

M62 junctions 25 to 30 smart motorway

Five-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 M62 junctions 25 to 30 dynamic hard shoulder (DHS) smart motorway scheme within five years of operation following its conversion from a conventional three lane motorway.

An initial study was conducted one year after the M62 junctions 25 to 30 project which opened in 2013, followed by this report after five years which provides 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 and how the scheme supports the economy.

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

¹ Post Opening Project Evaluation (POPE)

sections would have been unable to cater for today's traffic (at the busiest times) if they had not been converted into smart motorways.

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 original 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

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1. Executive summary

The M62 junctions 25 to 30 motorway is located in West Yorkshire south of Leeds and Bradford. The motorway was converted to a dynamic hard shoulder² (DHS) smart motorway, which opened in October 2013 to provide additional capacity on one of the most congested sections of the M62.

This project aimed to deliver improvements to capacity, journey times, reliability, safety and information to drivers, while minimising the effects on the environment and surrounding road network.

Overall, the M62 junctions 25 to 30 DHS scheme is currently on course to deliver some but not all its expected benefits within the 60-year appraisal period.

The scheme has met its safety objectives. Over the five-year evaluation period, there was a slight reduction in the annual average number and rate of personal injury collisions on the smart motorway section and on the surrounding network following the opening of the project. Each year there was an average reduction of 27 personal injury collisions on the project section which is in line with the appraised business case for the project. This is based on an annual average of 54 personal injury collisions after the project opened compared to 81 before the project was constructed. When accounting for the increased volume of road users over this period, the annual average rate of personal injury collisions per hundred million vehicle miles was also improved over time.

To safely operate the hard shoulder as a running lane, a maximum speed limit of 60mph is applied, with the ability to set lower limits. This slows down drivers to smooth the flow of traffic and achieve a higher capacity on the road. In line with this approach the evaluation shows that journeys have become slightly more reliable for customers travelling westbound (this is whilst accommodating a growth in traffic).

Average journey times are slightly slower than before the smart motorway was implemented³ whilst carrying a greater volume of traffic. When accounting for the observed increase in traffic, if the section of road had remained a 3-lane motorway it would have been unable to support the additional road users, without experiencing a reduction in speed.

Most environmental impacts were either 'as expected' or 'better than expected' in the pre-construction appraisal that supported the business case for the project. The impact on biodiversity is worse than expected at five years after as the mitigation planting had not been maintained.

Based on the evidence from the first five years, at this stage scheme is not yet fully realising its anticipated value for money over the 60-year life of the project, and we are exploring what further action can be taken to improve benefits. The primary reason for the overall reduced level of benefits is lower than expected traffic growth due to the 2009 economic crisis and lower population growth as well as slower journey times than anticipated. It is nevertheless delivering some benefits -

² Dynamic hard shoulder (DHS) running motorways apply technology to control speeds and use electronic signs to temporarily increase capacity by utilising the hard shoulder at busy times. Emergency areas are available at regular intervals providing places to stop in an emergency.

³ Even after taking into consideration the deterioration in journey times that we would have expected to have happened had the project not been implemented (the counterfactual). We estimate a small disbenefit.

construction of the project was delivered under budget - it is delivering safety benefits to road users and most of the environmental benefits are as expected.

2. Introduction

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

The M62, junctions 25 to 30, was included in the Roads Programme – Motorways and Trunk Roads Announcement in January 2009. This section of road is part of the key strategic east-west Trans Pennine corridor stretching across the north of England, connecting Merseyside, Lancashire and Manchester to Yorkshire and the Humber. It also serves as a local route, connecting Huddersfield, Leeds, Bradford and Wakefield.

This section of motorway carried as many as 170,000 vehicles per weekday across both carriageways, and as a result, drivers experienced considerable congestion and long delays. The section between junctions 26 and 27 saw the most congestion and delays due to the links to other strategic motorways in the area. Junction 26 serves the M606 to Bradford and junction 27 connects to Leeds via the M621, which then continues to join the M1 at junction 42. Along with this, a high proportion of HGVs regularly use this section of the M62. This combined with steep gradients around the Leeds and Bradford area leads to slower moving vehicles through the route.

National Highways constructed a smart motorway between junctions 25 and 30 of the M62. The project is a combination of the three types of smart motorway (Figure 1):

- Dynamic hard shoulder between junctions 26 and 28 (both carriageways), and on the westbound stretch from junction 29 through junction 30. Technology was applied to control speeds, and electronic signs temporarily increase capacity by utilising the hard shoulder at busy times. Emergency areas are available at regular intervals, providing places to stop in an emergency.
- Controlled motorway between junctions 28 and 29. This section already had four running lanes. Technology was applied to control speeds and we retained the permanent hard shoulder for emergency use.
- Controlled all lane running eastbound junction 29 to 30 and both carriageways junction 25 to 26. Technology was applied 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.

Ramp metering was also added at some junctions of the smart motorway. This is where traffic signals are used to limit the flow of traffic entering the motorway at extremely busy times. There is through junction running at Hartshead Moor motorway services.

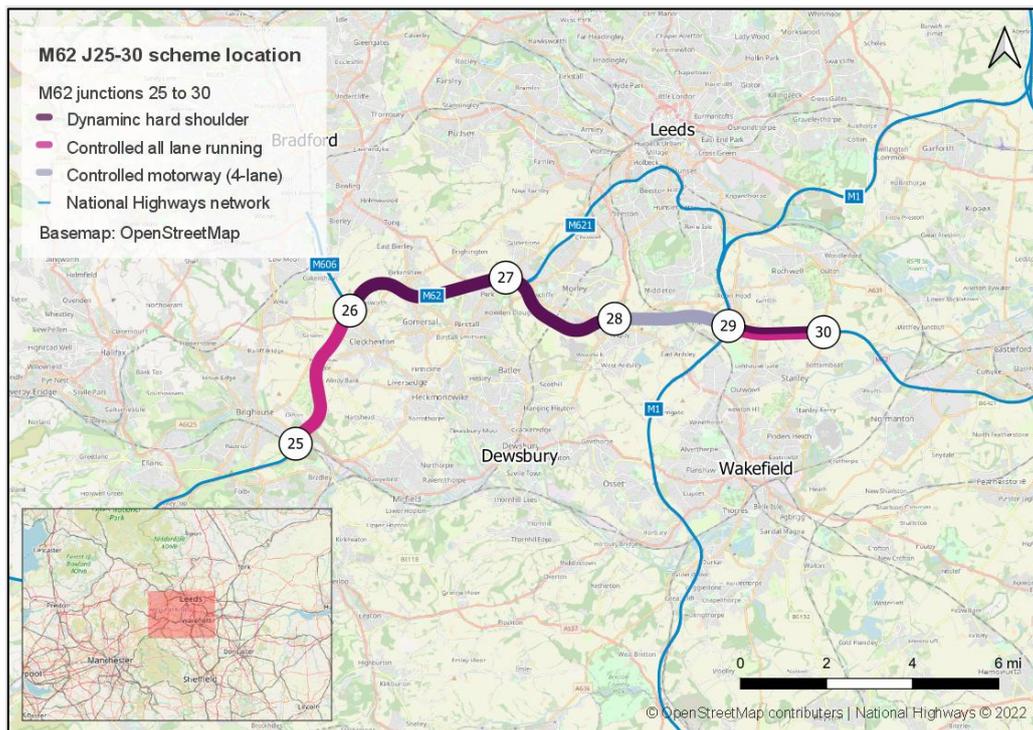
The smart motorway started construction in October 2011 and opened to traffic two years later in October 2013. Prior to the smart motorway construction, advanced works were carried out to install new drainage and concrete barriers between junctions 25 and 28, and junctions 29 and 30. The section between junctions 28 and 29 were not included as this was already a four-lane motorway with hard shoulder.

Project location

The smart motorway starts at junction 25 of the M62, just north of Huddersfield and west of Dewsbury continuing through West Yorkshire for approximately 15 miles where it meets the M1 at junction 42, then carries on to junction 30 (Figure 1). The smart motorway runs through a predominantly rural area, with a few short motorways connecting it to Leeds and Bradford on the northern side of the project.

