

M6 junctions 16 to 19 all lane running

One-year post-opening project evaluation



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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 POPE¹ 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 M6 junctions 16 to 19 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.

¹ 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 2024

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1. Executive summary

The M6 junctions 16 to 19 smart motorway is a 19-mile strategic route through the North West which opened for traffic in March 2019. Prior to the upgrade to all lane running², this stretch of road was a three-lane motorway between junctions 16 and 19, which experienced congestion and unreliable journey times.

The smart motorway sections on our network have provided additional road capacity, creating more road space on congested sections of motorway. Typically, this has provided more reliable journeys for road users at the busiest periods of the day. This has allowed people to travel as conveniently, reliably, and safely as possible. This means more traffic can use the strategic road network rather than divert on to the local road network causing further congestion.

The project aimed to provide additional capacity, improve journey times and reliability, and maintain safety performance.

During the first 12 months of the smart motorway opening, the annual number of personal injury collisions decreased from an average of 94 before construction to 33. This falls below the range of what would have been expected if the road were to remain a conventional motorway and is an early indication that the smart motorway has improved safety for users. The annual average rate of personal injury collisions per hundred million vehicle miles has also improved.

The project has delivered additional capacity within the existing highway boundary through the conversion of the hard shoulder northbound and southbound for use as a permanent traffic lane. The project at one year after has not seen an increased number of users, with the forecast traffic growth found to be optimistic compared with the observed flows.

Since the conversion, the route generally experiences slightly more reliable journeys for most road users with northbound and southbound at one year after seeing marginal improvements to journey time reliability during all time periods. In both directions during most time periods, there was a considerable improvement in the longest journey times compared with before construction. However, the longest journeys in the northbound AM peak experienced greater variability one year after opening.

Average journey times along the route also improved in both directions, with the northbound PM peak and southbound AM peak experiencing the largest journey time savings compared to before construction.

Our evaluation found that the outcome of the environmental impacts at one year after were as or better than expected compared to the appraisal. The environment impacts of the project that were assessed at one year after included air quality, noise and greenhouse gases. For the five years after evaluation, a more detailed environmental assessment will be undertaken to determine the longer-term environmental impacts scoped within the evaluation.

² 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.

2. Introduction

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

The M6 junctions 16 to 19 smart motorway covers a 19 mile stretch of the M6 between Crewe and Knutsford. The project opened in March 2019.

Prior to construction, the motorway experienced congestion and unreliable journey times. This reflects the motorway severing a densely populated area and the M6 function as a north-south route.

The project aimed to reduce congestion, reduce journey times, improve journey reliability and maintain safety performance. Without the smart motorway, these issues were expected to be exacerbated by predicted growth in traffic volumes.

The key features of the project were:

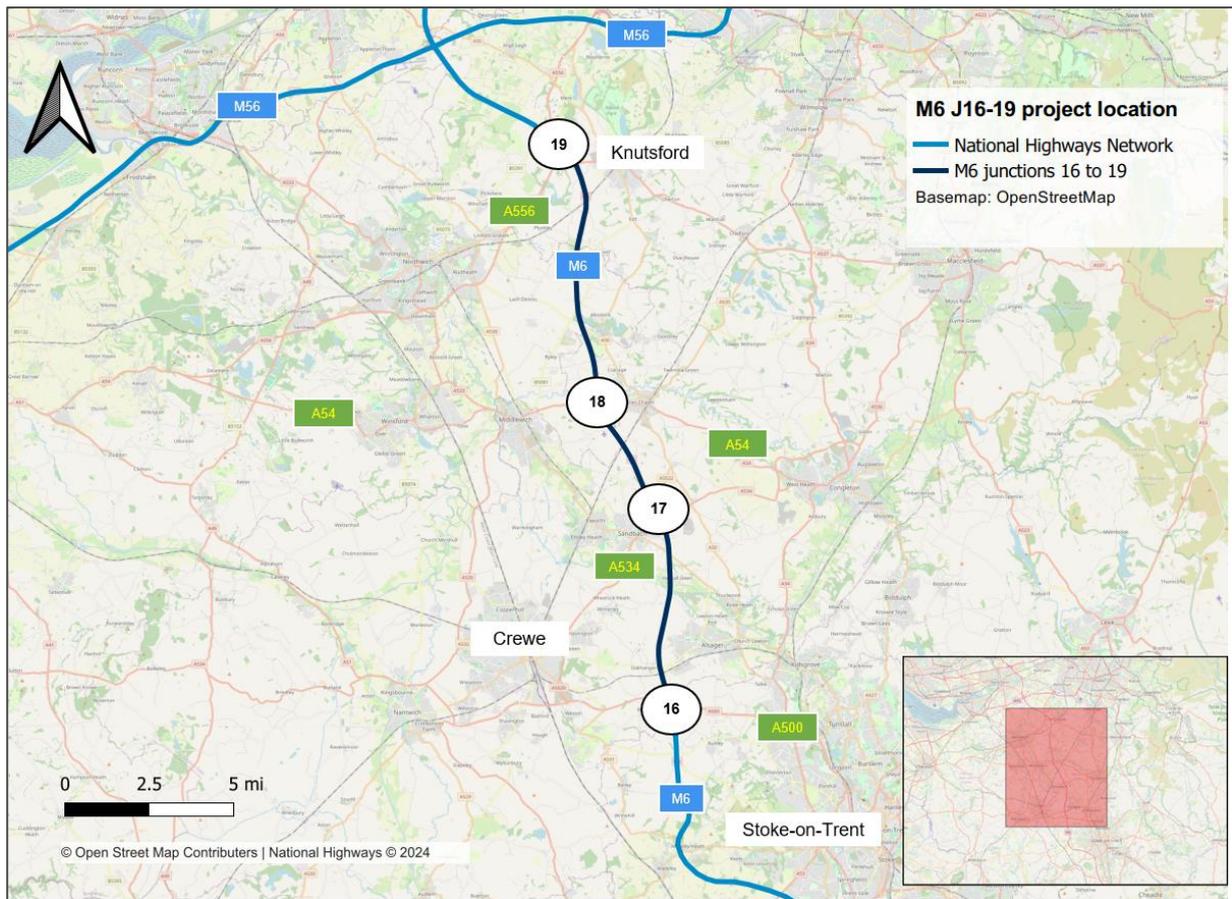
- Conversion of the hard shoulder northbound and southbound for use as a permanent traffic lane (all lane running) to provide additional capacity with four lanes in each direction.
- Through junction running at junctions 17 and 18, as well as the two Motorway Service Areas at Sandbach and Knutsford.
- Upgrading of the central reserve to rigid concrete barrier.
- Introduction of smart motorway infrastructure, including variable mandatory speed limits (VMSL) to manage traffic flows and improve journey times.

Project location

The M6 is a strategic route which extends from the Midlands to the border with Scotland. The project extends between junctions 16 (Barthomley Interchange) and 19 (Tabley Interchange). This section of the M6 connects two particularly densely populated areas in the West Midlands and the Manchester-Liverpool corridor (via Staffordshire). The route predominantly resides in the county of Cheshire East, with short sections falling in Cheshire West.

Junction 19 (at the northern extent of the project) is an interchange with the A556 which links to the M56 and Manchester Airport, a key strategic route between Manchester and Chester. Junctions 16 to 18 also link to the local road network via the A500 (junction 16), A534 (junction 17) and A54 (junction 18). The location of the project in relation to the region and surrounding highway network, is shown in Figure 1.

Figure 1 M6 junctions 16 to 19 scheme location



Source: National Highways and OpenStreetMap contributors.

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 and are important for providing transparency and accountability for public expenditure, by assessing whether projects are on track to deliver value for money. They also provide opportunities to learn and improve future project appraisals and business cases.

A post-opening project evaluation (POPE) compares changes in key impact areas³ 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 POPE methodology manual on our website⁴.

³ Key impact areas include safety, journey reliability and environmental impacts.

⁴ <https://nationalhighways.co.uk/media/expyqk11/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 are defined early in the business case when project options are being identified. While these benefits are appraised to be realised over 60 years, the one year after evaluation provides early indication if the project is on track to deliver the benefits.

Table 1 summarises the project’s performance against the objectives from the standard smart motorways programmatic Benefits Realisation & Evaluation Plan (BREP), mapped against the scheme specific objectives, using evidence gathered for this study.

Table 1 Objectives and Evaluation summary

RIS objective ⁵	Scheme objective ⁶	One-year evaluation
<p>Improving Safety for All We need to keep our customers, people and supplier safe, above all else.</p>	<p>To deliver an upgraded motorway section of motorway with no deterioration in safety performance</p>	<p>The early indications are that the safety objective is on track to being achieved. In the first year of being operational, there has been a reduction in the number and rate of personal injury collisions compared with the annual average five years before construction.</p>
<p>Providing Fast and Reliable Journeys We want to help people and businesses have safe, reliable and efficient journeys.</p>	<p>To combat traffic congestion throughout the main north-south transport axis, providing a high-standard strategic route, connecting key areas of the country from the Midlands to the North of England and West Scotland.</p> <p>To unlock local growth and to support the national economic growth by improving access to labour markets and by eliminating traffic delays.</p>	<p>One year after opening, the smart motorway has improved the journey time reliability for most road users in both directions.</p> <p>Whilst wider economic impacts are not assessed within the POPE methodology, it is expected that at the early stage of the project, the smart motorway has helped to unlock opportunities for growth by improving traffic flow and making journeys more reliable for road users.</p>
<p>A Well Maintained and Resilient Network Our network is complex and varied and requires careful stewardship to keep it in good condition.</p>	<p>-</p>	<p>This objective has not been assessed within this evaluation.</p>

⁵ During the first Road Investment Strategy (RIS) from 2015 to 2020, and subsequent RIS2 (2020-2025), universal objectives were created to ensure consistency across the smart motorway programme.

⁶ The objectives as part of the original business case when the investment decision was made for the project.

RIS objective ⁵	Scheme objective ⁶	One-year evaluation
<p>Delivering Better Environmental Outcomes We want our roads to work more harmoniously with the communities that live alongside them, and the environment that surrounds them.</p>	-	Initial assessment of noise, air quality and greenhouse gases indicated that the project is performing as / or better than expected. A full environmental assessment for the project will be considered in future POPE reports following an environmental evaluation site visit.
<p>Meeting the Needs of All Users We want to meet and exceed the expectations of all those who use our network.</p>	To make best use of the existing infrastructure and aim to provide additional capacity within the existing highway boundary and where possible within the existing paved area.	The project has delivered additional capacity within the existing highway boundary through the conversion of the hard shoulder northbound and southbound for use as a permanent traffic lane.
<p>Delivering Even More Value for Our Customers We are setting out to deliver £2.23bn of efficiencies, which will mean that taxpayers will see even more investment for their money than in the past.</p>	-	This will be considered in future POPE reports for the project following a Value for Money evaluation.

