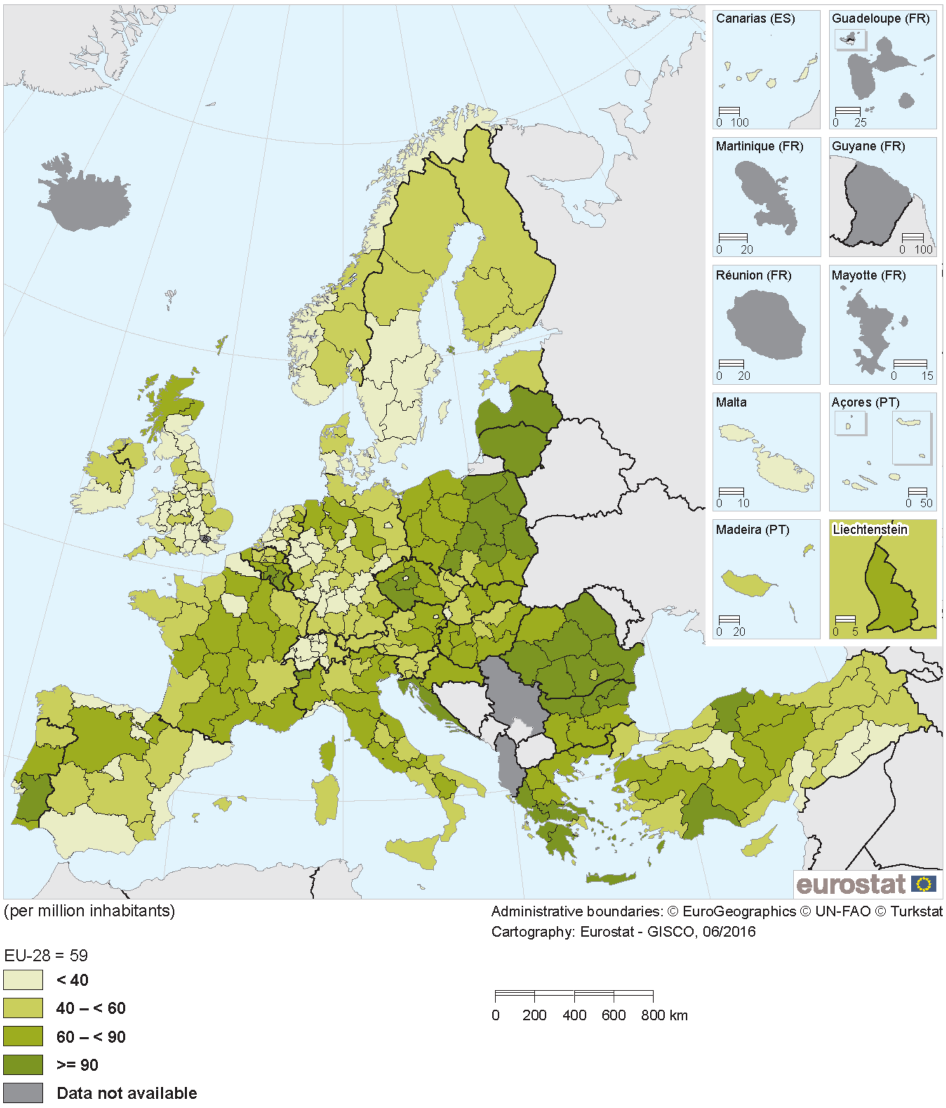
Appendix A
Understanding EuroStat

Appendix A – Understanding EuroStat

Figure A.1 EuroStat Number of deaths in road traffic accidents, by NUTS 2 regions (2014)



(¹) Ireland, Netherlands and Slovakia: 2013 instead of 2014.
Source: Eurostat (online data code: tran_r_acci)

Source: http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Number_of_deaths_in_road_traffic_accidents_by_NUTS_2_regions,_2014.PNG

Table A.1. NUTS2 Regions, Local Authority Commonality and Estimated Population (Mid-2014)

NUTS2 Region	**(NUTS3) Local Authority**	**Estimated Population (Mid-2014)**
UKM2 - Eastern Scotland	UKM21 - Angus and Dundee	264,870
	UKM22 - Clackmannanshire and Fife	418,440
	UKM23 - East Lothian and Midlothian	188,310
	UKM24 - Scottish Borders	114,040
	UKM25 - Edinburgh	492,610
	UKM26 - Falkirk	157,690
	UKM27 - Perth & Kinross and Stirling	240,450
	UKM28 - West Lothian	177,200
UKM3 - South Western Scotland	UKM31 - East Dunbartonshire, West Dunbartonshire, and Helensburgh and Lomond	196,420
	UKM32 - Dumfries and Galloway	149,960
	UKM33 - East and North Ayrshire mainland	258,610
	UKM34 - Glasgow	599,640
	UKM35 - Inverclyde, East Renfrewshire, and Renfrewshire	346,530
	UKM36 - North Lanarkshire	338,000
	UKM37 - South Ayrshire	112,530
	UKM38 - South Lanarkshire	315,300
UKM5 - North	UKM50 - Aberdeen and Aberdeenshire	489,450
UKM6 - Highland and Islands	UKM61 - Caithness and Sutherland, and Ross and Cromarty	415,500
	UKM62 - Inverness, Nairn, Moray, and Badenoch and Strathspey	
	UKM63 - Lochaber, Skye and Lochalsh, Arran and Cumbrae, and Argyll and Bute (except Helensburgh and Lomond)	
	UKM64 - Eilean Siar (Western Isles)	27,250
	UKM65 - Orkney Islands	21,580
	UKM66 - Shetland Islands	23,220

Figure A.2 EuroStat Safety Statistics – 2015 data (International Comparison)

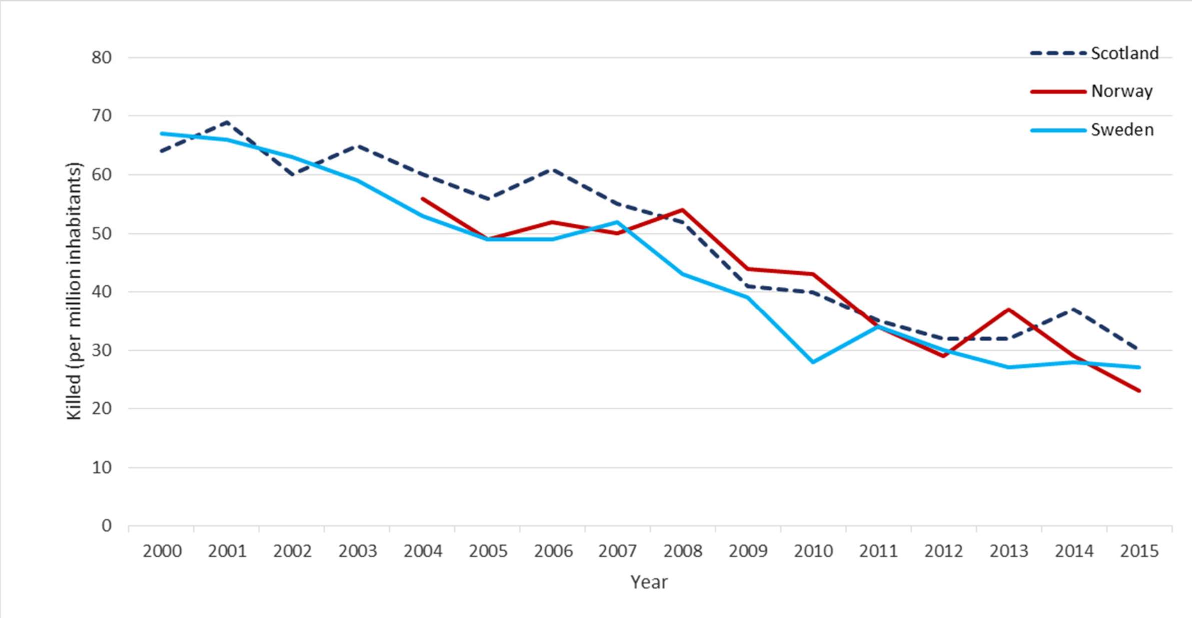
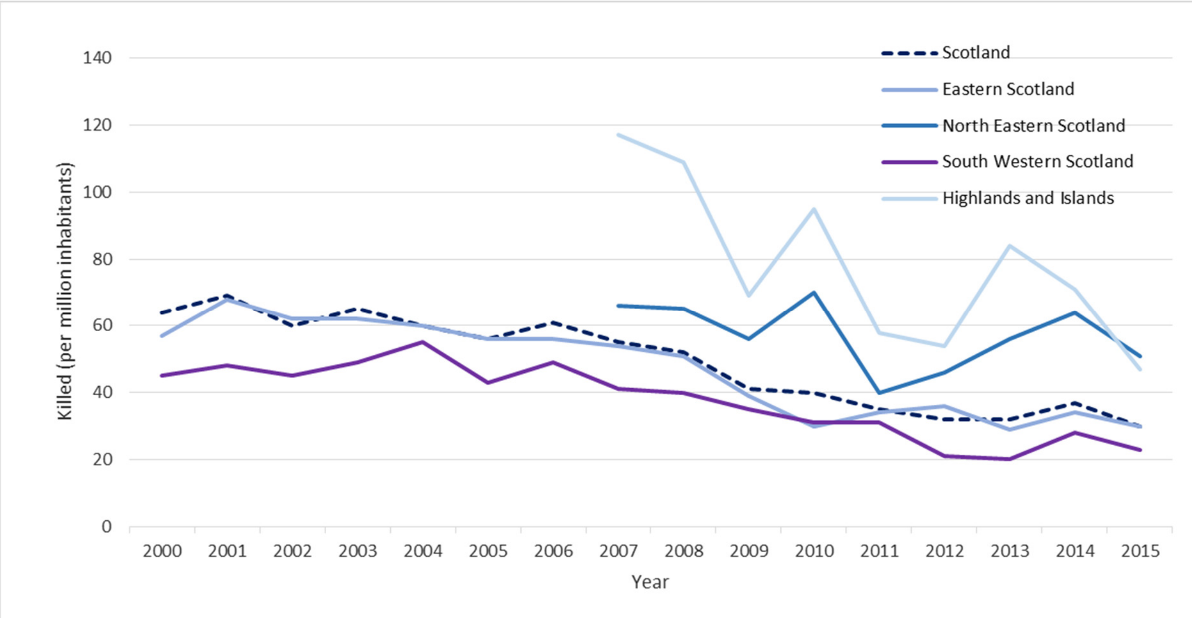


Figure A.3 EuroStat Safety Statistics – 2015 data (Scottish Regions)



Appendix B
Scottish Transport Statistics & Reported Road Casualties Data

Appendix B – Scottish Transport Statistics & Reported Road Casualties Data

Other Available Road Safety Statistics

While the available data from EuroStat provides a useful comparator of trends in safety across various European countries, caution should be taken when interpreting the absolute figures. The data presented (numbers killed per million inhabitants) could lead to a misinterpretation of prevailing accident trends due to the weighting by population and as such, a validation of the findings from the EuroStat data using other sources of readily available information can help to put into context the findings of the analysis.

Reported Road Casualties

Transport Scotland publishes accident statistics on an annual basis which presents detailed statistics about the circumstances of personal injury road accidents in Scotland that were reported by the police using the Stats 19 statistical returns. Each accident is classified according to the severity of the injury to the most seriously injured person involved in the accident.

'*Reported Road Casualties Scotland 2014'*[20], published in October 2015, includes data that was extracted from the Road Accidents statistical database on the 2 September 2015. The statistics presented may differ slightly from those published elsewhere (e.g. provisional figures published in Key Road Casualty Statistics in June) because they were extracted on a different date and wouldn't incorporate any later changes (e.g. due to late returns or late corrections). The information held in Transport Scotland's Road Accident Statistics database was collected by the police following each accident, and subsequently reported to Transport Scotland. Transport Scotland's statistics may differ slightly from the local authorities as changes or corrections that local authorities may have made, for use at local level, to their own data may not always be accounted for in the Transport Scotland database.

Based on the information presented within '*Reported Road Casualties Scotland 2014',* the total reported road casualties, including all severities, covering the period 2004 to 2014 inclusive, is presented in **Figure B.1**.

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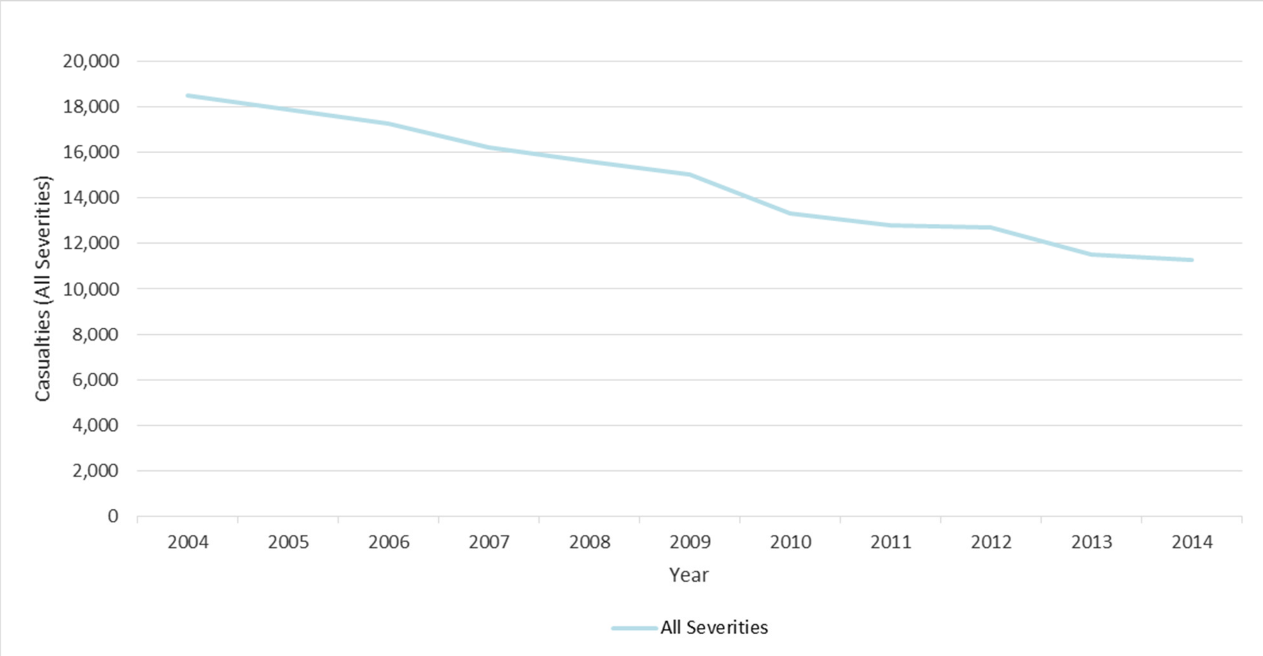
[20] http://www.transport.gov.scot/sites/default/files/documents/rrd_reports/uploaded_reports/j397988/j397988.pdf

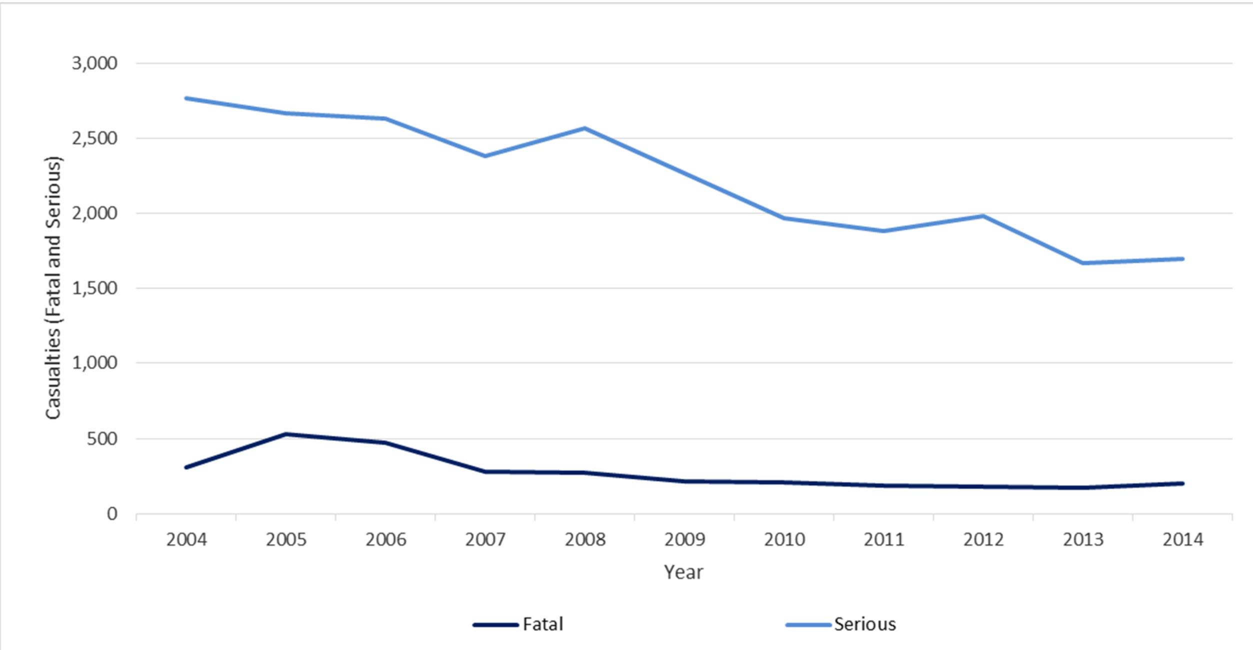
Figure B.1 Reported Road Casualties – All Severities (2004 – 2014)



As can be seen from the data presented in **Figure B.1**, , the total number of road casualties has fallen significantly across the Scottish road network over the period examined, with the total number of casualties in 2014 being some 7,200 casualties (39%) lower than 2004 levels.