The M62 provides a key strategic route from Manchester through Yorkshire, intersecting with the M1 and A1(M) spinal corridors, before terminating just west of Hull in East Yorkshire.

Figure 1 M62 J25-30 project location and surrounding highway network



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 also seek to determine whether the expected project benefits are likely to be realised. They provide opportunities to learn and improve future project appraisals and business cases too. 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 key impact areas⁴ 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

⁴ Key impact areas include safety, journey reliability and environmental impacts.

study please refer to the post-opening project evaluation (POPE) methodology manual on our website.⁵

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

3. Delivering against objectives

How has the project performed against objectives?

All National Highways major projects have specific objectives which are defined early in the business case when project options are being identified. These benefits are appraised to be realised over 60 years. The one-year evaluation provides early indication of progress, followed by the five-years after evaluation which gives a more detailed insight. The objectives for the M62 junctions 25 to 30 smart motorway included the following:

Table 1 Objectives and Evaluation Summary

Objective	Five-year evaluation
To provide additional motorway capacity, making best use of existing infrastructure where possible	An extra lane of driving capacity in the form of a dynamic hard shoulder and permanent lane in some sections. This had helped ease congestion, supporting an increase of 12% in road users since before construction.
To reduce the number and severity of accidents per vehicle kilometre	The evaluation found there has been a reduction in the number, and rate of personal injury collisions. The five year evaluation concludes that the objective has been met ⁶ .
To minimise the detrimental effects on traffic on the surrounding road network where possible	Local traffic flows surrounding the project had increased at a similar rate to the project section and it is not considered to have been detrimentally affected by the smart motorway.
To improve journey time reliability, as measured by the average delay experienced in the worst 10% of journeys	Journeys have become slightly more reliable for customers travelling westbound. The slowest 10% of journeys on the eastbound carriageway did not improve, likely due to the higher traffic growth.
To improve journey times on the M62 between junctions 25 and 30	Journey times were slightly worse than before the smart motorway was implemented. However, journey times were expected to rise over the lifetime of the smart motorway in the context of higher traffic growth.
To offset the detrimental environmental effects of the scheme through mitigation measures where technically and economically feasible	Biodiversity is worse than expected at five years after as the mitigation planting had not been maintained. All other aspects were either better or, as expected, from appraisal.
To improve the quality of information provided to drivers about the state of traffic flow in the motorway	New technology was installed to provide information on traffic flow in the form of variable mandatory speed limits and variable message signs.

⁶ Projects are appraised over a 60-year period. This conclusion is based on the findings at five years after the project opened for traffic

4. Traffic evaluation

Summary

Speed and journey time analysis indicated that before the smart motorway was constructed, the most congested parts of the project were primarily between junctions 26 and 28. These were particularly evident in the westbound direction between 4-7pm and in the eastbound direction between 7-10am. These were the times which saw the most benefit from the installation of the smart motorway, though smaller benefits have been realised among other sections and times.

The M62 junctions 25 to 30 smart motorway saw traffic growth of around 12% from before construction to five-years after, and now carries as many as 170,000 vehicles per weekday (two-way AWT⁷). This growth from the traffic model was expected, though absolute traffic volumes were slightly overestimated. This increase in traffic is also similar to what we have seen on motorways more generally over the same period.

After improving considerably at one year after, journey times for most times of the day are now worse than before construction at five years after. Within the business case for the conversion to smart motorways, journey times were expected to improve in the first few years after opening but would be longer over the appraisal period as traffic growth continues. These journeys would still be shorter than if the smart motorway had not been constructed. This is, however, against a much larger increase in traffic at five years after than was observed at one years, along with increased use of the hard shoulder and variable speed limits.

Although the reliability objective is considered to have been partially met, this was based on improving the slowest 10% of journeys along the route. These journeys were slower during all time periods on the eastbound carriageway, but quicker in the morning and evenings travelling westbound. Despite this, the average journeys (those occurring between the 25th and 75th percentiles) were better or no worse in all but one of the time periods, eastbound evenings.

Technologies on the smart motorway were used more often at five-years after compared to one-year. The hard shoulder experienced an increase in use and is in operation for around two thirds of both morning and evening peak periods. Lane utilisation for the hard shoulder increased, as more vehicles were making use of the additional lane during busy times. Speed limits were also being set more often, 60mph is used for more than half the time now, with the 50mph signal being used less often.

All aspects of the traffic analysis should be considered together, longer journeys may be because traffic levels have increased more than expected. This may lead to greater use of the available technology to open the hard shoulder for traffic and set speed limits in busy times. Five-years after opening is still early in the smart motorways lifespan and it may be another ten years before many of these benefits can be realised.

⁷ Two-way AWT – average weekday traffic (excluding holidays and weekends) averaged over a month and summed for both directions (junctions 26 to 27)

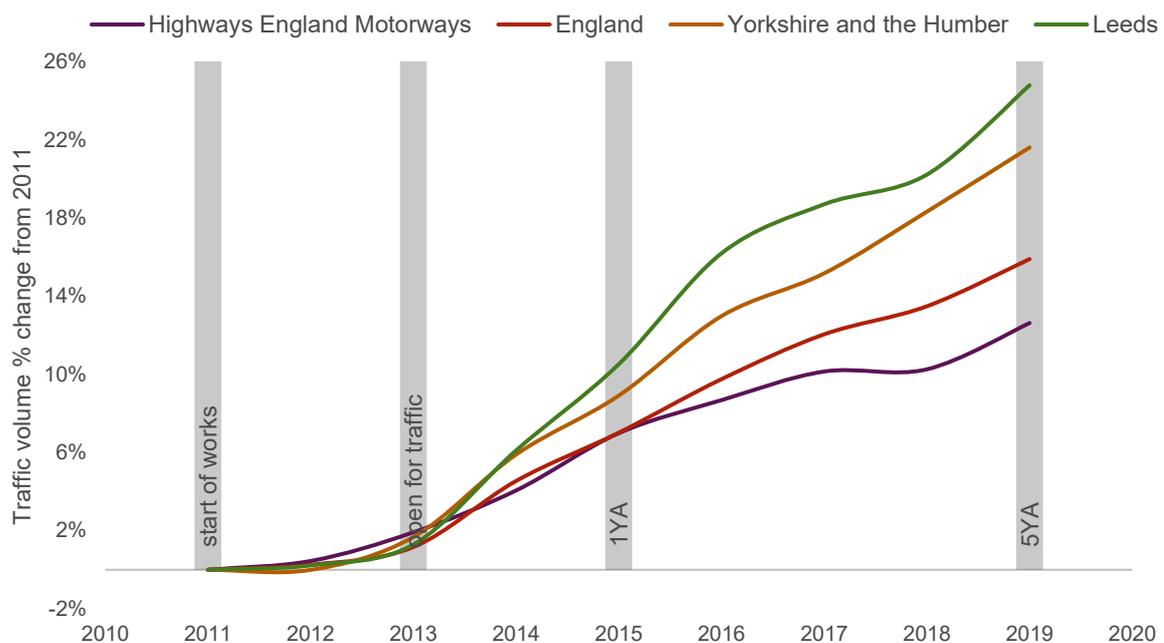
How have traffic levels changed?

Smart motorways are built on stretches of road which experience high levels of congestion, and/or are expected to increase in future years. This section examines how traffic levels have changed in the years since the project opened for traffic, and how it was expected to perform over the same timeframe.

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 (Figure 2). During the construction period, traffic volumes did not see any significant increase, partially after a dip due to the UK economic downturn in 2008. Traffic on the project had increased at a similar rate to those seen generally on motorways within the first five years of operation, though this is less than what was expected for the local area over the same period⁸. The appraisal did not anticipate that traffic would increase as much as the local trends would indicate, and these were more in line with general trends on motorways and across England. It is however expected that traffic on the project section could increase further with time.

Figure 2 National and regional percentage traffic volume changes since 2011



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

How did traffic volumes change?

The implementation of this smart motorway was focussed on increasing capacity on the M62 junctions 25 to 30, with specific emphasis on junctions 26 to 27; interchanges with other motorways linking to Bradford and Leeds respectively. This section of the report looks at the differences between traffic volumes, before and at five-years after the smart motorway was opened, to determine if the projected increase in the number of road users was being realised.