4. Customer journeys

Summary

For this one year after study, we have had to take account of the impact of the Covid-19 pandemic and national lockdowns on traffic volumes. For our traffic analysis, our baseline is March 2015 (before construction). For our one year after study, we have used data from February 2020 rather than March to avoid the period impacted by lockdown restrictions⁷.

The conversion has increased capacity along the route, though traffic growth saw a slight decline, with an average reduction of 2%⁸ across the project extent. This very small change in traffic levels was expected due to February being influenced by seasonality when less traffic growth is generally observed. Observed traffic flows after opening was contrary to the increase in flow anticipated in the forecasts.

The project had an objective to improve journey time reliability and journey times. For most road users, journeys were more reliable for nearly all times of the day in both directions. Northbound, slight improvements were seen during all time periods with the largest improvement during the PM peak (4-7pm). The PM peak southbound also saw great improvement compared to before construction, with a slight deterioration observed in the inter-peak (10am-4pm).

Journey times also reduced in both directions and in all time periods analysed for this evaluation. In the northbound PM peak, journey time savings of over 3 minutes were observed one year after and southbound AM peak (7-10am) journey times were shorter by nearly 3 minutes. Delays were also observed on the northbound approach to junction 19 at one year after, which were not evident prior to construction.

During the core commuter periods, southbound average speeds were higher and reasonably consistent one year after opening compared to before construction. From junction 16 to a few miles away from junction 19 northbound, speeds also increased. The fall in road users' speeds on the approach to junction 19 (Tabley Interchange) are aiming to be mitigated by a junction improvement scheme that opened in November 2021.

How have traffic levels changed?

Smart motorways have been implemented 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 examine if the traffic levels changed over the evaluation period and to what extent the forecast traffic levels were realised.

National and regional

To assess the impact of the project on traffic levels, it is helpful to understand the changes within the context of national and regional traffic. To do this, we use Department for Transport (DfT) annual statistics, the data is reported by local authority and road type, recording the total number of million vehicle miles

⁷ Timeline of UK government coronavirus lockdowns and measures, March 2020 to December 2021 - <https://www.instituteforgovernment.org.uk/sites/default/files/timeline-coronavirus-lockdown-december-2021.pdf>

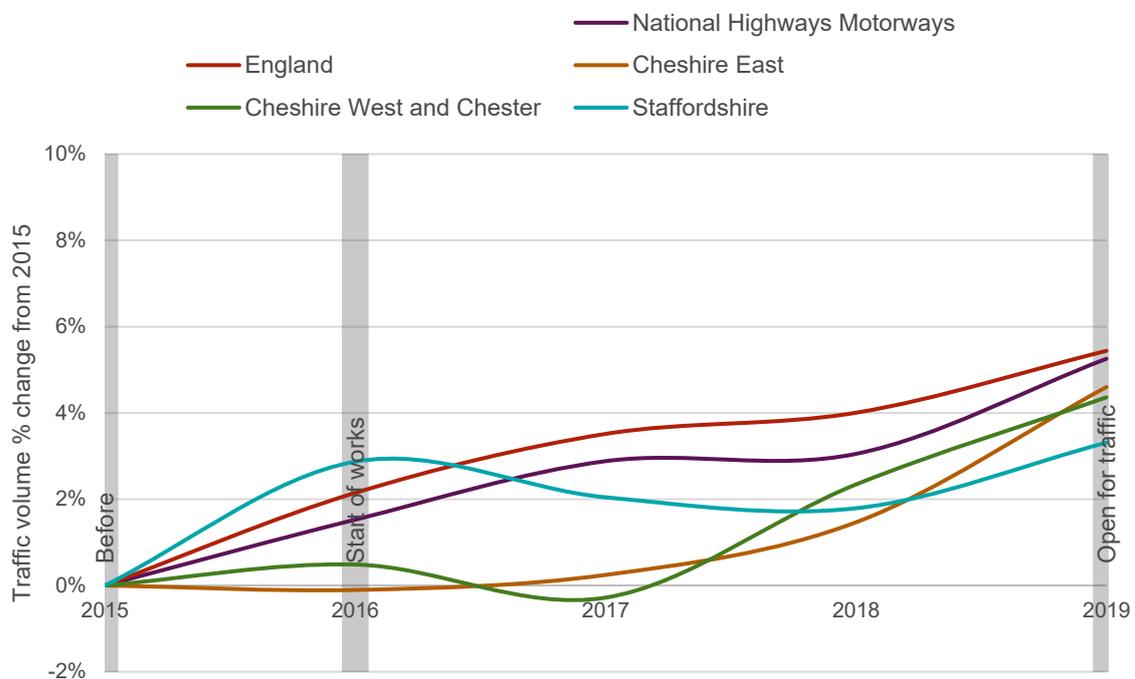
⁸ Comparing average weekday traffic (AWT).

travelled⁹. This data is used as a baseline, and we attribute any growth observed on roads in the project area which is above national and regional trends to the project.

Figure 2 shows the changes in traffic by year between 2015 (which is our baseline in this study) through to 2019.¹⁰ Trends over the period are presented for roads in the regions within which the M6 junctions 16 to 19 are located (Staffordshire, Cheshire East, and Cheshire West and Chester), all motorways managed by National Highways and for England as a whole.

Nationally, traffic volumes saw a gradual increase by over 5% from 2015. Regionally, there was more variation in traffic volumes, with Cheshire West and Chester and Cheshire East experiencing a decline between 2016-2017. Staffordshire also observed the lowest growth rate, despite having the highest level of traffic volumes at the start of the project works in 2016.

Figure 2 Changes in national and regional background levels of traffic



Source: DfT Road Traffic Statistics Table TRA8901.

How did traffic volumes change?

Traffic volumes were analysed for the M6 through the project area by comparing the average weekday traffic (AWT) data. The data was analysed for before (March 2015) and one year after (February 2020¹¹) project implementation and the changes in traffic volumes are shown in Figure 3.

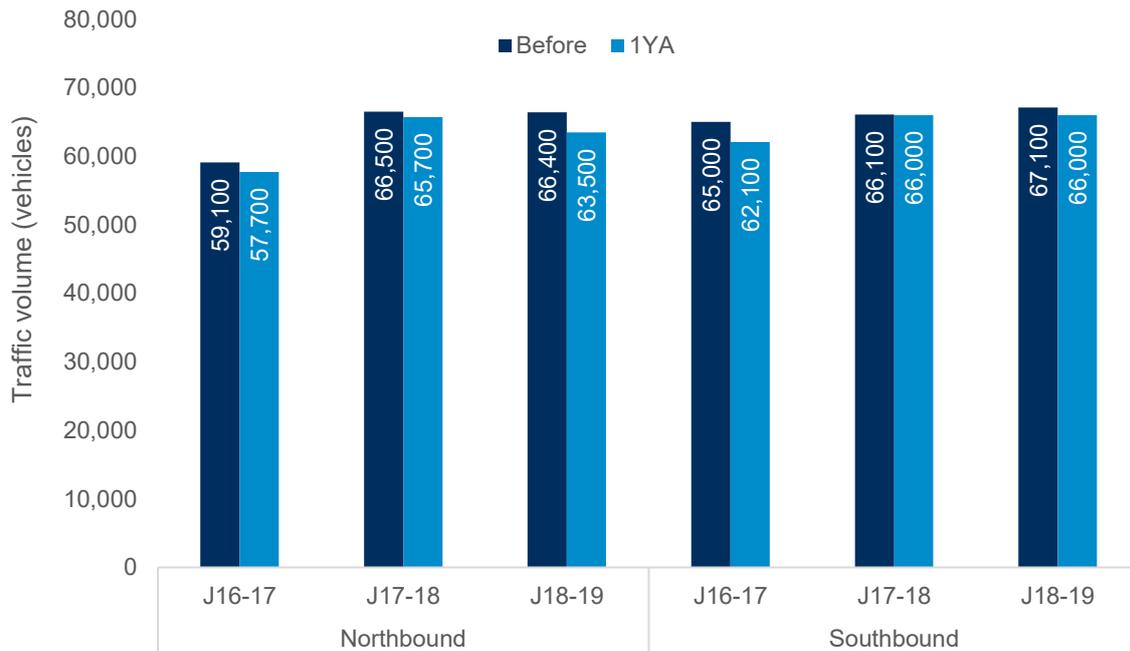
The evaluation found that there had been a slight fall in traffic volume, by an average of 2% across the project extent. This could be expected due to seasonality and comparing data from February with March, which is a more neutral month.

⁹ Motor vehicle traffic (vehicle miles) by region in Great Britain, annual from 1993 to 2021, Table TRA 8901, Department for Transport

¹⁰ Data shown to 2019 to reflect background growth, recognising traffic volumes in 2020 were affected by the outbreak of the Covid-19 pandemic and the government's announcements of measures to limit the impact and transmission.

¹¹ The one year after analysis used data from February 2020 to avoid the period impact impacted by Covid-19 lockdown restrictions.

