Annex A. High-level statistics

A.1 The high-level statistics presented in the *Stocktake* and *First year progress report* set out comparisons of casualty rates on different road types (including different types of smart motorway). This chapter describes those statistics, assesses alternative approaches and explains our findings.

Background

A.2 The high-level statistics are the only source of evidence updated in the *First year progress report* (March 2021). The most recent road casualty data from 2019 were added to the high-level statistics set out in the original *Stocktake* (March 2020).

A.3 Based on comparisons of these statistics, the *First year progress report* concluded (among other things) that:

(a) *This progress report shows that in terms of fatality rates, smart motorways are the safest roads in the country*.

(b) This is in line with the findings of the 2020 Stocktake that "overall, what the evidence shows is that in most ways, smart motorways are as safe as, or safer than, the conventional ones. But not in every way".

A.4 This section of our review focuses on the data underpinning these conclusions and directly relates to two of the key questions posed in the remit:

(a) are the data and evidence used in the stocktake and the One Year Progress Report reliable and robust and in line with established/best practice; and

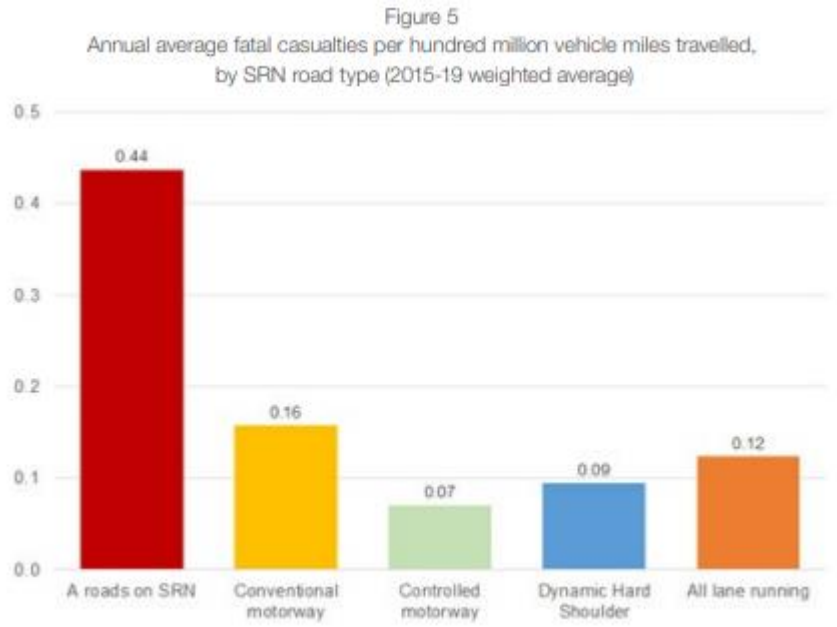
(b) have comparisons been made in an appropriate way about the relative safety of ALR motorways, with reference to conventional motorways and other roads?

Summary of evidence

A.5 The conclusions drawn from the high-level statistics are largely based on three key pieces of evidence: casualty rates, fatal and weighted injuries (FWI) rates; and live lane fatality rates.

A.6 Casualty rates (fatal/serious/slight) are set out for different road types on the SRN. For example, fatality rates are summarised in figure 5 of the *First year progress report* (Figure A.1).

Figure A.1 Copy of figure 5 from the *First Year Progress Report*



A.7 The Fatal and Weighted Injuries Index gives a fatality 10 times the weight of a serious casualty, and a serious casualty 10 times the weight of a slight casualty[1]. The *First year progress report* states that: "*Like other transport authorities across the UK the key measure we use to assess the safety of roads, is Fatal and Weighted Injuries*."

A.8 FWI is widely used across different sectors to compare fatal and nonfatal accidents. Specifically, within the rail sector, FWI is a prominent safety indicator. Compared to other transport modes, FWI is less widely used in road safety: the methodology was derived from that used by the Rail Safety and Standards Board (RSSB). RSSB has since adopted new weightings for calculating FWI, but we consider that the weightings used by Highways England were appropriate.

