

Quality Assurance of Smart Motorways Third-Year Progress Report and Before- After Assessment

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Executive summary

In January 2023, the Department for Transport (DfT) commissioned the Office of Rail and Road to carry out a quality assurance review of the data and evidence in National Highways' [Smart Motorways Stocktake Third-Year Progress Report](#) and [Smart Motorways Scheme Safety Before Versus After Assessment](#). The scope of our review was based around questions set by DfT in its [commissioning letter](#).

The *Third-Year Progress Report* primarily considers high-level statistics that compare safety outcomes across different types of road. In this area, the scope of our work considered additional analysis and changes from the previous year's *Second-Year Progress Report*.

National Highways' *Before Versus After Assessment* compares five years' worth of safety data before and up to five years' worth of data after a smart motorway scheme opens that can be used to determine the impact of individual schemes on safety. This is the first time before-after analysis has been updated since the company's [Smart Motorway All Lane Running Overarching Safety Report 2019](#), which was published alongside the [Smart Motorway Evidence Stocktake and Action Plan](#).

Our review considered the relevance and clarity of the analysis in both reports and whether National Highways has continued to follow its analytical assurance processes. For the before-after analysis only, we also considered whether the company has addressed the relevant points in our first review of smart motorways, published in September 2021, [ORR Quality Assurance of All Lane Running Motorway Data](#).

We completed our review over a six-week period in February and March 2023. We found that:

- Where new data and analysis are included in the *Third-Year Progress Report* this is relevant to the wider report and the conclusions drawn are appropriate.
- Where National Highways made changes to how data are presented in the *Third-Year Progress Report*, the reasons for this are sound and clearly communicated.
- National Highways has updated the before-after analysis of all lane running smart motorways published in its 2019 *Overarching Safety Report* and also expanded it to cover both dynamic hard shoulder and controlled motorways, going beyond the recommendation from our earlier work.

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- The company has developed its approach to the counterfactual and statistical testing of differences in personal injury collision (PIC) rates, applying methods used in its other analysis, and it has described these clearly in its report.
- National Highways has been cautious in drawing firm conclusions from its before-after analysis. This is appropriate at this stage – for example because the methodological developments applied to PIC rates have not yet been extended to the fatal and weighted injuries (FWI) and killed or seriously injured (KSI) rates. This results in more focus on simpler before-after comparisons, rather than using more complex statistical methods which could support firmer conclusions.
- In updating, expanding and developing its analysis, National Highways has continued to follow appropriate analytical assurance processes to ensure the reliability of its analysis.

1. The scope of our review

- 1.1 In January 2023, the Department for Transport (DfT) commissioned The Office of Rail and Road (ORR) to carry out a quality assurance review of the data and evidence in National Highways' [Smart Motorways Stocktake Third-Year Progress Report](#) (referred to as the *Third-Year Progress Report*) and [Smart Motorways Scheme Safety Before Versus After Assessment](#) (referred to as the *Before-After Assessment*).
- 1.2 This report describes the scope of our review, how we carried it out and our conclusions. The [commissioning letter](#) setting out the scope of our work is available on our website.
- 1.3 This builds on similar assurance work that we undertook in each of the past two years. In 2021 we published our first review, [ORR Quality Assurance of All Lane Running Motorway Data](#) (all lane running motorways are a type of smart motorways in which the hard shoulder is converted into a permanent running lane). This was followed, in 2022, by our second review, [Quality Assurance of Smart Motorways Second Year Progress Report Data and Evidence](#).
- 1.4 The *Third-Year Progress Report* gives a high-level comparison of safety outcomes on different road types. Our review of this report focused on additional sections of analysis and changes from the *Second-Year Progress Report*.
- 1.5 The *Before-After Assessment* presents analysis of scheme-level safety data before and after roads were converted to smart motorway. Where possible, this analysis also considers a counterfactual scenario – a hypothetical estimate of what would have happened had the road not been converted to smart motorway. Similar evidence supported the *Stocktake*, where it was considered to be the strongest form of evidence. The *Before-After Assessment* updates and expands the scope of that earlier analysis, in line with recommendations from our 2021 review.
- 1.6 For both reports, the scope of our review was based around the following questions:
 - (a) Are analytical outputs relevant and are the conclusions drawn appropriate? For the high-level statistics, this only applies to additional sections of analysis that are new to the *Third-Year Progress Report* (for example additional information on customer insights).