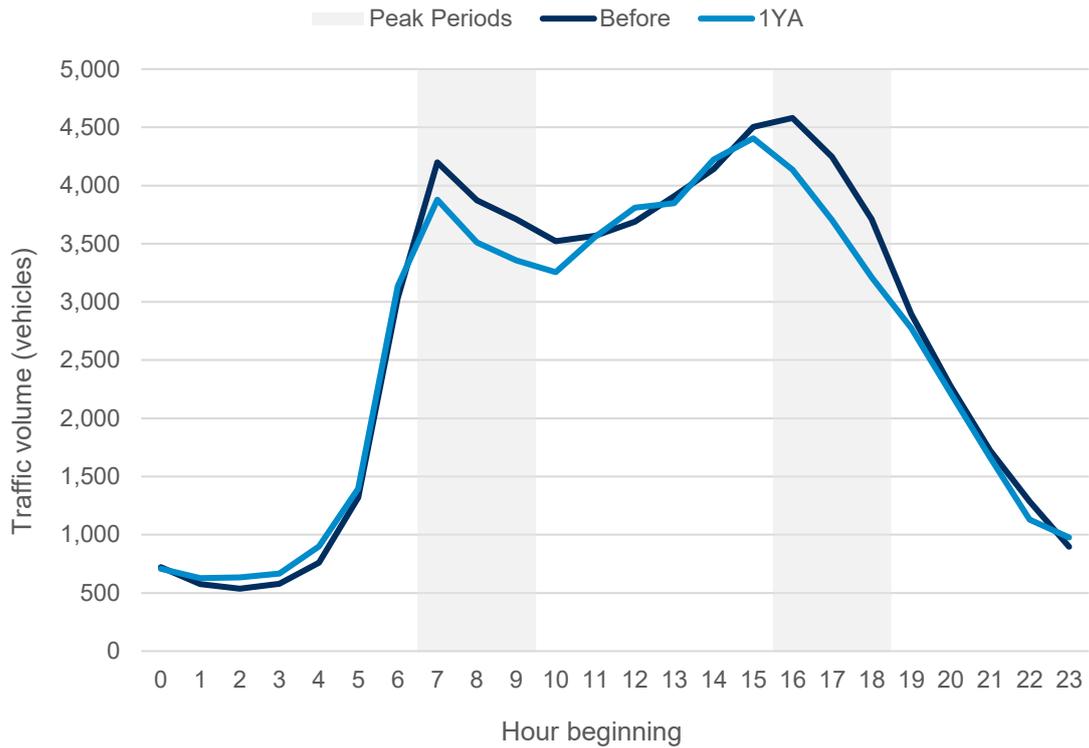
Figure 3 Average weekday traffic volume (24hr AWT, average day in month)



Source: National Highways WebTRIS. Before: March 2015, 1YA: February 2020.

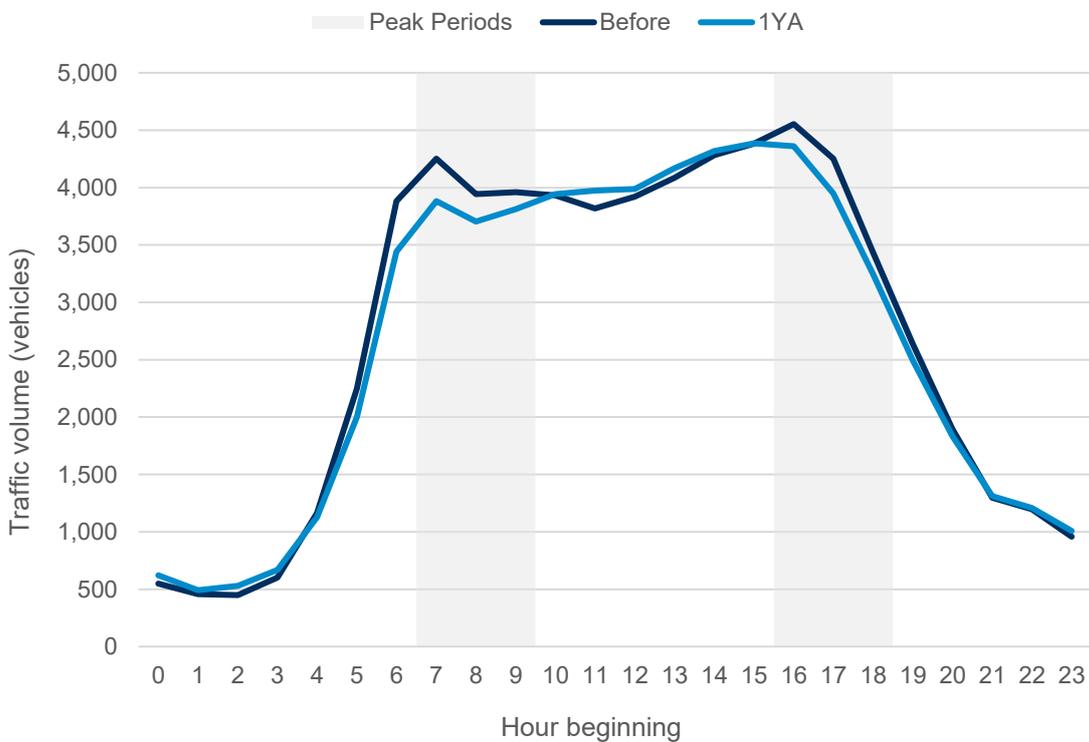
Analysis of hourly weekday traffic volumes for the route northbound and southbound (Figure 4 and Figure 5) also demonstrated that there was a lower traffic volume observed during the peak periods one year after opening. In both directions, the largest variances in traffic volumes between before and one year after opening were evident in the peak periods. Furthermore, the southbound curve highlights higher inter-peak traffic volumes one year after opening. The curves illustrate the PM peak was earlier one year after opening in the northbound direction.

Figure 4 Hourly weekday flow profile northbound (distance weighted AWT)



Source: National Highways (WebTRIS). Before: March 2015, 1YA: February 2020.

Figure 5 Hourly weekday flow profile southbound (distance weighted AWT)



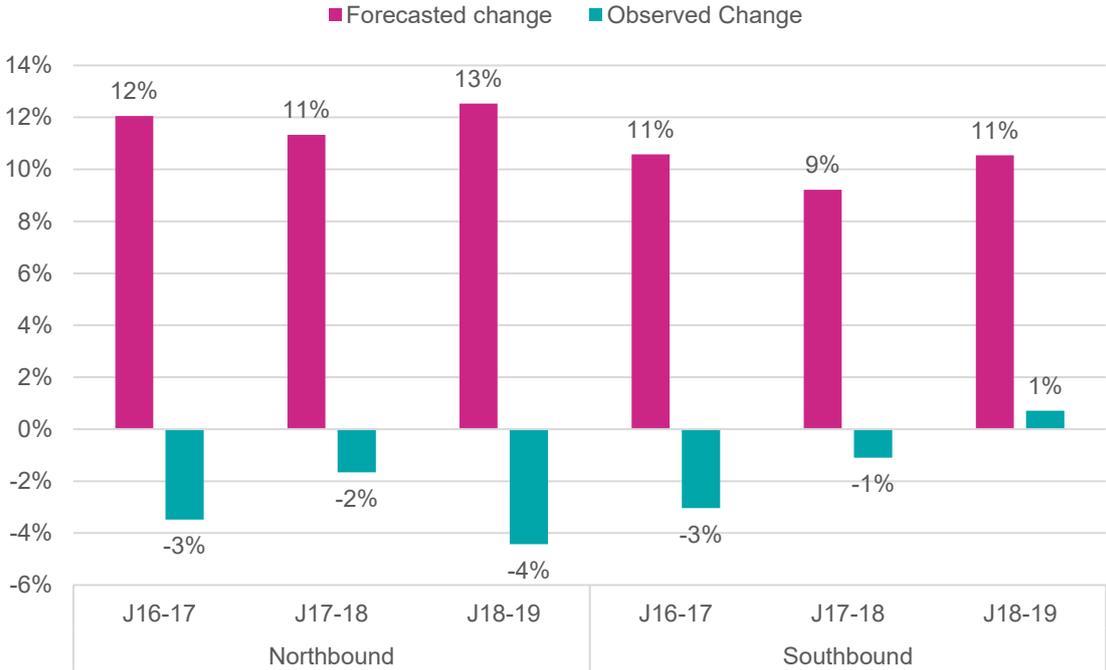
Source: National Highways (WebTRIS). Before: March 2015, 1YA: February 2020.

Was traffic growth as expected?

The appraisal forecasted and observed changes in traffic volumes are shown in Figure 6. The forecasted change compares the forecasts for the 2015 without

smart motorway and the 2020 with smart motorway¹². Figure 6 shows forecast growth along the project extent of 9-13%, with the forecasts marginally higher northbound compared with southbound. The observed change in traffic volume shows the change before and one year after, with the annual average daily traffic (AADT) for one year after being factored from March 2019 to February 2020 (subject to data availability) due to the Covid-19 pandemic. A small change of -4% to 1% within each section of the project extent has been observed. In contrast to the forecast, less growth was observed, with the trends showing a marginal reduction in traffic levels. This could be due to the forecasts expecting the Middlewich Eastern Bypass scheme to have opened, as well as not anticipating the M6 junctions 13 to 15 smart motorway construction, which began in March 2018.

Figure 6 Forecasted change in traffic volume (2015 DM vs 2020 DS) and observed change in traffic volume (24Hr AADT before vs 1YA)

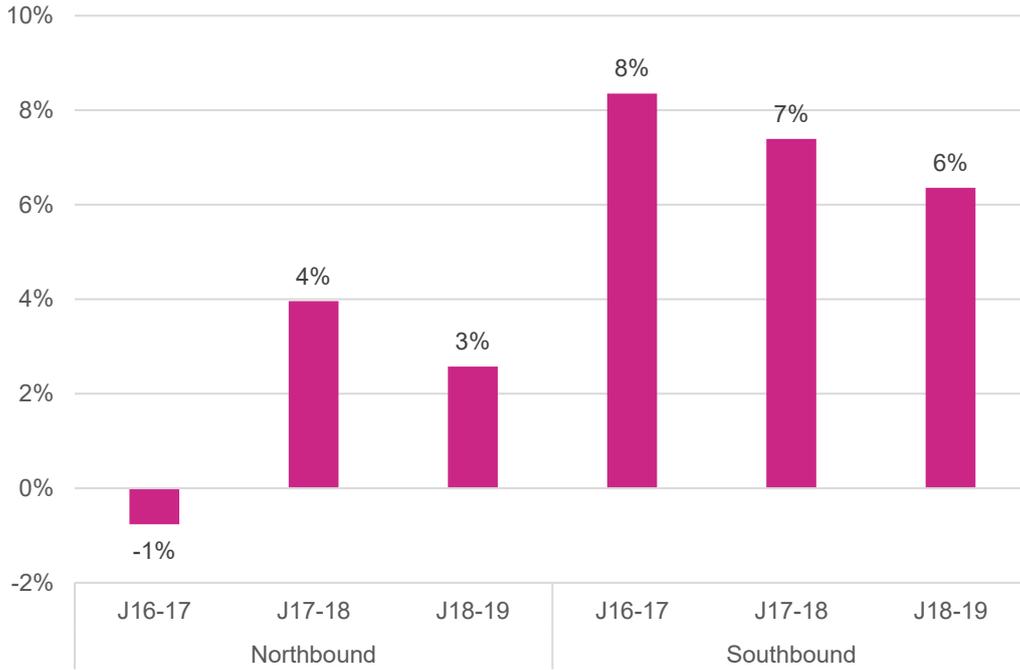


Source: National Highways Traffic and Economic Appraisal Report (TEAR) and National Highways WebTRIS. Before: March 2015, 1YA: March 2019 to February 2020.

