

# M1 junctions 23a to 25 all lane running

One-year post-opening project evaluation



This document has been prepared by National Highways with assistance from its consultants (where employed). The document and its accompanying data remain the property of National Highways.

While all reasonable care has been taken in the preparation of this document, it cannot be guaranteed that it is free of every potential error. In the absence of formal contractual agreement to the contrary, neither National Highways nor its consultants (where employed), shall be liable for losses, damages, costs, or expenses arising from or in any way connected with your use of this document and accompanying data.

The methodology used to generate the data in this document should only be considered in the context of this publication. This methodology, and its subsequent outputs may differ to methodologies used in different analyses at different points in time. This is due to continuous improvements of data mapping, capture, and quality. As these factors evolve over time any comparison with earlier data or data from other sources, should be interpreted with caution.

# Foreword

As Chief Customer and Strategy Officer, I want to know whether developments on our network are meeting their objectives and making a difference for our customers – the four million people that use the Strategic Road Network every day.

Evaluation is a key function in the safe running of the Strategic Road Network (SRN) and we carry out POPE<sup>1</sup> evaluations at set points during a major enhancement scheme's lifetime to enable us to take stock and make any necessary interventions. POPEs provide an early indication if the scheme is on track to deliver the benefits over 60 years as set out in the business case appraisal.

This report evaluates the M1 junctions 23a to 25 all lane running (ALR) smart motorway scheme one year after its opening in 2019 following conversion from a conventional three lane motorway.

This report will be followed by a five years after report which will provide more robust data and analysis. The report includes an understanding of the safety and environmental impacts of a scheme, as well as how traffic has changed due to a scheme being in place.

There are three types of smart motorway, all lane running (ALR), dynamic hard shoulder (DHS) and controlled motorway. ALR and DHS motorways create more space on some of the most congested sections of the SRN by using hard shoulder as a running lane either permanently or only at busy times. They create extra capacity with less disruption to road users and fewer environmental impacts than physically widening the road, along with reduced carbon emissions associated with construction.

Although the performance of individual scheme is important at a local level, drawing together findings at a programme level helps us to understand patterns and trends across our network.

Safety remains our number one priority and the five-year POPEs published to date (representing approximately a quarter of those in operation) demonstrate that smart motorways are delivering safety benefits in line with or above those originally forecast, with most schemes evaluated having lower collision rates than would have been expected on the conventional motorways they replaced. Where it has been possible to assess changes to the severity of such collisions, the evidence shows those collisions have been less severe.

The published five-year POPEs show that smart motorways are broadly on track to realise their envisaged environmental objectives. With further planned mitigation these will be fully met.

The five-year ALR and DHS POPEs published to date for smart motorways also show that the schemes are delivering much needed capacity with schemes accommodating up to almost a quarter (22%) more traffic than before they were converted into smart motorways. The reports indicate that many of the motorway sections would have been unable to cater for today's traffic (at the busiest times) if they had not been converted into smart motorways.

---

<sup>1</sup> Post Opening Project Evaluation (POPE)

According to the reports, the schemes are currently on course to deliver benefits, but will not deliver all the originally expected benefits within the 60-year appraisal period. There has been lower traffic growth than was expected when these schemes were appraised, due to the 2008 financial crisis and lower population growth than originally forecast (this will impact all transport schemes, built around this time). This means fewer drivers are benefiting today from smart motorway schemes than originally anticipated. Five-year POPEs also show that traffic on some smart motorway sections is not travelling as quickly as was forecast at the appraisal stage. Together these factors have resulted in the value for money for all schemes with five-year appraisals, over the 60-year appraisal period, currently being lower than anticipated at this stage when compared with the original appraisal. This is, however, a forecast and there is the opportunity to take further action to improve benefits.

We have therefore examined these results in detail and have identified specific actions to further improve the performance of schemes, including:

- Standardised operating procedures for DHS schemes
- Technology improvements
- Optimisation of the algorithms that set speed limits
- Investigating physical constraints off the network that impact performance

We will continue to monitor schemes in operation, enabling us to track their benefits and take further action if required to ensure these schemes deliver an improved experience for our customers.

Elliot Shaw

Chief Customer and Strategy Officer

September 2023

# Table of contents

Chapter	Page
Table of contents	3
Foreword	3
1. Executive summary	6
2. Introduction	8
What is the project and what was it designed to achieve?	8
How has the project been evaluated?	9
3. Delivering against objectives	10
How has the project performed against objectives?	10
4. Customer journeys	12
Summary	12
How have traffic levels changed?	12
Relieving congestion and making journeys more reliable	16
5. Safety evaluation	23
Summary	23
Safety study area	23
What were the emerging safety trends in the first 12 months?	24
What changes in safety numbers did we see in the wider area?	27
Appendix A: Traffic data issues	30
Appendix B: Speed by distance analysis	31
Appendix C: Counterfactual safety methodology	33
Appendix D: Incident reporting	34
Appendix E: Unadjusted Collision Severity	35

# 1. Executive summary

The M1 junctions 23a to 25 smart motorway is a key strategic route through the East Midlands which opened to traffic in February 2019. This stretch of motorway was previously was a four-lane motorway with a hard shoulder between junctions 23a and 24 and a three-lane motorway with a hard shoulder between junctions 24 and 25. The route is 7.1 miles long and connects the A42 at Diseworth (junction 23a) and the A52 (junction 25). The A52 provides a strategic route between Derby and Nottingham.

This scheme aimed to provide additional capacity to reduce congestion, better manage traffic conditions and improve journey time reliability while maintaining safety for road users and minimising adverse environmental effects of the project.

Before the project, drivers experienced congestion and unreliable journey times at busy periods. Traffic demand in the area was expected to increase, particularly with the growth expected at East Midlands Airport, the development of the East Midlands Gateway Interchange and construction of Kegworth Bypass. In the absence of the project, it was anticipated that congestion and unreliable journey times would worsen because of predicted traffic growth.

Following the project, the section now operates as a four-lane controlled motorway<sup>2</sup> between junctions 23a and 24 and all lane running<sup>3</sup> between junctions 24 and 25.

Before the smart motorway was implemented, there was congestion causing low average peak hour speeds and unreliable journeys, particularly between junctions 24 and 25. After the route was converted to a smart motorway, road users' northbound journey times were faster by nearly three minutes in the evening peak and more in line with other times of the day. This improvement was attributed mainly to the additional lane capacity provided between junctions 24 and 25. The improvement in journey times has been realised, against an increase in traffic of between 2% and 7% outside of the project extent<sup>4</sup>. Journey time reliability has improved during the evening for northbound journeys. At less congested times, the journey time reliability has not significantly changed or slightly worsened. The benefit of variable mandatory speed limit technology can be seen where congestion was evident in the before period.

The safety objective for this smart motorway was to achieve no worsening of safety performance. In the first year of the smart motorway being operational, there has been a reduction in the rate and number of personal injury collisions compared with the annual average for the five years before the project was built. Collisions are reducing at a time where congestion is being released and traffic is moving quicker in some time periods. However, it is important to highlight that a one-year evaluation draws upon twelve-month of post opening safety data, and therefore it is too early to conclude what the impact has been on safety. The follow up evaluation will provide more certainty when we have a minimum of three years safety data.

---

<sup>2</sup> A controlled motorway applies technology to control speeds but retains a permanent hard shoulder.

<sup>3</sup> All lane running (ALR) motorways apply technology to control speeds, and permanently convert the hard shoulder to a running lane. Emergency areas are available at regular intervals providing places to stop in an emergency.

<sup>4</sup> We encountered issues collecting traffic data on the project section. See Appendix A for further information.

A one-year after evaluation typically involves an evaluation of the environmental objectives using traffic data. Due to inconsistencies in the type of traffic counts used to collect traffic data on the project extent before and after the project opened, it was not possible to ascertain the change in traffic on the project extent. A full environmental assessment will be undertaken for the five years after evaluation report.

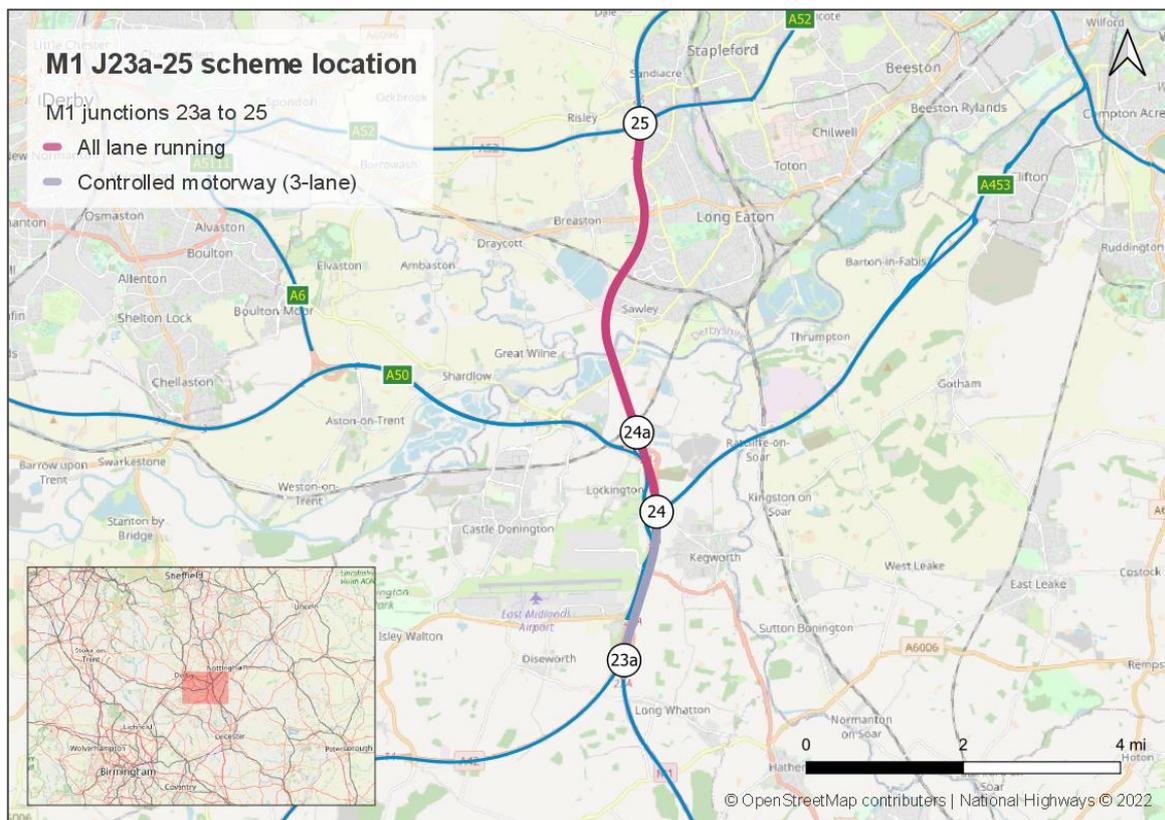
## 2. Introduction

### What is the project and what was it designed to achieve?

The M1 junctions 23a to 25 smart motorway opened in February 2019 and is part of a strategic corridor (M1) that extends 193 miles between London in the south, the Midlands, and Leeds in the north. In the absence of the project, it was anticipated that congestion and unreliable journey times would worsen because of predicted traffic growth, particularly near East Midlands Airport. The additional lane capacity was expected to help during periods of heavy congestion and improve incident management.

Before the project was implemented, the M1 between junctions 23a and 24 was a four-lane motorway plus a hard shoulder. Between junctions 24 and 25 the motorway was three lanes with a hard shoulder (Figure 1).

Figure 1 M1 junctions 23a to 25 project location



Source: National Highways and OpenStreetMap contributors

Following completion of the project, the carriageway is now operated as a four-lane controlled motorway between junctions 23a and 24 with gantry signs to enable the use of variable mandatory speed limits (VMSL), to control the speed of traffic, while retaining a permanent hard shoulder. Overhead electronic signs display messages to drivers, such as displaying red X signs and warning of an incident ahead.

Between junctions 24 and 25, the carriageway is operated as a four lane all lane running (ALR) motorway, following the conversion of the hard shoulder to a permanent running lane. ALR motorways apply the controlled motorway technology, and feature orange emergency areas. Other places to stop in an emergency include sections of remaining hard shoulder, such as on slip roads at

junctions. When it is necessary to reduce the speed limit the VMSL are activated, and the reduced speed limit is displayed on gantry signs and signal on relevant parts of the motorway.