Based on the information presented within '*Reported Road Casualties Scotland 2014',* the reported road casualties for fatal and serious casualties only, covering the period 2004 to 2014 inclusive, is presented in **Figure B.2**.

Figure B.2 Reported Road Casualties – Fatal and Serious (2004 – 2014)



As can be seen from the data presented in **Figure B.2**, the total number of serious road casualties has fallen significantly across the Scottish road network over the period examined, with the total number of casualties in 2014 being some 1,100 casualties (39%) lower than 2004 levels.

The data also indicated that total number of fatal road casualties has fallen significantly across the Scottish road network over the period examined. The total number of fatal casualties in 2014 was some 100 casualties (35%) lower than 2004 levels. While the general trend suggests a reduction in fatal casualties, it is noteworthy that in recent years, the number of fatal casualties has actually increased, i.e. 2014 fatal casualty levels were some 30 casualties (16%) greater than 2013 fatal casualty levels and are now more in-line with 2010 levels.

The latest publication, '*Reported Road Casualties Scotland 2015'*[21], which was published in October 2016, includes data that was extracted from the Road Accidents statistical database on the 2 September 2016. At the time of this research, corresponding safety data for international comparison was not available. As such, the findings from the 2014 publication have formed the basis of this analysis.

An overview of the statistics presented within the latest publication indicate that, in 2015:

- There were 157 fatal accidents, 24 (13%) less than in 2014.
- Serious injury accidents between 2014 and 2015 decreased by 74 (5%) to 1,417.
- Slight injury accidents fell by 270 (4%) between 2014 and 2015 to 6,900.
- There were 168 people killed in road accidents in Scotland in 2015, 35 (17%) less than in 2014.
- 1,596 people were seriously injured in road accidents in 2015, 108 (6%) less than in 2014.
- 9,204 people were slightly injured in road accidents in 2015, 196 (2%) fewer than in 2014.
- There were a total number of 10,968 casualties in 2015 – 339 (3%) fewer than in 2014.

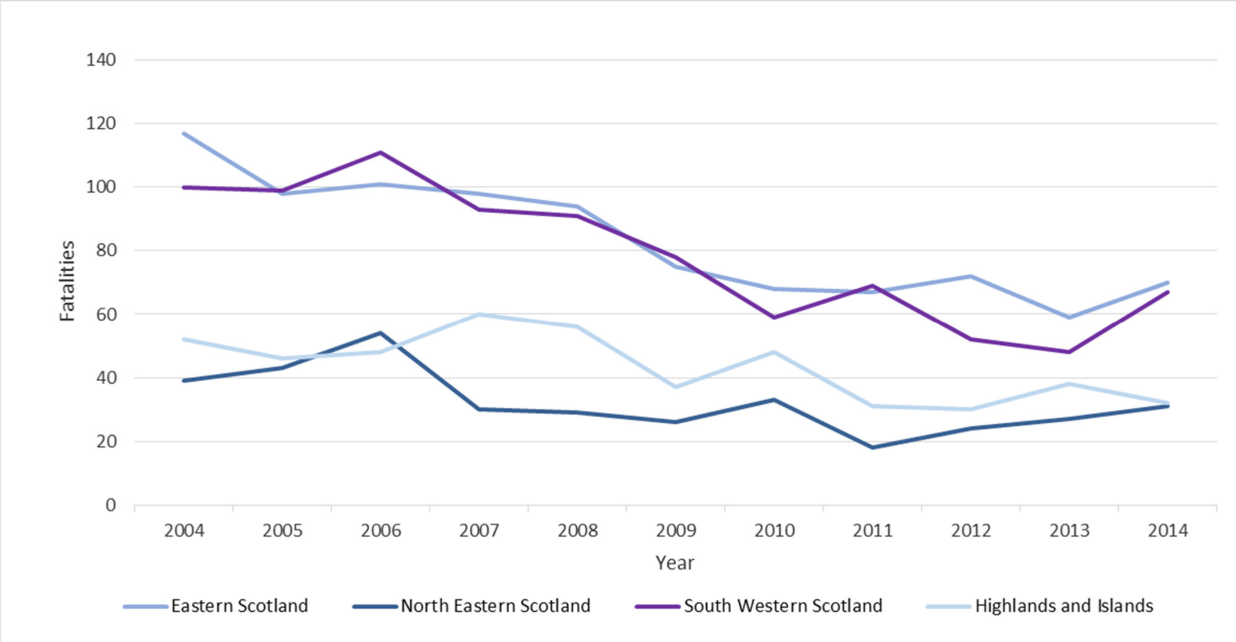
The report noted that the figures for all types of injury were the lowest since records began suggesting that road safety in Scotland continues to improve. The report also noted that the reductions in the numbers of accidents and casualties in recent years are notable particularly given the rise in vehicle and subsequent traffic e.g. in 2015 the number of vehicles licensed in Scotland was about an eighth higher than in 2005 and traffic on Scottish roads was estimated to have grown by 6% since 2005.

Reported Road Casualties – Fatalities by Region

To put the casualty statistics into a geographical context, the fatality statistics presented in '*Reported Road Casualties Scotland 2014'* have been considered by NUTS Level 2 region. This allows comparison with the Eurostat data presented earlier in this section. A graphical representation of the fatality statistics are presented in **Figure B.3**.

[21] http://www.transport.gov.scot/sites/default/files/documents/rrd_reports/uploaded_reports/j452722/j452722.pdf

Figure B.3 Reported Road Casualties by Region - Fatalities (2004 – 2014)



As can be seen from the data presented in **Figure B.3**, the absolute number of fatalities recorded across each of the four regions varies, with significantly greater numbers of fatalities recorded in the Eastern Scotland and South Western Scotland regions compared with the North Eastern Scotland and Highlands and Islands regions. This is as a consequence of the significantly greater traffic volumes present on the road network within the Eastern Scotland and South Western Scotland regions.

Scottish Transport Statistics – Million Vehicle Kilometres by Region

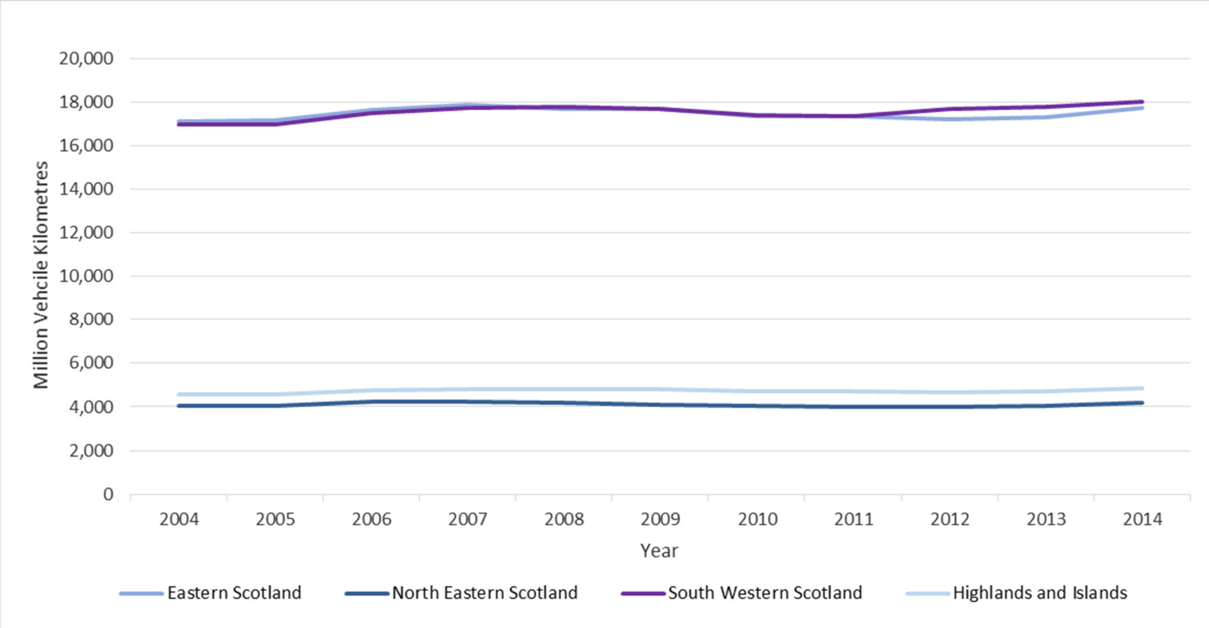
An additional analysis of million vehicle kilometre data from '*Scottish Transport Statistics No 34'*, 2015[22] and road safety statistics from '*Reported Road Casualties Scotland 2014'*[23] has been undertaken to put into context the EuroStat data to other widely available data from Transport Scotland.

A graphical representation of the million vehicle kilometres statistics are presented in **Figure B.4**.

22 http://www.transport.gov.scot/report/scottish-transport-statistics-no-34-datasets-8914

23 http://www.transport.gov.scot/reported-road-casualties-scotland-2014-datasets

Figure B.4 Scottish Transport Statistics - Million Vehicle Kilometres (2004 – 2014)

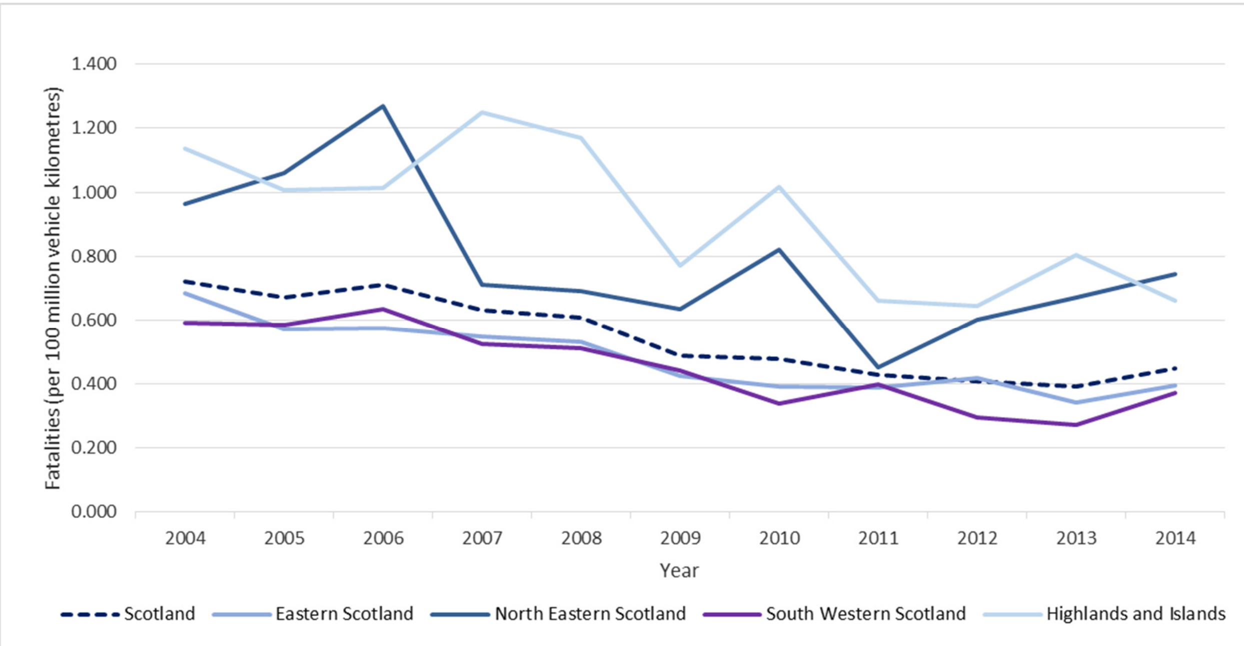


As can be seen from the data presented in **Figure B.4**, the vehicle kilometres recorded across each of the four regions varies, with a significantly greater volume of vehicle kilometres recorded in the Eastern Scotland and South Western Scotland regions compared with the North Eastern Scotland and Highlands and Islands regions. This is as a consequence of the significantly greater traffic volumes present on the road network within the Eastern Scotland and South Western Scotland regions.

Killed Per 100 Million Vehicle Kilometres by Region

To put the number of fatalities into context of the prevailing traffic conditions within each of the four regions, an analysis to determine the number of fatalities per 100 million vehicle kilometres has been undertaken to ensure a robust comparison across each of the four regions can be made. Utilising the available million vehicle kilometre and road safety statistics from Transport Scotland, a comparison of the numbers of fatalities per 100 million vehicle kilometres within the four Scottish regions identified within the EuroStat data is presented in **Figure B.5** below.

Figure B.5 Killed Per 100 Million Vehicle Kilometres (2004 – 2014)



As can be seen from the data presented in **Figure B.5**, the analysis undertaken on the basis of 100 million vehicle kilometres travelled does go some way to validate the findings of the EuroStat data for Scotland. Fatalities per 100 million vehicle kilometres in both the North Eastern Scotland and Highlands and Islands regions are somewhat higher than the Scottish average and are significantly higher than the Eastern Scotland and South Western Scotland regions. This is likely due to a number of factors including but not limited to:

- The more rural nature of the areas covered by these regions
- Prevailing weather conditions, particularly during winter months
- Lower levels of daylight hours during the winter months
- Other geographical / social causes

Table B.1. Scottish Transport Statistics – Million Vehicle Kilometres (2004– 2014)

NUTS2 Region	**(NUTS3) Local Authority**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
UKM2 - Eastern Scotland	UKM21 - Angus and Dundee	1,861	1,865	1,960	1,972	1,987	1,961	1,942	1,931	1,936	1,940	1,980
	UKM22 - Clackmannanshire and Fife	3,100	3,067	3,150	3,210	3,192	3,210	3,161	3,153	3,110	3,126	3,207
	UKM23 - East Lothian and Midlothian	1,457	1,483	1,529	1,567	1,529	1,523	1,507	1,506	1,477	1,479	1,531
	UKM24 - Scottish Borders	1,166	1,168	1,201	1,212	1,196	1,198	1,180	1,180	1,165	1,174	1,210
	UKM25 - Edinburgh	2,972	2,973	2,988	3,040	2,957	2,978	2,884	2,902	2,879	2,888	2,944
	UKM26 - Falkirk	1,439	1,436	1,491	1,524	1,517	1,505	1,480	1,489	1,521	1,525	1,554
	UKM27 - Perth & Kinross and Stirling	3,425	3,448	3,592	3,627	3,567	3,542	3,472	3,468	3,402	3,442	3,556
	UKM28 - West Lothian	1,688	1,702	1,713	1,743	1,762	1,746	1,716	1,717	1,709	1,727	1,763
	Total	**17,107**	**17,141**	**17,624**	**17,895**	**17,707**	**17,663**	**17,342**	**17,346**	**17,199**	**17,301**	**17,745**
UKM3 - South Western Scotland	UKM31 - East Dunbartonshire, West Dunbartonshire, and Helensburgh and Lomond	1,148	1,158	1,180	1,184	1,177	1,194	1,167	1,169	1,169	1,163	1,197
	UKM32 - Dumfries and Galloway	1,920	1,944	1,952	2,022	2,021	1,998	1,974	1,963	1,928	1,956	2,015
	UKM33 - East and North Ayrshire mainland	1,730	1,671	1,847	1,852	1,844	1,831	1,804	1,794	1,756	1,756	1,812
	UKM34 - Glasgow	3,384	3,417	3,360	3,406	3,429	3,391	3,330	3,340	3,492	3,536	3,566
	UKM35 - Inverclyde, East Renfrewshire, and Renfrewshire	2,503	2,501	2,740	2,783	2,796	2,756	2,699	2,726	2,693	2,710	2,795
	UKM36 - North Lanarkshire	2,968	2,964	2,983	3,049	3,060	3,025	3,001	2,958	3,236	3,221	3,118
	UKM37 - South Ayrshire	971	962	982	993	986	983	979	974	951	947	972
	UKM38 - South Lanarkshire	2,343	2,335	2,453	2,463	2,467	2,491	2,444	2,436	2,477	2,490	2,556

	Total	**16,968**	**16,951**	**17,497**	**17,752**	**17,780**	**17,669**	**17,398**	**17,360**	**17,702**	**17,779**	**18,031**
UKM5 - North Eastern Scotland	UKM50 - Aberdeen and Aberdeenshire	4,051	4,053	4,257	4,224	4,193	4,090	4,024	3,980	3,989	4,033	4,171
	Total	**4,051**	**4,053**	**4,257**	**4,224**	**4,193**	**4,090**	**4,024**	**3,980**	**3,989**	**4,033**	**4,171**
UKM6 - Highland and Islands	UKM61 - Caithness and Sutherland, and Ross and Cromarty	4,070	4,071	4,194	4,248	4,240	4,252	4,183	4,166	4,130	4,187	4,282
	UKM62 - Inverness, Nairn, Moray, and Badenoch and Strathspey											
	UKM63 - Lochaber, Skye and Lochalsh, Arran and Cumbrae, and Argyll and Bute (except Helensburgh and Lomond)											
	UKM64 - Eilean Siar (Western Isles)	186	176	208	209	205	206	203	202	203	206	213
	UKM65 - Orkney Islands	128	128	136	137	137	137	135	133	131	133	139
	UKM66 - Shetland Islands	195	198	205	206	206	203	202	202	200	204	210
	Total	**4,579**	**4,572**	**4,743**	**4,800**	**4,788**	**4,798**	**4,723**	**4,703**	**4,664**	**4,730**	**4,844**