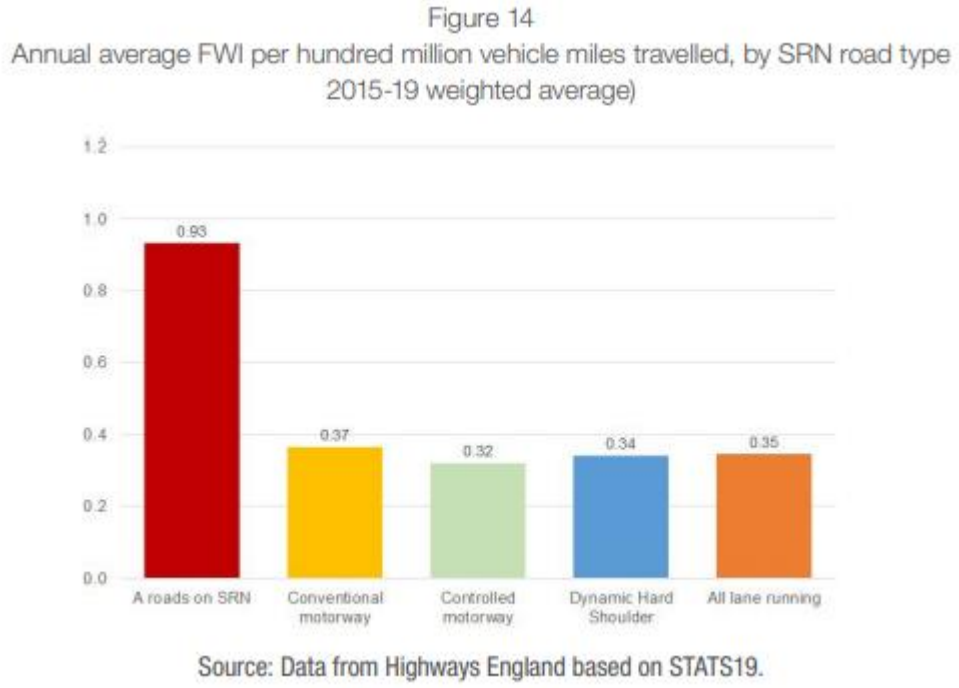
A.9 The *First year progress report* then describes FWI for different road types in the body of the text but, unlike with fatal casualty rates, only includes charts in the annex of the document, alongside other charts for slight and serious casualty rates.

A.10 This may cause confusion as the report describes FWI as the key measure for assessing road safety, but then appears to focus more heavily on fatal casualty rates. The chart showing FWI by SRN road type from the annex is copied below

[1] It is calculated as: Fatal casualties + (Serious Casualties * 0.1) + (Slight Casualties * 0.01).

(Figure A.2). In terms of relative safety, it shows the different road types in the same order as the fatality rates chart.

Figure A.2 Copy of figure 14 from the *First Year Progress Report*



A.11 The third piece of evidence is set out in Table 2 of the *First Year Progress Report*, which presents live lane fatality rates per year (2015 to 2019) on different types of motorway. These figures are derived from the same source as the other casualty statistics, but exclude any fatalities which do not occur in a live lane (e.g. on a hard shoulder or lay-by). Live lane fatalities for ALR are the same as 'all' fatalities for ALR because there have been no fatalities reported in emergency refuge areas in this period. The result is a slightly less favourable comparison between ALR and other motorways that have hard shoulder/layby fatalities removed. It also points towards a possible trend of increasing fatality rates on ALR motorways that is not observed on conventional motorways. Overall, live lane fatality rates show a similar relationship between different types of smart motorway as presented by the fatal casualty rates.

Figure A.3 Copy of Table 2 from the *First Year Progress Report*

Table 2

Live Lane Fatality Rates (moving and stopped vehicles)	2015	2016	2017	2018	2019	Total (2015-19)
Fatality rates (per hundred million vehicle miles) on live lanes of **conventional motorways**	0.16	0.14	0.17	0.14	0.13	**0.15**
Fatality rates (per hundred million vehicle miles) on live lanes of **controlled motorways**	0.08	0.02	0.05	0.11	0.07	**0.06**
Fatality rates (per hundred million vehicle miles) on live lanes of **DHS motorways**	0.07	0.06	0.03	0.03	0.18	**0.08**
Fatality rates (per hundred million vehicle miles) on live lanes of **ALR motorways**	0.00	0.04	0.10	0.19	0.14	**0.12**