## How has the project been evaluated?

Post-opening project evaluations are carried out for major projects to validate the accuracy of expected project impacts which were agreed as part of the business case for investment. They seek to determine whether the expected project benefits are likely to be realised, provide opportunities to learn and improve future project appraisals and business cases. And are important for providing transparency and accountability for public expenditure, by assessing whether projects are on track to deliver value for money.

A post-opening project evaluation compares changes in safety, journey reliability and environmental impact areas, by observing trends on a route before a project is constructed (baseline) and tracking these after it has opened to traffic. The outturn impacts are evaluated against the expected impacts (presented in the forecasts made during the appraisal) to review the project's performance. For more details of the evaluation methods used in this study please refer to the post-opening project evaluation methodology note<sup>5</sup>.

---

<sup>5</sup> <https://nationalhighways.co.uk/media/exypgk11/pope-methodology-note-jan-2022.pdf>

### 3. Delivering against objectives

#### How has the project performed against objectives?

All our major projects have specific objectives which were defined early in the business case when project options were being identified. The project had four key objectives, primarily related to improving journey times, maintaining safety for road users, and supporting wider government transport policy. These benefits are appraised to be realised over 60 years; a one-year evaluation provides early indication if the project is on track to deliver the benefits.

Table 1 summarises the project’s performance against each of the objectives, using evidence gathered for this study.

**Table 1 Objectives and Evaluation summary**

Objective	One-year evaluation
To support and enhance the role of the current motorway network as a major national and inter-urban regional transport artery.	The project has added additional capacity through the conversion of the hard shoulder to permanent all-lane running between junctions 24 and 25, along with technology between junctions 23a and 24 to enable it to operate as a controlled motorway. It has not been feasible to assess changes in the number of road users at one-year after. This objective will be re-assessed as part of a future evaluation.
To deliver a programme of interventions which, as a minimum, do not increase the average number of FWI <sup>6</sup> casualties per billion vehicle miles per annum.	We are unable to assess the change in rate of FWI at this early stage. However, there were positive early signs of improvements for the project extent. Personal injury collisions and rates had reduced in the twelve months since the project opened to traffic. A longer time frame will be required to draw firm conclusions. This objective will be re-assessed as part of a future evaluation.
To reduce congestion and to develop solutions that provide additional capacity, increase journey time reliability and ensure the safe and economic operation of the motorway network.	Congestion had reduced around the project extent with reliability improving during the slower times of the day on the project. Variable mandatory speed limits (VMSL) had been deployed on the project extent. At the time of evaluation congestion had yet to reach levels where its use was necessary, as indicated by usage patterns, though traffic volumes are expected to increase in later years.
To deliver interventions that support the delivery of the Government’s transport policy objectives.	The highway capacity added between junctions 24 and 25 had reduced congestion, particularly in the northbound direction. This objective will be re-assessed as part of a future evaluation.

<sup>6</sup> Fatalities and Weighted Injuries



## 4. Customer journeys

### Summary

During the first year since the project opened, traffic either side of the project extent had increased by between 2% and 7%.<sup>7</sup> Traffic at regional and national levels increased too, by 6%, from before the project's construction start (2016) to opening. We therefore expect traffic flows to have increased along the project. Traffic growth along the project extent was forecast to be between 4% and 17%, and the observed changes on the M1 either side of the project are around the lower end of this range (Figure 3).

Before the smart motorway was implemented, road users' speeds in most time periods were around 60mph, around a 'mile a minute' suggesting there were limited issues with congestion. The project was therefore an act of futureproofing rather than fixing an existing issue, and the evaluation results should be interpreted in this context.

Before the project, road users' northbound journey times in the evening were the highest at nearly 11 minutes, while average speeds were around 40mph. After the smart motorway was implemented, journey times were now eight minutes and more in line with the average at other times of the day. This reduction was attributed mainly to the additional lane capacity provided between junctions 24 and 25. Southbound journeys were little changed.

Journey time reliability has also improved during the evening for northbound journeys, however all other time periods in both directions have either experienced negligible changes or a slight worsening. The use of VMSL during these periods is likely to have some effect on journey times if the volumes of traffic are not high enough to warrant an intervention.

### How have traffic levels changed?

Smart motorways are built on stretches of motorway which experience high levels of congestion and/or are expected to see traffic levels increase in future years. The following sections will examine if the traffic levels changed over the evaluation period and to what extent the forecast traffic levels were realised.

#### National and regional

The Department for Transport produces annual traffic statistics by local authority and road type, recording the total number of million vehicle kilometres travelled<sup>8</sup>. This data has been extracted and indexed to 2014,<sup>9</sup> to reflect the changes in national, regional and local traffic flows over the past decade (see Figure 2).

We found that traffic has generally increased at a local (Derby and Nottingham), regional (East Midlands) and national level since 2014. The increase between 2014 and 2019 was between 6% and 10% locally, and 11% both regionally and

---

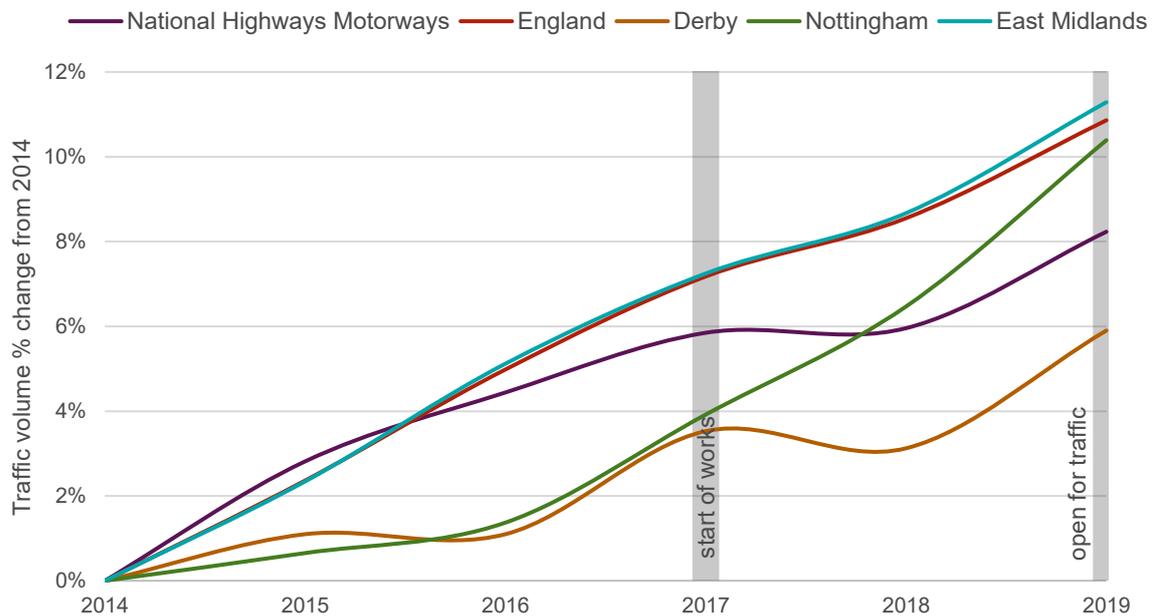
<sup>7</sup> We encountered issues collecting traffic data on the project section. See Appendix A for further information.

<sup>8</sup> Motor vehicle traffic (vehicle kilometres) by region in Great Britain, annual from 1993 to 2019, Table TRA 8904, Department for Transport

<sup>9</sup> The data is presented from 2014 as this is the base model year in the East Midlands Traffic Assignment Model used in the appraisal of the project.

nationally. In terms of motorway traffic across England, this has increased by 8% between for the same period, similar to the changes in local traffic.

**Figure 2 National, regional and local traffic trends**



Source: Department for Transport road traffic statistics <https://www.gov.uk/government/statistical-data-sets/road-traffic-statistics-tra>

### Wider area

We were unable to directly assess the changes in traffic on the project extent<sup>10</sup>. We therefore assessed the changes in traffic on key roads close to the project section to provide context. We considered whether the size of the changes observed was in line with what had been observed at a local, regional, and national level. COVID-19 impacted the period of data used for our assessment.<sup>11</sup>

Figure 3 compares the pre-project (October 2016) and post-project (October 2019) average daily traffic (ADT)<sup>12</sup> flows and percentage changes on roads near the project, where data was available.<sup>13</sup>

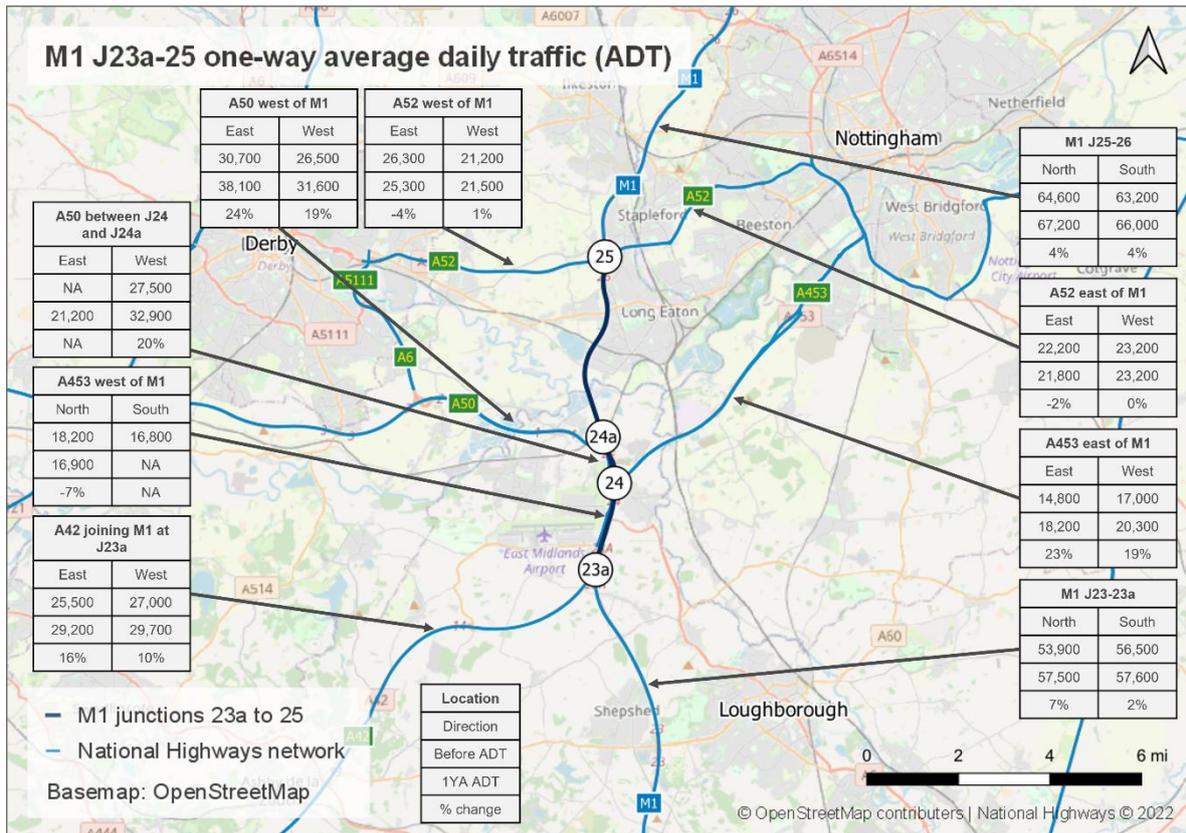
<sup>10</sup> We encountered issues collecting traffic data on the project section. See Appendix A for further information.

<sup>11</sup> Data was extracted from the National Highways Traffic Information System (WebTRIS) database. The typical period to use for one year after opening would have been March 2020, however as the UK Government announced the first national lockdown in response to COVID-19, October 2019 was used instead as a more suitable evaluation period.

<sup>12</sup> ADT flows were used to enable direct comparison with the forecast flows.

<sup>13</sup> No pre-project data was available on the A50 between junctions 24 and 24a (eastbound). No post-project data were available on the A453 west of M1 (southbound).

Figure 3 Comparison of before and after average daily traffic



Source: National Highways traffic count data and OpenStreetMap contributors

On the M1 to the north of the project section (junctions 25 to 26) traffic increased by 4% in both directions, and by 2% (southbound) and 7% (northbound) to the south of the project (junctions 23 to 23a). The rate of increase observed was generally slightly lower than what was observed at a regional and national level (6%).

The M1 to the north of the project is busier than the south with between 8,000 and 10,000 more vehicles per day in each direction. This could be a result of traffic joining the M1 via the A42 and A52 at junctions 23a and 25 respectively. Traffic from Derby to the west, Nottingham to the east, and that from Birmingham would all join over the project section.