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- (b) Has National Highways continued to follow its analytical assurance processes?
- (c) Have key methodology considerations and changes to the analysis (if any) been communicated clearly and transparently?

1.7 For the *Before-After Assessment* report only, the scope also included the following question:

- (a) Has National Highways addressed the points made relating to before-after analysis in the Quality Assurance of All Lane Running Motorway data?

1.8 We completed our review in around six weeks, with the majority of the assurance activity concentrated in the first two weeks. We received an initial set of documents from National Highways on 3 February 2023, and provided our initial comments and findings on 22 February 2023.

1.9 In December 2022 we reported on the operation and effectiveness of safety systems on smart motorways in our [First Annual Assessment of Safety on the Strategic Road Network](#). We continue to hold National Highways to account for its performance in this area, but this was not within the scope of this review and report. We will provide an update on this work in our next annual safety report by December 2023.

2. Our approach

- 2.1 Our work was structured around the questions set out by DfT in its commissioning letter of January 2023. In addressing these questions, we considered National Highways' *Third-Year Progress Report* and *Before-After Assessment* separately.
- 2.2 National Highways provided us with draft versions of both reports to review as well as the underlying data, tables and charts, and information relating to its analytical assurance processes.
- 2.3 As set out in the scope, we did not revisit areas of investigation from our review of last year's *Second-Year Progress Report*. For example, assessing whether the underlying calculations are correct was not part of the scope because this was considered in our previous review, and National Highways' processes were unchanged in the *Third-Year Progress Report*. However, we undertook spot-checks of key figures to provide us with further assurance.
- 2.4 We had regular contact with the relevant teams at National Highways, who provided materials to support our review, and responded to our questions and comments. We would like to thank them for their open approach to our review.

Relevance of analysis and conclusions

- 2.5 Our review of the *Third-Year Progress Report* focused on additional analysis and conclusions that did not form part of last year's *Second-Year Progress Report*. We considered the relevance of new analysis within the context of the wider report and whether the conclusions were supported by the underlying data and evidence.
- 2.6 In contrast, our review of the *Before-After Assessment* report focused on how the analysis has evolved since the 2019 *Overarching Safety Report*. We reviewed National Highways' methods, including how they had been informed by independent, academic peer review as part of the company's assurance process. We considered the appropriateness of the conclusions in the context of the analytical approach taken.

Clear and transparent communication of methodology

- 2.7 Again, our review of the *Third-Year Progress Report* focused on any changes to the methodological and analytical approach compared to the previous year's report. The approach taken in the *Third-Year Progress Report* was broadly similar

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to the *Second-Year Progress Report* so there were relatively few changes to consider. Where there were changes in the latest report, we reviewed how these were communicated and provided comments and feedback to National Highways.

- 2.8 For the *Before-After Assessment* report we reviewed how National Highways described its analytical approach with a focus on:
- (a) the balance between describing the approach in a way that is accessible to the non-technical reader and providing a full description of the methods used; and
 - (b) the inclusion of appropriate caveats that outline the limitations of the analysis.
- 2.9 As above, this was informed by National Highways' independent peer review, and the actions it had taken in response. As with the *Third Year Progress Report* we provided the company with feedback on a draft, which it took on board positively.

National Highways' assurance process

- 2.10 Our review of last year's *Second-Year Progress Report* identified that National Highways had demonstrated a strong application of the cross-government [Aqua Book](#) on assurance.
- 2.11 National Highways provided us with analytical assurance statements and other documents that set out the analytical processes it followed in relation to both the *Third-Year Progress Report* and *Before-After Assessment*. We reviewed these documents to assess whether the company had continued to follow the analytical assurance processes it had demonstrated last year.

Recommendations from our 2021 review

- 2.12 For the before-after analysis, we grouped the recommendations from our 2021 review under four areas, to:
- (a) update the before-after analysis and extend its scope to include dynamic hard shoulder smart motorways;
 - (b) clearly describe the technical approach, including appropriate caveats or health warnings;
 - (c) develop the approach to the counterfactual, statistical significance testing and other sources of uncertainty in the analysis; and

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- (d) consider the timing of safety evaluations and review alternative techniques used elsewhere.

2.13 Given the overlap between these recommendations and the first two scope points described above, our review of the *Before-After Assessment* report was largely structured around progress in these four areas. This included discussions with the relevant teams in National Highways, particularly relating to their plans for longer-term aspects of points (c) and (d) in the list above.