Table B.2. Reported Road Casualties – Fatalities (2004 – 2014)

NUTS2 Region	(NUTS3) Local Authority	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
UKM2 - Eastern Scotland	UKM21 - Angus and Dundee	17	14	11	15	17	12	11	7	7	5	7
	UKM22 - Clackmannanshire and Fife	33	16	23	15	16	9	15	13	7	11	12
	UKM23 - East Lothian and Midlothian	9	5	8	9	6	11	4	4	4	8	4
	UKM24 - Scottish Borders	11	16	10	16	9	13	9	6	10	4	7
	UKM25 - Edinburgh	8	6	13	5	13	7	4	10	13	8	10
	UKM26 - Falkirk	7	8	5	2	4	3	1	1	10	3	5
	UKM27 - Perth & Kinross and Stirling	25	24	20	25	20	14	23	24	16	15	20
	UKM28 - West Lothian	7	9	11	11	9	6	9	2	5	5	5
	Total	**117**	**98**	**101**	**98**	**94**	**75**	**76**	**67**	**72**	**59**	**70**
UKM3 - South Western Scotland	UKM31 - East Dunbartonshire, West Dunbartonshire, and Helensburgh and Lomond	6	9	5	5	4	4	8	4	3	1	3
	UKM32 - Dumfries and Galloway	8	17	25	12	10	10	5	9	7	12	11
	UKM33 - East and North Ayrshire mainland	19	15	9	13	14	9	10	8	5	8	6
	UKM34 - Glasgow	16	17	26	14	15	18	11	13	7	4	18
	UKM35 - Inverclyde, East Renfrewshire, and Renfrewshire	13	10	8	14	12	6	4	10	11	7	10
	UKM36 - North Lanarkshire	13	9	12	12	13	10	2	11	6	6	5
	UKM37 - South Ayrshire	11	5	10	9	6	3	10	3	4	4	2
	UKM38 - South Lanarkshire	14	17	16	14	17	18	12	11	9	6	12

	Total	**100**	**99**	**111**	**93**	**91**	**78**	**62**	**69**	**52**	**48**	**67**
UKM5 - North Eastern Scotland	UKM50 - Aberdeen and Aberdeenshire	39	43	54	30	29	26	33	18	24	27	31
	Total	**39**	**43**	**54**	**30**	**29**	**26**	**33**	**18**	**24**	**27**	**31**
UKM6 - Highland and Islands	UKM61 - Caithness and Sutherland, and Ross and Cromarty	45	39	44	55	53	37	45	30	23	34	25
	UKM62 - Inverness, Nairn, Moray, and Badenoch and Strathspey											
	UKM63 - Lochaber, Skye and Lochalsh, Arran and Cumbrae, and Argyll and Bute (except Helensburgh and Lomond)											
	UKM64 - Eilean Siar (Western Isles)	6	4	1	0	1	0	2	1	2	1	4
	UKM65 - Orkney Islands	0	0	2	0	2	0	0	0	5	2	2
	UKM66 - Shetland Islands	1	3	1	5	0	0	1	0	0	1	1
	Total	**52**	**46**	**48**	**60**	**56**	**37**	**48**	**31**	**30**	**38**	**32**

Appendix C
Recent Trunk Road Improvement Projects

Appendix C - Recent Trunk Road Improvement Projects

Overview

Transport Scotland continues to invest in the trunk road network across Scotland with a range of projects of varying scale and nature implemented over the past 10 years. A key focus of this investment in infrastructure has been the drive to improve safety in-line with Scottish Government objectives on primary trunk routes, as discussed in **Section 3**.

Significant investment in trunk road infrastructure has been made in recent years with projects opened to traffic on the A75 in 2014 (Dunragit Bypass and Hardgrove to Kinmount), the A77 in 2014 (Symington and Bogend Toll) and the A82 in 2015 (Pulpit Rock and Crianlarich Bypass). Work on several other major trunk road projects, including the M8/M73/M74 Network Improvements, the Forth Replacement Crossing and the A9 Dualling programme, continues reflecting the desire of the Scottish Government to ensure Scotland is served by a modern, efficient and fit for purpose transport network.

Trunk Road Projects

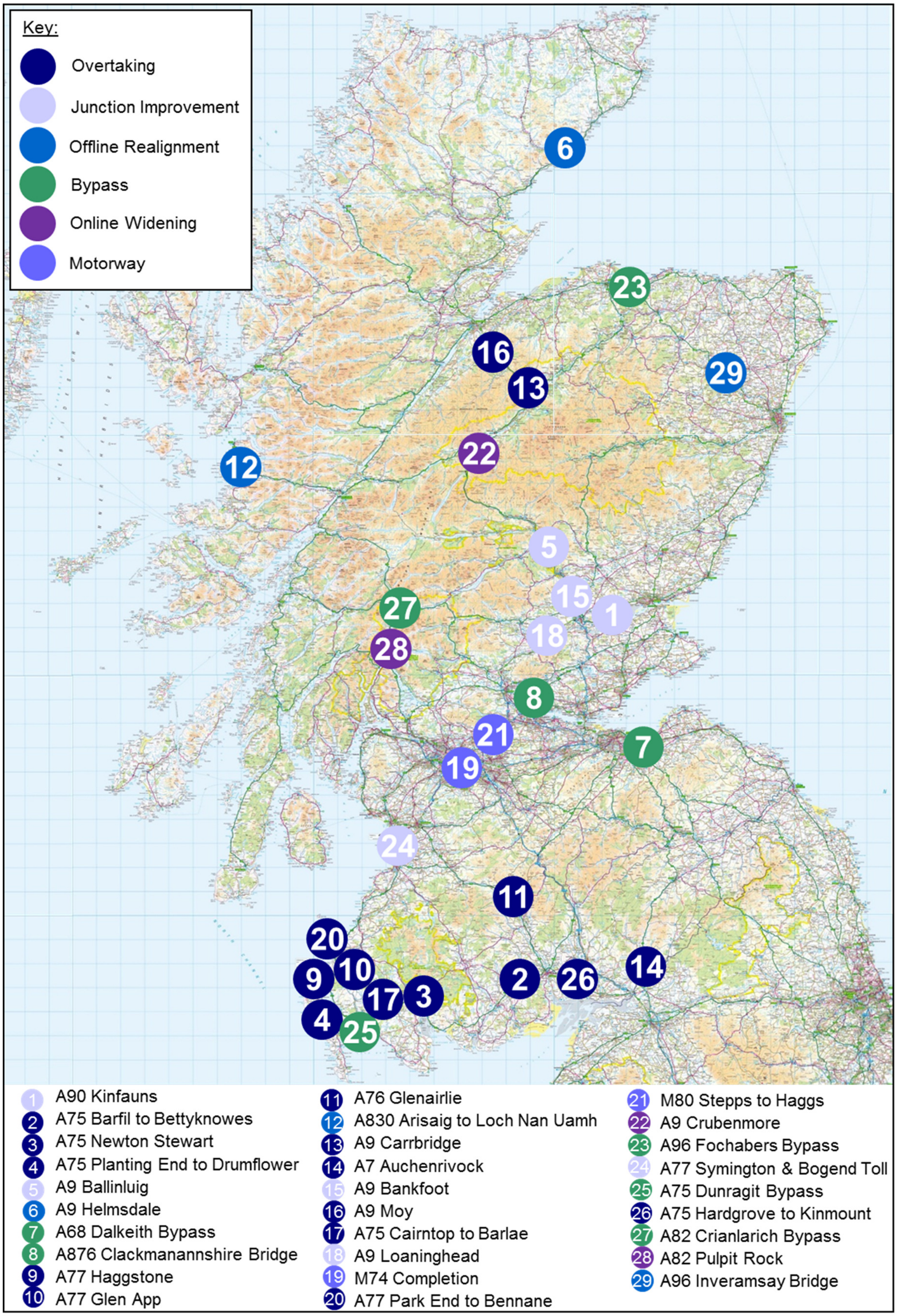
Those trunk road projects delivered by Transport Scotland within the last 10 years (2007 – 2016) involving construction of upgraded carriageway or new junctions etc. and costing over £5m, are presented in **Table C.1**. Their locations are presented in **Figure C.1**.

Table C.1. Completed Trunk Road Projects (2007- 2016)

Route	Project	Opened to Traffic	Description
A90	Kinfauns Interchange	February 2007	Grade separated interchange and closure of central reserve gaps on the A90
A75	Barfil to Bettyknowes	April 2008	Upgrade of 1.4 kms of single carriageway to WS2+1 carriageway providing a dedicated westbound overtaking opportunity over approximately 0.9 kms
A75	Newton Stewart	April 2008	Differential Acceleration Lane providing a dedicated westbound overtaking opportunity over a length of 375 m
A75	Planting End to Drumflower	April 2008	WS2+1 carriageway providing a dedicated eastbound overtaking opportunity over a length of 1 km
A9	Ballinluig	May 2008	Grade separated junction, including two new slip roads on the western side of the A9
A9	Helmsdale Phase 2	August 2008	2.1 kms of 6 m wide single carriageway and a 280 metre-long, 10 metre-wide section of climbing lane for northbound traffic
A68	Dalkeith Bypass	September 2008	5.4 km bypass to the north of Dalkeith with 2.6 kms of single carriageway and a 2.8 km southbound climbing lane
A876	Clackmannanshire Bridge	November 2008	4 km bypass to the west of Kincardine including the Clackmannanshire Bridge, incorporating the upgrade of 2.4 kms of the A876 carriageway and grade separation of Bowtrees Roundabout
A77	Haggstone	December 2008	1 km long climbing lane on the northbound carriageway
A77	Glen App	December 2008	1 km of off-line WS2 in addition to approximately 250 m of online improvement
A76	Glenairlie	March 2009	2.5 km of off-line WS2+1 with 0.5 kms of on-line improvements
A830	Arisaig to Loch Nan Uamh	April 2009	Upgrade of 7.5 kms of single track road with passing places to single carriageway
A9	Carrbridge	May 2009	1 km northbound overtaking lane
A7	Auchenrivock	June 2009	1.6 kms of single 2-lane carriageway and 1.7 kms of WS2 carriageway
A9	Bankfoot Improvements	September 2009	Removing right turn manoeuvres across the main A9 to/from the B867 and Bankfoot Village through improvements to the existing junction and the realignment of a minor road to the north, providing left-in, left-out junctions on the A9 for both northbound and southbound traffic
A9	Moy	August 2010	1.1 kms northbound overtaking lane
A75	Cairntop to Barlae	October 2010	2.4 kms of off-line dual carriageway
A9	Loaninghead	December 2010	New roundabout to the south of the A9 overbridge at its junction with the A823 and a new southbound slip road onto the A9 from the roundabout
M74	Completion	June 2011	8 kms of off-line dual three-lane motorway

A77	Park End to Bennane	July 2011	Widening of the existing A77 over approximately 2.9 kms to provide unambiguous, guaranteed overtaking in both directions through the provision of WS2+1 carriageway
M80	Stepps to Haggs	August 2011	18 kms of both on and off-line dual 2-lane and dual 3-lane motorway extending from M80 Junction 3 Hornshill to M80 Junction 7 Haggs
A9	Crubenmore Extension	September 2011	2.7 kms of on-line dual carriageway
A96	Fochabers Bypass	January 2012	5.1 kms of new carriageway providing bypass of Mosstodloch and Fochabers
A77	Symington and Bogend Toll	May 2014	Construction of two grade-separated junctions, located at Symington and Bogend; the closure of a number of gaps in the central reservation of the existing A77 dual carriageway and the rationalisation of a number of side roads accessing the A77 dual carriageway
A75	Dunragit Bypass	May 2014	5.3 km off-line WS2+1 carriageway bypass providing overtaking opportunities in both directions of travel
A75	Hardgrove to Kinmount	September 2014	3.6 km of WS2+1 lane carriageway providing guaranteed overtaking facilities in both the eastbound and westbound directions
A82	Crianlarich Bypass	February 2015	1.3 km single 2-lane carriageway bypass
A82	Pulpit Rock	May 2015	400 m of largely on-line single carriageway, a new viaduct running parallel with Loch Lomond and widening of the existing carriageway to the north of the viaduct
A96	Inveramsay Bridge	March 2016	1.45 km of new single carriageway and a new crossing over the Aberdeen to Inverness Railway line

Figure C.1 Trunk Road Project Locations



The scale and nature of the projects delivered over the past decade varies significantly from standalone junction improvements to major motorway projects. Each project, however, has been developed taking cognisance of Scottish Government objectives surrounding improving safety and contributes to this through aiming to reduce the number and severity of accidents occurring on the trunk road network.

On behalf of Transport Scotland, CH2M undertakes post opening evaluations of trunk road projects costing over £5m. This evaluation considers project's impacts on safety and how those projects have (or are moving towards) achieving their TPOs. Details of Transport Scotland's evaluation programme are available at http://www.transport.gov.scot/road/project-evaluation.

Appendix D
Scottish Case Studies

Appendix D – Scottish Case Studies

Wide Single 2+1 Carriageway

WS2+1 lane roads are described in the Design Manual for Roads and Bridges (DMRB) TD 70/08[24]. WS2+1 roads consists of two lanes of travel in one direction and a single lane in the opposite direction and provide overtaking opportunities in the two lane direction. Overtaking in the single lane direction is prohibited.

Where platooning and/or a lack of overtaking opportunities exist on an existing section of S2 or WS2 carriageway roads, a WS2+1 configuration can assist in the improvement of the operational characteristics of the route. The 2 lane overtaking section is required to be of sufficient length to disperse platoons of traffic but not so long as to cause driver frustration in the single lane section (within which overtaking is prohibited). The length of an overtaking lane section will also be determined by the local topography, road geometry and location of junctions within the vicinity.

It is considered best practice to implement WS2+1s in the context of the overall route strategy to ensure the driver is not confronted with numerous types of road layout. Transport Scotland has constructed several WS2+1 sections on various routes on the trunk road network, including on the A75, A77, A76, A9 and A82. A '*Review of WS2+1 Roads in Scotland*' report was prepared by CH2M for Transport Scotland in March 2013. This considered the application of WS2+1s in Scotland and assessed their effectiveness in meeting objectives.

Safety Camera Systems

The Scottish Safety Camera Programme was established following the successful trial of a UK-wide pilot in 2002. The purpose of the programme is to contribute to Scotland's road safety vision and road safety targets as set out in the Scottish Government's Road Safety Framework to 2020[25].

A variety of safety cameras are used to detect speeding vehicles. All cameras are Home Office Type approved and calibrated on a regular basis, by a third party. Safety cameras have a camera information sign placed prior to the point where enforcement takes place and camera housings and vehicles are clearly visible to road users.

In the context of this study Safety Camera Systems refer to Average Speed Cameras (ASCs). ASC Systems use linked Automatic Number Plate Recognition (ANPR) cameras to monitor the average speed of traffic over a section of road, or network of roads. Cameras can be installed in front and rear-facing orientation and offending vehicles can be recorded between multiple locations and multiple lanes within the system. They are used at permanent locations to control speeds on routes with a collision history and on a temporary basis at major roadworks to manage speeds through areas where narrow lanes and contraflows can affect safety.

Transport Scotland has successfully trialled ASC systems on the A77, with other schemes now implemented across the trunk road network.

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[24] http://www.standardsforhighways.co.uk/ha/standards/dmrb/vol6/section1/td7008.pdf

[25] http://www.gov.scot/Resource/Doc/274654/0082190.pdf

A75 – Gretna to Stranraer

The A75 is approximately 159 kilometres in length, extending from Gretna in the east to Stranraer in the west, within the Dumfries and Galloway local authority area. The route forms an important transport corridor in the south-west of Scotland, linking the A74(M) with the major town of the region, Dumfries and the port at Loch Ryan, providing onward travel to Northern Ireland and the Republic of Ireland.

The standard of the route varies across its extents from single carriageway (S2) sections (which forms the majority of the route), short sections of wide single (WS2), wide single 2+1 (WS2+1) lane carriageway and differential acceleration lanes (DAL) at specific locations to short dual carriageway (D2AP) sections, predominantly located at the eastern extent of the route.

Traffic volumes vary significantly across the extents of the route. Based on the information from Transport Scotland's traffic counters, in 2015 traffic flows varied from approximately 4,100 vehicles per day (vpd) at Glenluce (approximately 18 km east of Stranraer) to approximately 22,000 vpd on the Dumfries Bypass.

A RAP was developed for the A75, published in March 2000, which set out a number of significant constraints on the route which affected its performance and level of service. These were as follows:

- Sub-standard road geometry
- Insufficient and infrequent overtaking opportunities
- Platooning effects from ferry traffic
- Accident 'problem' areas
- Environmentally and scenically sensitive areas.