As illustrated in Figure 7, the observed before flows were generally higher than the 2015 DM forecast, particularly southbound where observed flows were 6-8% higher than the 2015 DM forecast. Additionally, a comparison of 1YA observed and interpolated values (Figure 8) indicate a small variation southbound (observed flows 3-5% lower than forecast), but greater variation northbound (observed flows 8-15% lower than forecast). The modelling forecast lower flows before the project opened and higher growth with the smart motorway in place than was observed.

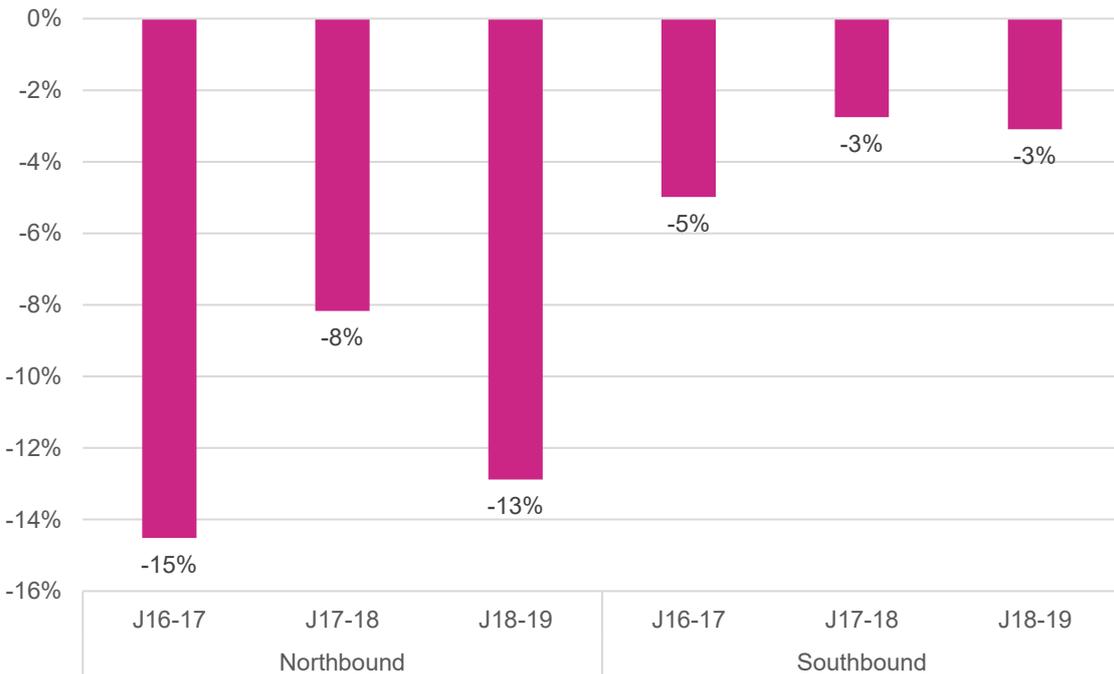
¹² The 2020 with project forecast was interpolated from the 2017 and 2031 with project forecasts.

Figure 7 Forecast vs observed change in traffic volume (DM vs Observed traffic in 2015)



Source: National Highways TEAR and National Highways WebTRIS. Before: March 2015.

Figure 8 Forecast vs observed change in traffic volume (DS vs Observed traffic 1YA)



Source: National Highways TEAR and National Highways WebTRIS. 1YA: March 2019 to February 2020.

Relieving congestion and making journeys more reliable

We implement smart motorways on the busiest routes to ease congestion and ensure journey times are more predictable. Often these routes are where we anticipate congestion will increase in the future and our actions seek to limit this.

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?

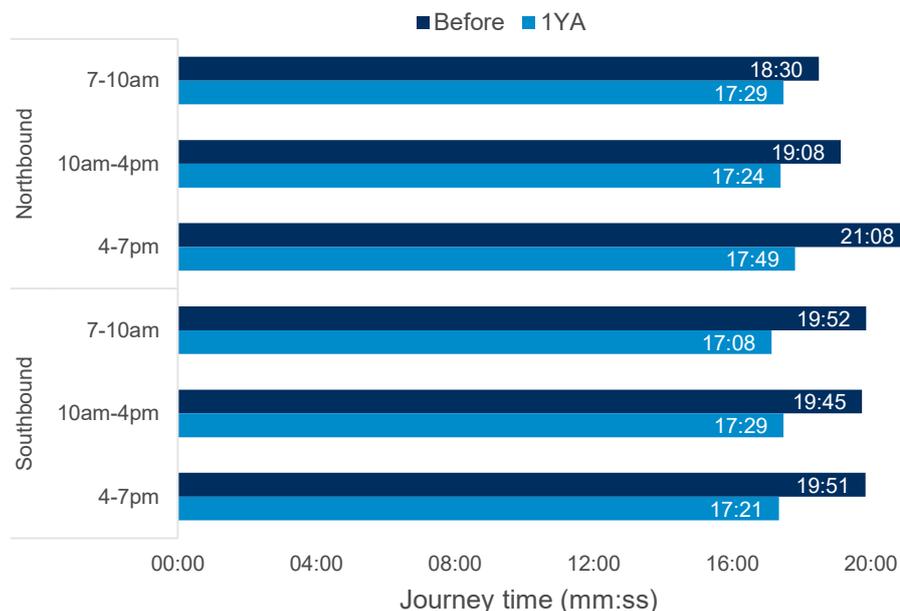
Improvements in journey times were also an objective of this project and at one-year after results, show that journey times have improved, with the smart motorway appearing to remove several delays along the route northbound and southbound. One year after opening, route sections between M6 junctions 16 and 19 saw journey time savings during all periods of the day and in both directions, as presented in Figure 9.

Average journey times northbound one year after opening improved by over one minute in the AM peak, inter-peak and PM peak. The greatest improvement northbound was seen in the PM peak with a saving of over three minutes.

Southbound, average journey times one year after opening improved by over two minutes in the AM peak, inter-peak and PM peak. The greatest improvement in average journey times southbound was in the AM peak with a saving of 2 minutes and 44 seconds.

Before the smart motorway was implemented, the journey times indicated the northbound PM peak was experiencing average journey times approximately 2-3 minutes longer than the average journey times in the AM peak and inter-peak. The one year after data shows this has reduced, with the average journey time being just 20 seconds longer compared with the AM peak and inter-peak.

Figure 9 Change in average journey times northbound and southbound (before vs 1YA)



Source: Satellite Navigation (TomTom). Before: March 2015, 1YA: February 2020.

Additionally, on the northbound approach to junction 19, delays were observed at one year after which were not evident prior to construction. It has been reported that junction 19 (Tabley Interchange) experienced congestion with tailbacks being a common occurrence at the junction¹³. The Tabley Interchange is a key intersection roundabout where the A556 crosses the M6 from Northwich to Greater Manchester, and links to the M56 and Manchester Airport. Between March 2020 and November 2021, National Highways undertook works to improve junction 19,

¹³ <https://www.newcivilengineer.com/the-future-of/future-of-roads-through-about-eases-congestion-at-key-m6-junction-in-cheshire-31-03-2021/>

the works included; the construction of two new link roads with one from the M6 northbound to the A556 northbound and the other from the M6 southbound to the A556 southbound; improved local access for non-motorised users and improving the local authority junction immediately to the south of junction 19 to make journeys safer for all users. It is too early to determine whether these works will relieve the congestion experienced on the project extent.

Furthermore, the A556 Knutsford to Bowdon improvement project opened in March 2017 and saw the construction of a new two-lane dual carriageway between M56 junction 8 and M6 junction 19, an upgrade from the original A556 two-lane single carriageway. At one year after, journey times were quicker¹⁴ on the new A556 compared to before the project and the route is likely to be more attractive for users, perhaps contributing to the congestion observed at junction 19 in this study.

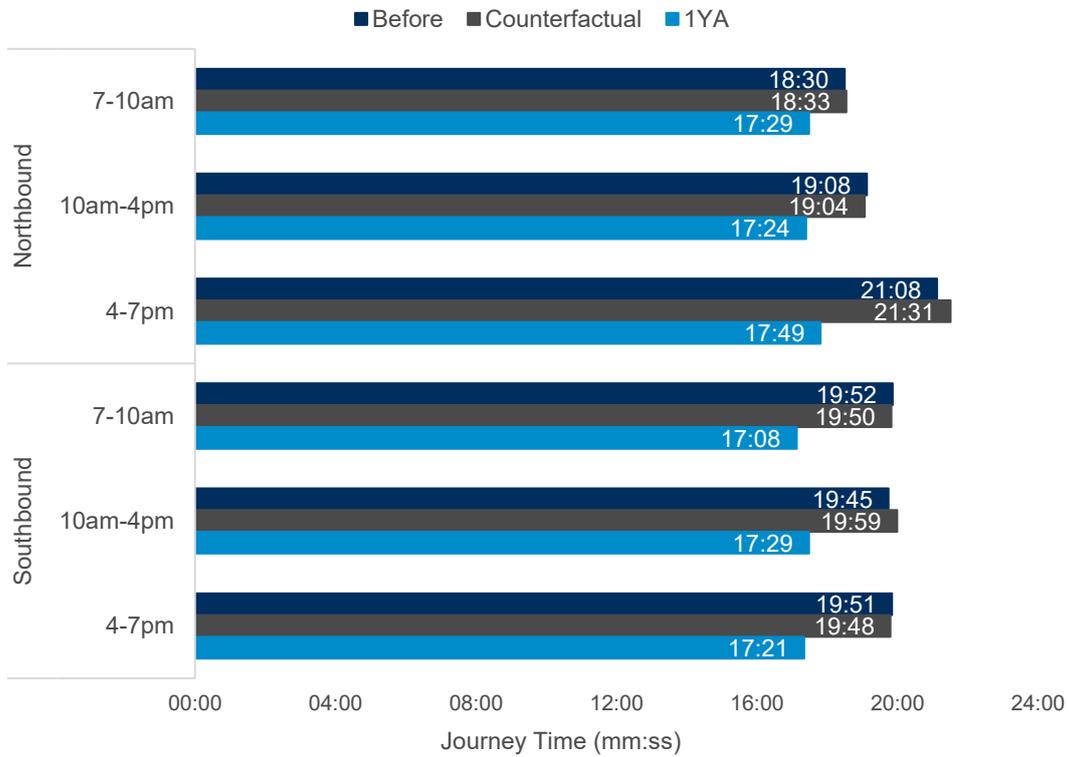
The counterfactual was calculated to give an estimate of what the journey time would likely have been had the project not been implemented and journey times continued to deteriorate with increasing traffic levels. Given the impact of the Covid-19 pandemic on traffic trends, the counterfactual for the project is based on journey times before the project was implemented and factored using regional traffic trends from 2019 rather than 2020.