On other nearby strategic roads, we found traffic increased by around 20%. These roads were: the A453 east of the M1, the A50 between junctions 24 and 24a, and the A50 west of junction 24a. These increases may be due to external factors in the area, such as development of the East Midlands Gateway Interchange and construction of the Kegworth Bypass. Both were in development and under construction at the time of this evaluation and may have contributed to increases to traffic on strategic roads within the area, though not fully operational until afterwards.

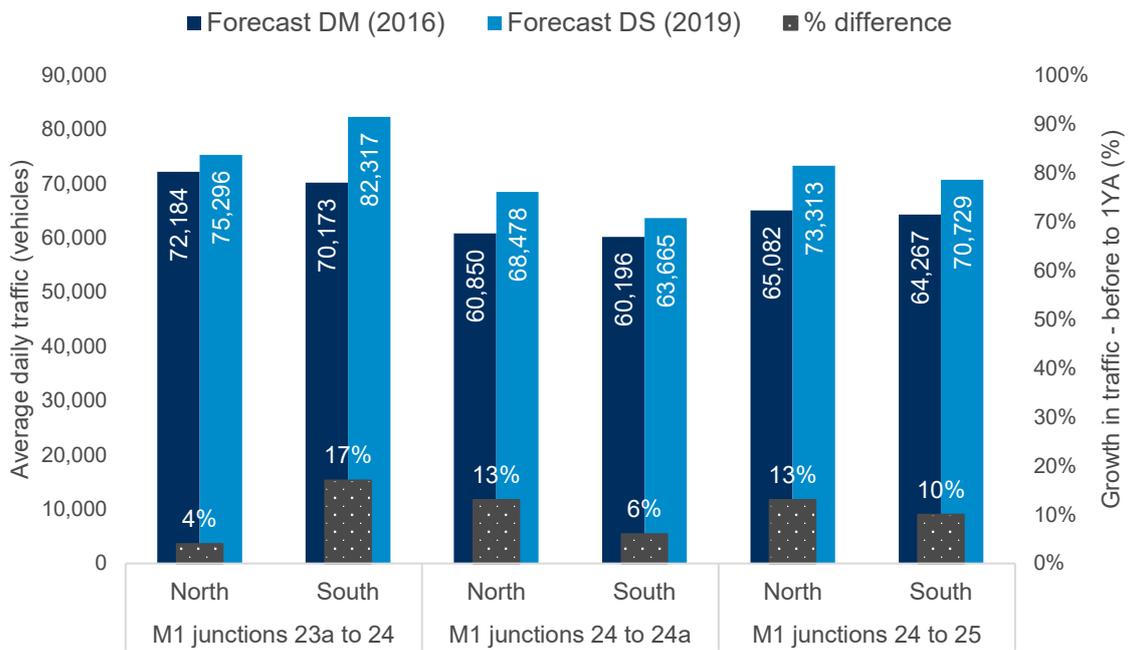
### Was traffic growth as expected?

Due to the data limitations on the project section, it was not possible to undertake a comparison between observed and forecast traffic flows. To understand the changes that were predicted we compared interpolated forecast traffic flows

produced by the appraisals' traffic model<sup>14</sup> for the 'without project' (Do Minimum) and 'with project' (Do Something) scenarios.<sup>15</sup>

We found the appraisal's traffic model predicted mainline traffic flows on the project extent would increase by between 4% and 17% after opening (Table 2). As seen earlier, observed traffic flows either side of the project extent have increased by 2% and 7% in the northbound and southbound direction respectively between junctions 23 and 23a, and by 4% in both directions between junctions 25 to 26. While traffic on adjacent local roads, the A50 and A453, increased by up to 20% likely due to the redevelopment in the area. Based on this evidence, it is likely that flows on the mainline may have increased by amounts similar to that forecast.

**Table 2 Forecast average daily traffic flows**



Source: East Midlands Traffic Assignment Model (2015).

<sup>14</sup> The East Midlands M1 Traffic Assignment Model was used to model the future impact of the project. It used a 2014 base model and calculated future year with and without project forecast scenarios based on 2017, 2021 and 2032.

<sup>15</sup> To determine the forecast traffic flows for the year before the project opened (2016) and following the project opening (2019), the traffic flows from the model and as provided in the Traffic Forecasting Report (2015), have been interpolated to calculate a 2016 without project and a 2019 with project forecast scenario. The flows presented in Table 2 are average daily traffic flows.

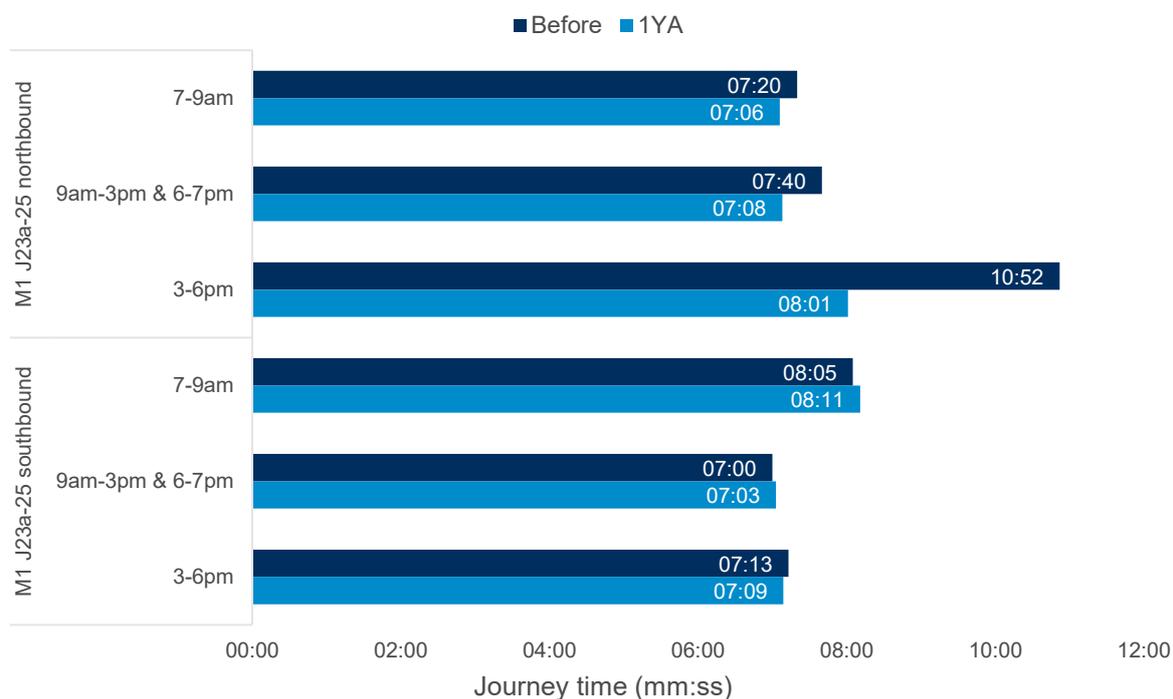
## Relieving congestion and making journeys more reliable

Improving journey time reliability and reducing congestion were two of the key objectives for this project. Analysis of journey times and speeds can indicate the impact of the smart motorway on congestion. The extent to which journey times vary from the expected average journey time indicates how reliable a journey is.

### Did the project deliver journey time savings?

We analysed satnav data<sup>16</sup> to determine whether the project had reduced road user's average journey times across the whole project extent and whether the objective of reducing congestion had been achieved. Figure 4 presents journey time results for the project.

Figure 4 Average journey times along the project – northbound and southbound



Source: TomTom satellite navigation data October 2016 and October 2019.

Before the project, most road users could achieve good journey times between junctions 23a and 25 and were travelling at a 'mile a minute' along the 7.1-mile project length. Their northbound journeys in the evening peak were the exception. These were slower and indicative of congestion.

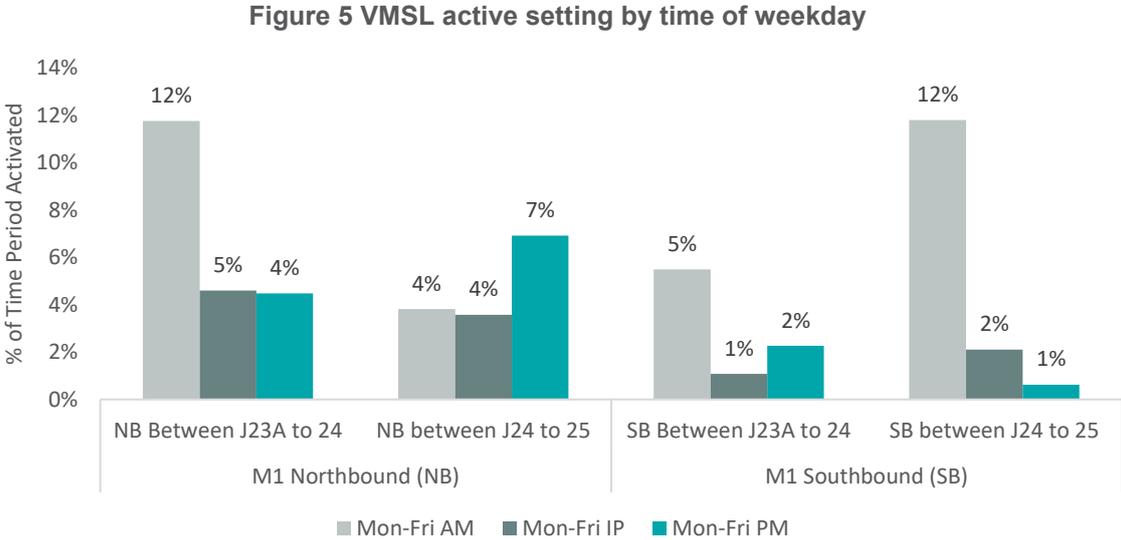
At one year after, the project's capacity enhancements had improved road users' journey times in the period where congestion was most evident. Their northbound journeys in the evening peak were improved by almost three minutes. The savings were made mainly between junctions 24 and 25 (see Appendix B: Speed by distance analysis) where the hard shoulder was converted to a lane permanently open to traffic. Northbound journey times at other times of the day showed some

<sup>16</sup> We used TomTom satellite navigation data in our analysis. It provides vehicle speeds (average, median, percentiles), journey times and standard deviations. Routes were divided between each section of the project area to assess the impact of the project in isolation, including the use of variable mandatory speed limits and the conversion of the hard shoulder to a permanent running lane.

improvement too. While southbound journeys were generally little changed, indicating performance had been maintained.

**How was the smart motorway operated?**

Our smart motorways include capability to use VMSL along their extents.<sup>17</sup> We analysed data for several points along the project extent as the speed limits setting can vary along the project (Figure 5).



Source: National Highways HALOGEN, all time periods (October 2019)

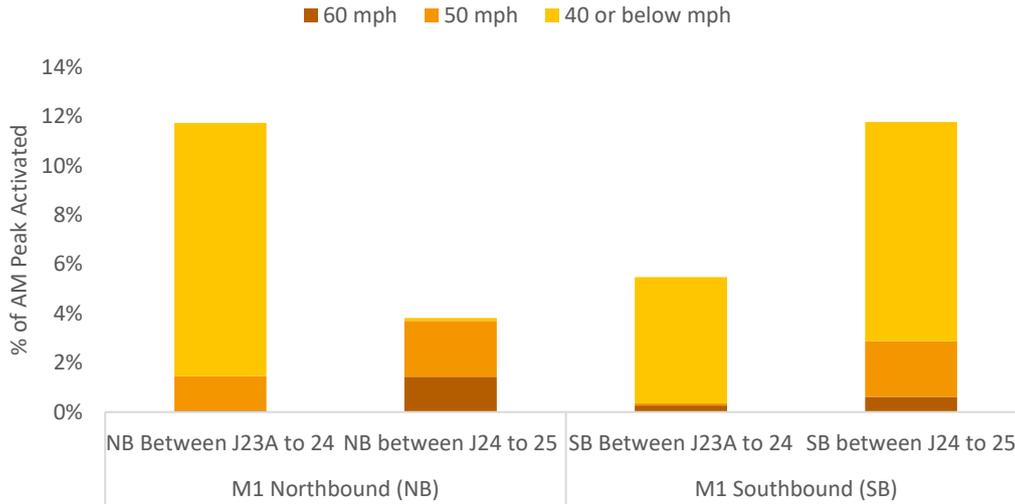
Our analysis of VMSL usage provided further evidence that congestion levels at one year after had yet to reach the point where road users’ speeds needed to be managed to maintain performance. VMSL was used most in the morning (between 4% and 12%), and less in the evening peak (between 1% and 7%).