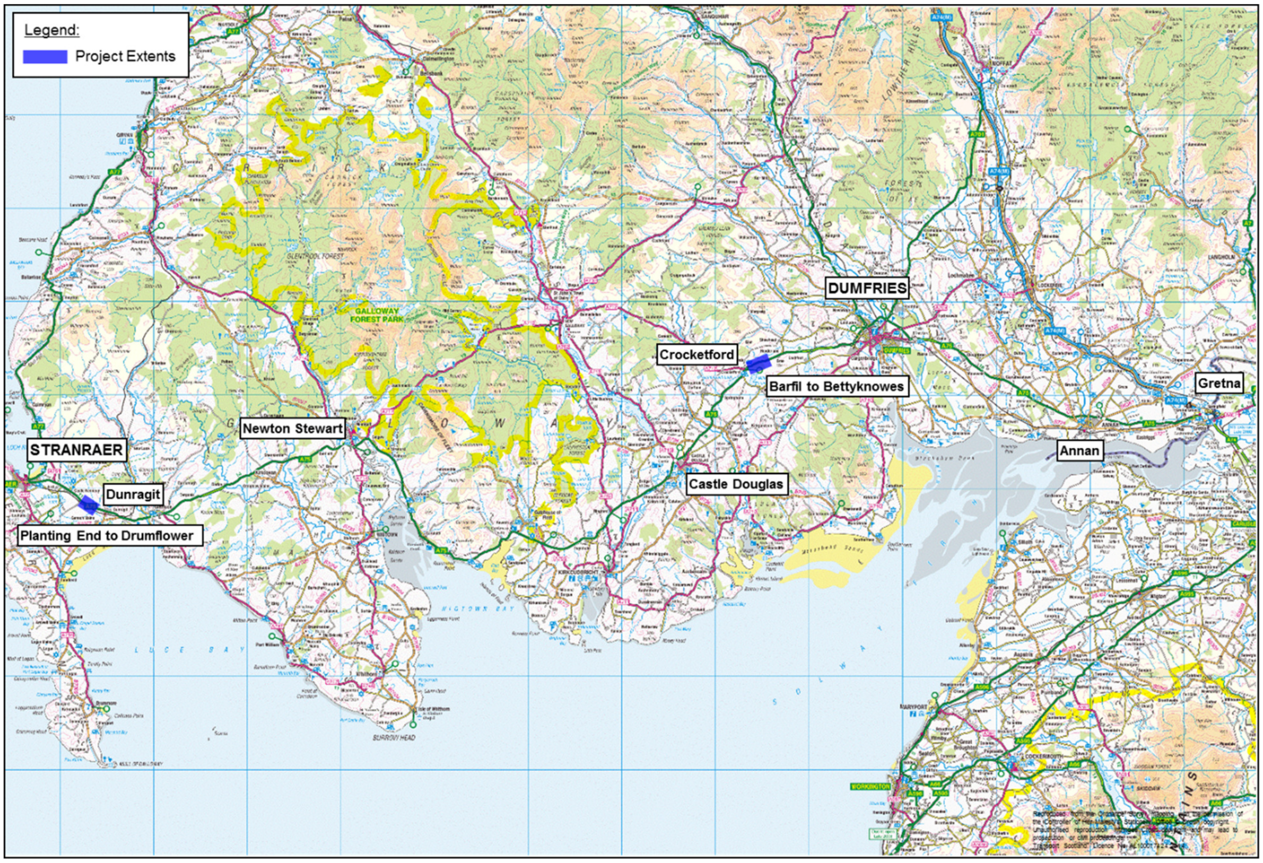
In order to address the constraints noted above, the RAP considered a number of objectives for the route. These were as follows:

- Develop a RAP which establishes a sustainable development strategy for short, medium and long term improvement measures, which demonstrates good value for money and addresses the needs of the A75 taking into account its multi-function role within a Local, National and European context as part of the Trans-European Road Network
- The RAP should aim to improve safety, maintenance liability (carriageway condition) and provide shorter and more reliable journey times, as well as providing improved overtaking opportunities and an improved level of service
- Develop measures which will provide for the protection and enhancement of existing landscape and townscape qualities and set out suitable mitigation proposals for any identified adverse effects
- Identify measures that will take account of opportunities to enhance the local and regional economy through tourism and other commercial development
- Investigate measures which will enhance opportunities for public transport, freight and non-motorised users on the A75

Subsequently, a range of projects were identified along the extent of the route which were judged to help meet the objectives set out within the RAP. A number of these projects, which have now been implemented on the A75 and which are considered relevant to this research, are the **Barfil to Bettyknowes** and **Planting End to Drumflower** schemes.

The locations of the projects relative to the A75 are shown in **Figure D.1**. The projects noted above, and their impacts on safety, are described in more detail within the following sections.

Figure D.1 A75 Projects Location Plan



Barfil to Bettyknowes

The Barfil to Bettyknowes project opened to traffic in April 2008 and involved the upgrade of 1.4 kilometres of single carriageway to wide single 2+1 (WS2+1) carriageway between Barfil and Bettyknowes. This involved the provision of a dedicated westbound overtaking opportunity over approximately 0.9 kilometres and the improvement of the alignment of the route. A shared pedestrian and cycle facility was also provided to the north of the road. The project had one transport planning objective (TPO) relating to safety, which was as follows:

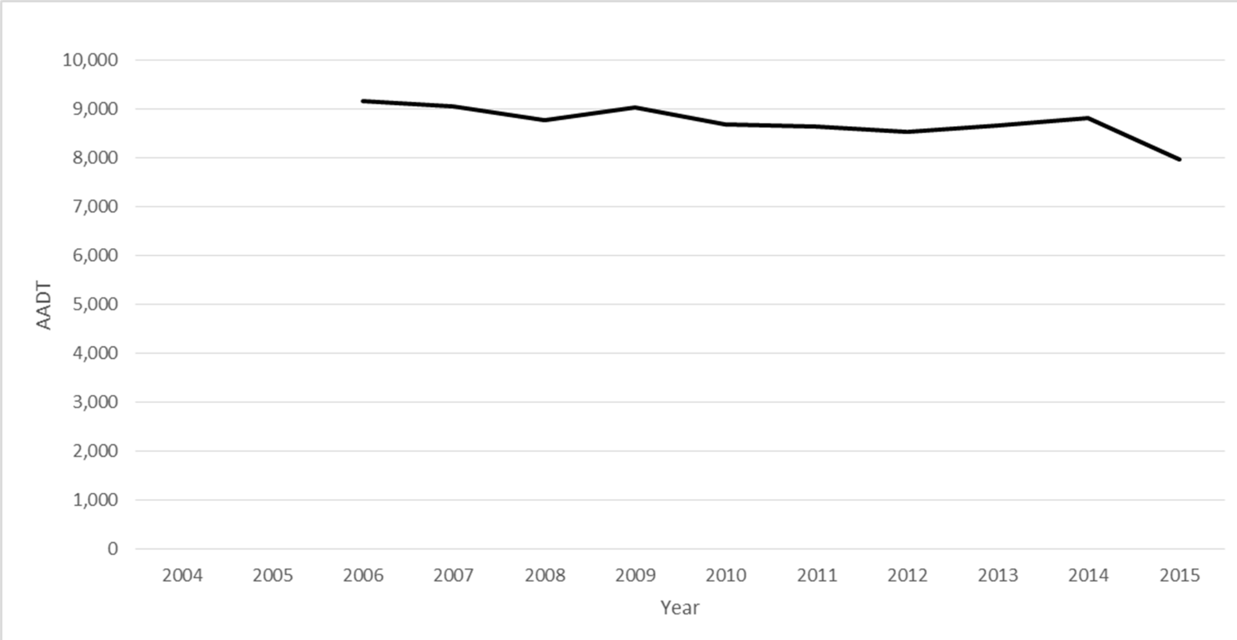
- To reduce driver frustration by providing a guaranteed overtaking opportunity thus providing greater safety on the network.

Section Characteristics

This section of the A75 is largely rural in nature, being located some 10 km to the west of Dumfries, within the vicinity of the village Crocketford. The vertical and horizontal geography of the route at this location is relatively flat in nature, with no significant gradients. The national speed limit for S2 carriageways applies over the extents of the project

To put the project into the context of the prevailing traffic flows observed on the route, the historic annual average daily traffic volume on the section of the A75 within which the Barfil to Bettyknowes project is located have been examined. Transport Scotland operates and maintains one traffic counter within the vicinity of the project, namely JTC00375 – 'A75 Crocketford'. The available data from the traffic counter is presented in **Figure D.2** below.

Figure D.2 Barfil to Bettyknowes Historic AADT Levels



As can be seen from **Figure D.2**, the prevailing traffic volume on this section of the route is between approximately 8,500 to 9,000 vpd. The percentage of Heavy Goods Vehicles (HGVs) observed on this section of the A75 is in the order of 8% to 9%.

Safety Impacts

Accident data for the period 2004 to 2015 inclusive (12 years) has been examined to assess the impact of the Barfil to Bettyknowes project on safety within its vicinity. This expands on the work undertaken on the project's STRIPE 1YA and 3YA Evaluations, undertaken by CH2M on behalf of Transport Scotland, which examined accidents over the period three years prior and three years post opening of the project.

The analysis undertaken as part of the project's STRIPE 3YA Evaluation indicated that one accident (slight) had occurred during the period three years prior to opening. This was in comparison to one accident (slight) that had occurred during the three year period following opening. The 3YA Evaluation concluded that the project had not impacted significantly on road safety within its extents.

Based on the latest available information, the collision and casualty trends over the period 2004 to 2015 are presented in **Figure D.3a** and **Figure D.3b** respectively.

Figure D.3a Barfil to Bettyknowes Collision Trends

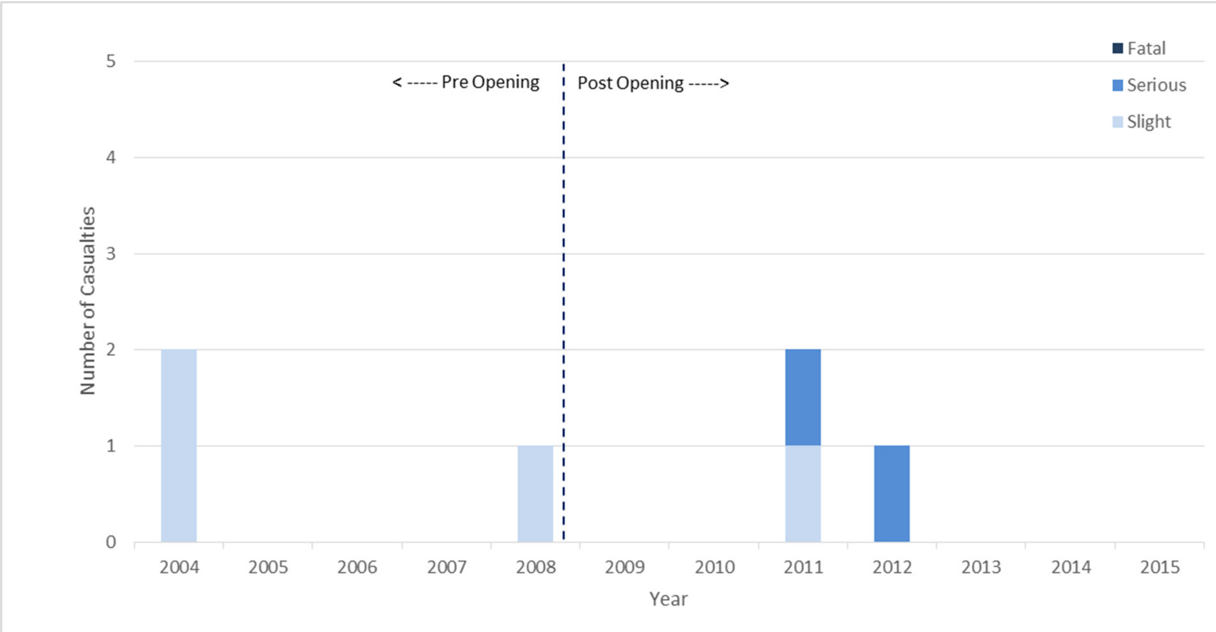
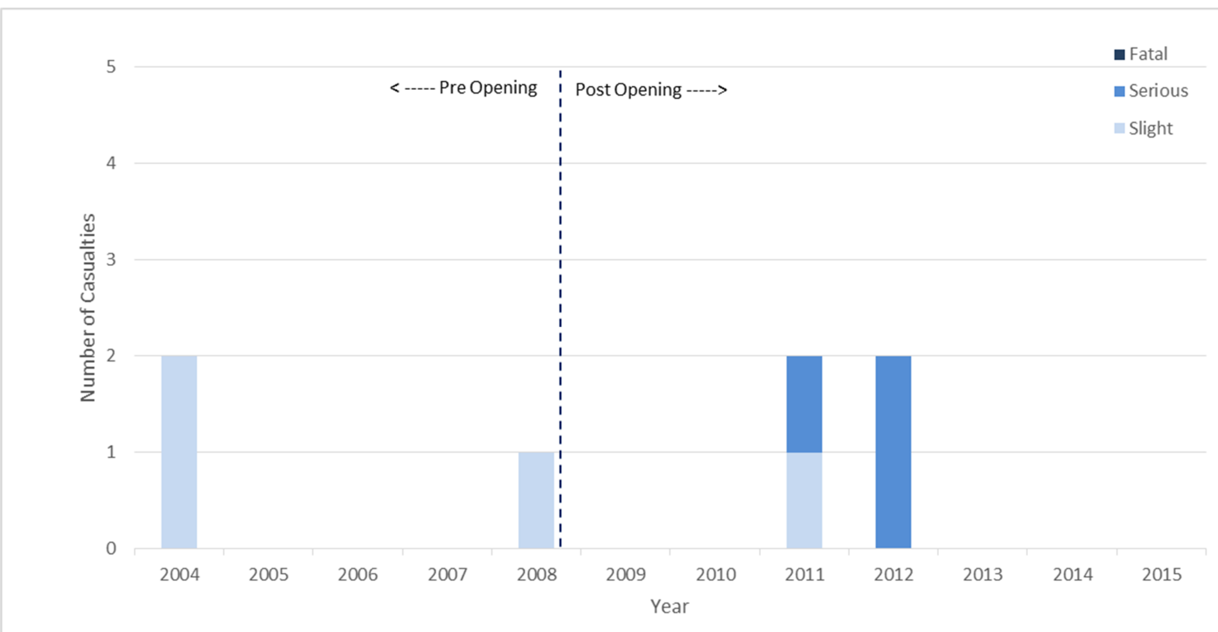


Figure D.3b Barfil to Bettyknowes Casualty Trends



As can be seen from **Figure D.3a** and **Figure D.3b**, the number of collisions (or accidents) and the number and severity of casualties occurring within the extents of the project may have increased following opening in 2008.

Due to the random nature of accidents and the short section over which the improvement has been made (1.4 kilometres), however, it is difficult to draw any firm conclusions with regards to the project's impact within its extents alone.

Pre Opening (2004 - 2008)

- **Three** slight collisions
- **Three** slight casualties

Post Opening (2009 - 2015)

- **Three** collisions, two serious, one slight
- **Four** casualties, three serious, one slight

Road Safety Audits

As part of the STRIPE 1YA and 3YA Evaluations carried out by CH2M on behalf of Transport Scotland for the Barfil to Bettyknowes project, the available Road Safety Audits (RSAs) were reviewed. The RSAs were examined to provide a more in depth analysis of any accident trends which may be emerging following opening of the project and to enable commentary to be provided on any issues which may require attention.

Two separate RSAs were undertaken and examined during the project's evaluation period, namely:

- A75 Trunk Road Overtaking Opportunities, Stage 4 - Year After Opening, August 2009
- A75 Trunk Road Overtaking Opportunities, Stage 5 Safety Audit - Post Implementation Monitoring (36 Months), December 2011

The Stage 4 RSA, examined as part of the project's 1YA Evaluation, noted that one personal injury accident (slight) occurred during the construction of the project (i.e. during the period 3 years before opening) and involved the collision of five vehicles during a period when a temporary traffic management scheme was active. The RSA report also noted that the collision was caused by a vehicle braking suddenly due to an oncoming HGV, in wet conditions. The report suggested that the main factors were reduced lane widths through the works and possible reckless driving by the driver of the HGV. The RSA report concluded that as the collision occurred during construction of the overtaking section, it could not be considered to be connected to the layout of the project.

The RSA report also noted two non-injury accidents which occurred within the vicinity of the project during the period 1 year after opening. It was concluded, however, that both of these accidents were attributable to poor driving rather than the layout of the project.

The Stage 5 RSA, examined as part of the project's 3YA Evaluation, indicated that two slight accidents had occurred within the vicinity of the project in the three year period following opening. This varied from the analysis presented in the 3YA evaluation as one of the accidents identified within the RSA was deemed to have occurred out-with the extents of the project and was therefore excluded from the analysis. The causation factor of both accidents identified within the RSA, both of which involved a single vehicle only, was given as loss of control due to driver error.

The RSA recommended that a speed survey be undertaken at this location to determine whether there is a speed problem and consult with the police over any enforcement requirements. A post opening overtaking survey was undertaken on the A75 in June 2014 to provide an indication of conditions between Barfil and Bettyknowes, enabling an estimation of mean vehicle speeds to be undertaken. The findings of the survey suggested that the project was not considered to have introduced speed related safety issues within its vicinity.