3. Findings

- 3.1 The scope of our quality assurance work was based around the list of questions specified by DfT in its commissioning letter of January 2023. Our findings against each question are set out below and presented separately for the *Third-Year Progress Report* and the *Before-After Assessment*.

Third-Year Progress Report

Are additional sections to the Third-Year Progress Report analysis relevant and are the conclusions drawn appropriate?

- 3.2 Additional sections in the *Third-Year Progress Report* largely relate to changes in the presentation of some trend analysis and additional evidence on road users' perceptions of safety. As part of our review, we provided National Highways with comments and suggested improvements around the presentation of some data and conclusions. However, these were relatively minor and, overall, we consider that any new evidence is relevant and the conclusions drawn are appropriate.

Has National Highways continued to follow its analytical assurance processes?

- 3.3 We are content that National Highways continued to follow appropriate analytical assurance processes in producing its *Third-Year Progress Report*. Our review of last year's *Second-Year Progress Report* found that National Highways' Analytical Assurance framework was a strong application of the cross-government Aqua Book on assurance.
- 3.4 This year, we reviewed the company's latest analytical assurance statements, which provided us with evidence that it continues to follow the same processes. The company responded to our feedback during the review and provided us with more detail on its processes when we requested this.

Have key methodology considerations and changes to the analysis been communicated clearly and transparently in the Third-Year Progress Report?

- 3.5 Methodological and analytical changes in the *Third-Year Progress Report* are relatively minor. Mainly this relates to presenting trend analysis for rolling five-year

periods, rather than by individual years. The rationale for doing this is sound, as it mitigates the impact of lower traffic levels and casualties during the Coronavirus (COVID-19) pandemic, which can distort shorter term trends.

- 3.6 As part of the review, we provided feedback on how these changes were communicated. Again, our comments were relatively minor, and the company responded to these. Overall, we are satisfied that methodology considerations and changes to the analysis have been communicated clearly and transparently.

Before-after assessment

Are analytical outputs relevant and are the conclusions drawn appropriate?

- 3.7 National Highways has updated and extended the scope of its previous before-after analysis. The company extended the analysis from covering just all lane running smart motorways to also cover dynamic hard shoulder and controlled motorways. Earlier analysis has highlighted increased risks around collisions involving stopped vehicles on smart motorways. Given this, the analysis also considers the changes in frequency of different types of collisions, including involving vehicles stopped in live lanes.
- 3.8 National Highways had to make decisions about how far to take the analysis in different areas. In line with our earlier recommendations and the approach in the *Third-Year Progress Report*, the company has consistently focused on PIC, FWI and KSI rates as its key metrics. And it has considered each smart motorway scheme on a consistent basis, with five years of 'before' period data and up to five years of 'after' data.
- 3.9 However, National Highways faced more difficult choices on the use of more complex statistical methods. The counterfactual is an estimate of what would have happened if the road had not been converted to a smart motorway and statistical significance testing assesses the statistical likelihood of changes being caused by a fundamental shift or variation in the statistics. The company has applied these approaches to PIC rates, using methods that it has established in previous analysis.
- 3.10 There are greater challenges in applying these methods to FWI and KSI rates, including:
- the smaller number of fatal and serious collisions and casualties;

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- variation in the number of casualties per collision;
- adjustments made to account for changes in police reporting systems; and
- how to account for the weights in the FWI metric.

3.11 Also, because of the long time period covered from the introduction of the first controlled motorways to the most recent all lane running schemes, National Highways has urged caution in aggregating its scheme-level analysis to compare the different types of smart motorway.

3.12 This approach meant there was more focus on simple before-after comparisons than more complex statistical methods and National Highways' conclusions are heavily based on that simpler analysis.

3.13 There is uncertainty around how comparison against a counterfactual, rather than the before period, would affect the conclusions for the FWI and KSI rates. And more widespread use of statistical testing, especially if coupled with an approach to aggregating schemes to 'smart motorway type', would provide greater confidence in the extent to which the data show that smart motorways have improved safety.

3.14 Overall, we recognise the importance of developing the analysis further. We consider that the outputs are relevant and the conclusions are appropriate, given the current position of the analysis. However, it is important that National Highways continues to develop its approach, acting on our previous recommendations, to tackle the remaining analytical challenges.

3.15 We will work with the company as it develops its approach and, once completed, we would expect the robust application of more advanced statistical methods to support more definitive conclusions.