A.12 The *First year progress report* compares five separate measurements of casualties across six different categories of road type. These variables are summarised in Table A.1:

Table A1.1 List of road and casualty types compared in the *First Year Progress Report*

SRN Road type	Casualty type
'A' road	Fatality
Conventional motorway	Serious
Controlled motorway	Slight
Dynamic hard shoulder motorway	FWI
ALR motorway	Live lane fatalities
All smart motorway combined	

Methodology and assumptions

Data sources

A.13 The high-level statistics are calculated from three statistical datasets produced by DfT:

(a) **road casualties (STATS19).** DfT produces estimates of road casualties that are based on data reported to police using the STATS19 reporting system. These estimates are widely regarded as the most detailed, complete and reliable source of road casualty statistics. However, there are acknowledged limitations of the data. These are discussed in more detail on DfT's website and include: under-reporting of non-fatal casualties to police; changes in reporting systems used by police; and online self-reporting of collisions. DfT published a detailed review of STATS19 in 2021;

(b) **road traffic.** Traffic estimates for the SRN are taken from DfT's wider road traffic estimates that cover all roads in Great Britain. A detailed methodological note is set out on DfT's website; and

(c) **road lengths.** Road length statistics are also taken from the wider series that covers all roads in Great Britain. A methodological note is set out on DfT's website.

A.14 These are all designated as National Statistics, which means that they are assessed as fully compliant with the Code of Practice for Statistics to meet the highest standards of trustworthiness, quality and value. National Statistics accreditation is designated by the Office for Statistics Regulation, the regulatory arm of the UK Statistics Authority. As National Statistics are subject to an established process of scrutiny that applies across all government departments, the collection and production of these data is considered reliable and robust.

A.15 Highways England then mapped these data to the SRN by matching casualties and traffic volumes to conventional motorways and different types of smart motorway (ALR, controlled and dynamic hard shoulder running). This enabled high level casualty rates to be calculated for the different road types.

A.16 The locations of smart motorways on the network have been mapped using a geographic information system (GIS). The location of each collision on the smart motorway (or wider strategic road network) was then identified and validated against the GIS map. During our review Highways England noted potential limitations in this approach, mainly on precise start and end locations of different

types of smart motorway, but it considered that these do not have a significant impact.

A.17 Casualty rates were calculated by dividing the number of casualties ('fatal', 'serious' or 'slight') on a particular type of road by the corresponding volume of traffic. These rates were then compared to determine the relative safety of different road types.

A.18 As part of our review we undertook a systematic check of the spreadsheets that were used to calculate these data for different road types. We found no errors in the underlying calculations.

Analytical approach

A.19 A number of decisions were made by DfT and Highways England when deciding how to calculate and present the high-level statistics. We examined five key decisions that underpin the analysis in more detail:

(a) analysis of high-level casualty statistics focuses on both FWI and casualty rates;

(b) traffic (vehicle miles) is used as the denominator for calculating casualty rates;

(c) five-year averages are used for presenting headline casualty rates for different road types;

(d) statistical significance testing was not used to determine whether differences between casualty rates for ALR and other roads are significant; and

(e) casualty data were not adjusted to account for the impact of changes to police reporting systems.

A.20 **Decision:** Analysis of high-level casualty statistics focused on both FWI and casualty rates.

- **Rationale:** DfT explained that it wanted to focus on outcome metrics that would resonate with people and would allow them to understand the risk exposure to themselves. The choice of metrics was partly driven by the ongoing public debate. Also, the original stocktake was planned to be completed in a short time, which required focusing on data that was already available.

Casualty and FWI data matched these requirements as it measured injuries and deaths on smart motorways and was already used for safety analysis. FWI data is also a key metric used to measure safety in other transport sectors and Highways England set this out as the measure that would be used to demonstrate safety when the first smart motorways were introduced in 2012.

DfT did not express any views as to whether casualties was a 'better' metric than FWI or vice versa. DfT's focus was to make sure it communicated information and data to the public clearly.

Killed or Seriously Injured (KSI) rates, which is a commonly used road safety metric, were not included as a headline metric. However, fatalities and serious injuries were presented separately in the annex, which allows anyone to calculate KSI rates if they wanted to.