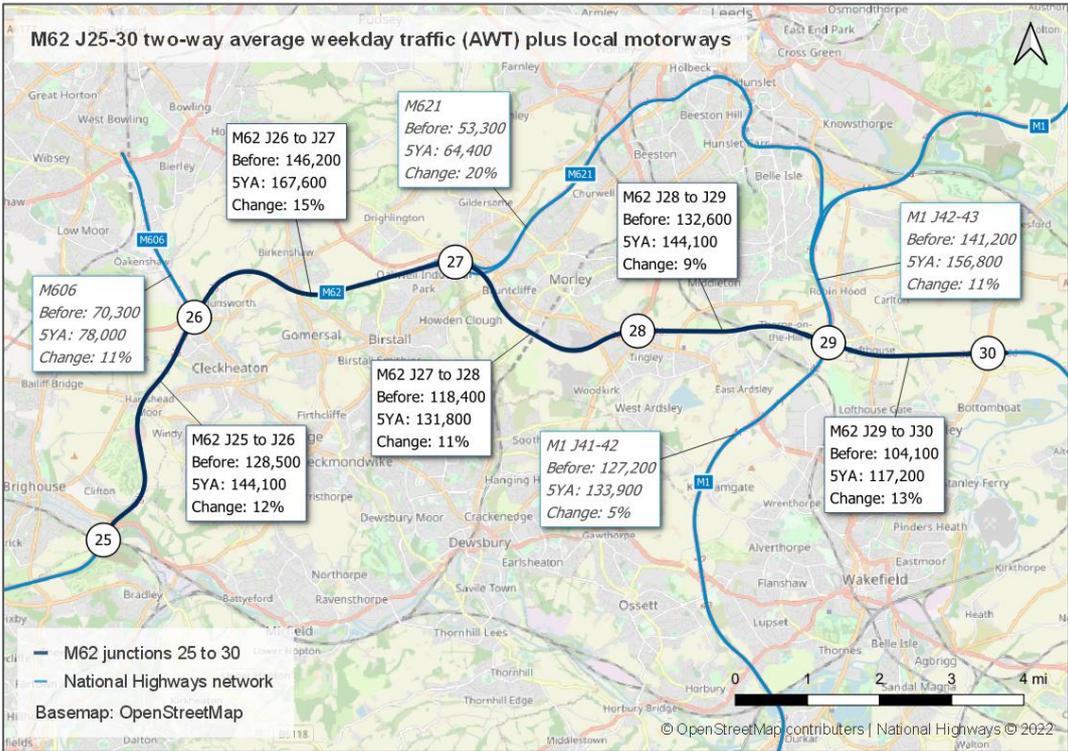
⁸ Road traffic statistics have been revised since 2010 following a minor road benchmarking exercise <https://www.gov.uk/government/publications/road-traffic-statistics-minor-road-benchmarking>

For this evaluation, traffic volumes were assessed in March 2011 before construction began and March 2019 five years after opening, with some reference to the one-year study which was based on trends from March 2015. In selecting a representative month for analysis, aspects such as peaks and troughs caused by seasonality and availability of accurate counter data can be mitigated against.

The number of vehicles travelling along this stretch of the M62 increase on average by 11-12%, which is in line with the national trend for motorways. The 22-25% increase around Leeds and Yorkshire and the Humber was not reflected in the motorway volumes, or local roads in the same area. The stretch between junction 26 and junction 27 was a key consideration within the business case for the conversion to smart motorway due to the link roads with Bradford (M606) and Leeds (M621). This section has seen the largest increase across the project, 15% across both carriageways, compared to 12% for the other project sections.

The M621, which starts at junction 27 and weaves through Leeds before joining the M1 at junction 43, saw an increase in the number of road users of around 20%, which may explain the greater increase on the M62 at this junction. However, the M606 from junction 26 towards Leeds increased by 11% in the same period.

Figure 3 Changes in average weekday traffic (AWT) on the project and other surrounding motorways



Source: National Highways traffic count data and OpenStreetMap contributors

Was traffic growth as expected within the business case?

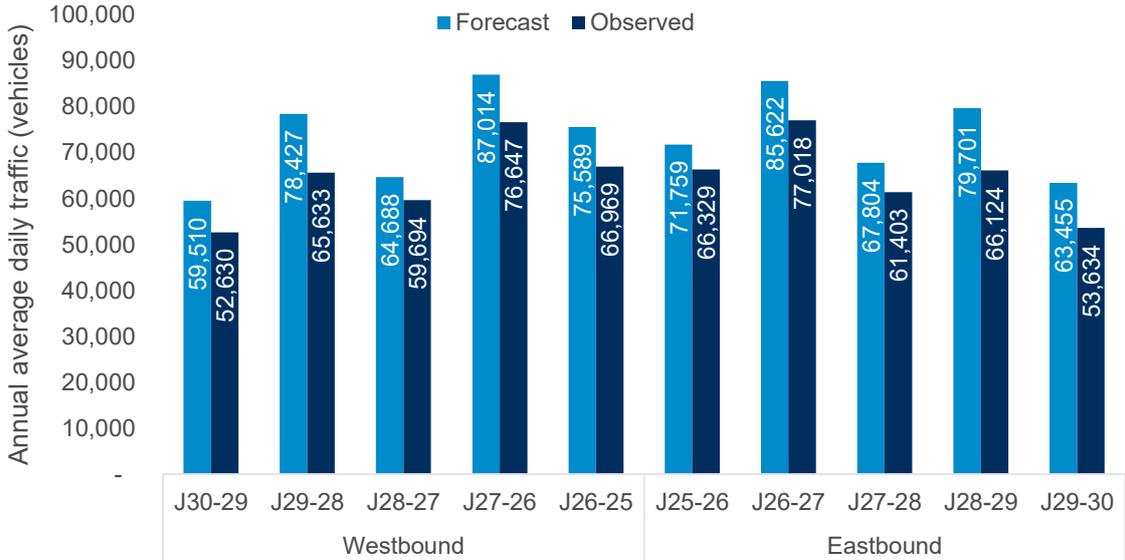
Overall, the traffic forecasts were accurate in the proportion of traffic growth expected at this time period following conversion to a smart motorway, but the absolute volumes were overestimated due to the baseline in the appraisal being too high. This can be partly explained by the impact of the recession which stalled traffic growth in 2008-2011 as a consequence of impacts on fuel price and travel demand. We can be confident that this is the cause as the discrepancy also impacted the without improvement forecasts (do minimum). The business case,

completed before signs of an economic recession, forecast a higher demand in travel, due using projected growth trends observed before 2008⁹.

In terms of absolute numbers of road users, the appraisal estimate was on average 14% higher than the volumes observed after five years (Figure 4)¹⁰.

However, the growth prediction was considerably more accurate. The difference in growth between observed (before construction and five-years after) and forecast (with and without the improvement) was a lot closer, with an average of 1% difference between the two values (Figure 5).

Figure 4 Forecast traffic volume with smart motorway (2019) and observed one year after traffic volume (2019)



Source: Forecasts from traffic forecast report. Observed data from National Highways traffic count data. Note: Forecasts of do something (2019 interpolated) – with smart motorway and observed post smart motorway volumes (2019). 2019 forecasts were interpolated using the opening year (2016) and design year (2031).