Wider Route Impacts

CH2M carried out a review of accidents occurring over a wider extent of the A75 upstream and downstream of the Barfil to Bettyknowes project in September 2012. This examined accidents occurring during the period 3 years before and 3 years after opening of the project.

It was concluded that the available accident statistics suggested that the implementation of the project may have had a positive impact on vehicle speed. It was also suggested that, on the basis of the reported statistics, a reduction in speed related accidents appeared to have directly followed the implementation of the project.

Planting End to Drumflower

The Planting End to Drumflower project opened to traffic in April 2008 and involved the construction of a WS2+1 carriageway on the A75 between Planting End and Drumflower. This comprised the provision of a dedicated eastbound overtaking opportunity over a length of 1 kilometre and improvement of the alignment of the route to current design standards. The project had one TPO relating to safety, which was as follows:

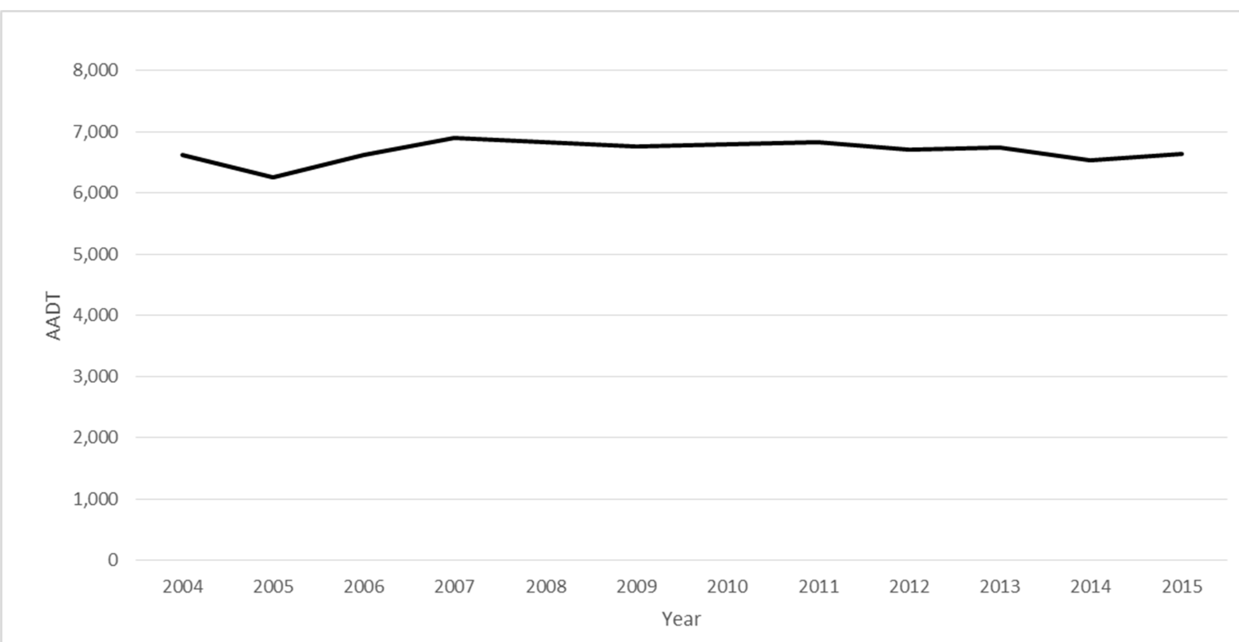
- To reduce driver frustration by providing a guaranteed overtaking opportunity thus providing greater safety on the network.

Section Characteristics

This section of the A75 is largely rural in nature, being located some 6 km to the east of Stranraer, within the vicinity of the village Dunragit. The vertical and horizontal geography of the route at this location is relatively flat in nature, with no significant gradients. The national speed limit for S2 carriageways applies over the extents of the project

To put the project into the context of the prevailing traffic flows observed on the route, the historic annual average daily traffic volume on the section of the A75 within which the Planting End to Drumflower project is located have been examined. Transport Scotland operates and maintains one traffic counter within the vicinity of the project, namely JTC00118 – 'A75 Southeast of A751'. The available data from the traffic counter is presented in **Figure D.4** below.

Figure D.4 Planting End to Drumflower Historic AADT Levels



As can be seen from **Figure D.4**, the prevailing traffic volume on this section of the route is between approximately 6,500 to 7,000 vpd. The proportion of Heavy Goods Vehicles (HGVs) is not available as classified traffic data by vehicle type is not available from the ATC within the vicinity of the project.

Safety Impacts

Accident data for the period 2004 to 2015 inclusive (12 years) has been examined to assess the impact of the Planting End to Drumflower project on safety within its vicinity. This expands on the work undertaken on the project's STRIPE 1YA and 3YA Evaluations, undertaken by CH2M on behalf of Transport Scotland, which examined accidents over the period three years prior and three years post opening of the project.

The analysis undertaken as part of the project's STRIPE 3YA Evaluation indicated that two accidents (slight) had occurred during the period three years prior to opening. This was in comparison to one accident (serious) that had occurred during the three year period following opening. The 3YA Evaluation concluded that the project had not impacted significantly on road safety within its extents and that the causation factor of the serious accident which occurred in the three year period following opening of the project was recorded as a loss of control. The 3YA Evaluation suggested that there was no available evidence to suggest that the design or layout of the project, excessive speed or manoeuvres associated with overtaking were contributing factors.

Based on the latest available information, the collision and casualty trends over the period 2004 to 2015 are presented in **Figure D.5a** and **Figure D.5b** respectively.

Figure D.5a Planting End to Drumflower Collision Trends

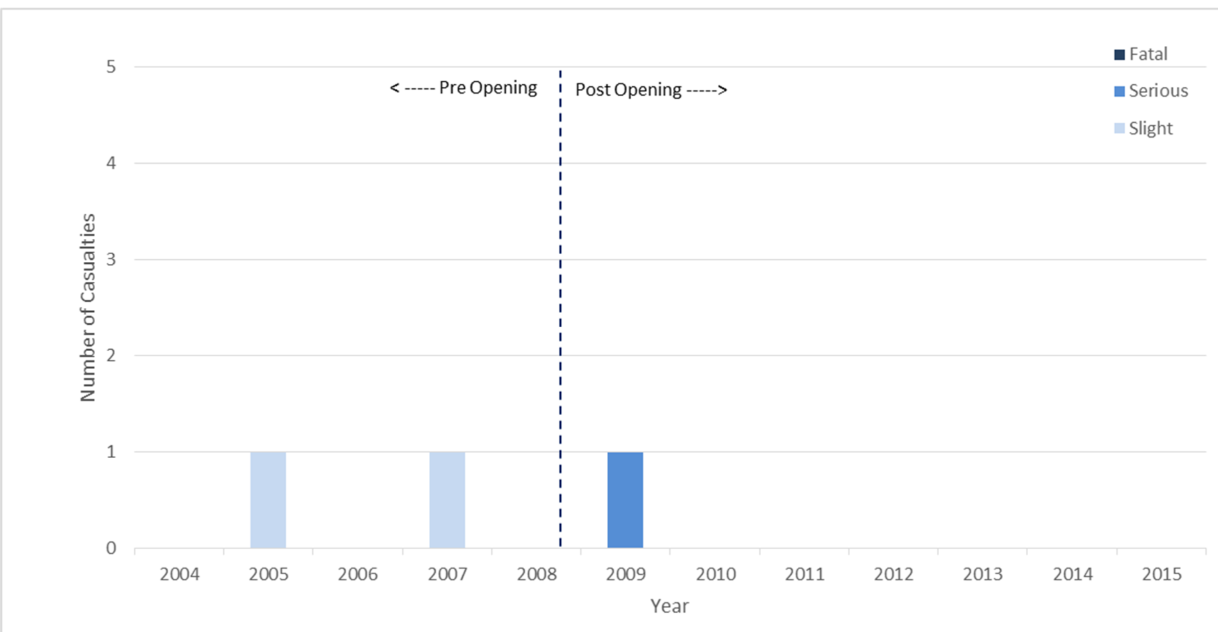
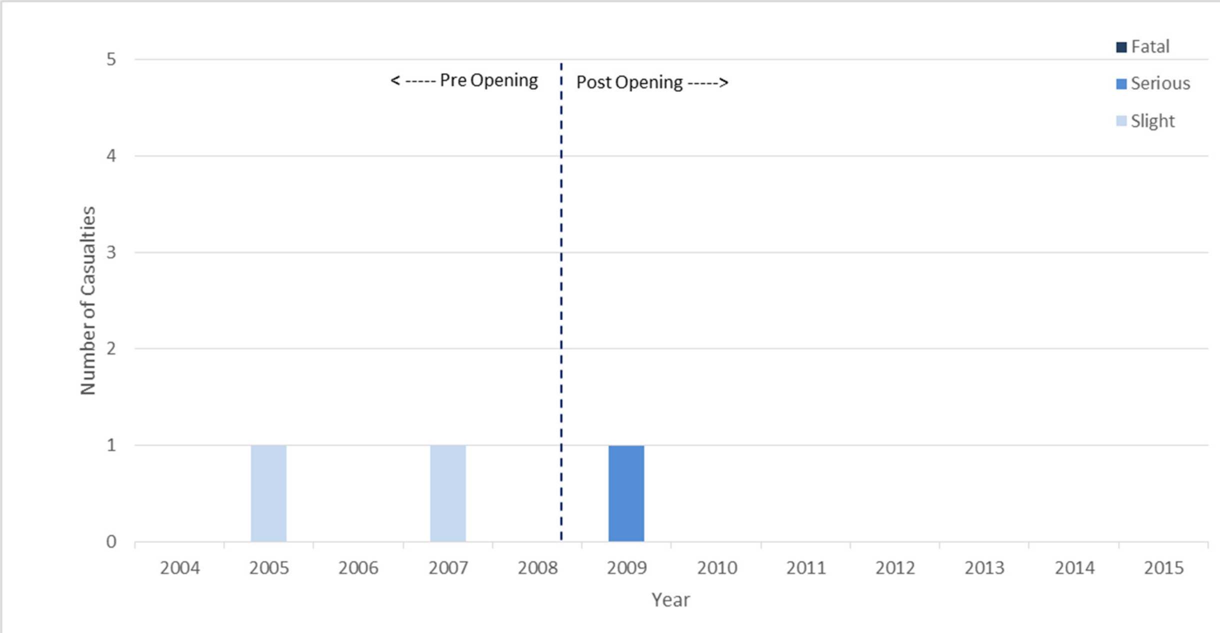


Figure D.5b Planting End to Drumflower Casualty Trends



As can be seen from **Figure D.5a** and **Figure D.5b**, the number of collisions (or accidents) and casualties occurring within the extents of the project have reduced following opening in 2008. The severity of casualties within the extents of the project, however, may have increased following opening in 2008.

Due to the random nature of accidents and the short section over which the improvement has been made (1 kilometre), however, it is difficult to draw any firm conclusions with regards to the projects impact within its extents alone.

Pre Opening (2004 - 2008)

- **Two** slight collisions
- **Two** slight casualties

Post Opening (2009 - 2015)

- **One** serious collision
- **One** serious casualty

Road Safety Audits

As part of the STRIPE 1YA and 3YA Evaluations carried out by CH2M on behalf of Transport Scotland for the Planting End to Drumflower project, the available RSAs were reviewed. The RSAs were examined to provide a more in depth analysis of any accident trends which may be emerging following opening of the project and to enable commentary to be provided on any issues which may require attention.

Two separate RSAs were undertaken and examined during the project's evaluation period, namely:

- A75 Trunk Road Overtaking Opportunities, Stage 4 - Year After Opening, August 2009
- A75 Trunk Road Overtaking Opportunities, Stage 5 Safety Audit - Post Implementation Monitoring (36 Months), December 2011

The Stage 4 RSA, examined as part of the project's 1YA Evaluation, noted one personal injury accident (serious) that occurred in the 1 year period following the opening of the project. The accident (involving a single vehicle which lost control and collided with a tree on the verge) occurred out with the extents of the project and, as such, was not included within the safety analysis undertaken as part of the evaluation.

The RSA report noted that the driver lost control at a bend before coming to rest further along the road and that the alignment of the road had not changed due to the overtaking section, however, the wider cross-section may be encouraging higher vehicle speeds. It was stated that it was unclear from the data provided what the main contributing factors to the accident were. It was noted, however, that Dumfries and Galloway Police indicated concerns from the public regarding this tie-in and increased vehicle speeds.

The RSA report also confirmed one non-injury accident which occurred within the vicinity of the project during the period 1 year after opening. It was concluded, however, that the accident was attributable to the temporary traffic management scheme associated with the completion of the project rather than the layout of the project.

The Stage 5 RSA, examined as part of the project's 3YA Evaluation, referred to one personal injury accident (slight) that occurred in the three year period following the opening of the project. The accident involved a single vehicle which lost control and collided with a tree. From the accident data records examined as part of the project's evaluation, it would appear that the accident occurring within the extents of the project resulted in a serious injury as opposed to a slight injury as indicated by the RSA. The RSA concluded, however, that there is no specific accident problems or clusters relating to the introduction of the overtaking sections.

The Stage 5 RSA recommended that a speed survey be undertaken at this location to determine whether there is a speed problem and consult with the police over any enforcement requirements. A post opening overtaking survey was undertaken on the A75 in June 2014 to provide an indication of conditions between Planting End and Drumflower, enabling an estimation of mean vehicle speeds to be undertaken. The findings of the survey suggested that the project was not considered to have introduced speed related safety issues within its vicinity.

Wider Route Impacts

CH2M carried out a review of accidents occurring over a wider extent of the A75 upstream and downstream of the Planting End to Drumflower project in September 2012. This examined accidents occurring during the period 3 years before and 3 years after opening of the project.

It was concluded that the available accident statistics suggested that in the wider area, the accident statistics suggest that the implementation of the project may have had a positive impact on vehicle speeds. On the basis of the reported statistics, a significant reduction in the number of reported accidents, including speed related accidents, appears to have directly followed the implementation of the project in 2008.

A77 – Fenwick to Stranraer

The A77 is approximately 108 kilometres in length, extending from the transition from the M77 motorway at Fenwick in the north to Stranraer in the south, crossing East Ayrshire, South Ayrshire and Dumfries and Galloway local authority areas. The route forms an important transport corridor in the south-west of Scotland, linking Glasgow and the wider central belt with the major towns of the region, Prestwick Airport and the port at Loch Ryan, providing onward travel to Northern Ireland and the Republic of Ireland.

The standard of the route varies across its extents from S2 carriageway sections (which forms the majority of the route), short sections of WS2 and WS2+1 lane carriageway at specific locations to D2AP carriageway sections, predominantly located at the northern extent of the route.

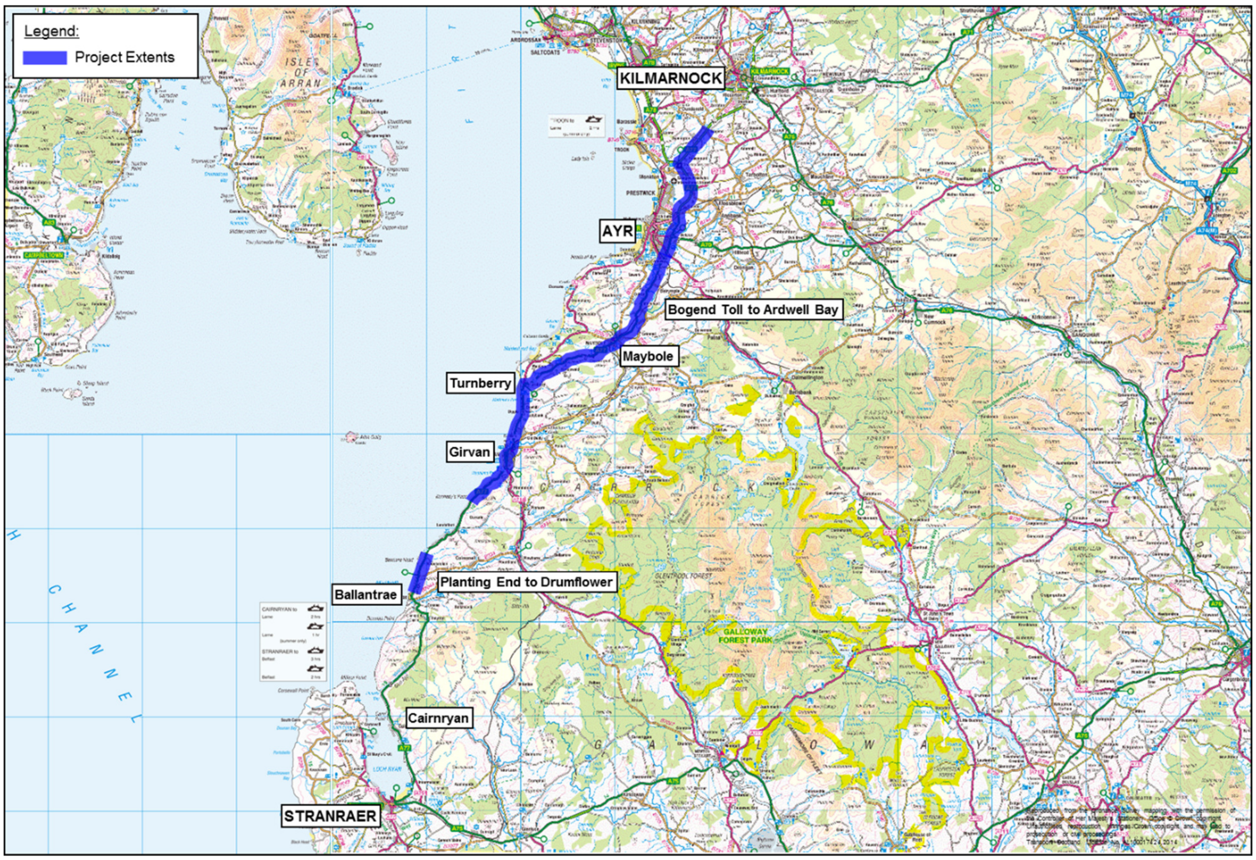
Traffic volumes vary significantly across the extents of the route. Based on the information from Transport Scotland's traffic counters, in 2015 traffic flows varied from approximately 2,800 vpd to the north of Stranraer (directly to the east of the A751 junction) to approximately 43,300 vpd to the north of the junction with the A71 / A76 (Bellfield Interchange) at Kilmarnock.