- **Alternatives:** An alternative to casualty and FWI data in the *First year progress report* could be collision rates. Damage-only collision data may be less robust and DfT does not hold estimates of damage only collisions on the SRN

- **ORR assessment:** DfT's focus on casualties on smart motorways supports the use of FWI and/or casualty rates as the key measures of safety in the *Smart Motorway Stocktake and Action Plan*.

  The *First year progress report* subsequently focused more closely on fatality and FWI rates in the main body of the report but still includes rates for serious and minor casualties in the annex.

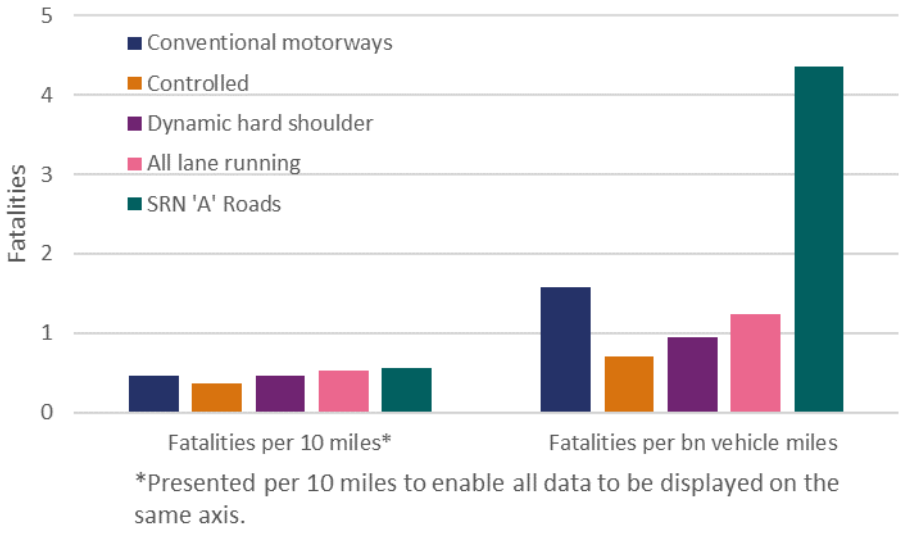
  Fatality data is generally considered to be more accurate than data for serious and slight injuries, as it is less affected by under-reporting or by changes in how police record casualties.

  It is a strength of the original *Stocktake* and *First year progress report* that data for all severity types were presented, as this is important in increasing transparency around the depth of analysis. However, Highways England should be clearer as to what metrics underpin the key conclusions. These conclusions could also be clearer if a single headline metric for measuring smart motorway safety were presented (i.e. choosing either fatality or FWI rates), along with an explanation as to why that had been chosen.

A.21 **Decision:** Traffic (vehicle miles) is used as the denominator for calculating casualty rates.

- **Rationale:** Rate-based metrics enabled comparisons of different road types that take account of relative levels of traffic. This provided a more valid comparison than simply considering absolute casualties.
- **Alternatives:** An alternative denominator for calculating rates is road length rather than vehicle miles. Using data presented in the *First Year Progress Report*, ORR compared fatality rates per mile (road length) to fatality rates per vehicle mile (traffic) on the SRN. This analysis is presented in Figure A.4 below.

Figure A.4 Comparison of fatality rates per mile and per bn vehicle miles (five-year average)