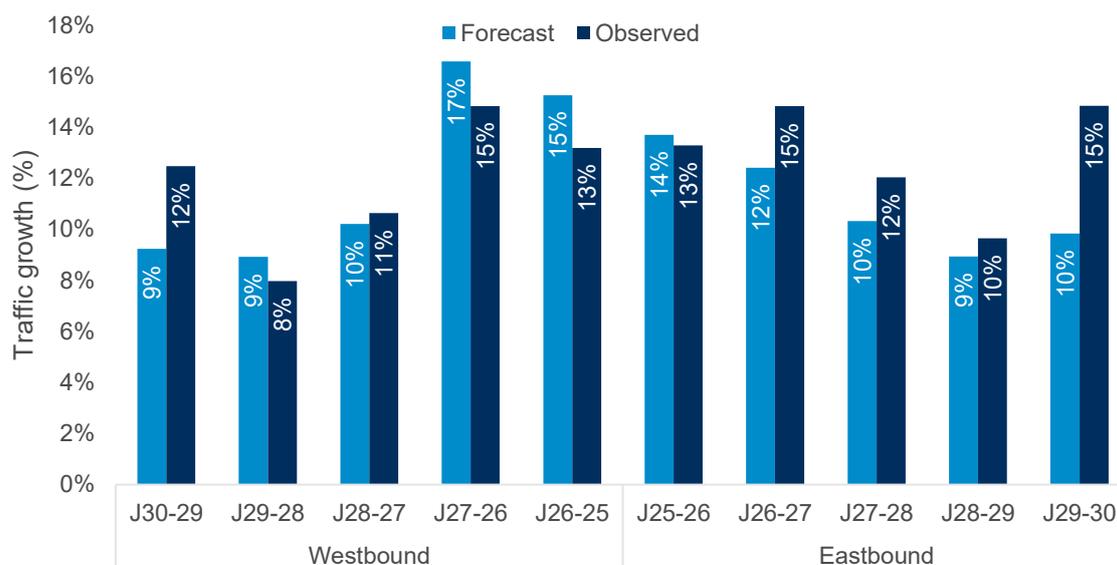
As there was not a forecast year for 2019, the year chosen for the five-years after traffic analysis, interpolation was used for traffic flows between the forecast opening year of 2016 and the design year 2031. Traffic flows are considered to increase linearly with time.

⁹ The traffic model supporting the business case was created with a base year of 2005. In 2008 Department for Transport guidance was revised to reflect the uncertainties in forecasting future impacts (webTAG unit 3.15.5). It required a more detailed handling of the sources of uncertainty and required a minimum of two additional scenarios to be used to inform the business case. The current version of this guidance can be found in TAG unit M4.

<https://www.gov.uk/government/publications/tag-unit-m4-forecasting-and-uncertainty>

¹⁰ Based on trends from the Annual Average Daily Traffic (AADT) – average number of vehicles on the project per day, averaged over a year

Figure 5 Forecast traffic growth (with vs without smart motorway) compared with observed traffic growth (before vs one year after)



Source: Forecasts from traffic forecast report. Observed data from National Highways traffic count data. Note: Forecast change: Do minimum (2019) to do something (2019). Observed change: before smart motorway (2011) to post smart motorway (2019). 2019 forecasts were interpolated using the opening year (2016) and design year (2031).

Even at five-years after opening, the M62 junctions 25 to 30 smart motorway is at the early stages of its lifetime, and traffic is predicted to increase further over time. The additional lane is likely to be utilised even more in future years.

Relieving congestion and making journeys more reliable

Smart motorways are applied to the busiest routes, to ease congestion and ensure journey times are more predictable. These routes are often where we anticipate congestion will increase and the smart motorway seeks to limit this. Analysis of journey times and speeds 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. This section evaluates how the project impacted journey times and the reliability of journeys.

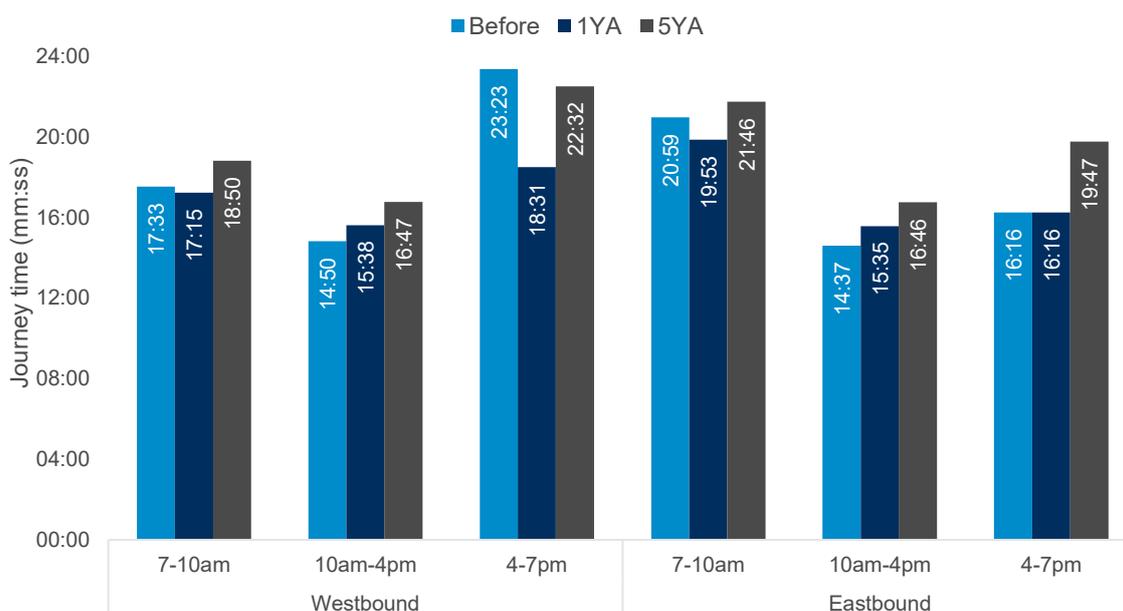
Did the project deliver journey time savings?

For this section satnav data is used to calculate the average journey times for each direction, and time-period, set out in the traffic forecast documentation. To compare like for like against our original forecasts and one-year after data, journey time savings, speed and reliability were calculated from junctions 25 to 30 of the M62. The dates used for this analysis was March 2011, 2015 and 2019 for before, one-year and five-years after respectively.

At five-years after, journey times have worsened from the one-year study. Initially journey times improved at one-year in most peak periods, but since then they have increased. This may be due to the increased use of the hard shoulder and variable speed limits, which will slow vehicles down during busy periods (*How was the smart motorway operated?*).

Average journey times have increased across all the peak periods compared to one-year after as well as from before, except 4-7pm on the westbound carriageway, which is still showing a saving compared to before (Figure 6).

Figure 6 Average weekday journey times at 1YA, 5YA and before construction of the smart motorway



Source: TomTom satellite navigation data March 2011, 2015 and 2019.

At five years after the journey times have worsened, with most now slower than 60mph in the morning and evening peak periods. We typically see journey times improve after the introduction of this type of project, but the journey times tend to increase thereafter as traffic levels increase over time. This is what we are seeing in our five-year evaluation analysis. Calculations undertaken to support the value for money analysis in section 7 have shown that even when considering how conditions were likely to deteriorate had the project not been implemented (the 'counterfactual'), the project was not offering an overall improvement at five years after¹¹. When accounting for the observed traffic growth seen at five years after, if the section of road had remained as a 3-lane motorway they would have been unable to support the additional road users, without experiencing a reduction in speed¹².

Were journey time savings in line with forecast?

When the smart motorway was first opened, journey times were broadly in line with what was forecast, except for the eastbound carriageway in the morning. At five-years after it is more difficult to say with certainty how journey times compare to what was forecast. The scenarios only accounted for the opening and design years, 2016 and 2031.

There is also the added complexity that the journey time forecasting used a different model to that of the traffic flows. This meant that journey times in the

¹¹ In this section we are presenting before and after journey times unadjusted. For section 7 (value for money) we have compared outturn journey times against a counterfactual estimate of what journey times are likely to have been without the project. This allows for the deterioration in journey times that we would have expected to have happened due to growth in background traffic levels causing additional congestion. The counterfactual calculation estimated a disbenefit of 96,500 vehicle hours in the fifth year after opening.

¹² Analysis has shown that with observed increased in traffic at five years after, a 3-lane motorway would not be able to support these additional road users without experiencing a reduction in speed, in at least one peak time period.

scenario without the smart motorway, predicted that journey times would be lower in the opening year than what they were before construction. This assumption meant that both scenarios, with and without the smart motorway, were inaccurate.

It is difficult to show how journey times were performing against what was expected, but we can give an indication based on the opening and design year forecast scenarios.