A RAP was developed for the A77 which sets out a number of significant constraints on the route which affected its performance and level of service. While specific details of the RAP were not available at the time of this report, it is known that, in order to address the constraints noted within the RAP, a number of objectives were considered for the route. Subsequently, a range of projects were identified along the extent of the route which were judged to help meet the objectives set out within the RAP. One such project, which has now been implemented on the A77 and which is considered relevant to this research is the **Park End to Bennane** scheme.

A further aspect of this research is the examination of safety camera systems installed to improve safety through the monitoring of average speeds. One such system operates on the A77, namely the **Bogend Toll to Ardwell Bay Safety Camera System**.

The locations of the projects relative to the A77 are shown in **Figure D.6**. The projects noted above, and their impacts on safety, are described in more detail within the following sections.

Figure D.6 A77 Projects Location Plan



Park End to Bennane

The Park End to Bennane project opened to traffic in July 2011 and involved the improvement and widening of the existing A77 over approximately 2.9 kilometres to provide unambiguous, guaranteed overtaking in both directions through the provision of WS2+1. The layout of the WS2+1 project is such that approximately 0.7 kilometres of unambiguous overtaking is provided in each direction, with the 2-lane overtaking sections facing each other on approach to the changeover. The project had one TPO relating to safety, which was as follows:

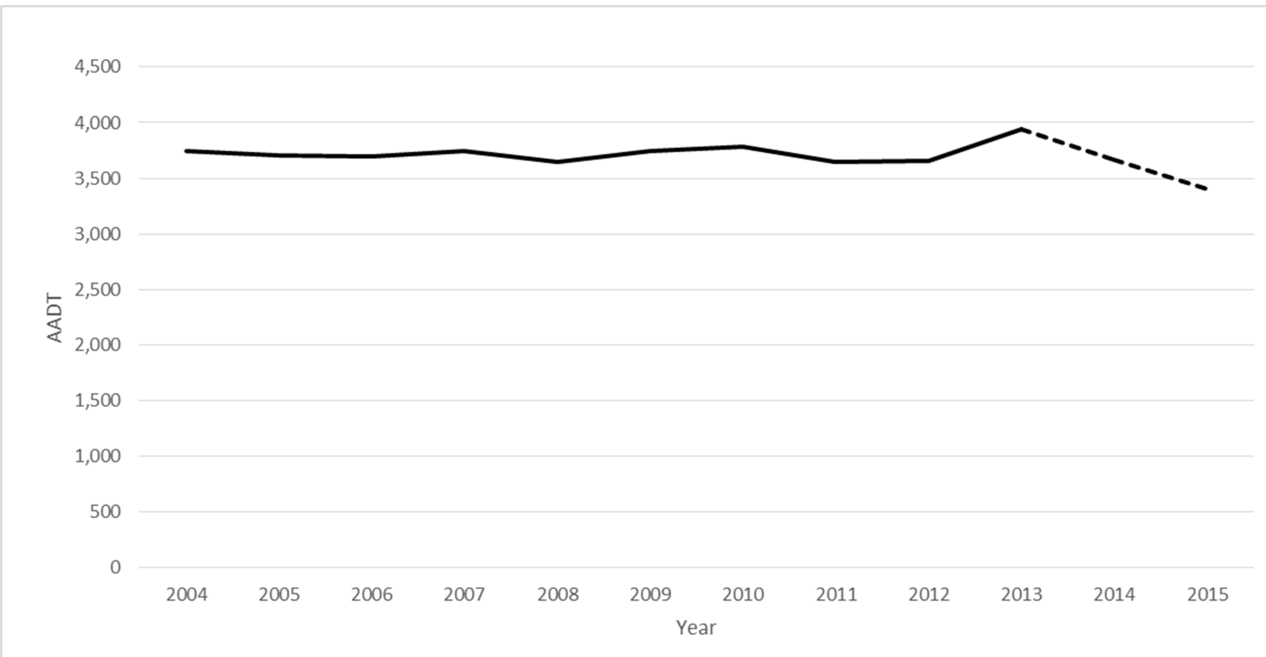
- To improve the operational performance and level of services and safety on the A77 by reducing the effects of driver stress and journey times; by constructing dedicated overtaking sections designed to break up the effects of convoys / platoons of vehicles.

Section Characteristics

This section of the A77 is largely rural in nature, being located some 28 km to the north of Stranraer, within the vicinity of the village Ballantrae. The vertical and horizontal geography of the route at this location is relatively flat in nature, with no significant gradients. The national speed limit for S2 carriageways applies over the extents of the project

To put the project into the context of the prevailing traffic flows observed on the route, the historic annual average daily traffic volume on the section of the A77 within which the Park End to Bennane project is located have been examined. Transport Scotland operates and maintains one traffic counter within the vicinity of the project, namely JTC00113 – 'Bennane'. The available data from the traffic counter is presented in **Figure D.7** below.

Figure D.7 Park End to Bennane Historic AADT Levels



Note: 2014 traffic flows are estimated

As can be seen from **Figure D.7**, the prevailing traffic volume on this section of the route is between approximately 3,500 to 4,000 vpd. The proportion of HGVs is not available as classified traffic data by vehicle type is not available from the ATC within the vicinity of the project.

Safety Impacts

Accident data for the period 2004 to 2015 inclusive (12 years) has been examined to assess the impact of the Park End to Bennane project on safety within its vicinity. This expands on the work undertaken on the project's STRIPE 1YA and 3YA Evaluations, undertaken by CH2M on behalf of Transport Scotland, which examined accidents over the period three years prior and three years post opening of the project.

The analysis undertaken as part of the project's STRIPE 3YA Evaluation indicated that one accident (slight) had occurred during the period three years prior to opening. This was in comparison to one accident (slight) that had occurred during the three year period following opening. The 3YA Evaluation concluded that the project had not impacted significantly on road safety within its extents.

Based on the latest available information, the collision and casualty trends over the period 2004 to 2015 are presented in **Figure D.8a** and **Figure D.8b** respectively.

Figure D.8a Park End to Bennane Collision Trends

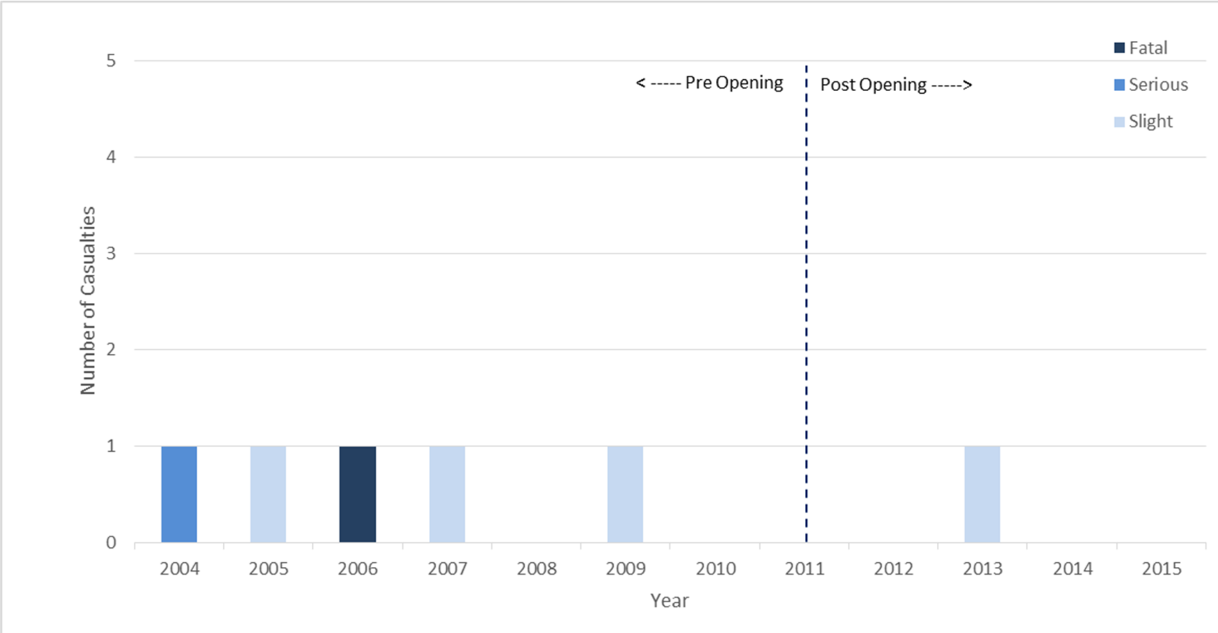
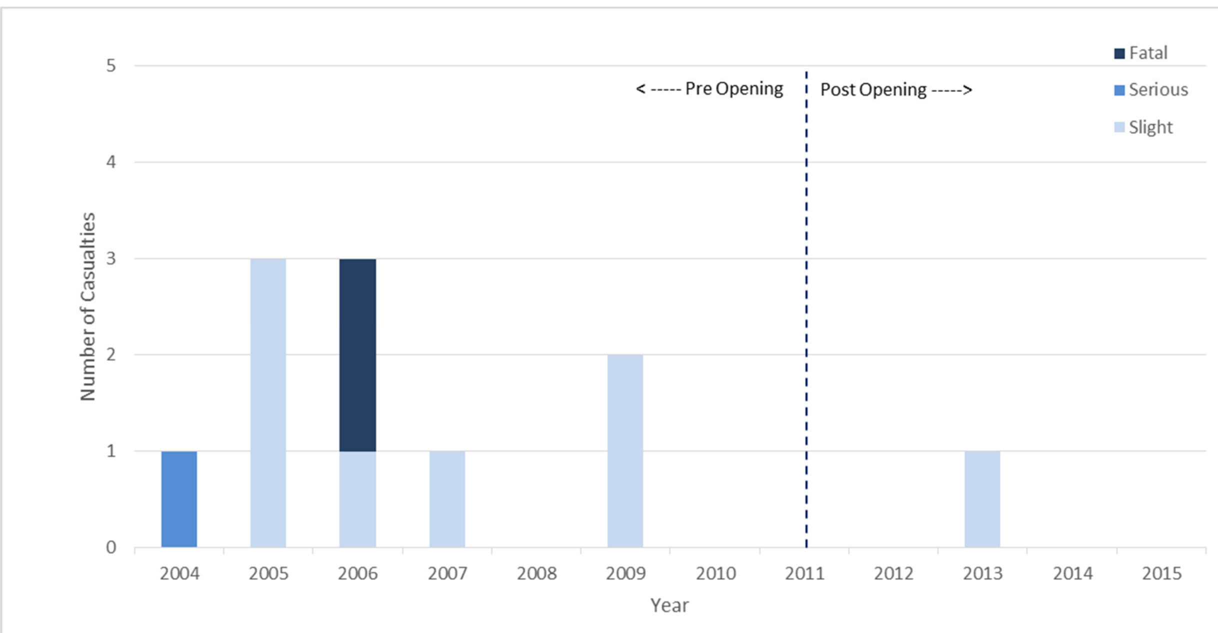


Figure D.8b Park End to Bennane Casualty Trends



As can be seen from **Figure D.8a** and **Figure D.8b**, the number of collisions (or accidents) and the number and severity of casualties occurring within the extents of the project have reduced significantly following opening in 2011.

Due to the random nature of accidents and the short section over which the improvement has been made, it is difficult to draw any firm conclusions with regards to the project's impact within its extents alone. It can be judged, however, given the available information, that the project had had a positive impact on safety within its extents.

Pre Opening (2004 - 2010)

- **Five** collisions, one fatal, one serious, three slight
- **Ten** casualties, two fatal, one serious, seven slight

Post Opening (2011 - 2015)

- **One** slight collision
- **One** slight casualty

Road Safety Audits

As part of the STRIPE 1YA and 3YA Evaluations carried out by CH2M on behalf of Transport Scotland for the Park End to Bennane project, the available RSAs were reviewed. The RSAs were examined to provide a more in depth analysis of any accident trends which may be emerging following opening of the project and to enable commentary to be provided on any issues which may require attention.

Two separate RSAs were undertaken and examined during the project's evaluation period, namely:

- Stage 4 – 12 Months Road Safety Audit Report, October 2012
- Road Safety Audit Stage 4 (36 Months), January 2016

The Stage 4 RSA, reviewed as part of the project's 1YA Evaluation, confirmed that no accidents had occurred within the vicinity of the scheme following opening and that no trends or common factors in accidents had been observed.

The Stage 5 RSA, reviewed as part of the project's 3YA Evaluation, confirmed that one slight accident had occurred within the vicinity of the project in the three year period following opening. The causation factor of the accident (which involved an HGV and a car) resulted from an overloaded or poorly loaded vehicle or trailer. The RSA noted that there was little evidence to suggest any engineering deficiencies at this location and the accident was therefore not considered to be connected to the layout and design of the project.

Bogend Toll to Ardwell Bay Safety Camera System

The Bogend Toll to Ardwell Bay Safety Camera System project became operational in July 2005 and operates over a distance of approximately 60 kilometres from Bogend Toll in the north to Ardwell Bay in the south. This covers both S2, WS2+1 and dual carriageway standard sections, through both rural and built-up areas.

As the system has been in operation for over 10 years, the equipment has recently been replaced with the Vysionics VECTOR system which is a development of the SPECS3 which is currently in use on the A9. The main visual difference is that the VECTOR system can monitor two lanes of traffic from a single camera, instead of one for each lane. In addition, all columns and camera heads will be painted bright yellow to make them much more visible to all road users. The upgraded system went live in Summer 2016[26].

[26] http://a77road.info/files/2016-03/press-release-a77-asc-go-live-june-2016.docx

Section Characteristics

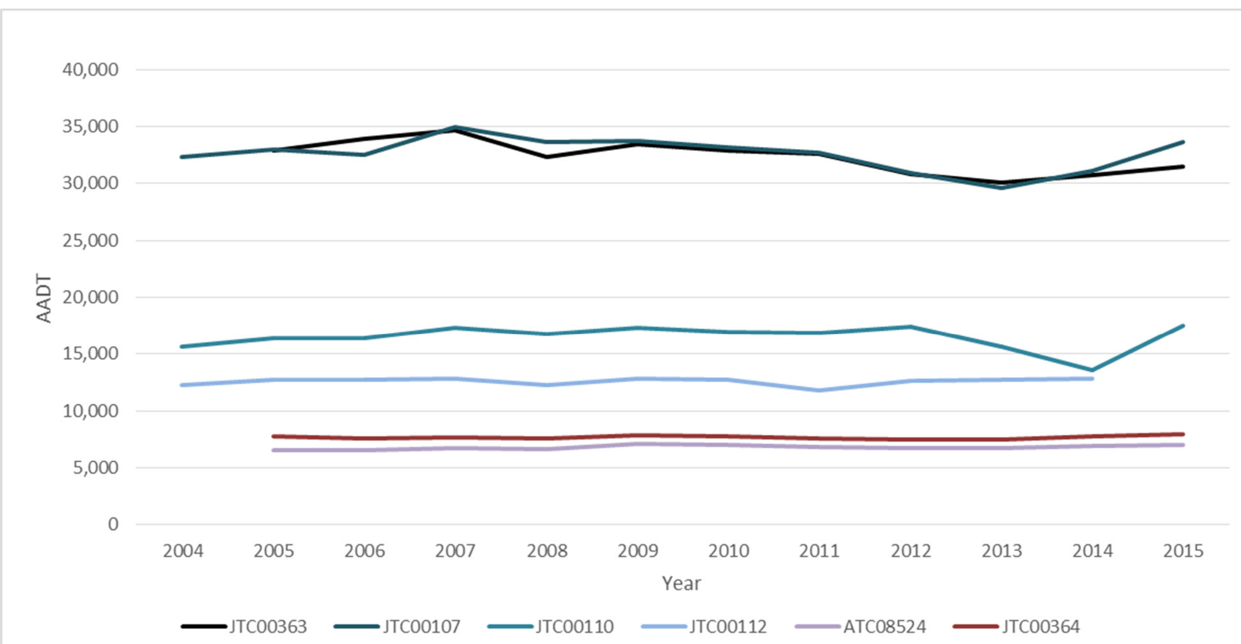
The section of the A77 over which the Bogend Toll to Ardwell Bay Safety Camera System operates is some 60 kilometres in length and encompasses both urban and rural sections, the latter being the predominant characteristic of the route , particularly towards the southern extent of the section, south of Ayr. The vertical and horizontal geography of the route varies in nature across the extents of the project, with both relatively flat sections and those with significant gradients present. The speed limit also varies across the extents of the project, from 50mph on the dual carriageway section at the project's northern extent, to the national speed limit for dual carriageways on section of the route to the north of Ayr. The national speed limit for S2 carriageways applies over the majority of the rural sections of carriageway with shorter sections over which speed limits of 40mph, 30mph and 20mph are enforced, in particular, where the route travels through Turnberry and through the town, Maybole.