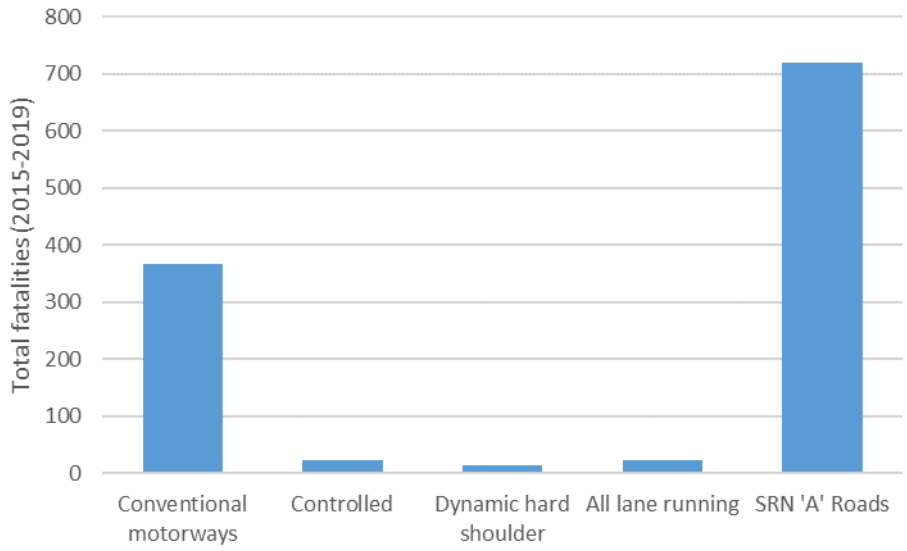


This shows that fatality rates per mile are similar on SRN 'A' roads and motorways. However, fatality rates per vehicle mile are much higher on SRN 'A' roads in comparison to motorways. The reason for this is that motorways carry significantly more traffic per mile than SRN 'A' roads, which results in comparatively lower fatality rates per vehicle mile travelled.

Another alternative to a rate-based analysis is to consider absolute casualties.

Using data from the *First Year Progress Report*, our analysis of the total number of fatalities on SRN 'A' roads and different types of motorway between 2015 and 2019 is presented in Figure A.5.

Chart A.5 Total fatalities on the SRN between 2005 and 2019 by road type



This shows that, on the SRN, the highest number of fatalities occur on 'A' roads, followed by conventional motorways.

ORR assessment: The conclusions in the stocktake are based on analysis of casualty rates per vehicle mile. In our opinion this is an appropriate metric to compare relative safety of different road types.

We agree that absolute casualties do not provide a useful comparison of relative safety because this measure does not take account of the volume of traffic using different road types, or the proportion of the network made up by these types of road. As new sections of ALR are built, and the number of journeys on them increases, absolute casualties on ALR motorways can also be expected to increase.

Casualty rates allow for a more meaningful comparison between different road types. Normalising for traffic allows casualties to be compared on a like-for-like basis, irrespective of how busy individual stretches of road are. They also account for changes in the relative proportions of different road types in the future.

A.22 **Decision:** Headline casualty rates for different road types are averaged over five years.

- **Rationale:** Five years represents the longest possible time series for analysis of ALR motorways in the *First year progress report* (the original stocktake was published a year earlier and therefore used a four-year average). The number of casualties on smart motorways each year is small in comparison to conventional motorways so this approach was adopted to include as much data as possible.

- **Alternatives:** Instead of a five-year average, it is possible to produce casualty rates for individual years, or as two-, three- or four-year averages. Charts showing 5-year, 3-year and 2-year average fatality rates for conventional and ALR motorways are shown below.

Figure A.6: Comparison of annual and five-year average fatality rates per bn vehicle miles for conventional and ALR motorways