For the M6 junctions 16 to 19, the journey times observed at one year after show a large improvement compared to journey times before and calculated for the counterfactual, as illustrated in Figure 10. The largest difference in journey times at one year after compared to the counterfactual was in the northbound PM peak (4-7pm). For this period, the counterfactual predicted journey times would increase to

¹⁴ <https://nationalhighways.co.uk/media/faih0do3/a556-knutsford-to-bowdon-pope-one-year-after-report.pdf>

over 21 minutes, however at one year after, they were lower at 17 minutes and 49 seconds (difference of 3 minutes and 42 seconds).

Figure 10 Counterfactual comparison to Before and 1YA Journey Times



Source: Satellite Navigation (TomTom) and National Highways (WebTRIS). Before: March 2015, 1YA: February 2020.

Were journey times in line with forecast?

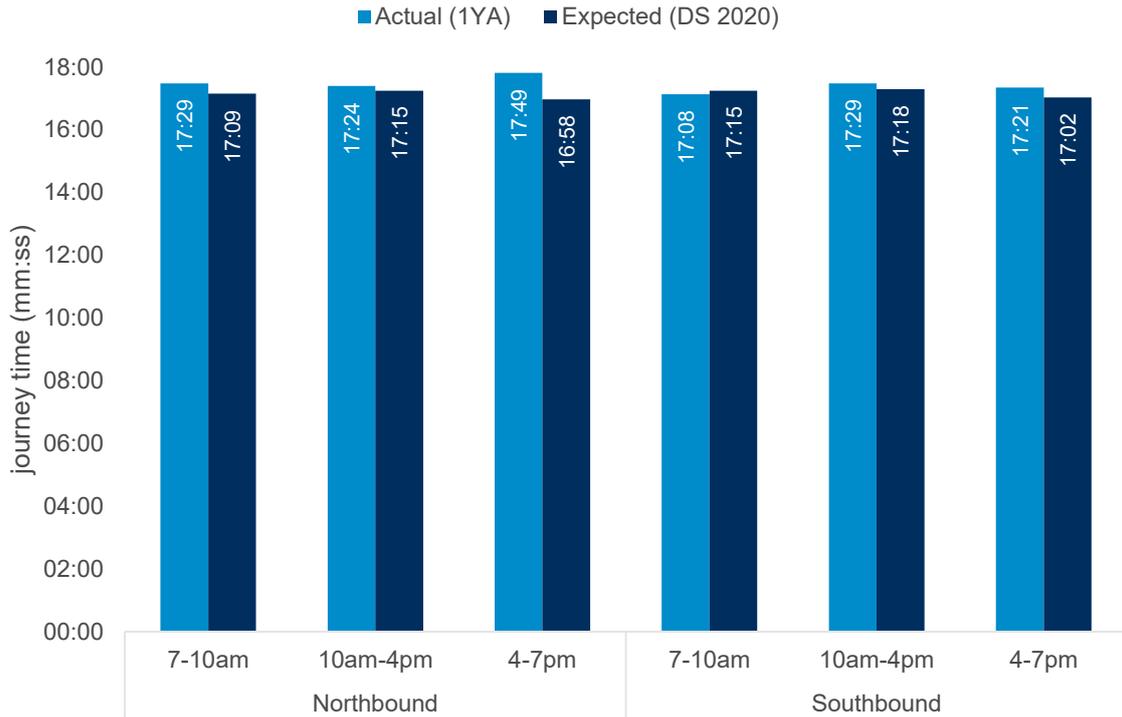
A comparison has been made between the observed journey times one year after, and the forecast journey times, referenced as 'expected' in this section.

The expected journey times have been calculated by interpolating the modelled journey times, to present the same year as the observed journey times, which for this project is 2020.¹⁵

As illustrated in Figure 11, the observed journey times at one year after were within 20 seconds of the expected values in both directions during the time periods, the exception being northbound in the PM peak when the journey time was nearly 1 minute longer than expected. The impact of congestion at junction 19 would have impacted one year after journey times and should be considered when interpreting these results.

¹⁵ As presented in the TEAR - forecasted journey times have been interpolated using the 2017 and 2031 modelled journey time values.

Figure 11 Actual versus expected journey times



Source: Satellite Navigation (TomTom) and National Highways TEAR.

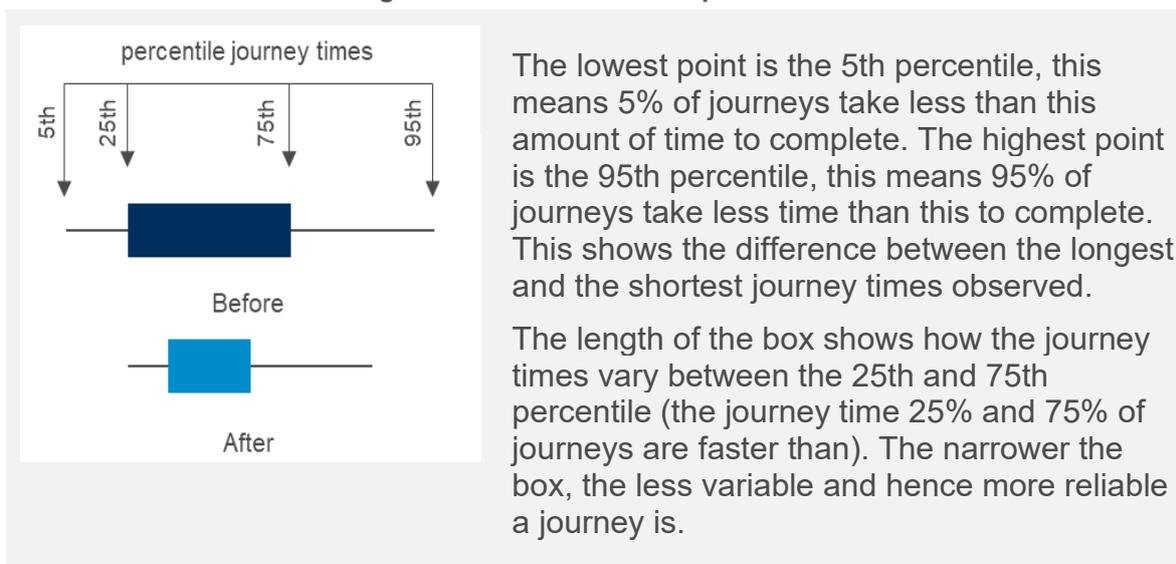
Did the project make journeys more reliable?

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.

To measure journey time reliability, we examine how much journey times vary from the average journey time, on any day or time-period. The distribution of journey times is a good indication of how much journey times vary.

Four metrics of the distribution of journey times for the M6 junctions 16 to 19 route have been used and presented as box-and-whiskers diagrams for northbound and southbound journeys. An explanation of the metrics shown in the box-and-whiskers diagrams is provided in Figure 12.

Figure 12 What does a box plot show?



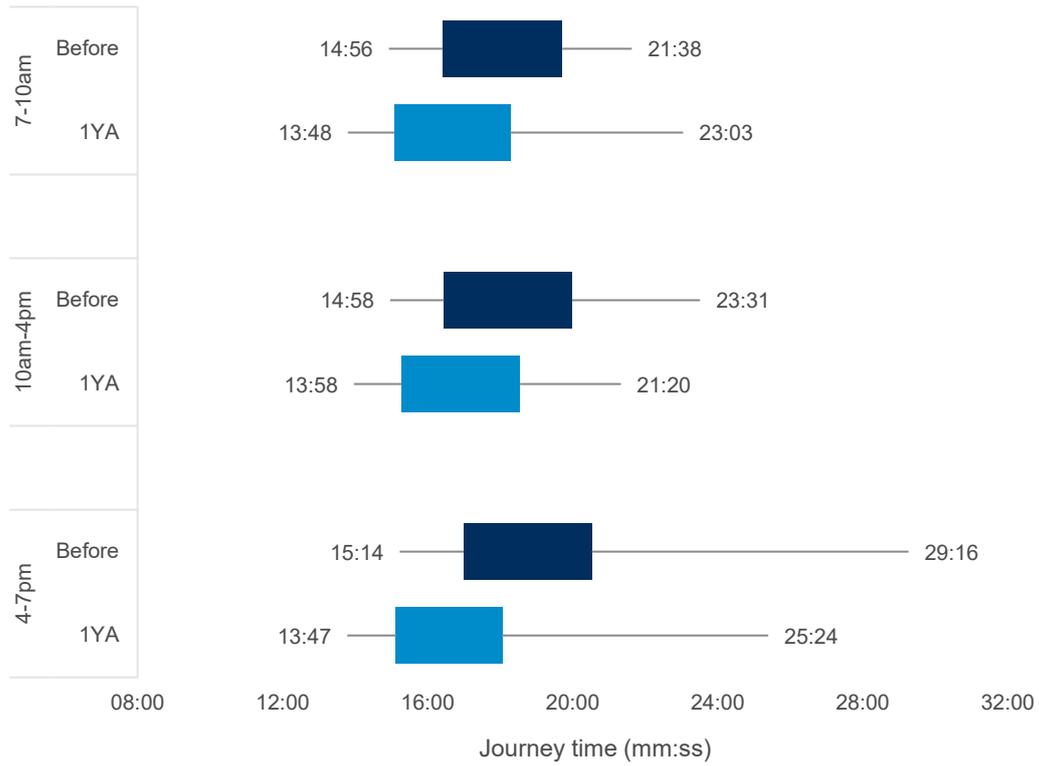
The journey time reliability, referenced as half of all journeys, is depicted by the 25th to 75th percentile boxes in Figure 13 and Figure 14; if the boxes get shorter, this indicates journeys become more reliable. For roads users northbound (Figure 13), there has been a slight improvement in the reliability of journeys. The average reliability improved the most during the PM peak with a 37 second improvement one year after the smart motorway opening. During the other time periods, there were small improvements in journey time reliability.