Our findings provided further evidence suggesting the extra capacity provided between junctions 24-25 was the main contributory factor for the journey time improvements observed, rather than VMSL technology.

Figure 6 presents further analysis of the specific speed settings used on each section by direction. The most set speed limit during the morning peak was 40mph or below. It was also used more frequently along the southbound carriageway.

<sup>17</sup> VMSL are employed along sections of smart motorway to lower speeds to ensure a consistent flow of traffic and ease congestion. When the variable speed limit signs are switched off the national speed limit applies.

**Figure 6 Variable speed settings - morning peak**



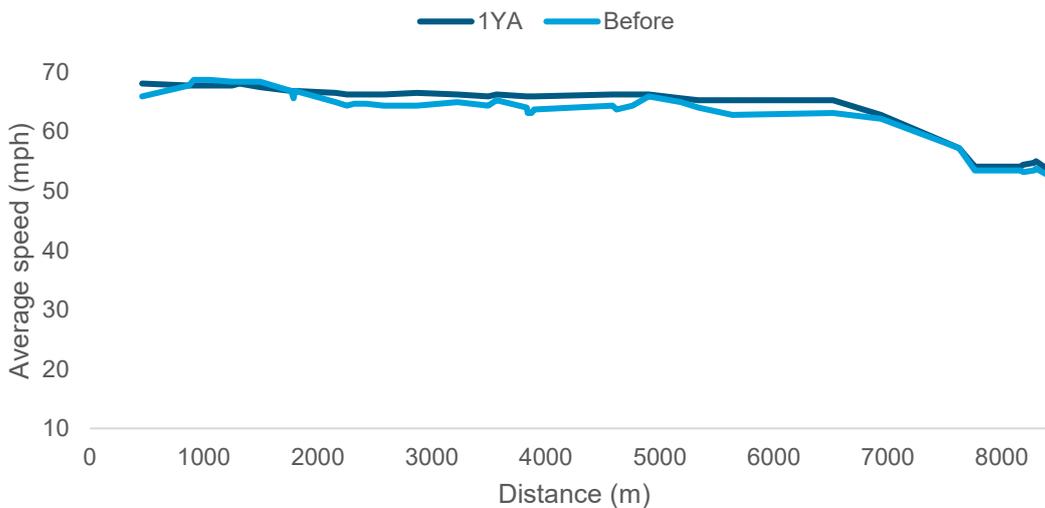
Source: National Highways HALOGEN Data, morning peak period (October 2019)

**How did the project impact road users' speeds?**

The satnav data allowed us to see where average traffic speeds along the project had changed. Speed by distance analysis for each section of the project, time of day and direction are provided in Appendix B: Speed by distance analysis. As previously noted, we identified improvements between junctions 24 and 25, on the southbound carriageway in the morning, and on the northbound carriageway in the evening. But overall, there were minimal changes across the weekday; speeds remained high and consistent along the project section before and after it opened.

We noted that a decline in speeds observed on the northbound approach to junction 25 before the project remained after its implementation (Figure 7). Anecdotal evidence from stakeholders indicated that this was due to congestion issues at junction 25 causing delays. The delays were not believed to be due to the project as no changes were made to the junction.

**Figure 7 Speed by distance analysis – junctions 24 to 25 northbound morning peak**

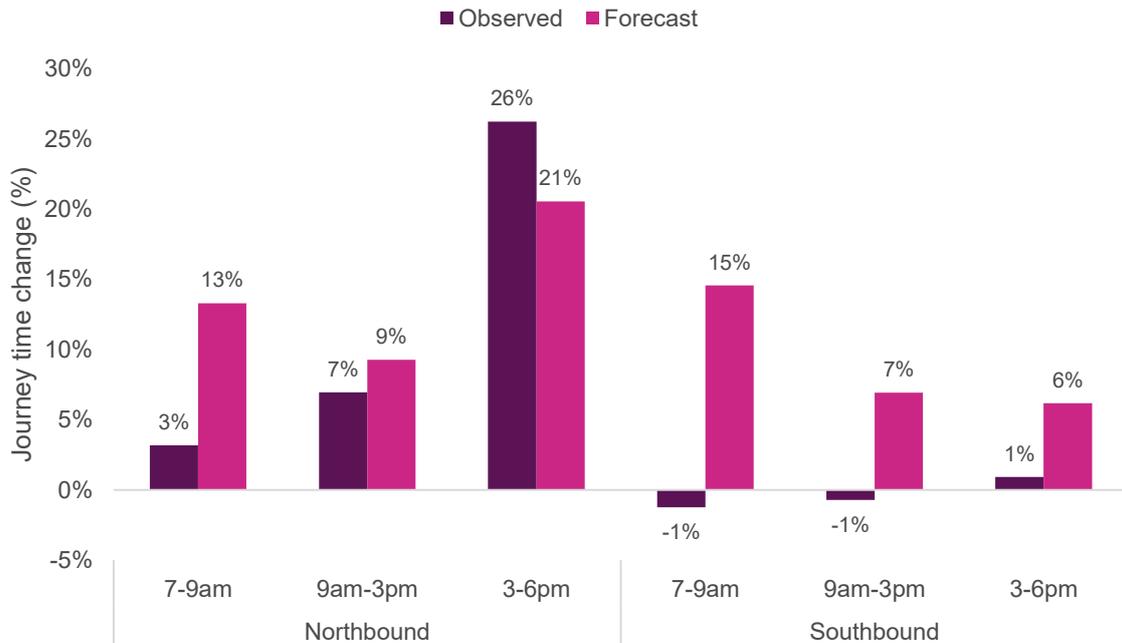


Source: TomTom satellite navigation data October 2016 and October 2019.

## Were journey time savings in line with forecast?

The project's appraisal used the East Midlands M1 Traffic Assignment Model to make predictions on its traffic impacts.<sup>18</sup> We undertook analysis to understand whether current journey times were in line with what was expected (2021 is the closest forecast year). Figure 8 compares the observed post-project journey times to those predicted in 2021 (with project). They also compare the journey times predicted for 2021 both with and without the project to understand the expected scale of savings. These are then considered against the observed savings.

**Figure 8 Journey time forecast comparison (observed versus forecast change)**



Source: TomTom satellite navigation data October 2016 and October 2019 and the East Midlands M1 Traffic Assignment Model (2015).

It was forecast that without the project (do minimum), journey times by 2021 would be as high as nine and half minutes. With the project, most of the changes in journey times were forecast to occur between junctions 24 to 25, which is to be expected given the additional lane capacity provided by the project.

A reduction in journey times of between 9% and 21% was expected in the northbound direction and between 6% and 15% in the southbound direction. Most of the benefits to journey times on the southbound route were expected to be in the morning (7-9am), but a slight increase was seen instead. This was similar for the daytime (9am-3pm), but there was a small improvement in the evening (3-6pm). Observed journey times for the southbound were lower than predicted.

<sup>18</sup> A 2014 base model was used to calculate future year 'with project' and 'without project' forecast scenarios for the years 2017, 2021 and 2032. Forecast journey times were extracted from the East Midlands M1 Traffic Assignment Model for the nearest available interim modelled year (2021). As such, they are not directly comparable with the observed data which uses data from 2016 before the project opened and 2019 after the project opened. Furthermore, it is possible that there are discrepancies between the route lengths for the model's journey times and those used in the observed TomTom data. Nonetheless, the comparison can be used to provide an indication of the likely journey time impact in comparison to forecasts. Journey time impacts will be reviewed further at the five-years after evaluation.

For the northbound route, changes in journey times were generally more accurate and positive. The evening peak (3-6pm) saw an improvement of 26%, a greater reduction in journey times than the forecasted 21%. Journey times between 9am and 3pm were also well forecasted at 9%, with an observed improvement of 7%. The morning peak (7-9am) had a lower than forecast change (3% compared to 13%), though this was still an improvement. Journey times on the northbound route were generally well forecasted when compared to observed.

### Did the project make journeys more reliable?

Congestion can make journey times unreliable. If the time taken to travel the same journey each day varies, journey times are unreliable, and the road user is less confident in planning how long their journey will take them. If journey times do not vary, the road user can be more confident in the time their journey will take and allow a smaller window of time to make that journey.

**Figure 9 What does a box plot show?**

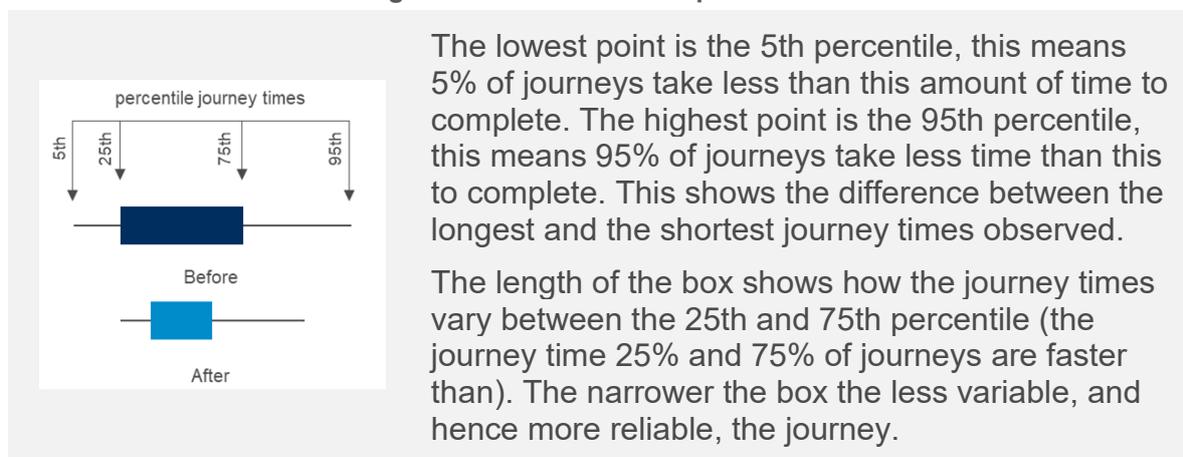
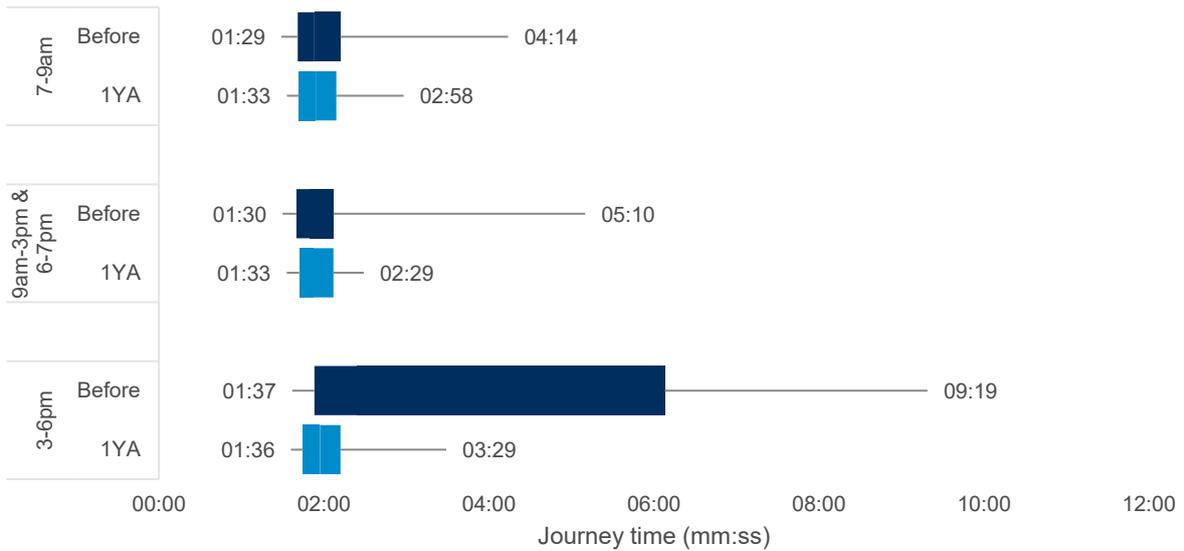


Figure 10 to Figure 13 provide the variability in journey times in both directions between junctions 23a to 24 and junctions 24 to 25, respectively.

Before the project, northbound journeys in the evening peak were significantly unreliable, more so between junctions 23a to 24 than junctions 24 to 25. At one year after, the project had brought considerable improvements in reliability for these journeys on both sections. Northbound journeys at other times of the day before the project were generally reliable for most road users and remained so at one year after.