Journeys taking place during the day, between 10am and 4pm, were roughly in line with these forecasts and occur somewhere between the with and without smart motorway forecasts. This is similar for the eastbound evening and westbound morning journeys, where the five-years after observed journey times were between the same two scenarios. The main differences between observed and forecast journey times occur for the converse routes, westbound evening and eastbound morning. The former of these is performing worse than the latter against the recorded forecasts. The journey times observed westbound in the evening at five years after were faster than before construction but were almost the same as were forecasted to occur in 2031 had the smart motorway not been installed. Eastbound morning is not as extreme, but before, one-year and five-years after observed journey times were slower than the 2031 with smart motorway scenario, but faster than the without scenario.

Did the project make journeys more reliable?

A key aim of smart motorways is to improve the reliability of journeys, making them more predictable for road users. To measure this, we examine how much journey times vary from the average journey time, on any day or time-period. Where journeys were less variable, road users can allow a smaller window of time to travel through that stretch of smart motorway, when travelling at a similar time.

Overall, the reliability of journey times for this project is mixed. Most of the average journeys (those occurring between the 25th and 75th percentiles) were more reliable than before the smart motorway was constructed, however some of the slowest journeys were now longer. All the quickest (10%) of journeys were slightly slower than before, though this is expected for smart motorway projects where variable speed limit signs were installed which were not present before. The westbound carriageway during the evening were seen the largest improvement over time, with average journeys taking less time as well as the longest journeys being completed in a shorter amount of time too. Conversely, this same time on the eastbound carriageway were seen the most deterioration, with the middle journeys now more spread than they were before, and slowest 10% of journeys now taking over 7 minutes longer to complete.

Were the slowest journeys more reliable?

The reliability objective for the M62 junctions 25 to 30 was to provide more reliable journey times, as measured by the 10% of journeys which took the longest time to complete. This is depicted as the 90th percentile in Figure 8 and Figure 9; the line extending to the right of the boxes.

Heading west, the slowest 10% of journeys were still quicker than they were before the smart motorway in the morning and evenings, almost 5 minutes between 4pm and 7pm. During the daytime, the slowest journeys were slower than they were before the project by around 3 minutes. All three times of the day saw increase on one-year journey times, though this is to be expected.

On the eastbound stretch, the slowest journeys in the morning were back to the same they were before the project but have increased by over 7 minutes in the evening. The daytime saw a small increase too of 2.5 minutes, though this also increased at one-year after too.

Although there were significant journey time savings at one-year after, these were not expected to continue and were only an immediate benefit following the opening of the project. As time passes, traffic increases on the motorway and becomes more congested, leading to longer journey times.

Figure 7 What does a box plot show?

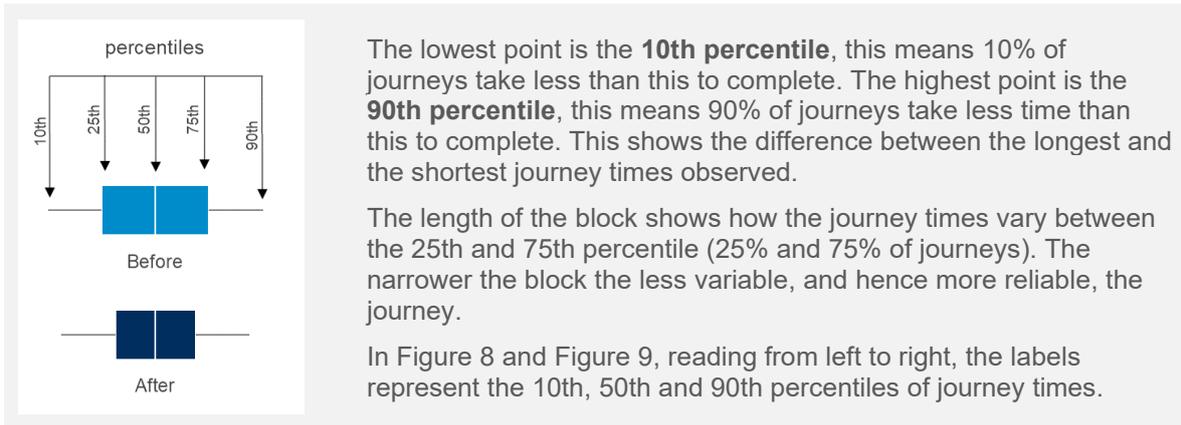
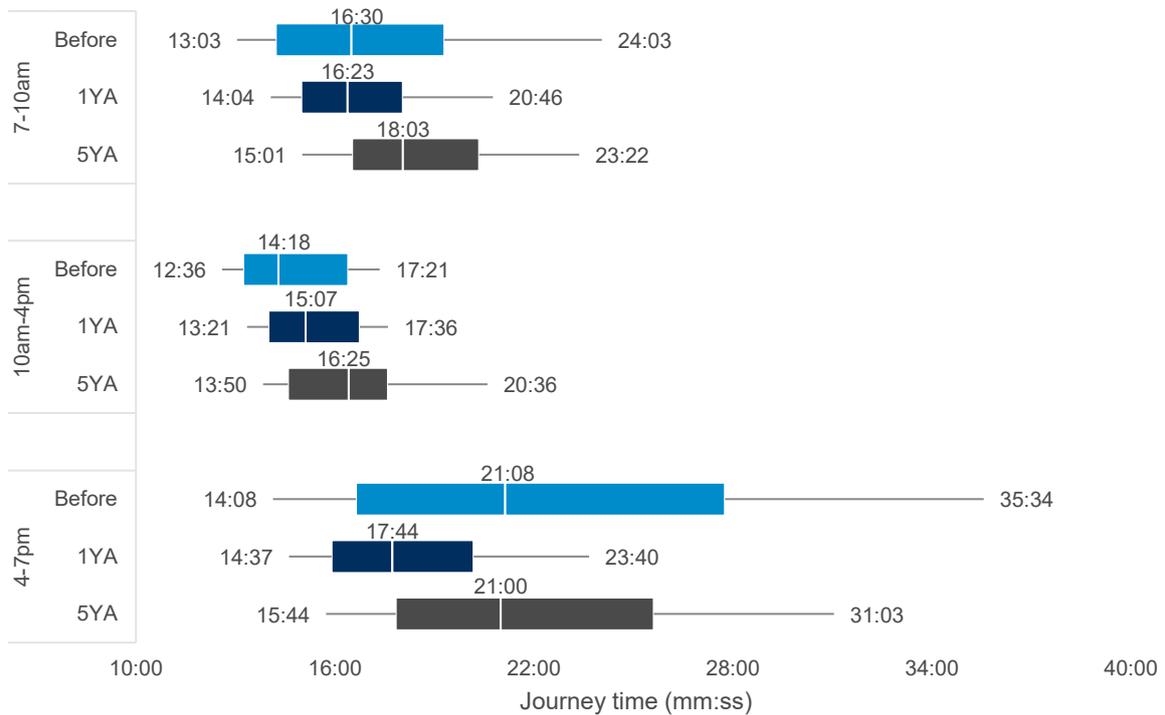
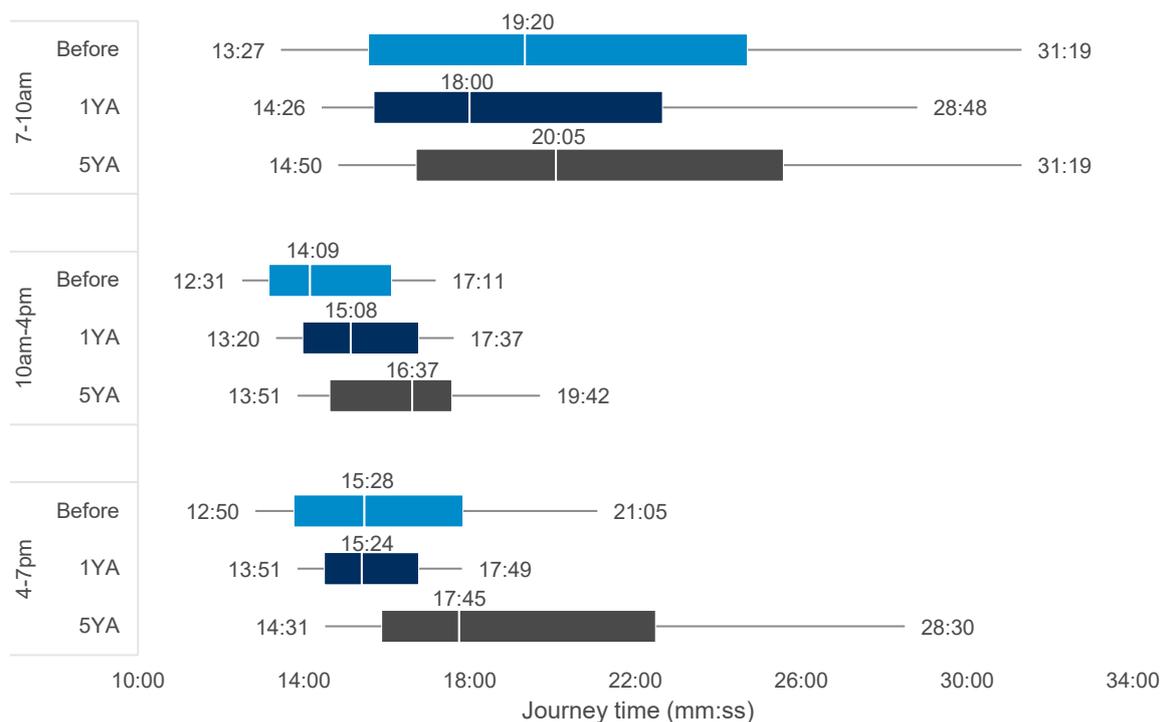