For southbound road users, a similar trend was seen (Figure 14), with the off-peak journeys experiencing a very small deterioration of 6 seconds, and reliability also seeing the largest improvement during the PM peak (19 seconds). During the other time periods, there were small improvements in journey time reliability.

Analysis of the longest journeys times depicted as the 95th percentile (the line extending to the right of the boxes) found for road users travelling northbound during the AM peak journey times increased by 1 minute and 25 seconds one year after compared with before construction. However, for the other time periods, the duration of the longest journeys reduced, with the largest reduction observed during the PM peak of nearly 4 minutes. Southbound, the longest journeys all saw considerable improvements in journey times, with the AM and PM peaks both seeing a reduction of 4 minutes and 17 seconds.

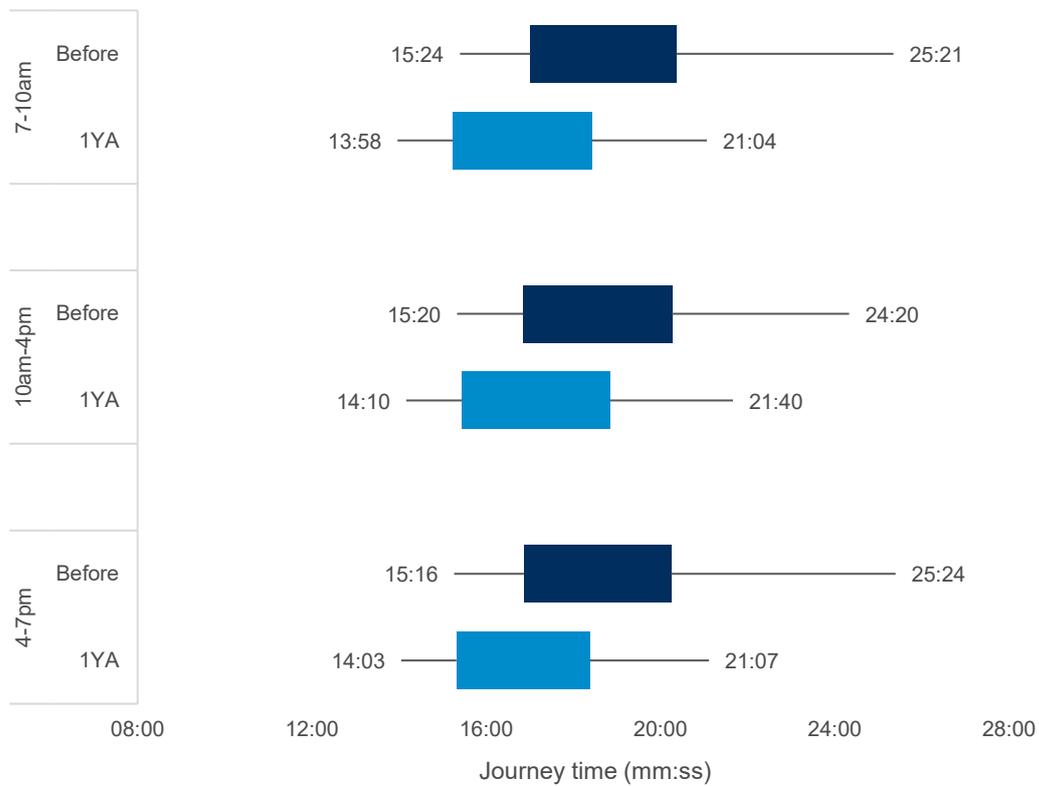
Furthermore, in both directions and in all time periods, road users saw improved journey times for the shortest journeys as depicted by the 5th percentile (the line extending the left of the boxes).

Figure 13 Journey time reliability northbound (mm:ss)



Source: Satellite Navigation (TomTom). Before: March 2015, 1YA: February 2020.

Figure 14 Journey time reliability southbound (mm:ss)



Source: Satellite Navigation (TomTom). Before: March 2015, 1YA: February 2020.

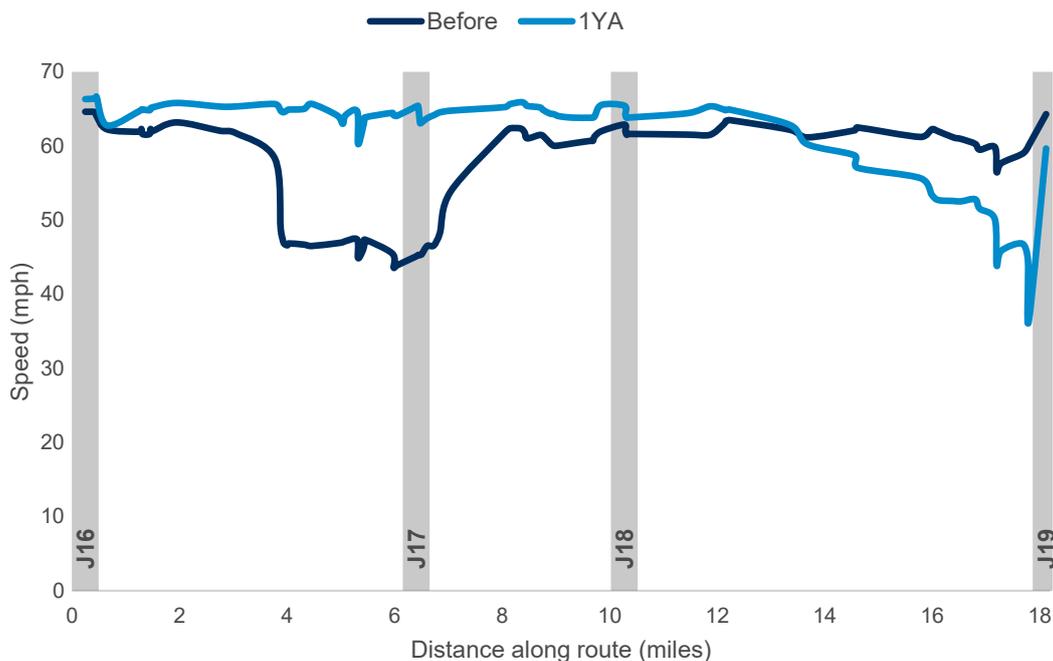
How did the project impact road user's speed?

In combination with journey time analysis, speed measurements can help to determine the impact the smart motorway had on congestion. Road users' average speeds are not necessarily quicker because of a smart motorway. Smart motorways are often implemented where there is congestion, and/or an increase in traffic is expected in the coming years. The aim is to make journeys smoother, and therefore speeds should be more consistent, with road users less likely to be accelerating and braking leading to unnecessary queuing.

Figure 15 shows the average journey speeds northbound in the AM peak. Before the smart motorway construction, the average speed was inconsistent, with speeds falling on the approach to and through junctions 17. Speeds then recover on the approach to junction 18 and remain consistent through to junction 19. One year after, improvements have been seen with speeds remaining around 65mph on the approach to and through junction 17.

However, between junction 18 and 19, the one year after results show a decline in average speeds to a low of 36mph close to junction 19. As noted earlier, works (outside of the M6 junction 16 to 19 project) have subsequently been undertaken to address congestion at junction 19.

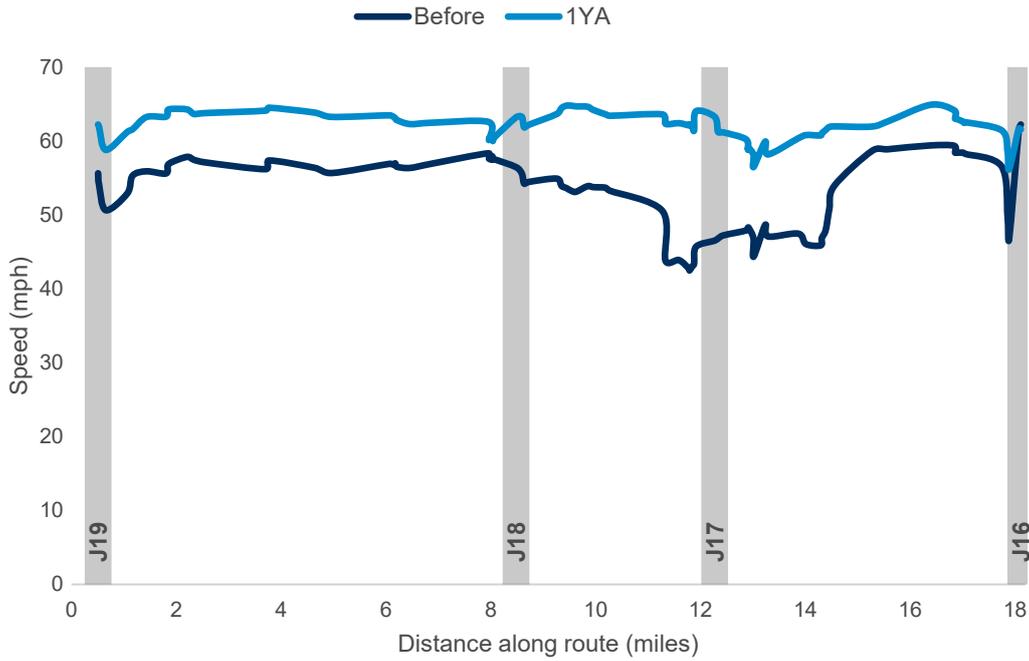
Figure 15 Speed over distance (northbound 7am to 10am)



Source: Satellite Navigation (TomTom). Before: March 2015, 1YA: February 2020.

For road users southbound, during the AM peak, the average speed profiles remained reasonably consistent one year after opening and were higher than those seen before construction. The most notable improvements were seen around junction 17 compared to before, as showed in Figure 16.