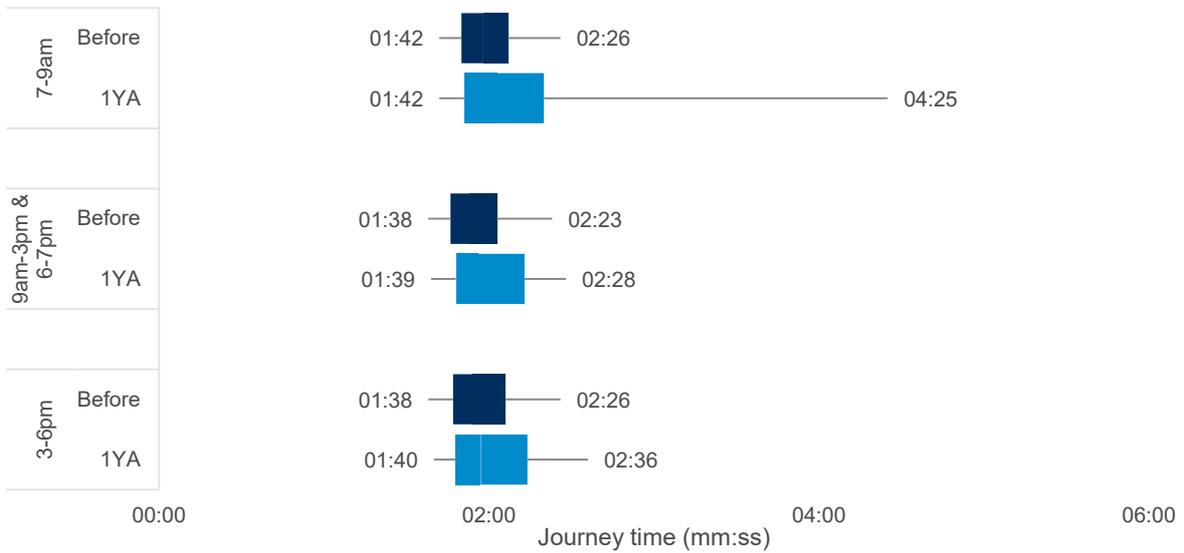
The reliability of road users' southbound journeys before the project was generally good in the inter peak and evening peak. We saw only marginal changes at one year after. Journey reliability in the morning peak before showed the greatest variability, as measured by the interquartile range and the spreads of the 5th to percentiles. At one year after, the reliability of journeys between junctions 23a and 24 had declined a little, but had improved between junctions 24 and 25, likely due to the provision of the additional lane on this section.

**Figure 10 Journey time reliability - M1 junctions 23a to 24 (northbound)**



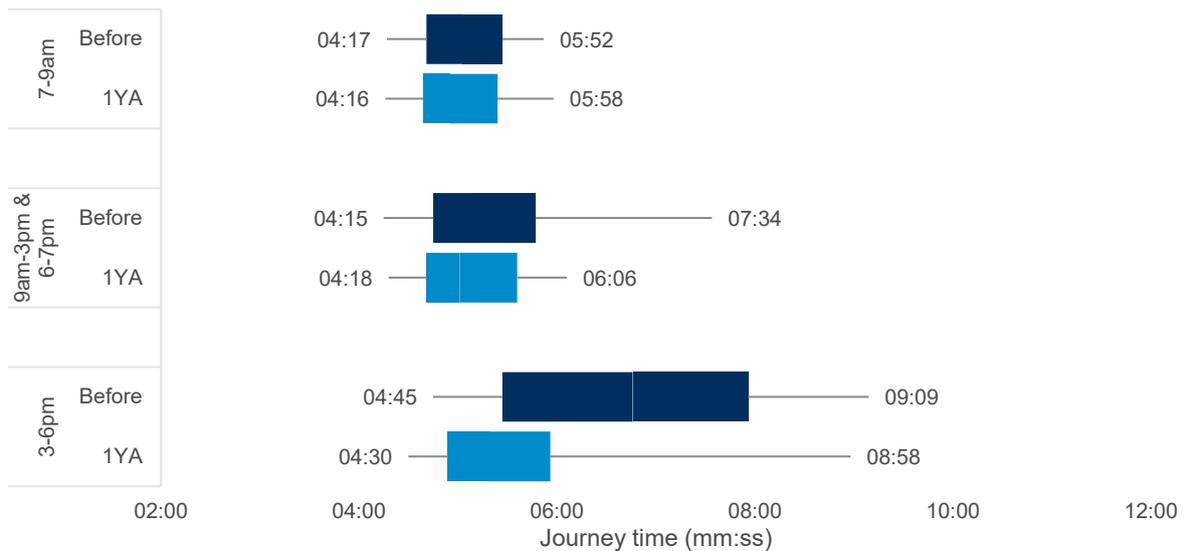
Source: TomTom satellite navigation data October 2016 and October 2019.

**Figure 11 Journey time reliability - M1 junctions 23a to 24 (southbound)**



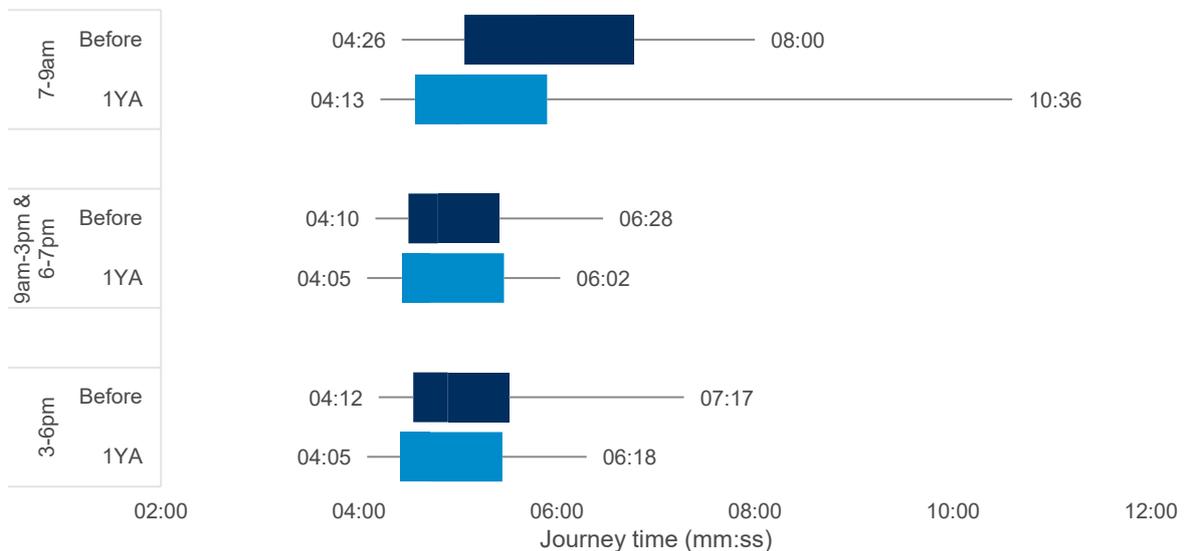
Source: TomTom satellite navigation data October 2016 and October 2019.

**Figure 12 Journey time reliability - M1 junctions 24 to 25 (northbound)**



Source: TomTom satellite navigation data October 2016 and October 2019.

**Figure 13 Journey time reliability - M1 junctions 24 to 25 (southbound)**



Source: TomTom satellite navigation data October 2016 and October 2019.

## Overview

Overall, the traffic analysis has shown that journey time improvements (reliability and time savings) are yet to fully materialise. Average speeds before the project opened were generally good - near to a 'mile a minute' in most time periods - and this remains the case after the project. As such, the project was mainly concerned with futureproofing this section in light of anticipated demand, rather than aiming at fixing an existing problem. The results should be considered in this light.

We found there had been a limited impact on journeys in most time periods. Combined with the fact that VMSL is currently used so infrequently, this suggests that congestion levels have not yet reached a point where the smart motorway technology is needed to improve performance. The project provides the capacity necessary to accommodate future traffic growth.

# 5. Safety evaluation

## Summary

The safety objective for this smart motorway was to achieve no worsening of safety performance. The number and rate per hundred million vehicle miles of personal injury collisions were analysed to track a change over time. In the first year of the smart motorway being operational, there has been a reduction in the rate and number of personal injury collisions compared with the annual average for the five years before the project was built.

During the first 12 months of the smart motorway being open there were four personal injury collisions compared with an average of 15 per year before the project was constructed. If the road had not been converted to a smart motorway, we estimate that the number of personal injury collisions would have changed to between 8 and 32.

When accounting for the increased volume of road users over this period, the annual average rate of personal injury collisions per million vehicle miles had also improved over time. The average collision rate had decreased to 1.3 personal injury collisions per hundred million vehicle miles, this equates to travelling 76 million vehicle miles before seeing a collision. Before the project, the collision rate was 5.2 personal injury collisions per hundred million vehicle miles, this equates to traveling 19.2 million vehicle miles before seeing an accident. If the project had not been implemented, we estimate the collision rate would increase to 5.6 personal injury collisions per hundred million vehicle miles<sup>19</sup>.

In the context of other findings in this report these are positive early signs. Collisions are reducing at a time where congestion is being released and traffic is moving quicker in some time periods. Traffic levels are set to increase in later years, however, and so results at the follow up evaluation will be essential to check if this trend continues and our findings are significant.

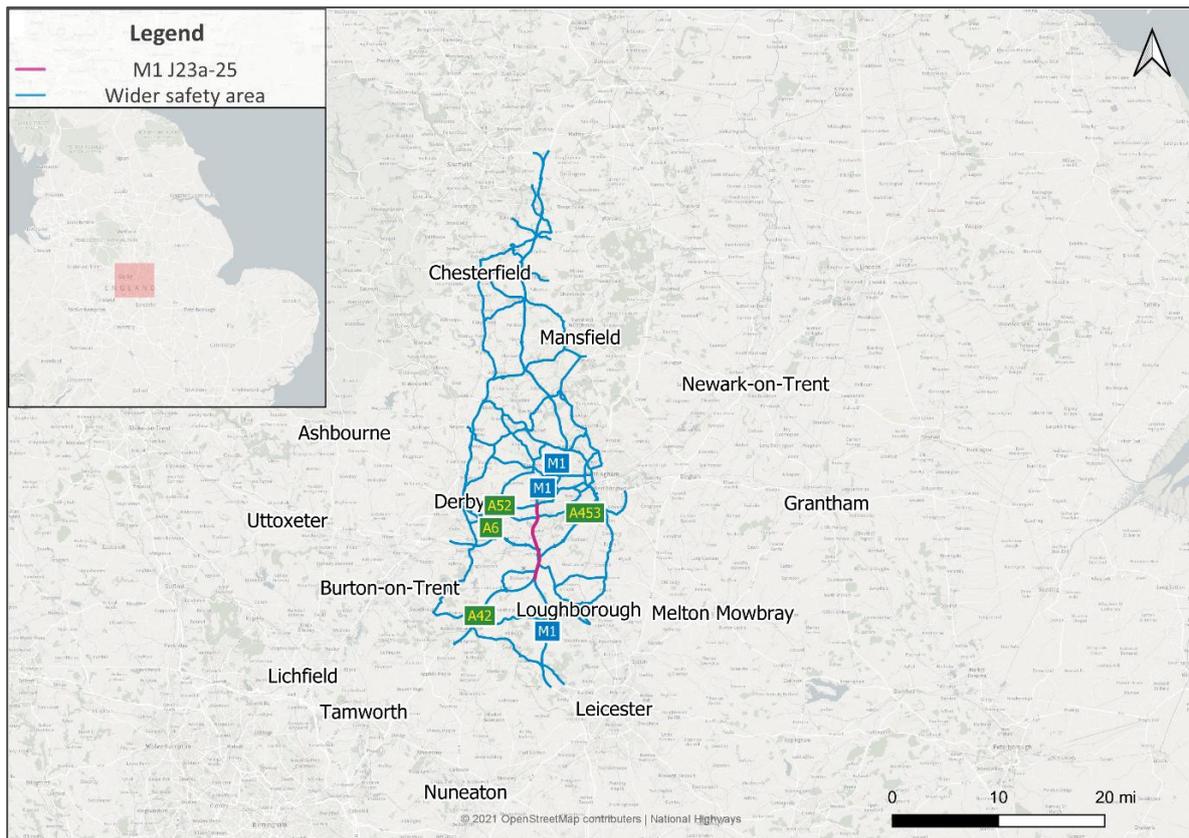
## Safety study area

The safety study area is shown in Figure 14. It encapsulates both strategic and local roads surrounding the smart motorway. This area is assessed in the appraisal supporting the business case for the project. It checks any potential wider implications for the intervention. This information is then used with other predictions around the potential impact of the project such as by how much traffic may grow. We have therefore replicated the appraisal study area to understand the emerging safety trends.