Has National Highways continued to follow its analytical assurance processes?

3.16 As above for the *Third-Year Progress Report*, our review found that National Highways has continued to follow its analytical assurance processes to ensure the reliability and robustness of its methods and analysis. It is positive that, in doing so, the company has used external, academic peer review as part of its 'fourth line' of assurance. We would encourage it to continue to engage with the wider road safety and statistical communities as it further develops its approach.

Have key methodology considerations been communicated clearly and transparently in the *Before-After Assessment*?

- 3.17 In producing the report National Highways has consciously considered the need to explain and describe the complexities of the statistical analysis, while also ensuring the report is accessible to non-technical readers. For example, the main body of the report focuses on simpler comparisons of before vs after (or counterfactual vs after) with the more complex description of the statistical testing approach and results reported in an annex.
- 3.18 Through our review we saw evidence of National Highways acting on feedback from its peer reviewer, as well as our own feedback on how it struck this balance. And it is positive for transparency that the company is publishing detailed tables of the numbers underlying its analysis alongside the report.

Has National Highways addressed the points made relating to before-after analysis in the Quality Assurance of All Lane Running Motorway data (2021)?

- 3.19 As discussed under our approach, in this review we considered the recommendations from our earlier work under four categories.

Update the before-after analysis and extend its scope to include dynamic hard shoulder smart motorways

- 3.20 National Highways has updated its analysis with the most recent available data. The company has also extended it to cover both dynamic hard shoulder and controlled motorways, and to include before-after analysis of types of collision, including those involved vehicles stopped in live lanes.

Clearly describe the technical approach, including appropriate caveats or health warnings

- 3.21 National Highways has described its technical approach and included appropriate caveats where needed. It should be noted that some of the choices National Highways has made at this stage – for example not to apply its current statistical testing method to FWI and KSI rates because of factors such as changes in police reporting systems – reduce the need for caveats around the reliability of those methods.

Develop the approach to the counterfactual, statistical significance testing and other sources of uncertainty in the analysis

- 3.22 Compared with the approach in its *Overarching Safety Report 2019*, National Highways has developed its approach to the counterfactual (using region-specific trends) and statistical testing (using a bootstrap simulation method). The company has applied these methods consistently with how they are used in other areas of its safety analysis.
- 3.23 National Highways has only applied the counterfactual and statistical testing techniques to PIC rates in the *Before-After Assessment*. The company has further work to do, and greater analytical challenges to overcome, to develop robust approaches for FWI and KSI rates, and to aggregate schemes.

Consider the timing of safety evaluations and review alternative techniques used elsewhere

- 3.24 National Highways evaluates the safety performance of its schemes in a number of ways, for example in its [monitoring of M25 all lane running schemes](#) and its wider programme of post opening project evaluations (POPEs). The *Before-After Assessment* itself, and subsequent updates to it, will improve the frequency and timeliness of safety evaluations for smart motorway schemes. And during our review we saw evidence that National Highways is considering the optimal timing for scheme safety evaluations as part of its POPE processes.
- 3.25 As National Highways further develops its approach, the company should review alternative techniques used elsewhere that might help it to overcome the remaining analytical challenges.

4. Conclusion

4.1 In summary, we conclude that:

- (a) Where new data and analysis are included in the *Third-Year Progress Report* this is relevant to the wider report and the conclusions drawn are appropriate.
- (b) Where National Highways has made changes to how data are presented in the *Third-Year Progress Report*, the reasons for this are sound and clearly communicated.
- (c) National Highways has updated the before-after analysis of all lane running smart motorways published in its 2019 *Overarching Safety Report* and also expanded it to cover both dynamic hard shoulder and controlled motorways, going beyond the recommendation from our earlier work.
- (d) The company has developed its approach to the counterfactual and statistical testing of differences in personal injury collision (PIC) rates, applying methods used in its other analysis, and it has described these clearly in its report.
- (e) National Highways has been cautious in drawing firm conclusions from its before-after analysis. This is appropriate at this stage – for example because the methodological developments applied to PIC rates have not yet been extended to the FWI and KSI rates. This results in more focus on simpler before-after comparisons, rather than using more complex statistical methods which could support firmer conclusions.
- (f) In updating, expanding and developing its analysis, National Highways has continued to follow appropriate analytical assurance processes to ensure the reliability of its analysis.



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