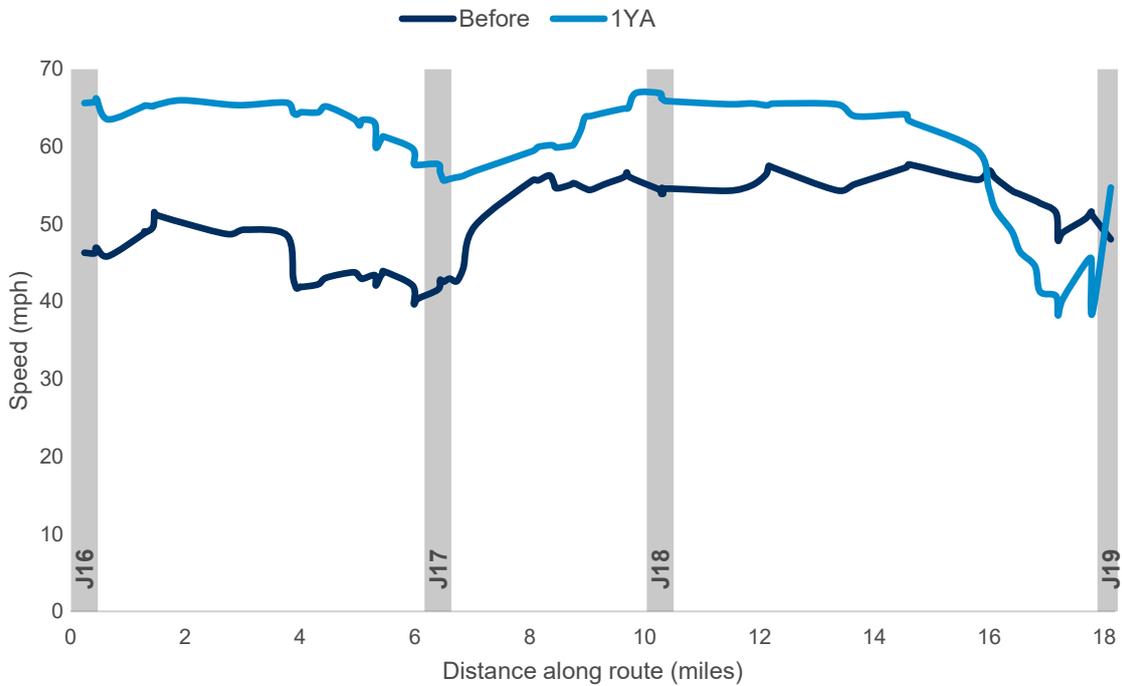
Figure 16 Speed over distance (southbound 7am to 10am)



Source: Satellite Navigation (TomTom). Before: March 2015, 1YA: February 2020.

Road users' average speeds northbound in the PM peak (Figure 17) have been higher than before the project between junction 16 to a few miles away from junction 19. As observed with the AM peak, on the approach to junction 19, speeds fell considerably.

Figure 17 Speed over distance (northbound 4pm to 7pm)

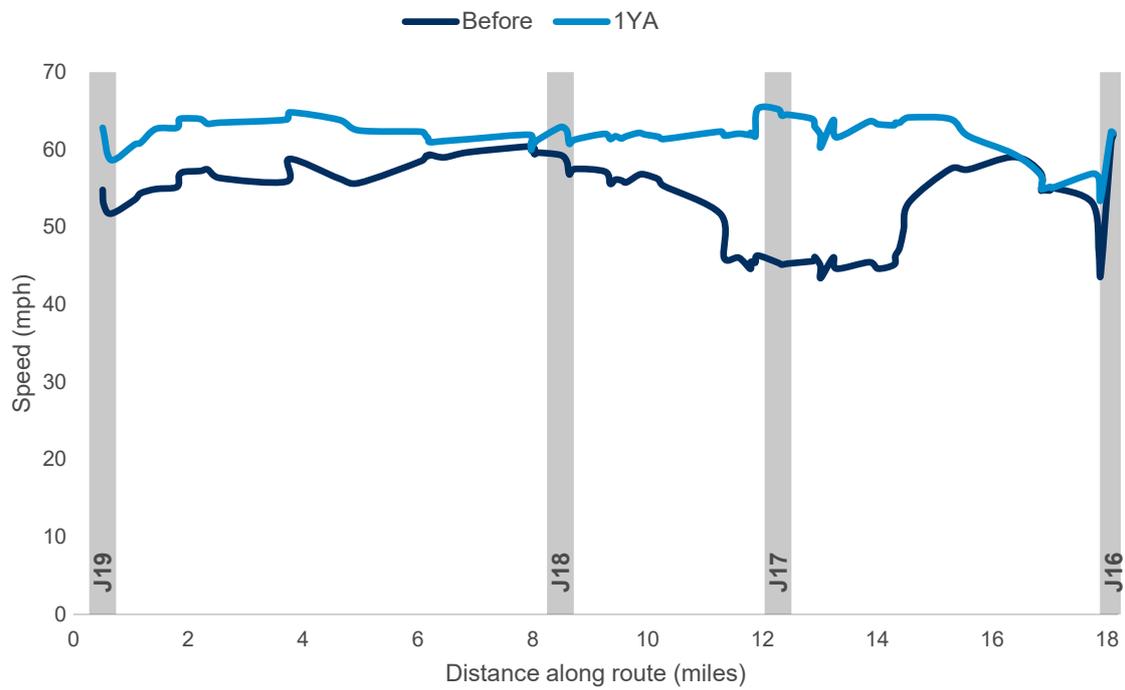


Source: Satellite Navigation (TomTom). Before: March 2015, 1YA: February 2020.

As shown in Figure 18, improvements to road users' speeds also occurred southbound in the PM peak with speeds higher across the project extent than

before construction. Furthermore, in comparison to before the smart motorway was implemented, there has been considerable improvements approaching and after junction 17 for road users' speeds.

Figure 18 Speed over distance (southbound 4pm to 7pm)



Source: Satellite Navigation (TomTom). Before: March 2015, 1YA: February 2020.

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 was 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 construction.

During the first 12 months of the smart motorway being open, there were 33 personal injury collisions compared with an average of 94 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 48 and 88.

The average collision rate decreased to 5 personal injury collisions per hundred million vehicle miles. Before the project, the collision rate was 13 personal injury collisions per hundred million vehicle miles. We estimate that if the road had not been upgraded to a smart motorway, the collision rate would reduce to 9 personal injury collisions per hundred million vehicle miles.

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 generally moving quicker. Traffic levels are set to increase in later years, however, and so results at the five-year after opening evaluation will be essential to check if this trend continues.

The early indications are that the safety objective is on track to be achieved. The analysis will need to be revisited in later years before we are sure that the change is significant. The evaluation will require a longer timeframe to determine if these initial positive findings are a real trend or natural fluctuation.

Safety study area

The safety study area is shown in Figure 19. The area identified was assessed in the appraisal supporting the business case for the project. The information is then used with other predictions around the potential impact of the project such as by how much traffic may grow. We have replicated the appraisal study area to understand the emerging safety trends.

Figure 19 Safety study area



Source: National Highways and OpenStreetMap contributors.

What are the emerging safety trends within the first 12 months of the smart motorway?

Safety data for this evaluation was obtained from DfT Road Safety Data. This records incidents on public roads that are reported to the police. This evaluation will only be considering 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. This provides an early indication of safety trends, but it will be monitored over a longer timeframe before conclusions can be drawn about the safety impact of the project.

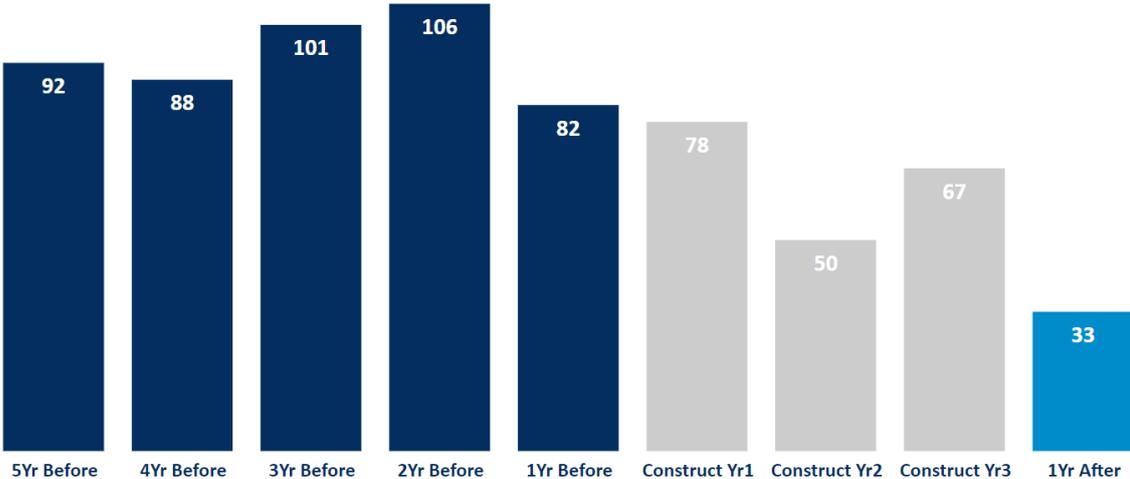
The analysis draws on the following data collection time periods:

- Pre-construction: 26 February 2011 to 25 February 2016
- Construction: 26 February 2016 to 20 March 2019
- Post-opening: 21 March 2019 to 20 March 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 20. The number of personal injury collisions for the first year of the smart motorway are lower than the five-year period before construction. The annual average number of personal injury collisions has fallen from 94 to 33 in the first 12 months of the smart motorway being open. Safety trends can vary each year and we will monitor this

trend over a longer timeframe before drawing conclusions about the safety impact of the smart motorway.

Figure 20 Annual personal injury collisions



Source: STATS19 26th February 2011 to 20th March 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 timeframe. 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 - see Figure 21 and the POPE methodology manual¹⁶). The counterfactual is based on changes in regional safety trends for conventional motorways with a high volume of roads users.

Figure 21 What does the counterfactual show?

The counterfactual is an estimation of what we think would occur without the project taking place. We estimate a range of collisions that follow regional trends. The chart shows:

1. Annual average number of collisions from before the project
2. Annual average number of collisions after the project
3. Estimated counterfactual range, which comes from a X^2 hypothesis test on one degree of freedom using a significance level of 0.05. More details can be found in the [POPE Methodology Manual](#).
4. National Highways are developing [new statistical methods to compare collision and casualty rates](#). We anticipate adopting these once the methods are finalised.