---

<sup>19</sup> The impact the project has had on casualties using the FWI measure is not considered in this report. This will be reported on during further evaluations of the project.

Figure 14 Safety study area



Source: National Highways and OpenStreetMap contributors

## What were the emerging safety trends in the first 12 months?

Safety data for this evaluation was obtained from Department for Transport Road Safety Data. This records incidents on public roads that are reported to the police. This evaluation considers only collisions that resulted in personal injury.

The safety analysis has been undertaken to assess changes over time looking at the trends in the five years before the project was constructed to provide an annual average. We have then assessed the trends from the first 12 months after the smart motorway was operational and open for road users. As noted in the chapter summary, this provides an early indication of safety trends, but this will be monitored over a longer time frame before conclusions can be drawn about the safety impact of the project across the following time periods:

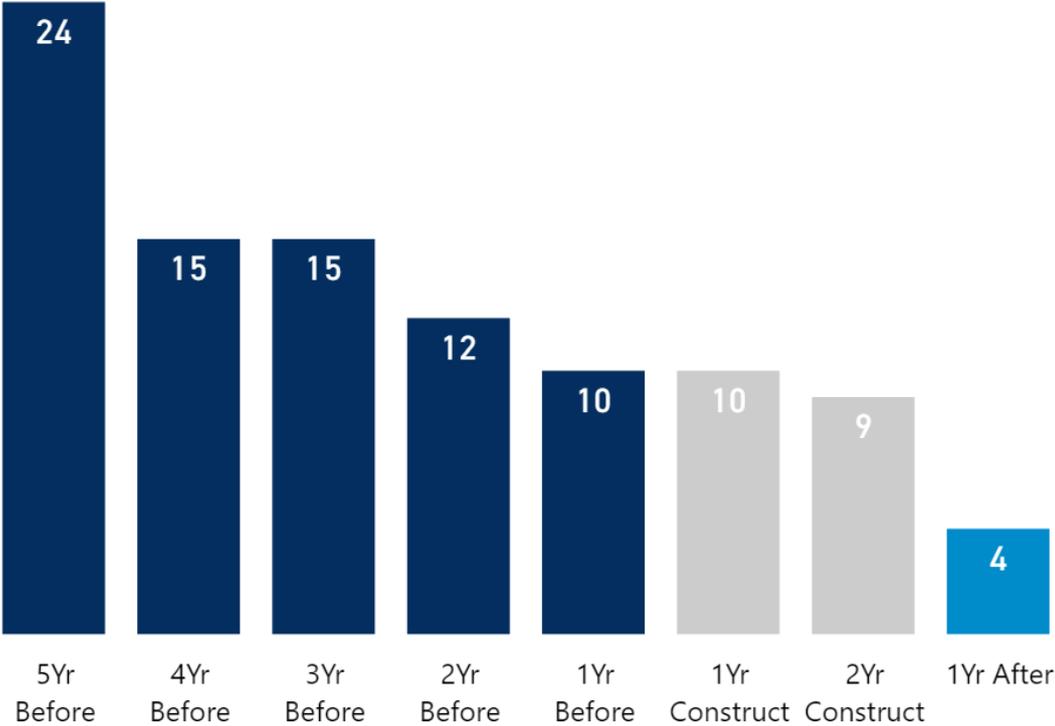
The analysis draws on the following data collection periods

- Pre-construction: 30 March 2012 - 29 March 2017
- Construction: 30 March 2017 - 26 February 2019
- Post-opening: 27 February 2019 - 26 February 2020

The early indications are that the number of personal injury collisions for the first year of the smart motorway are lower than the period before construction began. The annual number of personal injury collisions can be seen in Figure 15 and we can see this has reduced from an annual average of 15 to 4 personal injury collisions during the first 12 months of the smart motorway being open for road users. Safety trends can vary each year and we will monitor this trend over a

longer time frame before drawing conclusions about the safety impact of the smart motorway.

Figure 15 Annual personal injury collisions



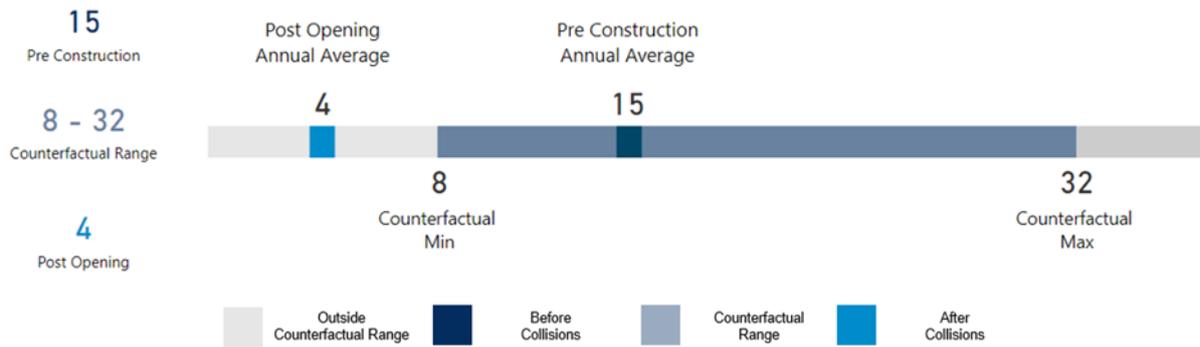
Source: STATS19 30<sup>th</sup> March 2012 – 26<sup>th</sup> February 2020

As part of the safety evaluation, we look to assess what changes in personal injury collisions might have occurred due to factors external to the project over this time frame. To do this we estimate the trend in personal injury collisions which might have occurred if the road had remained a conventional motorway (this is referred to as a counterfactual<sup>20</sup>). This is based on changes in regional safety trends for conventional motorways with a high volume of roads users. This helps us to estimate how the pre-construction safety levels would have changed over the evaluation period if the road had remained a conventional motorway. For more information see Appendix C.

Based on this assessment we estimate that had the smart motorway enhancements not been implemented the number of personal injury collisions would have ranged between 8-32. The observed number of collisions were below this range, indicating the smart motorway was on its way to achieving the objective to maintain, and where possible, improve safety standards.

<sup>20</sup> Our current counterfactual method provides information for average conventional motorways and those with higher-than-average traffic levels (which are more comparative to the motorways which were converted to smart motorways). It also allows for differentiation between different types of smart motorways. Previously the counterfactual for smart motorways was based on the national trends averaged across all types of motorways.

**Figure 16 Observed and expected range of personal injury collisions on the smart motorway**



Source: STATS19 30<sup>th</sup> March 2012 – 26<sup>th</sup> February 2020

A follow up study will be conducted after the smart motorway has been open for longer. This will allow us to gather more data and so be able to more confident in determining whether the safety objective has been achieved.

### How had traffic flows impacted collision rates?

Smart motorways are implemented on some of England’s busiest routes. It is, therefore, important to contextualise any incidents in the volume of traffic seen on this stretch. To do so a collision rate is calculated: the number of collisions per hundred million vehicle miles (HMVM).

The average collision rate had decreased to 1.3 personal injury collisions per HMVM, this equates to travelling 76 million vehicle miles before seeing a collision. Before the project, the collision rate was 5.2 personal injury per HMVM, this equates to traveling 19.2 million vehicle miles before seeing a collision.

The estimated rate if the project had not been converted to all lane running would increase to 5.6 personal injury collisions per HMVM. This counterfactual scenario indicates there would an increase in the number of collisions without the project, the frequency of collisions would also increase mainly because of increased traffic flows.

Similar to collisions, therefore, collision rates are also lower than what we would have expected without the project. This is a positive initial indication: even though traffic levels have increased slightly, collisions have reduced. As these are the first year’s results, however, we are not yet confident that these initial indications are enough to form a trend. An evaluation will be conducted at five years after opening to establish if early positive findings have continued.

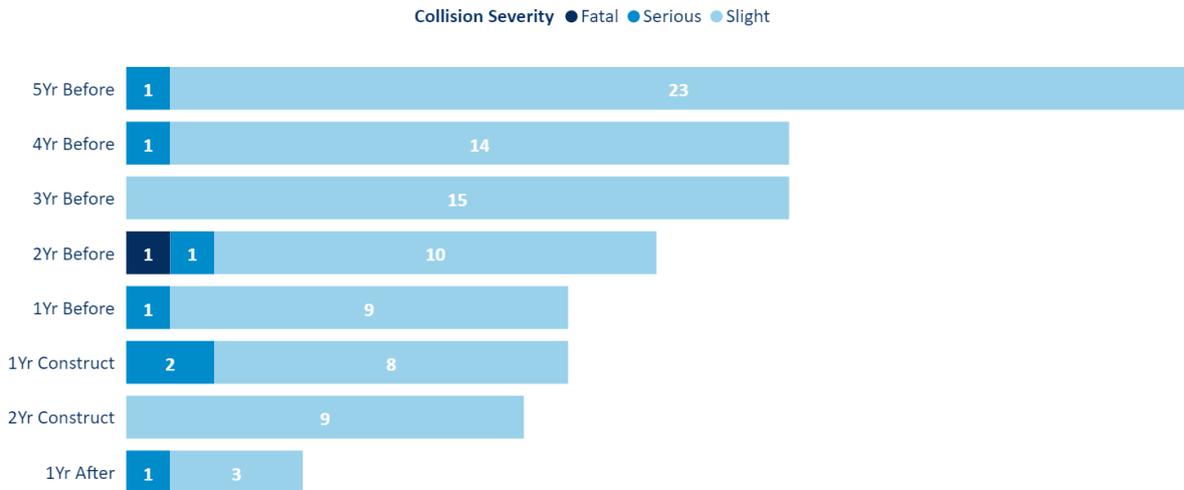
### What changes in the severity of collisions did we see?

Collisions which result in injury are recorded by severity as either fatal, severe or slight. At the time of this report, police forces are transitioning to a new method in how severity of incidents is recorded. However, Cheshire Police Constabulary have yet to transition to the new injury-based method. Collision severities are presented using unadjusted figures (more information on this can be found in Appendix D).

The evaluation found, after the project there were an average of 11 fewer collisions resulting in slight injuries (the annual average before the project was 14, compared to three after), and no change in collisions resulting in killed or serious injuries per

year (with one before and one after). Figure 17 shows the severity of personal injury collisions.

**Figure 17 Severity of personal injury collisions on the project extent**

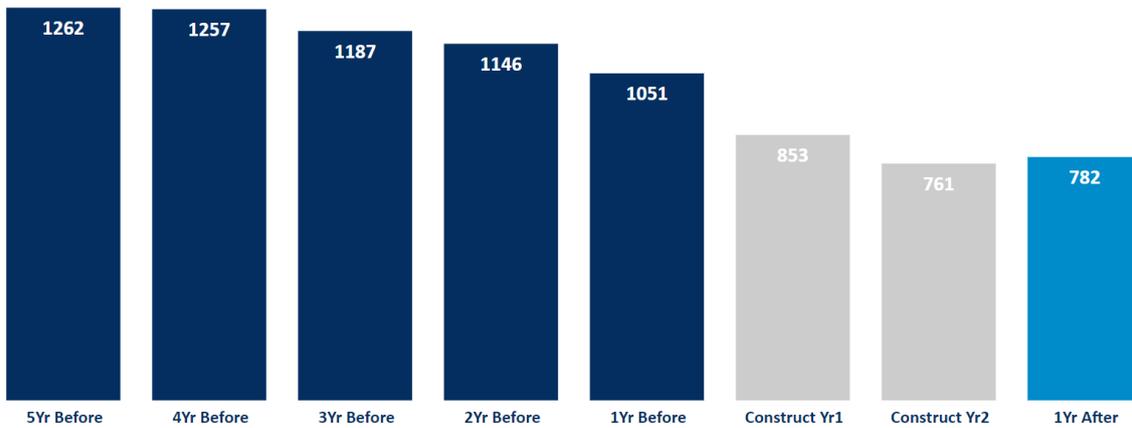


Source: STATS19 30th March 2012 – 26th February 2020

### What changes in safety numbers did we see in the wider area?

Personal injury collisions were observed for a wider impact area, which is derived from the safety appraisal for the project. At one year after we found that personal injury collisions in the wider area had fallen by around a third. Before the project there were on average 1180 personal injury collisions a year. After the project, this had fallen to 782, a reduction of 398 (Figure 18).