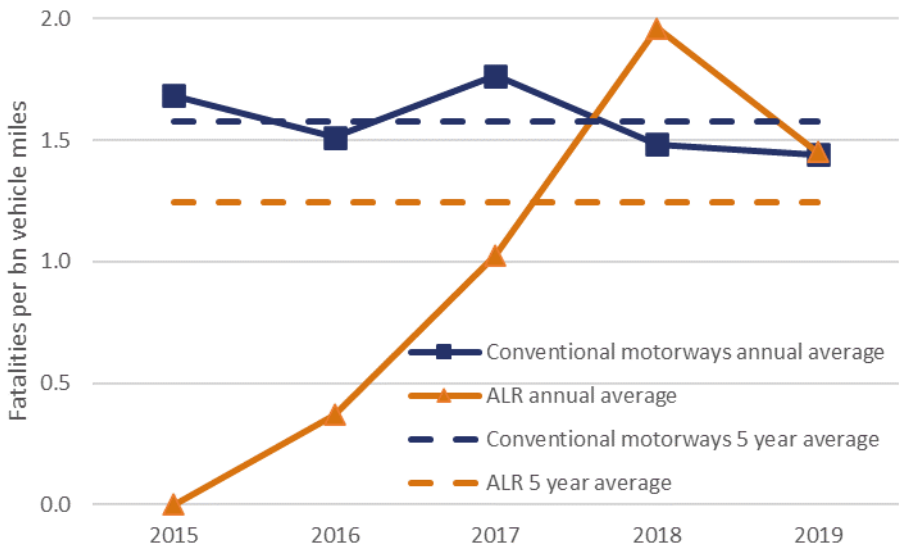
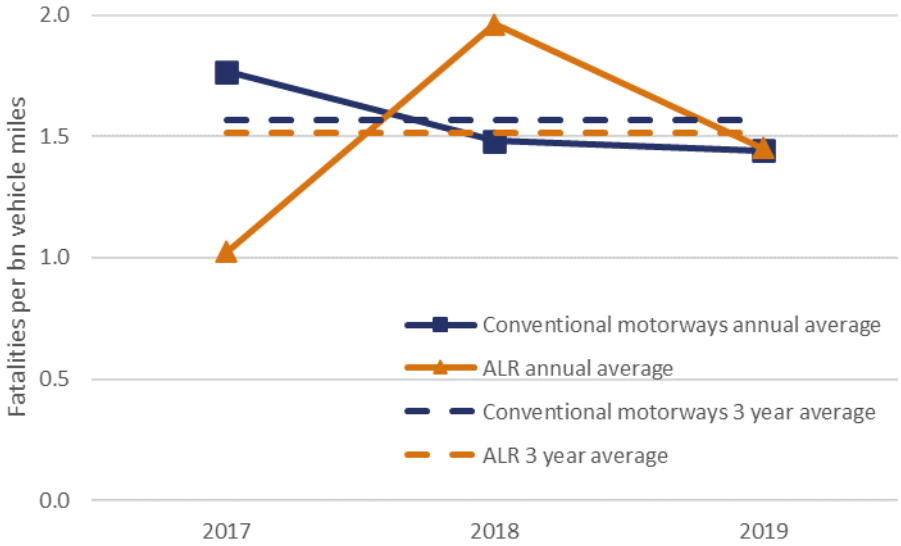


Figure A.7: Comparison of annual and three-year average fatality rates per bn vehicle miles for conventional and ALR motorways



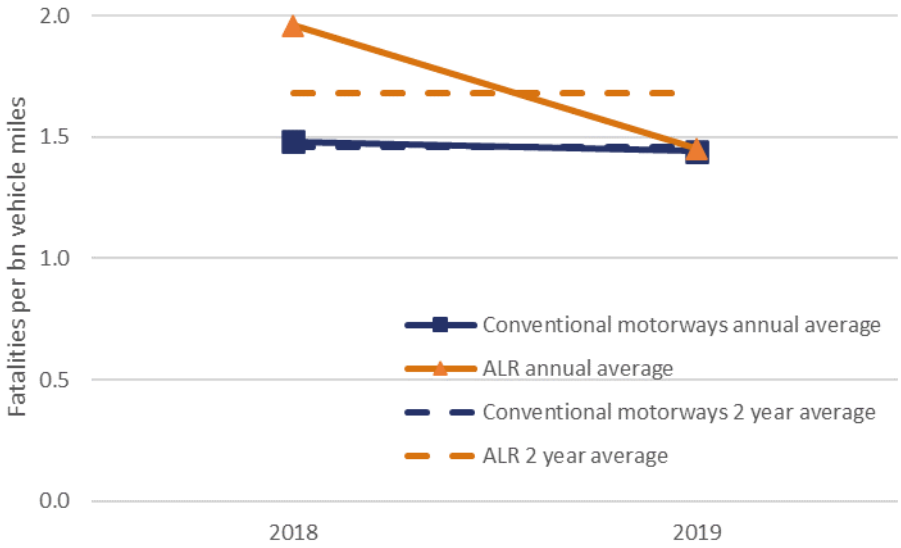
Comparing figures A.6 and A.7 shows that the five-year and three-year average fatality rates on conventional motorways are both higher than the five-year and three-year average for ALR motorways. However, the difference between the conventional and all lane running motorways is much smaller when the three-year average is considered. There is also a possible trend of increasing fatality rates over time, and greater volatility in annual fatality rates for ALR motorways compared to conventional motorways, resulting in a higher standard deviation from the mean. Factors that are likely to have influenced this include:

– Fewer schemes - there were 141 miles of ALR motorways in 2019, compared with 1,564 miles of conventional motorways.