Legend:

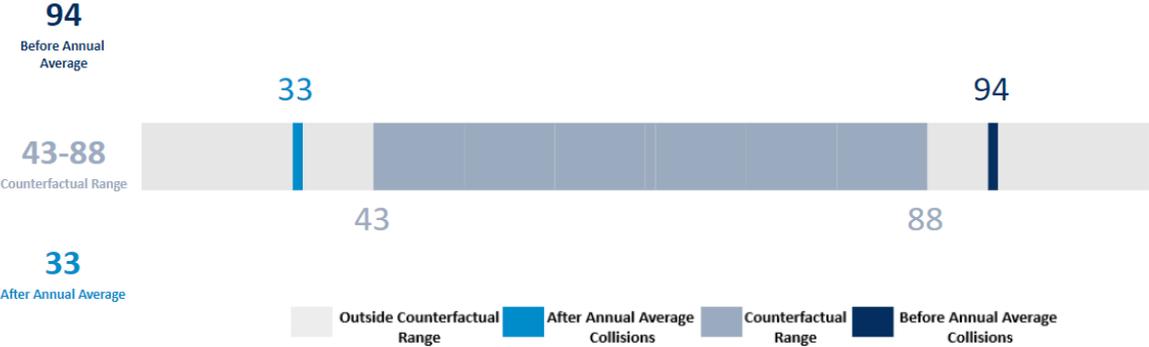
- Outside Counterfactual Range
- After Annual Average Collisions
- Counterfactual Range
- Before Annual Average Collisions

Based on this assessment, we estimate that if the road had not been converted to a smart motorway, the trend in the number of personal injury collisions would likely

¹⁶ <https://nationalhighways.co.uk/media/exyvgk11/pope-methodology-note-2024-v2.pdf>

have increased, and collision rates would remain stable. The counterfactual range of expected personal injury collisions would be between 43 and 88 (Figure 22). An annual average of 33 personal injury collisions were observed and this falls below the expected range. The early indication is, therefore, that the smart motorway is on its way to achieving its objective. Another study will be conducted after the smart motorway has been open for a longer timeframe, allowing a more representative time-period, to determine if the safety objective has been achieved.

Figure 22 Observed and expected range of personal injury collisions (annual average)



Source: STATS19 26th February 2011 to 20th March 2020.

How has traffic flow impacted on 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 via a collision rate. 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 5 personal injury collisions per hmvm, equating to travelling 19 million vehicle miles before seeing a collision. Before construction of the projection, the collision rate was 13 personal injury collisions per hmvm, this equates to traveling 8 million vehicle miles before seeing a collision.

The estimated rate, if the smart motorway had not been installed, would reduce to 9 personal injury collisions per hmvm. This counterfactual scenario indicates there would be a reduction in the number of collisions without the project, and the frequency of collisions would reduce, but not as much than has been observed.

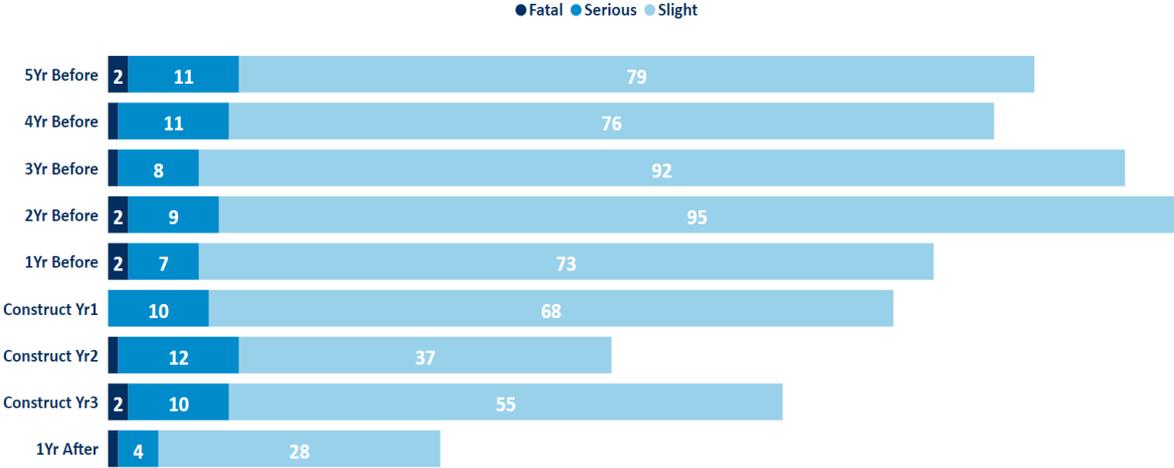
Like collisions, collision rates are also lower than what we would have expected without the installation of the smart motorway. While traffic levels have fallen slightly, collisions have reduced by a greater extent. As these are the first year’s results, we are not yet confident yet that these initial 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 impact did the project have on the severity of collisions?

Collisions which result in injury are recorded by severity as either fatal, severe or slight. Police forces are transitioning to a new method in how severity of incidents is recorded. Currently Cheshire Police Constabulary has not transitioned to using the new injury based method, hence collision severities are presented using unadjusted figures (more information on this can be found in annex A.1).

Figure 23 shows the severity of personal injury collisions within the project extent. In the first year after the project opened, there was an average of 55 fewer collisions resulting in slight injuries (the annual average before the project was 83, compared to 28 after). There was also a reduction in collisions resulting in serious injury per year (with an annual average of nine before and four after).

Figure 23 Severity of personal injury collisions within the project extent



Source: STATS19 26th February 2011 to 20th March 2020.

Is the project on track to achieve its safety objective?

The safety objective was to achieve no worsening of safety performance. Early indications are that the project is on track to meet this objective. This will be further assessed in later POPE reports when more data is available.

6. Environmental Evaluation

Summary

The environmental impacts of projects are assessed during the development of projects and consider the environmental sub-objectives within Transport Analysis Guidance (TAG)¹⁷. The evaluation of environmental impacts compares the predicted impact from appraisal to observed impacts. Post opening evaluations provide an opportunity for such findings to be captured early and ensure improvements are made, so the design outcome can be achieved.

The evaluation of environmental impacts used information on the predicted impacts gathered from the environmental appraisal within the business case, the environmental assessment report (EAR) and compares them with findings obtained one year after the project opened for traffic.

The findings at one year after the project opened were determined from the available traffic data, and the modelled traffic data was used as a comparison where available. A site visit with supportive desktop research will be undertaken at five years after opening to determine the impacts of the project on the TAG environmental sub-objectives, including the sub-objectives not assessed at one year after; Landscape, Townscape, Heritage of Historic Resources, Biodiversity, Water Environment, Severance, Physical Activity and Journey Quality.

Noise

The environmental appraisal predicted that the project would lead to a neutral effect on noise and would lead to different impacts on different social groups based on least to most deprived areas. Low Road Noise Surfacing (LRNS) was expected to be implemented during construction. Mitigation measures were implemented including noise barriers to reduce operational noise at receptors. The EAR (2014) expected there to be no significant adverse effects at noise sensitive receptors, with some receptors anticipated to see beneficial effects. The receptors expected to experience a benefit in noise level would experience the benefit due to the noise barrier reducing the noise level to below those that would be expected without the project.

The POPE Methodology for evaluating local noise from traffic compares forecast traffic flows with observed post project traffic flows. An assumption is made by the guidance that noise will be as expected if observed traffic flows are within 25% more or 20% less than predicted. Traffic flows for the project suggest that the impact of the project on noise results in an 'as expected' change. Forecast data predicted similar speeds and similar flow counts to the outturn traffic data. Five of the six links fell within the "to be expected" +/- 1 dB range. One of the six links fell within the "better than expected" greater than -1 dB range. This can be considered a "minor beneficial" change. Overall, the project is considered to be "as expected".

Air quality

In general, existing air quality was found to be poor near to the motorways, and the existing A556 between the M6 and M56. The environmental appraisal predicted

¹⁷ Transport Analysis Guidance (TAG) provides DfT guidance on transport modelling and appraisal.

that the air quality was anticipated to deteriorate due to an increase in nitrogen dioxide (NO₂) resulting from traffic flow increases and the running lanes moving closer to receptors. In the EAR, the assessment concluded that the project would lead to an increase in NO₂ concentrations, however, these were not considered to represent significant effects. It was also predicted that the project would lead to improvements in NO₂ concentrations, but that these would also not represent significant effects. It was anticipated that there would be localised negligible changes to particulate matter (PM₁₀) concentrations; however, the effects were not expected to be significant. The environmental assessment stated that no mitigation measures were required.

At one year after opening, the assessment found that it was likely the observed NO₂ concentrations are lower than expected. The conclusion was determined from the differences between the observed and forecast traffic data. A limitation of the assessment was that the effect of changes in Heavy Duty Vehicle (HDV) flows not being able to be assessed due to the full extent of forecast traffic not being available. In 2021, local authority monitoring adjacent to road links with forecast and observed traffic flows showed annual mean NO₂ concentrations are generally lower than the predicted concentrations at receptors in the EAR (2014) assessment year of 2017.

Overall, it is likely that the observed NO₂ concentrations are lower than expected due to the decrease in overall traffic from the forecast values to the observed values. Variations in speed are unlikely to make a substantial difference to the expected NO₂ concentrations. Furthermore, based on a comparison of available observed data to forecast data, it is not anticipated that the differences between the observed and forecast traffic would lead to a change in the overall evaluation of the significance for air quality for the project.

Greenhouse gases

The environmental assessment predicted that the project would lead to an overall increase in carbon emissions due to an increase in the overall length of journeys to use the project rather than alternative routes. For the one year after opening assessment, forecast and observed traffic data is required for the appraised study area. The full extent of traffic data required to evaluate and quantify greenhouse gas emissions was not available for this project at one-year after, which does mean that no consideration of the effect of changes in HDV flows has been able to be made. However, the comparison of available observed data to forecast data resulted in lower calculated greenhouse gas emissions than the forecast data. The evaluation suggests that the project may have led to a smaller increase in carbon emissions than what was predicted in the environmental assessment.

Overview

The results of the evaluation undertaken at one-year after are summarised against each of the TAG environmental sub-objectives and presented in **Table 2**.

Table 2 - Summary of Environmental findings

Sub Objective	AST Score	1YA Evaluation Outcome	1YA Evaluation Summary
Noise	<p><i>Total number of people annoyed with the Scheme: 694</i></p> <p><i>NPV: -£1.1M</i></p>	As expected	<p>Overall, based on a comparison of the limited available forecast data to outturn data, it is anticipated that the differences between the outturn and forecast traffic result in an “as expected” change on the noise environment.</p>
Air Quality	<p><i>NPV: -£0.6M</i></p>	As expected	<p>Based on a comparison of available observed data to forecast data, it is not anticipated that the differences between the observed and forecast traffic would lead to a change in the overall evaluation of significance for air quality for the project.</p>
Greenhouse Gases	<p><i>NPV: -£71M</i></p> <p><i>Change in non-traded carbon over 60y: 1,537,000 (tCO2e)</i></p> <p><i>Change in traded carbon over 60y: 2,000 (tCO2e)</i></p>	Better than expected	<p>The evaluation suggests that the project may have led to a smaller increase in carbon emissions than was predicted.</p>

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