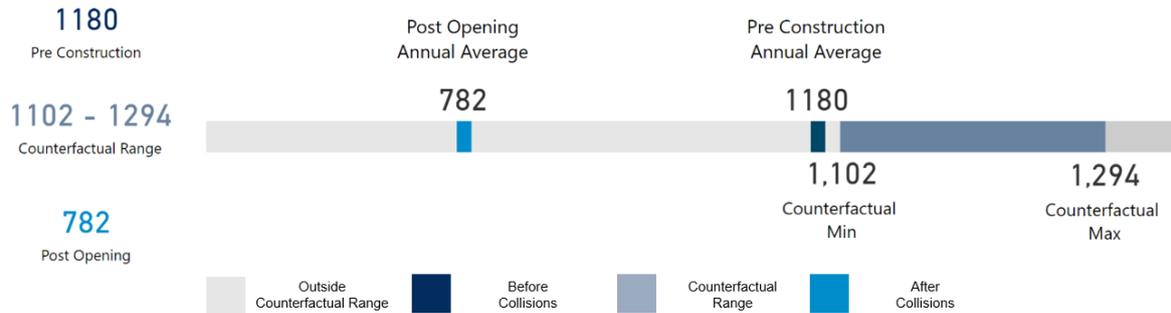
**Figure 18 Annual personal injury collisions in the wider area**



Source: STATS19: STATS19 30th March 2012 – 26th February 2020

The observed figure was below the range produced by the counterfactual analysis. In the counterfactual scenario the likely range of average number of personal injury collisions per year would have been 1102 to 1294 personal injury collisions per year (Figure 19). This suggests that the project may be having a positive impact on safety in the wider area.

**Figure 19 Observed and expected range of personal injury collisions in wider area**



Source: STATS19: STATS19 30th March 2012 – 26th February 2020

As with the project extent, we will conduct another study after the smart motorway has been open for longer. This will allow us to gather more data and so be able to more confident in determining whether the safety objective in the wider area has been achieved.

### What impact did traffic flows have on collision rates in the wider area?

The evaluation has identified a decrease in the rate of collisions per hundred million vehicle miles.

Prior to the project, there was an annual average of 23 personal injury collisions per hundred million vehicle miles. After the project improvements were made there was a decrease to 15 personal injury collisions per hundred million vehicle miles. A decrease of 8 personal injury collisions per hundred million vehicle miles.

The distance travelled before a personal injury collision occurred increased from four to seven million vehicle miles per personal injury collision.

A counterfactual test was undertaken. It found that the collision rate would likely have been 21 collisions per hundred million vehicle miles in the counterfactual scenario. This indicates we have observed a larger reduction in the rate that personal injury collisions occur than predicted. Statistical testing indicates this reduction is significant suggesting that the project could be having a positive impact on the wider area.

### What changes did we see in the severity of collisions in the wider area?

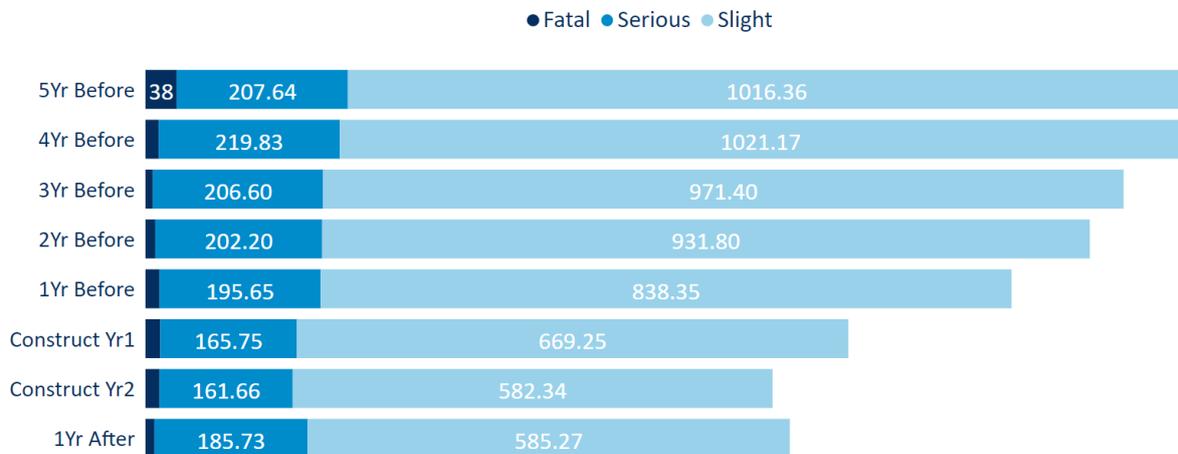
Collisions which result in injury are recorded by severity as either fatal, serious, or slight. The way the police record the severity of road safety collisions changed within the time frames of the evaluation, following the introduction of a standardised reporting tool – Collision Recording and Sharing. This is an injury-based reporting system, and as such severity is categorised automatically by the most severe injury. This has led to some disparity when comparing trends with the previous reporting method, where severity was categorised by the attending police

officer<sup>21</sup>. As a consequence, the Department for Transport have developed a severity adjustment methodology<sup>22</sup> to enable robust comparisons to be made.

For this evaluation, one reporting mechanism was largely used prior to the smart motorway conversion and another afterwards. The pre-conversion collision severity has been adjusted, using the Department for Transport’s severity adjustment factors, to enable comparability with the post-conversion safety trends.<sup>23</sup>

Before the project there was an average of 18 fatal collisions, 206 collisions resulting in a serious injury and 955 collisions resulting in a slight injury. During the first 12 months of operation, we have observed 11 fatal collisions, 184 collisions resulting in a serious injury and 585 collisions resulting in a slight injury. These early results are promising but we will revisit at a later stage to draw any definitive conclusions.

**Figure 20 Personal injury collisions by severity in the wider area**



Source: STATS19: STATS19 30th March 2012 – 26th February 2020

### Is the project on track to achieve its safety objectives?

The safety objective was to achieve no worsening of safety performance and the business case forecast was a 13% reduction in PICs as a result of this project, with a saving of 1684 accidents over the 60-year appraisal period. Early findings suggest a positive result in this direction, but more data and further analysis will be required to confirm whether this trend will continue.

<sup>21</sup>

[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/820588/severity-reporting-methodology-final-report.odt](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/820588/severity-reporting-methodology-final-report.odt)

<sup>22</sup> <https://www.gov.uk/government/publications/guide-to-severity-adjustments-for-reported-road-casualty-statistics/guide-to-severity-adjustments-for-reported-road-casualties-great-britain#guidance-on-severity-adjustment-use>

<sup>23</sup> Collision Severities within this report use the 2020 adjustment factor

# Appendix A: Traffic data issues

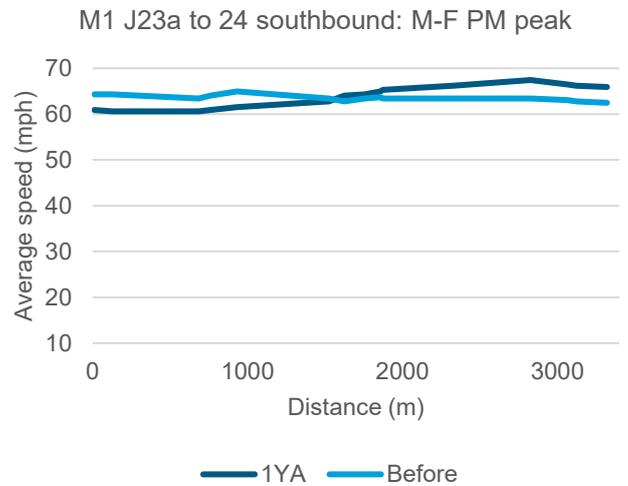
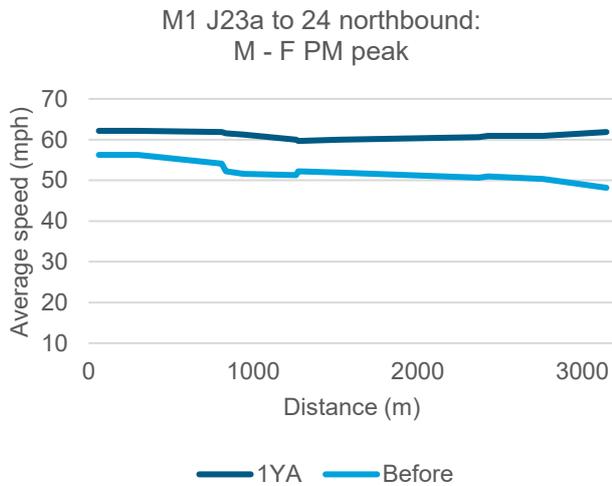
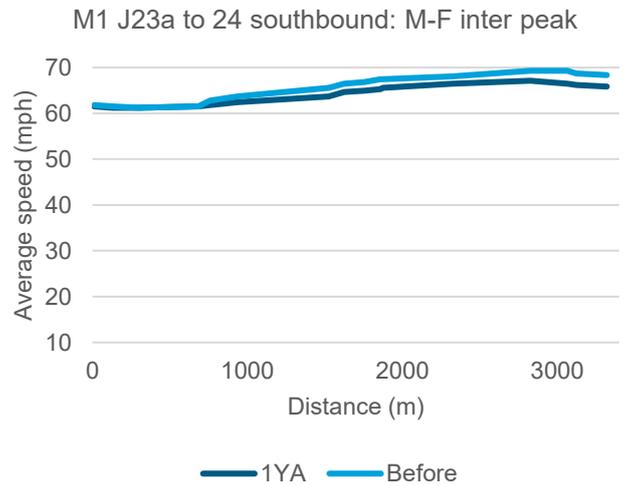
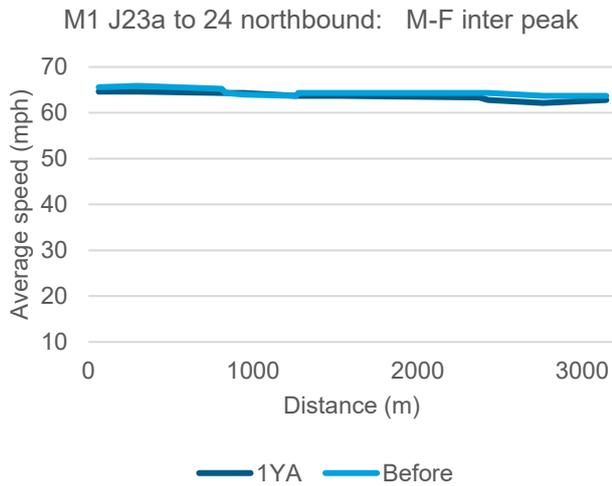
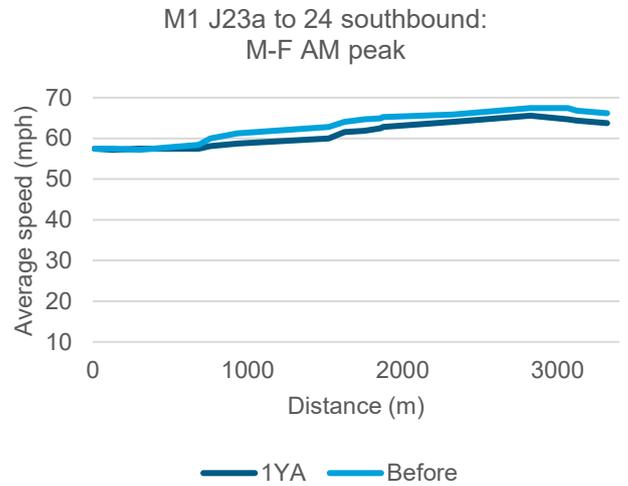
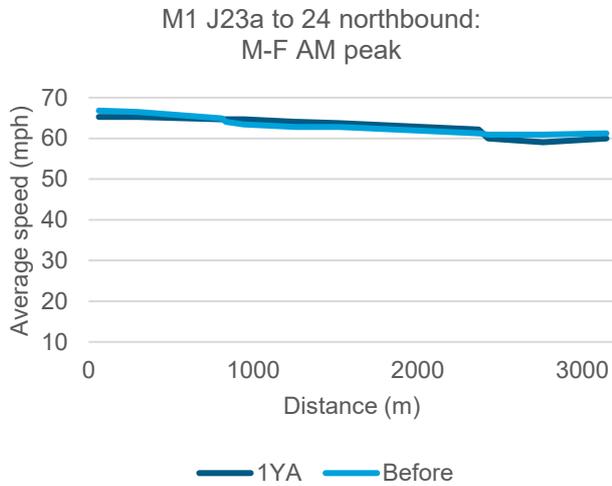
During an evaluation, we typically carry out a comparison of traffic flows and journey times before and after the project opened. This helps us to determine the impact the project has had on road users and if any changes in traffic flow are attributable to the project.