To put the project into the context of the prevailing traffic flows observed on the route, the historic annual average daily traffic volume on the section of the A77 across which the Bogend Toll to Ardwell Bay Safety Camera System operates have been examined. Transport Scotland operates and maintains a number of traffic counter within the extents of the project. For the purposes of this report, data from the following traffic counters has been examined:

- JTC00363 – South of Kilmarnock
- JTC00107 – North of Whitletts
- JTC00110 – Ayr Bypass
- JTC00112 – Minishant (South of Ayr)
- ATC08524 – South of Maybole
- JTC00364 – South of Turnberry

The available data from the traffic counters is presented in **Figure D.9** below.

Figure D.9 Bogend Toll to Ardwell Bay Historic AADT Levels



As can be seen from **Figure D.9**, the prevailing traffic volume on the A77 over the extents of the Bogend Toll to Ardwell Bay Safety Camera System varies significantly, from approximately 30,000 to 35,000 vpd on the section between Bogend Toll and Whitletts (on the Ayr Bypass) between 11,800 to 17,500 vpd on the Ayr Bypass to between approximately 6,500 to 8,000 vpd on the section between Maybole and Ardwell Bay. The percentage of HGVs observed on this section of the A77 varies between approximately 8% at the northern extent of the scheme to approximately 17% at the southern extent, approaching the ferry port at Cairnryan.

Safety and Speed Impacts

While detailed safety and speed data for the A77 Bogend Toll to Ardwell Bay scheme were not available at the time of writing, the following headline statistics were available.

Comparing the three year period prior to the installation of the safety camera system (2002 to 2005) with the latest available three year period (ending in July 2015) the system is found to have resulted in:

- A 77% reduction in fatalities with a 74% reduction of those seriously injured
- A 48% reduction in slight injuries
- An overall reduction in casualties of 54%

Road Safety Audits

Due to the nature of the scheme (i.e. the installation of ASCs at a number of locations along the route's extent) a single RSA was not undertaken for the project. Individual RSAs were, however, undertaken at the individual camera locations. These RSAs were not available at the time of writing. As the focus of the RSAs was related with the ASC locations themselves rather than the impact on traffic of the ASC scheme as a whole, it is considered that they are not relevant to the study.

A9 – Dunblane to Inverness

The A9 is approximately 439 kilometres in length, extending from Junction 5 of the M9 motorway (east of Falkirk) in the south to Scrabster, (north of Thurso), in the north, crossing Falkirk, Stirling, Perth & Kinross and Highland local authority areas. The route forms an important transport corridor in the north of Scotland, linking Glasgow and the wider central belt with the major towns of the region and, more generally, the Highlands and Islands. The section of the A9 route considered as part of this study is approximately 220 kilometres in length and is located between Dunblane in the south (north of Kier Roundabout) to Inverness in the north (south of Raigmore Interchange).

The standard of the route varies across its extents from single carriageway (S2) sections (which forms the majority of the route), short sections of WS2+1 lane carriageway at specific locations to dual carriageway (D2AP) sections, predominantly located at the southern extent of the route.

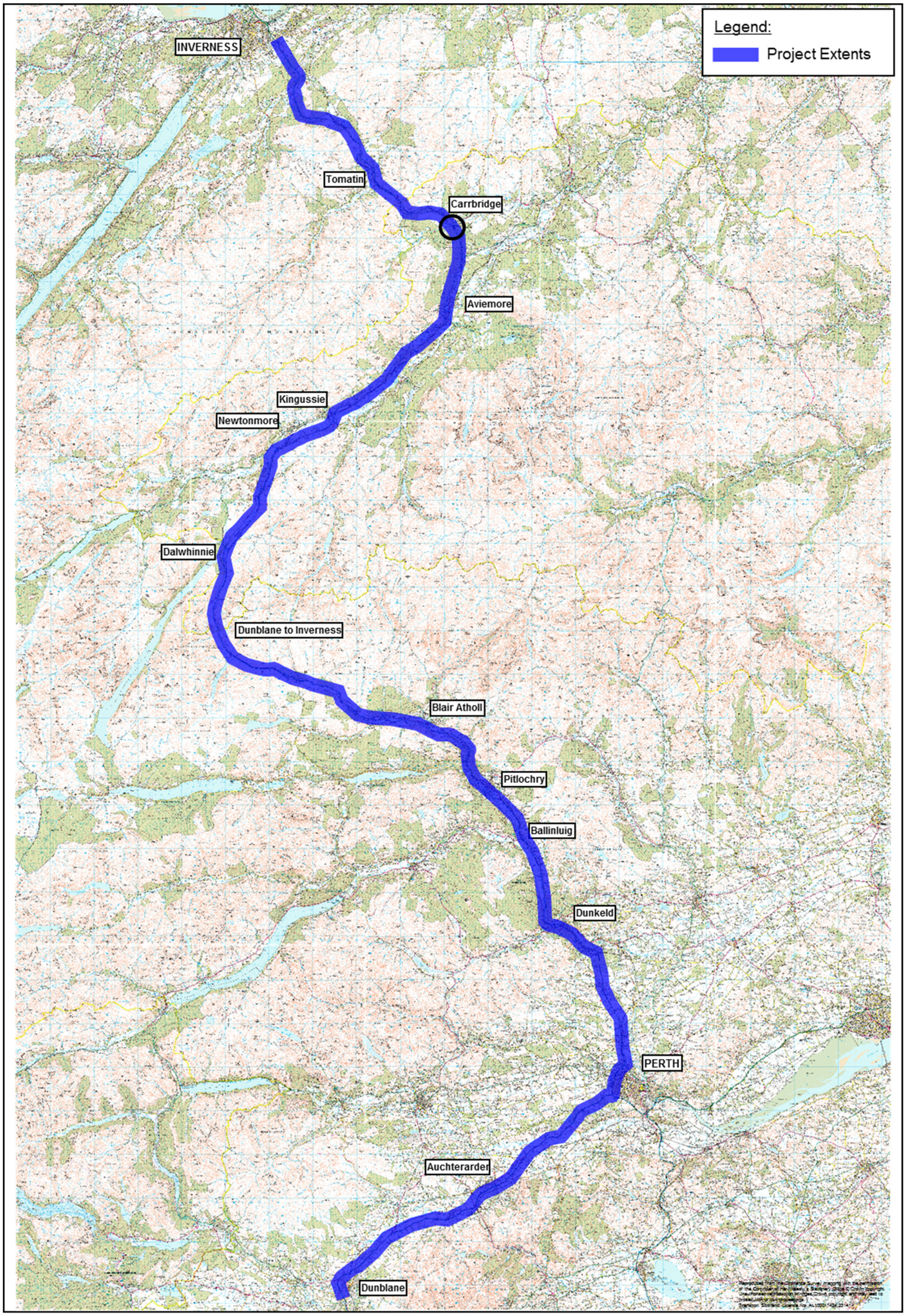
Traffic volumes vary significantly across the extents of the route. Based on the information from Transport Scotland's traffic counters, in 2015 traffic flows varied from between approximately 6,500 to 19,000 vpd on the section between Perth and Inverness to approximately 20,000 to 30,000 vpd on the section between Dunblane and Perth.

A range of projects have been identified and delivered by Transport Scotland along the extent of the route. These projects were implemented to help improve the operation of the A9. One such project, which is considered relevant to this research, is the **Carrbridge** scheme.

A further aspect of this research is the examination of safety camera systems installed to improve safety through the monitoring of average speeds. One such system operates on the A9, namely the **Dunblane to Inverness Safety Camera System**.

The locations of the projects relative to the A9 are shown in **Figure D.10**. The projects noted above, and their impacts on safety, are described in more detail within the following sections.

Figure D.10 A9 Projects Location Plan



Carrbridge

The Carrbridge project opened to traffic in May 2009 and involved the improvement and widening of the existing A9 over approximately 1.7 kilometres to provide unambiguous, guaranteed overtaking in the northbound direction of travel through the provision of a 1 kilometre WS2+1. The project falls within a section of the A9 over which the Dunblane to Inverness Safety Camera System operates. The project had one TPO relating to safety, which was as follows:

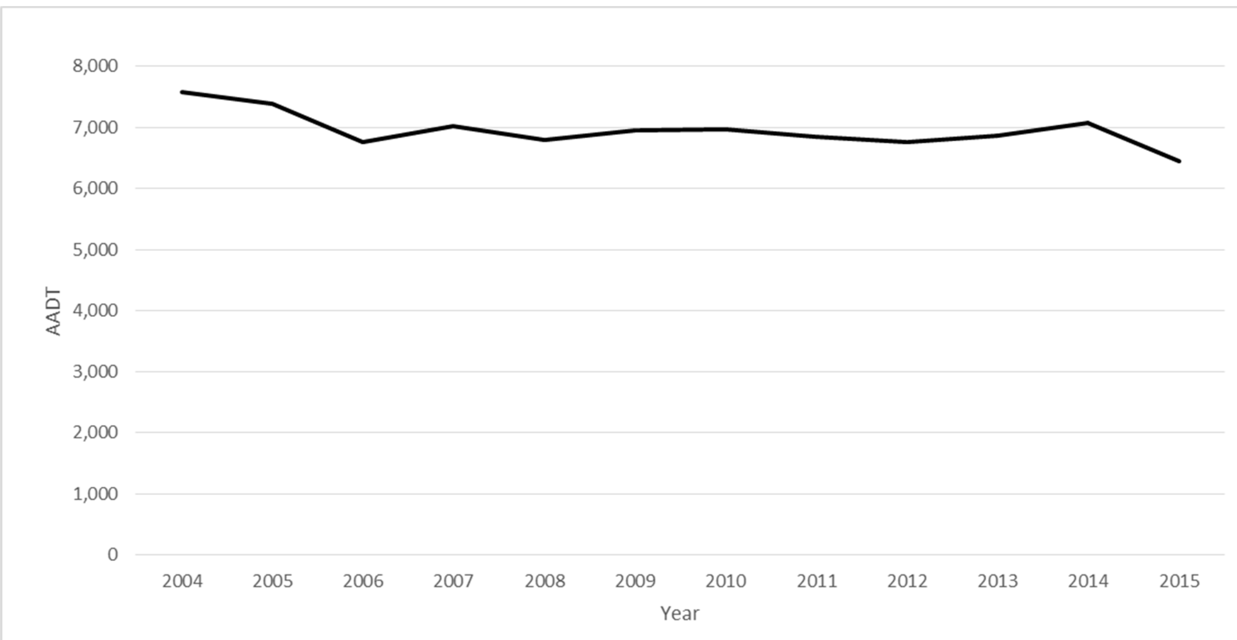
- To improve road safety

Section Characteristics

This section of the A9 is largely rural in nature, being located some 37 km to the south of Inverness, within the vicinity of the village, Carrbridge. The vertical and horizontal geography of the route at this location is relatively flat in nature, with no significant gradients. The national speed limit for S2 carriageways applies over the extents of the project

To put the project into the context of the prevailing traffic flows observed on the route, the historic annual average daily traffic volume on the section of the A9 within which the Carrbridge project is located have been examined. Transport Scotland operates and maintains one traffic counter within the vicinity of the project, namely ATC01005 – 'Granish'. The available data from the traffic counter is presented in **Figure D.11** below.

Figure D.11 Carrbridge Historic AADT Levels



As can be seen from **Figure D.11**, the prevailing traffic volume on this section of the route is between approximately 6,500 to 7,500 vpd. The percentage of HGVs observed on this section of the A9 is in the order of 10% to 11%.

Safety Impacts

Accident data for the period 2004 to 2015 inclusive (12 years) has been examined to assess the impact of the Carrbridge project on safety within its vicinity.

Based on the latest available information, the collision and casualty trends over the period 2004 to 2015 are presented in **Figure D.12a and Figure D.12b** respectively.

Figure D.12a Carrbridge Collision Trends

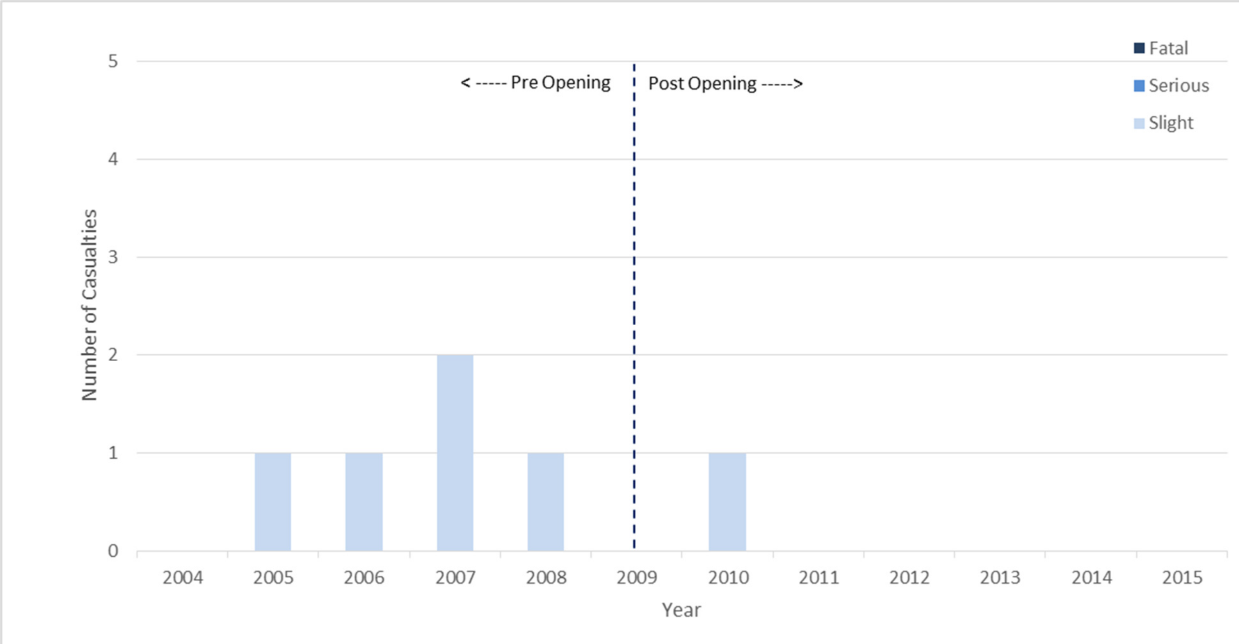
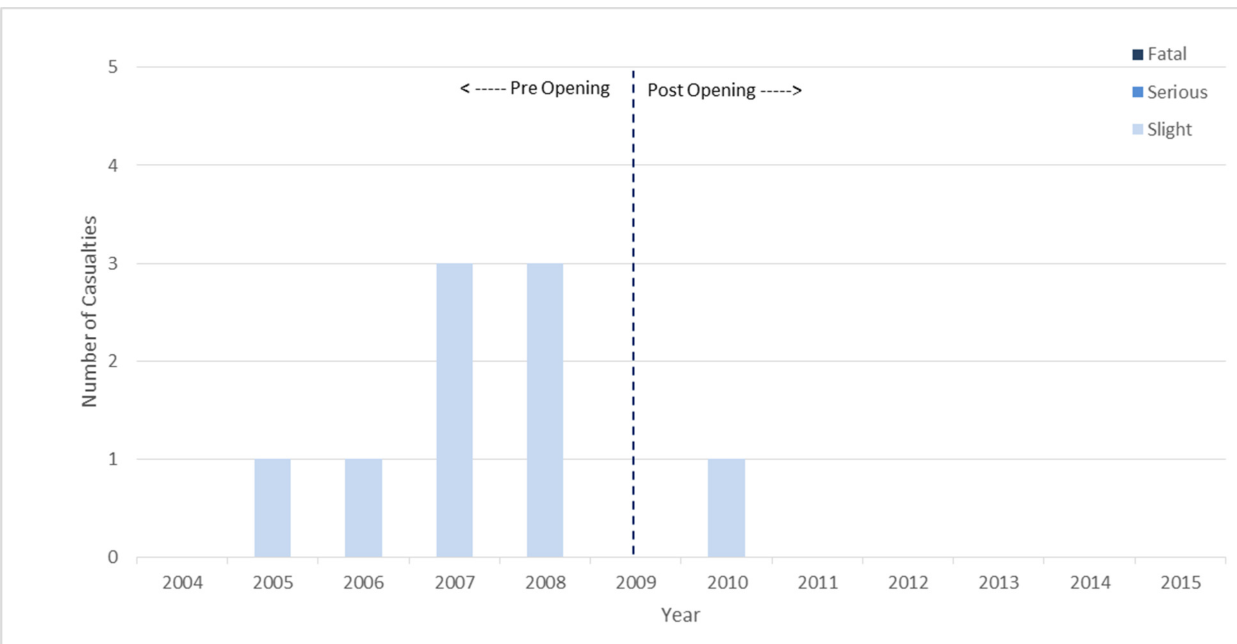


Figure D.12b Carrbridge Casualty Trends



As can be seen from **Figure D.12a** and **Figure D.12b**, the number of collisions (or accidents) and the number of casualties occurring within the extents of the project have reduced significantly following opening in 2009.