– Significant increases in the number of ALR motorways over time - there were 29 miles of ALR motorways in 2015 compared with 141 miles in 2019.

If the two-year average is considered (Figure A.8), this gives a higher fatality rate for all lane running motorways (1.7), compared with conventional motorways (1.5).

Chart A.8: Comparison of annual and two-year average fatality rates per bn vehicle miles for conventional and ALR motorways.



ORR assessment: Total vehicle miles driven on ALR motorways in 2015 is small (1.4bn vehicle miles) compared to 2019 (6.2bn vehicle miles). The averages in the *Smart Motorway Safety Evidence Stocktake and Action Plan* and *First year progress report* are weighted by traffic volume to account for this.

The First year progress report used a five-year average to maximise the amount of data available. However, averages calculated over a shorter period of time (e.g. two or three years) produce different results. The large differences in annual fatality rates on ALR motorways, combined with the growth in the length of these roads in recent years, affects the confidence we can have in drawing conclusions from the averaged data; therefore averages should be treated with caution. Any conclusions based on five-year averages should be clear that this approach might mask trends in fatality rates over time. The conclusions should also be clear about the about the impact of considering different time periods.

A.23 **Decision:** Statistical significance testing was not used to determine whether differences between casualty rates for ALR and other roads are significant.

- **Rationale:** DfT considered using statistical significance testing as part of the analysis. However, when it was originally commissioned there was no existing analysis on this and the small numbers involved made it very challenging to achieve. Given the initial short deadline, DfT decided that it

would be too complex and time consuming to produce anything more robust to include in the report.

- **Alternatives:** N/A
- **ORR assessment:** Statistical significance testing is something that DfT has stated it would like to see included in future analysis and Highways England is currently progressing work on this.

  Undertaking significance testing on the headline figures in future would help explain the levels of uncertainty around the results. **We recommend** that this is developed to be included with Highways England's published annual update of safety performance on smart motorways using 2020 road casualty statistics.

A.24 **Decision:** Casualty data was not adjusted to account for the impact of changes to police reporting systems (e.g. Collisions Reporting and Sharing Project (CRASH) which provides a common platform for the recording of statistics and police/investigation data on road traffic accidents, and Case Overview Preparation Application (COPA), the platform used by the Metropolitan Police), discussed in detail in DfT's 2019 road casualty report).

Rationale: At the time of the *Stocktake* and subsequent *First Year Progress Report*, work to produce adjustment factors for CRASH/COPA was not completed. DfT has now published conclusions from the ONS study into the impact of this change. However, police forces have continued to join CRASH since then and this would add further complexity to any time series analysis.

DfT and Highways England decided not to adjust for CRASH/COPA to ensure the data was as transparent as possible. Also, by focusing on fatality rates the impact from CRASH was avoided (or minimised in the case of FWI rates).

- **Alternatives:** Adjustment factors could have been calculated and applied to casualty data to account for the move to CRASH/COPA.
- **ORR assessment:** We consider that the treatment of changes to police reporting systems is appropriate in the high-level statistical analysis. Fatalities are unaffected by these changes so the fact that the conclusions focus on fatality data means that it is possible to present a data series that is consistent over time. Therefore, the value of adjusting for CRASH/COPA is limited.

Including an adjustment for serious and slight injuries separately would be highly complex and likely require re-calculation each year. This would probably make it more difficult to communicate the key findings from the stocktake.

Use of comparisons

A.25 Using the metrics described above, the original *Smart Motorway Stocktake and Action Plan* and *First year progress report* compare rates on SRN 'A'-roads, conventional motorways and each different type of smart motorway. This is important for understanding differences in safety performance between the different road types.

A.26 The reports also make comparisons between conventional motorways and all types of smart motorway combined. For this comparison, casualty rates on smart motorways are calculated by combining data for controlled, ALR and Dynamic Hard Shoulder motorways.