We have encountered issues collecting traffic data on the project section. The data available is unlikely to be directly comparable due to changes in the type of traffic counters installed during the pre-project and post-project periods. Prior to construction, loop traffic counts were used, and during construction of the project these were replaced with radar technology. The approach to recording traffic flows varies between the two technologies.

Loop counters are embedded in the carriageway and record vehicles as they pass over the counter. Whereas radar counters are located at the side of the road and record traffic across the carriageway. It is therefore possible that the counters underestimate the true extent of traffic, with larger vehicles potentially blocking other vehicles. For this evaluation we therefore compared traffic flows along the key roads surrounding the project to provide contextual evidence to provide an indication of potential traffic flow changes on the project extent. This will be re-assessed as part of a future evaluation.

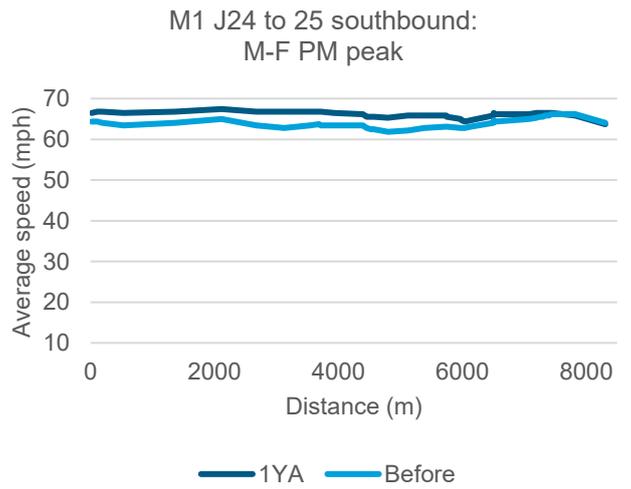
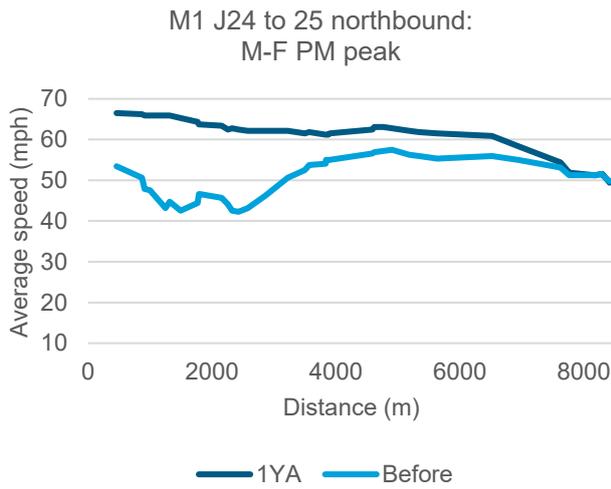
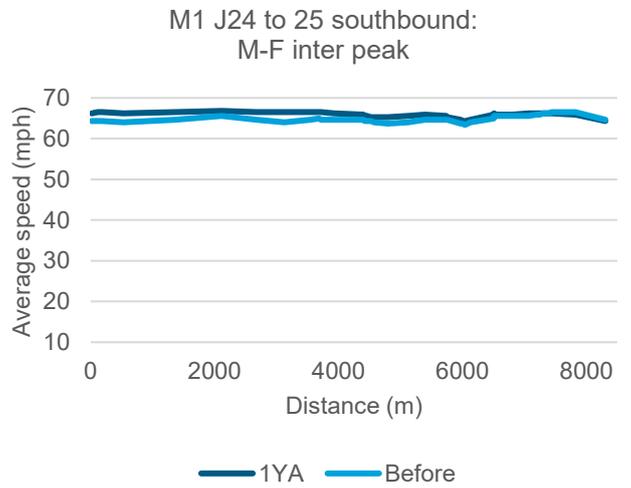
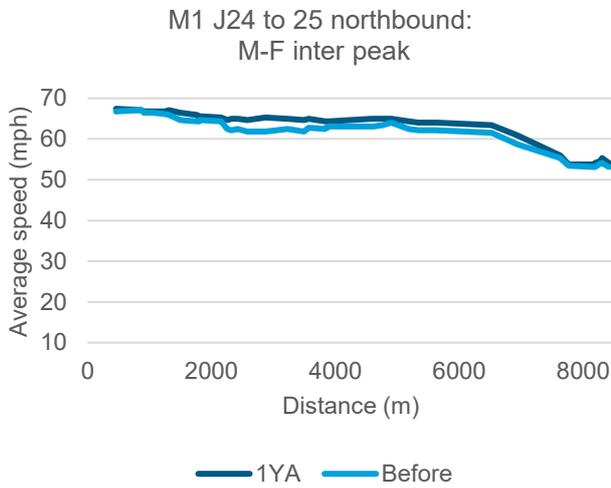
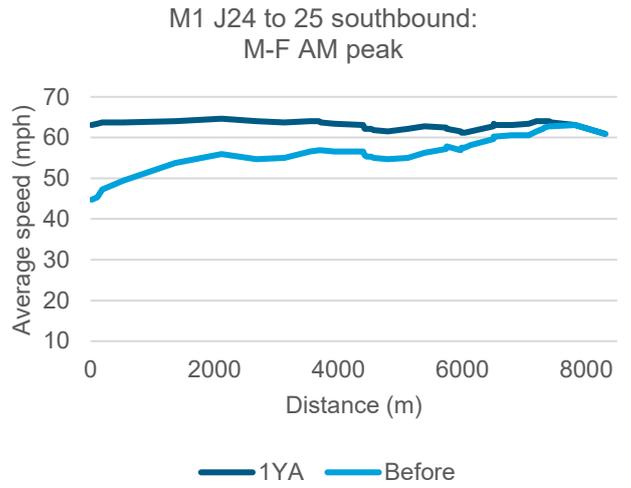
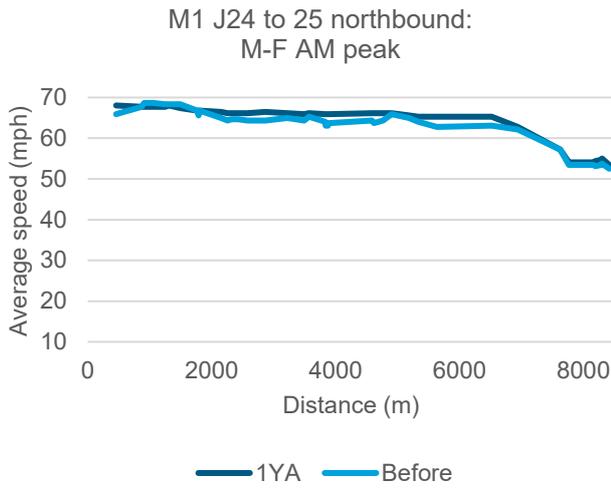
# Appendix B: Speed by distance analysis

## M1 junctions 23a to 24



Source: TomTom satellite navigation data October 2016 and October 2019

## M1 junctions 24 to 25



Source: TomTom satellite navigation data October 2016 and October 2019

# Appendix C: Counterfactual safety methodology

Personal injury collisions (hereafter referred to as collisions) on the strategic road network are rare and can be caused by many factors. Due to their unpredictable nature, we monitor trends over many years before we can be confident that a real change has occurred as result of the project.

To establish whether any change in collision numbers is due to the project or part of wider regional trends we have established a test we call the Counterfactual. The Counterfactual answers the question: What would have occurred without the project being implemented? To answer this question, we estimate the range of collisions that could have occurred without the project in place. Previous Post Opening Project Evaluations answered this question by looking at national trends in collisions. Adjustments have been made to the methodology for estimating the Counterfactual. These have been made to address the following areas:

## Amended Data Collection Method

- Revised method for identifying collisions that occurred on the network.
- Only validated STATS19 information is used for reporting purposes.

## Adjusting for Traffic Flows

- Baseline traffic flows are a principal factor when determining the counterfactual. We now assume that without the changes made to the network, the trends would follow regional background traffic growth patterns.
- We can now calculate the collision rate for the busiest stretches of conventional motorways.

## Better Differentiation between diverse types of Motorway

- The existing methodology only had one definition of motorway.
- The new method allows us to differentiate between conventional motorways, conventional motorways with high traffic flows and smart motorways.

## Assessing Regional Trends

- The new method uses regional rather than national trends for collision rates and background traffic growth, which provides greater granularity and makes the hypotheses more realistic.

We have found that the adjustments have resulted in a slight change from the previous methodology. We still have confidence in the accuracy of the previous methodology but believe we have made suitable changes that will ensure a methodology fit for purpose for the future.

Since this project, smart motorways have evolved. More recent all lane running projects have demonstrated that they are making journeys more reliable for those travelling during congested periods, enabling us to operate the road at a higher speed limit for longer periods, whilst maintaining safety.

## Appendix D: Incident reporting

Since 2012, many police forces have changed the way they collect STATS19 data<sup>24</sup>. These changes mean casualty severity is now categorised automatically based on the most severe injury, rather than the judgement of an attending police officer.

Police forces using the new systems, called injury-based severity reporting systems, (also known as CRaSH and COPA) report more seriously injured casualties than those which do not. These changes make it particularly difficult to monitor trends in the number of killed and seriously injured casualties over time, or between different police forces. In response to these challenges, DfT and the Office for National Statistics (ONS) have developed an approach to adjust the data collected from those police forces not currently using injury-based reporting systems.

These adjustments are estimates for how casualty severity may have been recorded had the new injury-based reporting system been used. These adjusted estimates apply retrospectively from 2004 and adjust historical data to show casualty severity 'as if' this was recorded under the new injury-based system. Until all police forces have started using the new systems, these historical adjustments will continue to be updated every year. Using these adjusted totals allows for more consistent and comparable reporting when tracking casualty severity over time, across a region, or nationally. While there is no impact on total casualties or collisions, and no impact on total fatalities, these adjustments do impact serious and slight casualties and collisions.

---

<sup>24</sup> <https://www.gov.uk/government/publications/guide-to-severity-adjustments-for-reported-road-casualty-statistics/guide-to-severity-adjustments-for-reported-road-casualties-great-britain>

## Appendix E: Unadjusted Collision Severity

Part of the wider safety area of the M1 J23a-25 is covered by Staffordshire police constabulary who transferred from Stats19 to CRASH system for reporting personal injury collisions in May 2015.

Figure 21 shows the unadjusted collision severities on the wider safety area:

**Figure 21 Unadjusted collisions by severity in the wider area**

Year_Type	Fatal	Serious	Slight
5Yr Before	9	147	1106
4Yr Before	16	156	1085
3Yr Before	9	149	1029
2Yr Before	12	146	988
1Yr Before	17	144	890
Construct Yr1	18	124	711
Construct Yr2	17	126	618
1Yr After	11	150	621

Source: STATS19: STATS19 30th March 2012 – 26th February 2020

If you need help accessing this or any other National Highways information, please call **0300 123 5000** and we will help you.

© Crown copyright 2023.

You may re-use this information (not including logos) free of charge in any format or medium, under the terms of the Open Government Licence. To view this licence visit [www.nationalarchives.gov.uk/doc/open-government-licence/](http://www.nationalarchives.gov.uk/doc/open-government-licence/) write to the **Information Policy Team, The National Archives, Kew, London TW9 4DU** or email [psi@nationalarchives.gsi.gov.uk](mailto:psi@nationalarchives.gsi.gov.uk).

Mapping (where present): © Crown copyright and database rights 2021 OS 100030649. You are permitted to use this data solely to enable you to respond to, or interact with, the organisation that provided you with the data. You are not permitted to copy, sub-licence, distribute or sell any of this data to third parties in any form.

This document is also available on our website at [www.nationalhighways.co.uk](http://www.nationalhighways.co.uk)

For an accessible version of this publication please call **0300 123 5000** and we will help you.

If you have any enquiries about this publication email [info@nationalhighways.co.uk](mailto:info@nationalhighways.co.uk) or call **0300 123 5000\***.

Please quote the National Highways publications code **PR218/22**.

\*Calls to 03 numbers cost no more than a national rate call to an 01 or 02 number and must count towards any inclusive minutes in the same way as 01 and 02 calls. These rules apply to calls from any type of line including mobile, BT, other fixed line or payphone. Calls may be recorded or monitored.

Printed on paper from well-managed forests and other controlled sources when issued directly by National Highways.

Registered office Bridge House, 1 Walnut Tree Close, Guildford GU1 4LZ

National Highways Limited registered in England and Wales number 09346363