Figure 8 Journey time reliability (westbound)



Source: TomTom satellite navigation data March 2011, 2015 and 2019.

Figure 9 Journey time reliability (eastbound)



Source: TomTom satellite navigation data March 2011, 2015 and 2019.

Were average journeys more reliable?

Half of all journeys made within these time periods are contained within the blue and grey boxes presented in Figure 8 and Figure 9. If these boxes get shorter then journeys become less variable, meaning road users can be more confident of the time it takes to travel through the route.

Reliability on the westbound carriageway is still better than before the smart motorway was constructed, with journeys in the evening seeing the most benefit of just over three minutes. Journeys were more reliable in the morning by just over a minute and is the same during the daytime. This means that half of all journeys¹³ were completed in a smaller travel window than before.

Heading east, journeys were not as consistent as the westbound direction. In the evening, journeys were more variable by an average of two and a half minutes, and these were taking longer than before. In the morning, journeys were marginally more reliable with the daytime remaining the same as before, as is the case with the westbound direction too.

Over the whole project, the smart motorway were resulted in more reliable journeys during the busiest times. Less variability in journey times comes with increased confidence that road users can complete their journeys within a smaller travel window.

Have the quickest journeys been impacted?

The quickest journeys on the smart motorway have all increased slightly from both before the project and on one-year after opening, which were shown as the 10th percentile tails to the left in Figure 8 and Figure 9. This is expected during the

¹³ 25th to 75th percentile range of journey times.

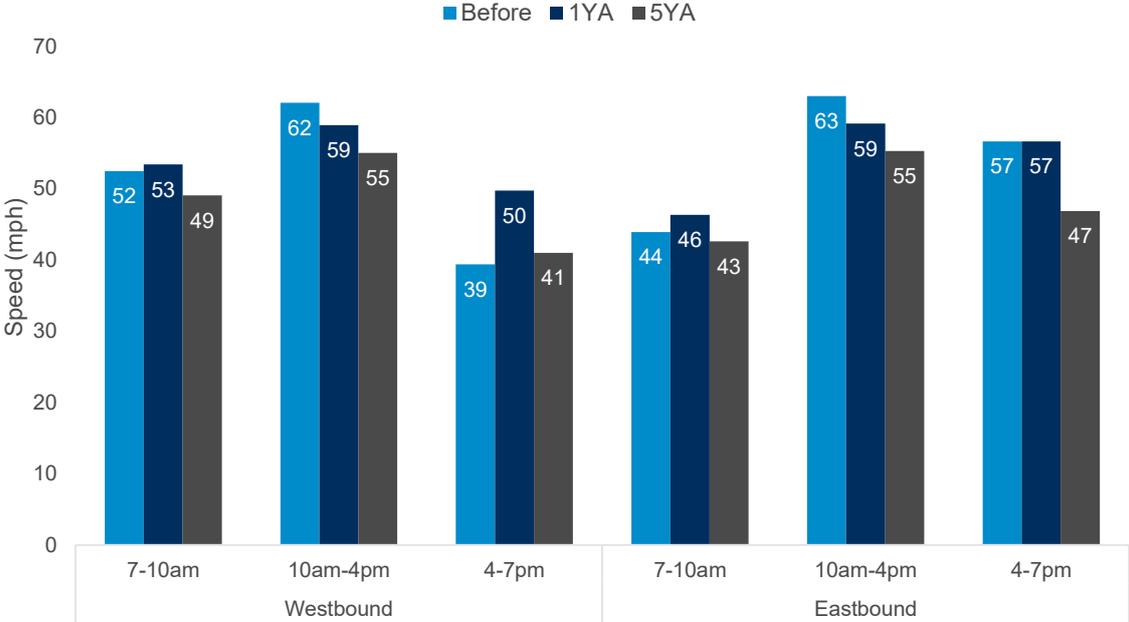
busier times of the day as variable speed limits are imposed to smooth the flow of traffic, resulting in the quickest journeys taking slightly longer.

How did the project impact speed?

In combination with journey time analysis, speed can help to determine the impact the smart motorway had on congestion. Speeds were not necessarily quicker as a result of a smart motorway. Instead, smart motorways aim to make journeys smoother, so ideally speeds should be more consistent.

Typically, average speeds have decreased across the project section when comparing prior to smart motorway construction (Figure 10). Most of these changes in speeds were relatively small, except for the eastbound carriageway during the evening which were decreased by 10mph. At the same time in the opposite direction, speed increased compared to before. There was very little change in speed during the mornings, with very small changes on both carriageways. The daytime saw a consistent fall between before, one-year and five-years after, a drop of around 1mph per year.

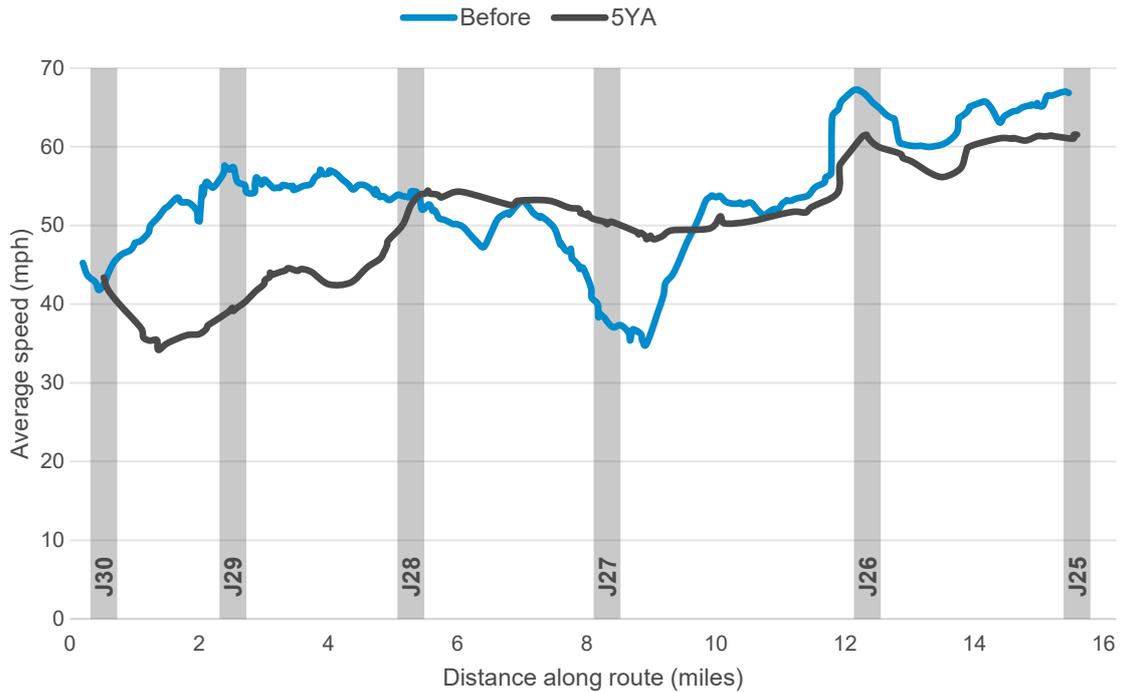
Figure 10 Average speed on M62 J25-30 during peak hours



Source: TomTom satellite navigation data March 2011, 2015 and 2019.