A.27 Comparisons between conventional and smart motorways are made throughout the *First Year Progress Report*. For example:

- at the bottom of page 32 and top of page 34 it reports that fatality and FWI rates are lower on smart motorways than conventional motorways; and
- in the conclusions section on page 38 it states that: *This Progress Report shows that in terms of fatality rates, smart motorways are the safest roads in the country.*

A.28 We recognise that the comparison between conventional motorways and (all) smart motorways is not a key focus of the *Stocktake*. However, combining data for controlled motorways with other types of smart motorway potentially masks the effect of removing the hard shoulder and can be confusing. Although these comparisons do not alter the conclusions of the *Stocktake*, we think that it would be clearer not to combine safety data for controlled motorways with other types of smart motorway for this type of analysis.

A.29 The *Smart Motorway Stocktake and Action Plan* and *First Year Progress* Reports do not make a direct comparison between the difference in casualty rates on ALR motorways and controlled motorways. Controlled motorways generally have the lowest casualty rate of all types of road and this would provide the most stretching comparison for ALR motorways. However, this comparison can be inferred from the charts presented in these reports.

A.30 Where the *Stocktake* compares overall casualty rates for different road types no assessment is made about whether the differences are statistically significant. Including information about the level of uncertainty associated with the high-level statistics, through statistical significance testing, would add important context to any conclusions. We understand that this is something DfT and Highways England are working towards and **we recommend** that Highways England puts this place in time for the company's published annual update of safety performance on smart motorways using 2020 road casualty statistics.

A.31 The high-level statistics are presented at an aggregate level for each different road type. This means that statistics are not presented on a scheme-by-scheme basis. One disadvantage of this is that outliers (individual schemes with unusually high casualty rates) cannot be identified. This makes it more difficult to assess the robustness of the high-level statistics. Data for individual schemes are available as part of the before and after analysis. **We recommend** that Highways England makes high-level statistics available through an updated SMALR Overarching Safety Report at an individual scheme level. This will support better understanding of the underlying variation across schemes and highlight any instances where the safety performance for an individual scheme is below average.

A.32 Overall, the high-level statistics provide useful context to help in understanding the relative safety of different road types. However, given that the safety objective of smart motorways is to be as safe as, or safer than, the roads they replace we agree that before and after analysis provides better evidence for considering the impact of converting a section of motorway to ALR. This analysis is considered in more detail in Annex B.

Conclusions

A.33 As set out at the beginning of this annex, the objective was to answer two key questions relating to the high-level statistical analysis:

(a) **Are the data and evidence used in the stocktake and the *First year progress report* reliable and robust and in line with established/best practice?**

(i) The underlying data for road casualties, traffic and road lengths can be considered as reliable. These are designated as National Statistics and therefore are independently assessed for trustworthiness, quality and value by the Office for Statistics Regulation.

(ii) Calculating casualty rates that take account of the number of casualties and the volume of traffic using the network is a reliable method for comparing high-level casualty statistics on these roads.

(iii) Presenting the high-level statistics for ALR motorways as five-year averages masks variability within the data; considering the most recent two, three or four years can give different results. Therefore, any conclusions from the averaged data should be treated with caution and the reports should be clearer about the impact on headline results when different time periods are considered.

(b) Have comparisons been made in an appropriate way about the relative safety of ALR motorways, with reference to conventional motorways and other roads?

(i) The *Stocktake* is not clear about whether FWI or casualty rates are most important in forming conclusions about the relative safety of ALR motorways. Either can be considered as appropriate, but the conclusions should be made clearer by focusing on one lead metric (and setting out the strengths and weaknesses of that metric). However, publishing the underlying data, and other metrics, in the annexes demonstrates a transparent approach and supports a better understanding of the robustness of the conclusions.

(ii) The *Stocktake* and *First year progress report* make some comparisons between conventional motorways and all smart motorways (a combination of controlled, all lane running and dynamic hard shoulder motorways). Although this comparison does not significantly affect the main conclusions, we consider it to be confusing to the reader. **We recommend** that Highways England's future analysis should always consider conventional and controlled motorways (which include a hard shoulder) separately from other types of smart motorway when comparing high-level casualty statistics.

(iii) The value of the analysis should be improved by quantifying the levels of uncertainty that exist around the high-level statistics, for example by undertaking statistical significance testing on the fatality rates on each road type. **We recommend** that Highways England should put this in place in time to be included with the company's published annual update of safety performance on smart motorways, using 2020 road casualty statistics.

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