Due to the random nature of accidents and the short section over which the improvement has been made, it is difficult to draw any firm conclusions with regards to the project's impact within its extents alone. It can be judged, however, given the available information, that the project had had a positive impact on safety within its extents.

Pre Opening (2004 - 2008)

- **Five** slight collisions
- **Eight** slight casualties

Post Opening (2009 - 2015)

- **One** slight collision
- **One** slight casualty

Road Safety Audits

As part of this research, the available RSAs were reviewed. The RSAs were examined to provide a more in depth analysis of any accident trends which may be emerging following opening of the project and to enable commentary to be provided on any issues which may require attention.

One RSA was examined as part of this research, namely:

- Stage 4a (12 Months), March 2011

The Stage 4a RSA, indicted that there were no injury accidents recorded within the extents of the project within the first year after opening. The RSA concluded that it appeared that the project was operating satisfactorily.

Details of further RSAs (i.e. a Stage 4b RSA) were not available at the time of writing.

Dunblane to Inverness Safety Camera System

The A9 Safety Group was set up by Transport Scotland in July 2012 as a multi-agency group to work closely together with partners to reduce road casualties on the route. The main aim of the A9 Safety Group before and during the A9 dualling programme is to work together to explore any measures which could be introduced on the route using engineering, enforcement, education and encouragement to positively influence driver behaviour in a way that helps reduce road casualties.

One such measure, the Dunblane to Inverness Safety Camera System project, became operational in October 2014 and operates from just north of Keir Roundabout (Dunblane) to just south of Raigmore Interchange (Inverness). While this is approximately 220 kms the system does not operate over the entire length. North of Perth there are seven distinct average speed camera system zones all of which are S2 carriageway sections. The cameras are generally 5 to 7 km apart. South of Perth, there are 12 camera locations on the northbound carriageway and 11 on the southbound carriageway spaced every 5 to 7 km apart. South of Perth the cameras were intended to address the high severity turning accidents being experienced at the cross-over junctions where the high speed through traffic is in conflict the slower turning traffic.

As part of this project, a trial surrounding increasing the speed limit for HGVs over 7.5 tonnes from 40mph to 50mph on S2 carriageway sections has also been implemented.

Section Characteristics

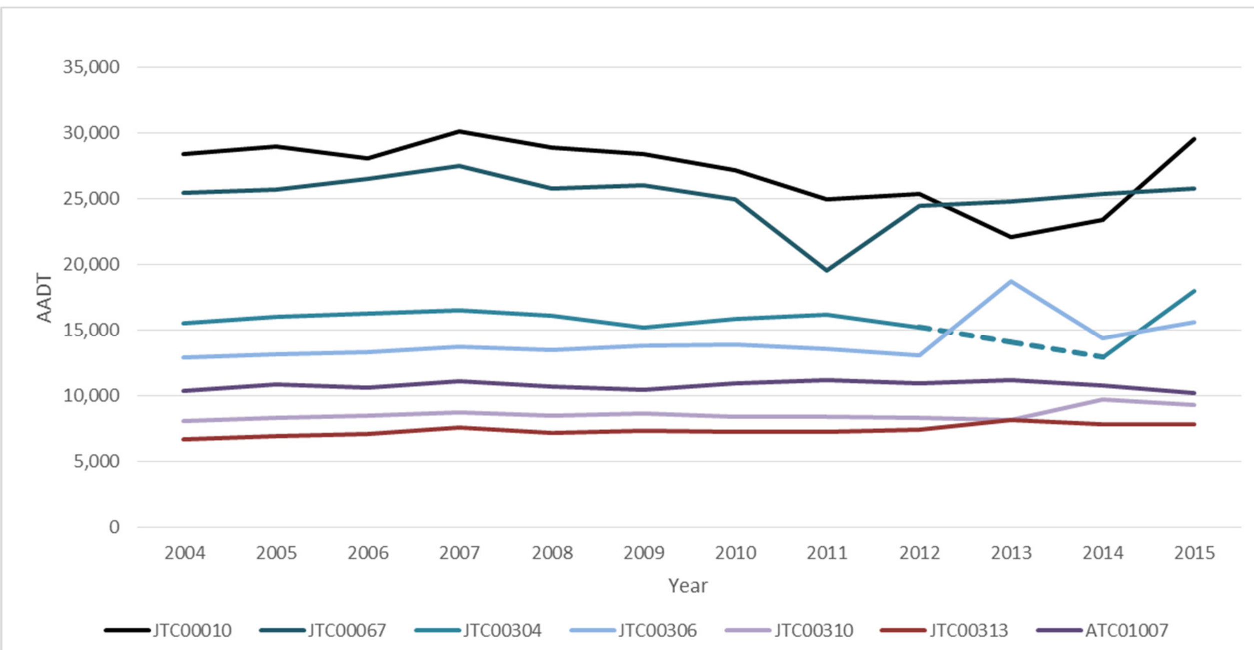
The section of the A9 over which the Dunblane to Inverness Safety Camera System operates is some 220 kilometres in length is predominantly rural in nature, excepting the section of the route where it travels through Perth. The vertical and horizontal geography of the route varies in nature across the extents of the project, with both relatively flat sections and those with notable gradients present. The national speed limits for single and dual carriageways applies over the extents of the route on single and dual sections respectively.

To put the project into the context of the prevailing traffic flows observed on the route, the historic annual average daily traffic volume on the section of the A9 across which the Dunblane to Inverness Safety Camera System operates have been examined. Transport Scotland operates and maintains a number of traffic counter within the extents of the project. For the purposes of this report, data from the following traffic counters has been examined:

- JTC00010 – North of Dunblane
- JTC00067 – North of Auchterarder
- JTC00304 – Luncarty (North of Perth)
- JTC00306 – Moulinearn (South of Pitlochry)
- JTC00310 – Dalnaspidal (Pass of Drumochter)
- JTC00313 – Aviemore
- ATC01007 – Daviot to Inshes (South of Inverness)

The available data from the traffic counters is presented in **Figure D.13** below.

Figure D.13 Dunblane to Inverness Safety Camera System Historic AADT Levels



Note: Counter JTC00304 - 2013 traffic flows are estimated

As can be seen from **Figure D.13**, the prevailing traffic volume on the A9 over the extents of the Dunblane to Inverness Safety Camera System varies significantly, from approximately 20,000 to 30,000 vpd on the section between Dunblane and Perth to between approximately 6,500 to 19,000 vpd on the section between Perth and Inverness. The percentage of HGVs observed on the A9, to the north of Perth, is in the order of 10% to 11%.

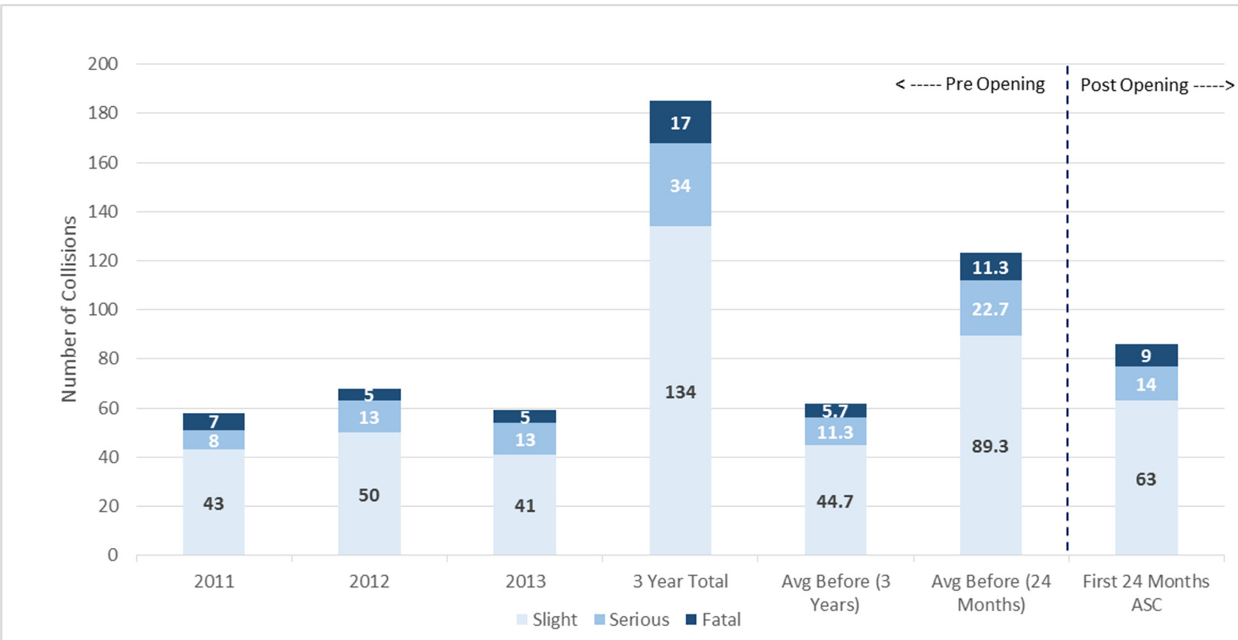
Safety and Speed Impacts

The A9 Safety Group reports on the impacts of the project in 6 monthly intervals, the latest report being published in February 2017[27]. This reports on the collision and casualty impacts during the first 24 months of the operation of the safety camera system. The report concluded that there continued to be a sustained improvement in driver behaviour and a corresponding fall in collisions and casualties.

The report indicated that the number of fatal casualties is down by almost 38% on the A9 between Dunblane and Inverness in the 24 month period compared to the equivalent baseline period. It suggested that there are also additional benefits brought through reduced incidents and their subsequent impact, which has improved journey time reliability.

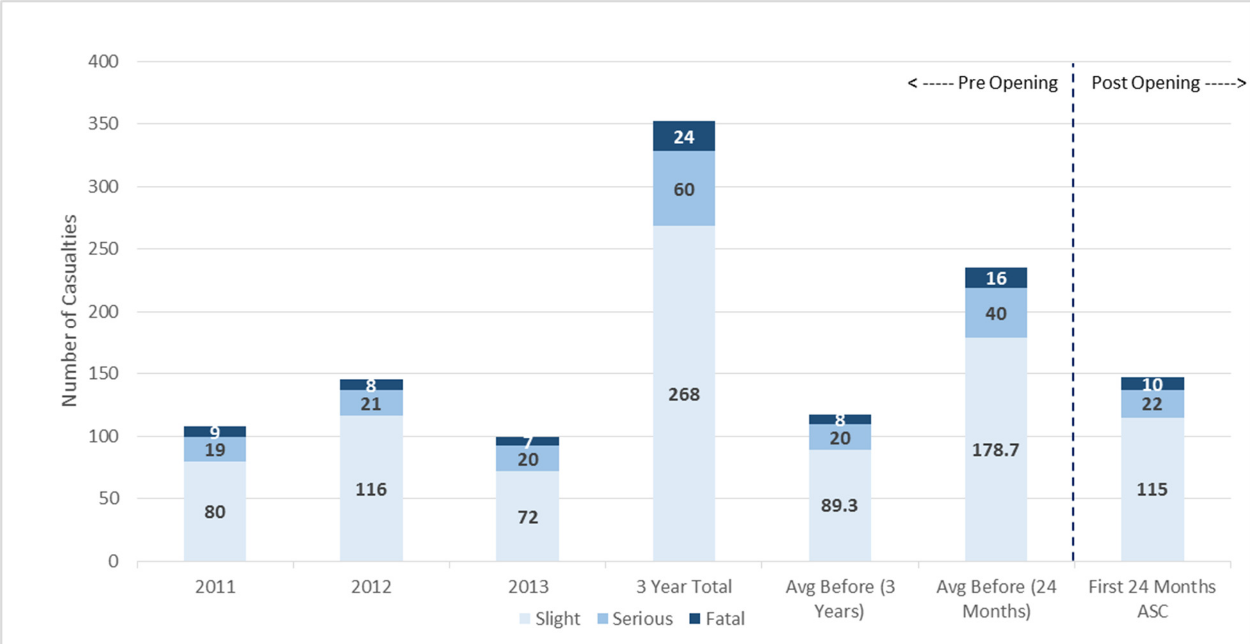
Based on the reported information, the collision and casualty trends pre and post opening are presented in **Figure D.14a** and **Figure D.14b** respectively.

Figure D.14a Dunblane to Inverness Safety Camera System Collision Trends



27 http://a9road.info/uploads/publications/A9_Data_Monitoring_and_Analysis_Report_-_February_2017.pdf

Figure D.14b Dunblane to Inverness Safety Camera System Casualty Trends

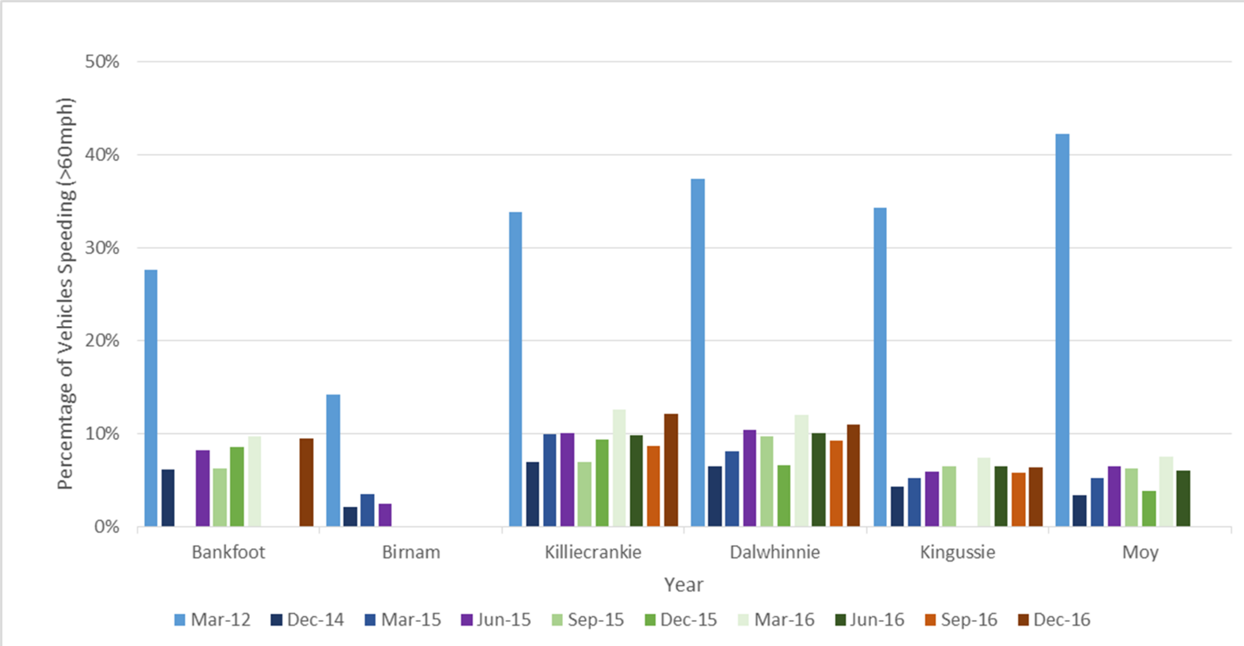


The main findings were:

- The number of fatal casualties between Dunblane and Inverness is **down by almost 38%** compared to the baseline average
- The number of 'fatal and serious' collisions between Dunblane and Inverness overall is **down by over 32%**, with fatal and serious casualties **down by almost 43%**
- There have been no fatal collisions between Dunblane and Perth and the number of serious collisions **down by over 45%** and serious casualties **down by almost 32%.**
- The number of 'fatal and serious' collisions between Perth and Inverness is down by 25%, with fatal and serious casualties **down by 43%**
- The number of serious injury casualties between Perth and Inverness is **down by 48%**
- The overall number of casualties of all classes between Dunblane and Inverness is **down by over 37%**

Based on the reported information, the vehicle speed trends pre and post opening are presented in **Figure D.15**.

Figure D.15 Dunblane to Inverness Safety Camera System Vehicle Speed Trends (% Travelling >60mph)



The main findings were:

- The number of vehicles exceeding the speed limit remains low, at 1 in 10 compared to the historic benchmark figure of 1 in 3 and the number of vehicles speeding excessively (more than 10 mph above the speed limit) remains low, with a sustained reduction from the historic benchmark figure of 1 in 10 vehicles to 1 in 250.
- The number of vehicles detected by the system which were considered by Police Scotland for further action remains extremely low at an average of 11 per day (less than 0.03% of the overall volume of vehicles using the route).

Road Safety Audits

Due to the nature of the scheme (i.e. the installation of ASCs at a number of locations along the route's extent) a single RSA was not undertaken for the project. Individual RSAs were, however, undertaken at the individual camera locations. These RSAs were not available at the time of writing. As the focus of the RSAs was related with the ASC locations themselves rather than the impact on traffic of the ASC scheme as a whole, it is considered that they are not relevant to the study.