The core section of the motorway, between junctions 26 and 28 in both directions, have seen more consistent speeds over the route compared to before. The bottleneck that existed at junction 27 on the westbound carriageway is now a lot faster, with consistent speeds from junction 28 through to junction 25 (Figure 11). In the evening, average speeds were very similar to that of before the smart motorway. There were some improvements between junctions 27 and 28, but these were offset by reductions on other parts of the project.

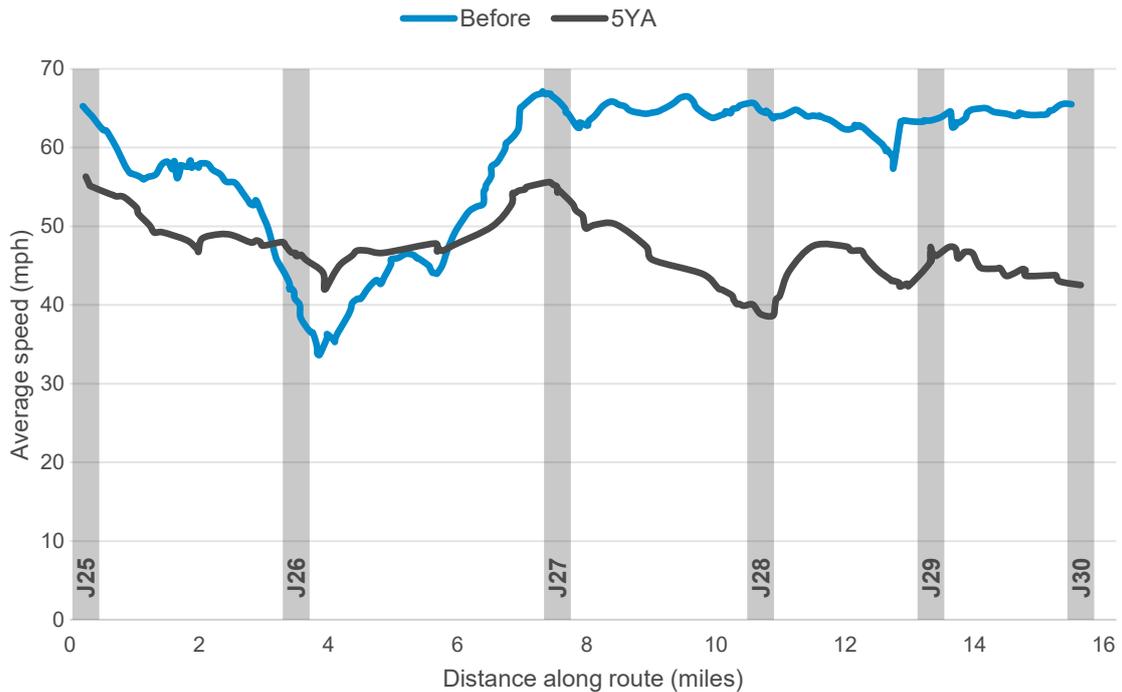
Figure 11 Average speed comparison 7-10am westbound



Source: TomTom satellite navigation data March 2011 and 2019.

Other sections of the project have suffered as a result of the smart motorway, particularly junctions 27 through 30 on the eastbound carriageway. At five-years after, average speed through this section is slower than before in both the morning and evening peaks. However, this same section saw speed improvements between junctions 25 and 27, especially in the evening, which is now more consistent than before, with less stop / start through the junctions (Figure 12).

Figure 12 Average speed comparison 4-7pm eastbound



Source: TomTom satellite navigation data March 2011 and 2019.

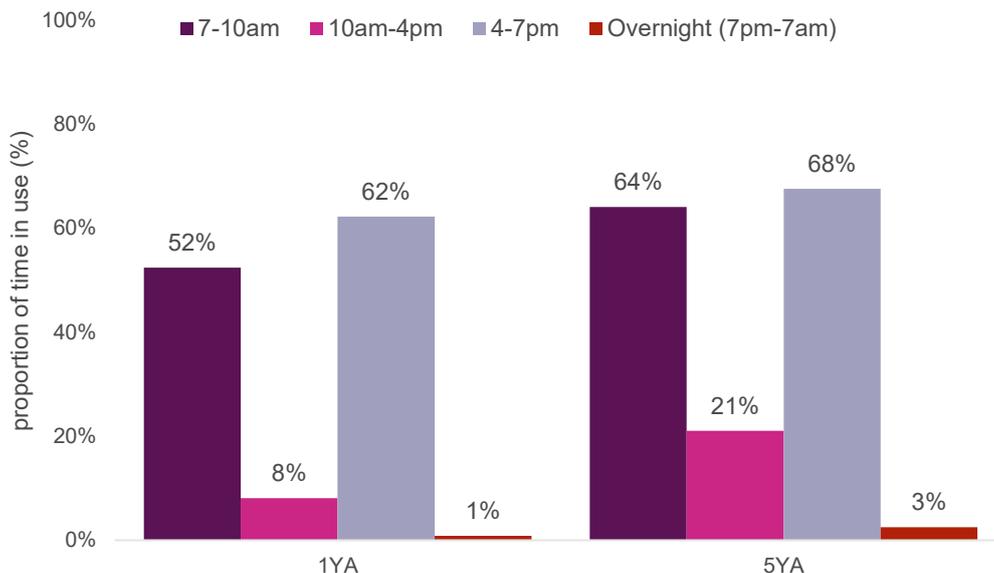
How was the smart motorway operated?

Smart motorways have introduced and use technologies and features not present on conventional motorways which help keep drivers moving safely. Some have hard shoulders (controlled), some use the hard shoulder as a running lane at the busiest times (dynamic hard shoulder running (DHS)) and all lane running (ALR) permanently converts the hard shoulder to a running lane and has a whole system of inter-related features, including emergency areas. This section looks at how these technologies have been used compared to one-year after.

How often is the hard shoulder used as a running lane?

A dynamic hard shoulder is in operation on some sections of this smart motorway; between junctions 26 and 28 in both directions, then eastbound between junctions 29 and 30. Usage of the hard shoulder as a temporary running lane increased since one-year after during busy times (Figure 13). Both the morning and evening peaks have seen an increase in use since one-year, with the hard shoulder now being in use more than half of the time (around two hours out of three). The largest increase in usage was been seen during the daytime, from 10am to 4pm. The hard shoulder is used for traffic for around 1 hour 15 minutes at five-years after, up from 30 minutes at one-year. Overnight, between 7pm and 7am, the hard shoulder is still being used very little at an average of 20 minutes over a 12-hour period.

Figure 13 Hard shoulder usage at five-years after compared to one-year



Source: National Highways MIDAS traffic data. Data aggregates J26-28 westbound, J26-28 and J29-30 eastbound.

Lane utilisation of the smart motorway

This section looks at how the individual lanes of the smart motorway were utilised by road users, specifically concentrating on the dynamic hard shoulder section between junctions 26 and 28. Typically on conventional motorways, lane one is used the most along with lane two, with the right-hand lane being used by vehicles the lowest. On smart motorways, an extra lane is added to the left of the usual lane one, so it is useful to understand how this additional lane is used.

The core section of the smart motorway between junctions 26 and 28, where a dynamic hard shoulder is used, saw a greater use of the additional lane at five-

years after. Within this section, junctions 26 to 27 is still seeing greater traffic volumes and usage of the hard shoulder than between 27 and 28.

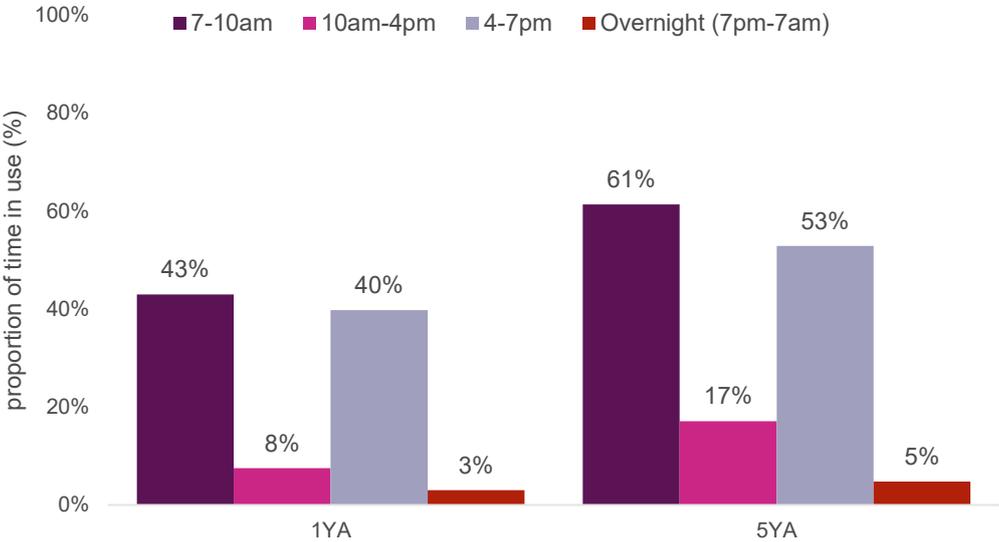
The evening sees a lot more use of the hard shoulder on the westbound carriageway towards Bradford, and conversely the eastbound towards Leeds saw an increase in the morning. However, across all times and both carriageways, the hard shoulder suffers from under usage, with lane 4 sometimes being used the most.

The lowest use of the hard shoulder is between junctions 27 and 28, which is sometimes a third of the average flow of the next lane. This can cause severe congestion at peak times with more vehicles using the outside lanes (3 and 4), slowing down passing traffic when they could be using lanes 1 and 2. Other relevant lane utilisation graphs for one and five-years after are shown in Appendix A.

How often were speed limits set?

Speed limits along the smart motorway were set more frequently than at one-year, with 60mph seeing the greatest usage. At one-year after the signal was set quite evenly across the morning and evening at around 40% of the time. At five-years it is set in the morning for around 60% of the time, and in the evening for just over half the time (Figure 14). This translates to roughly 2 hours and 1 hour 30 minutes across the three-hour periods respectively. There was no materialistic change to the use of this speed limit overnight, but the daytime (10am-4pm) saw a larger increase. This signal is now used for about an hour of the six-hour period, an increase of 30 minutes from one-year.

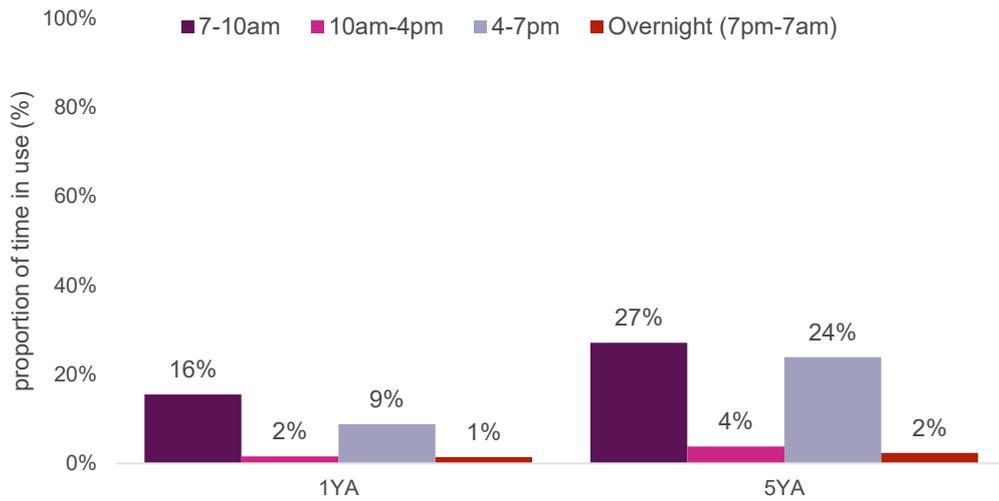
Figure 14 Use of the 60mph speed limit at one and five years after



Source: National Highways MIDAS traffic data, aggregate of J25-30 both westbound and eastbound.

The 50mph speed limit is used much less than the 60mph one and never exceeds more than a third the proportion of time (Figure 15). It is set for similar amounts of time in both the morning and evening, around 45 minutes of the three-hour periods. Both the daytime and overnight periods have not seen much of an increase; because these time periods are larger, the effect is negligible.

Figure 15 Use of 50mph speed limit at one and five years after



Source: National Highways MIDAS traffic data, aggregate of J25-30 both westbound and eastbound.

5. Safety evaluation

Summary

Over the five-year evaluation period, there was a slight reduction in the annual average number and rate of personal injury collisions¹⁴ on the M62 junctions 25 to 30 and on the surrounding network following the opening of the project. Each year there was an average reduction of 27 personal injury collisions on the project section which is in line with the appraised business case for the project. This is based on an annual average of 54 personal injury collisions after the project opened compared to 81 before the project was constructed.

When accounting for the increased volume of road users over this period, the annual average rate of personal injury collisions per hundred million vehicle miles was also improved after five years. Before the project was constructed there was an average of one personal injury collision per 6 million vehicle miles travelled. In the five years after the project opened to traffic, this changed to an average of one personal injury collision per 11 million vehicle miles travelled. This shows that over five years after the project opened, there were an additional 5 million vehicle miles travelled on the route without a personal injury collision. This result shows that there were fewer collisions as vehicles can travel further before an incident occurs.

However, safety trends can change overtime due to factors beyond the road layout. The findings indicate that there was a statistically significant¹⁵ reduction in the number or rate of personal injury collisions compared to the predicted¹⁶ trends if the route had remained a conventional motorway. It is estimated that if the road had remained as a conventional motorway over this period the average rate of personal injury collisions (per million vehicle kilometres) would most likely have remained consistent with the pre-project rate with the number ranging from 52-88 personal injury collisions on average per year. The safety improvements observed following the conversion to smart motorway were just within the lower bounds of this range and indicate that the route is as safe as the conventional motorway it replaced.

On the surrounding network¹⁷ there was an average reduction of 154 personal injury collisions per year (Based on an annual average of 258 personal injury collisions observed after the project had opened compared with 412 before the improvement). This is a statistically significant reduction in the number of personal injury collisions compared with the estimated trend if the project section had remained a conventional motorway, with an annual average of between 416 and 508 personal injury collisions over this time period. This indicates that the surrounding road network might have experienced an increase in personal injury collisions if the M62 25-30 had remained a conventional motorway.

¹⁴ A collision that involves at least one vehicle and results in an injury to at least one person

¹⁵ We have tested the results at 90% confidence interval. The critical value at 90% confidence interval is 54, the observed collision savings for the project extent is the same as this value of 54. We believe that the collisions savings observed for the project extent and wider safety area ensure that the project has met its safety objective

¹⁶ This assessment is based on changes in traffic flows for high volume conventional motorways and accounts for changes in regional safety trends. For more information please refer to Annex

¹⁷The road network is determined as part of the appraisal process to understand changes to road safety on the project extent and roads which the project may have an impact.

The severity of collisions was also reduced since the project opened. During the five years before the project was constructed there was a total of 7 fatal collisions and this has reduced to a total of 2 fatal collisions in the five-year period after the project had opened to traffic. On average there were 21 fewer collisions leading to slight injuries per year, an increase of 1 in the number of collisions leading to serious injuries per year. When accounting for the increased number of road users over this period, there was been a reduction from 0.7 to 0.3 fatality equivalents¹⁸ per hundred million vehicle miles travelled. Reducing the risk of a fatality equivalent by 0.4 for every hundred million vehicle miles travelled.

The evaluation found there has been a reduction in the number, and rate of personal injury collisions. The five-year evaluation concludes that the objective has been met¹⁹.

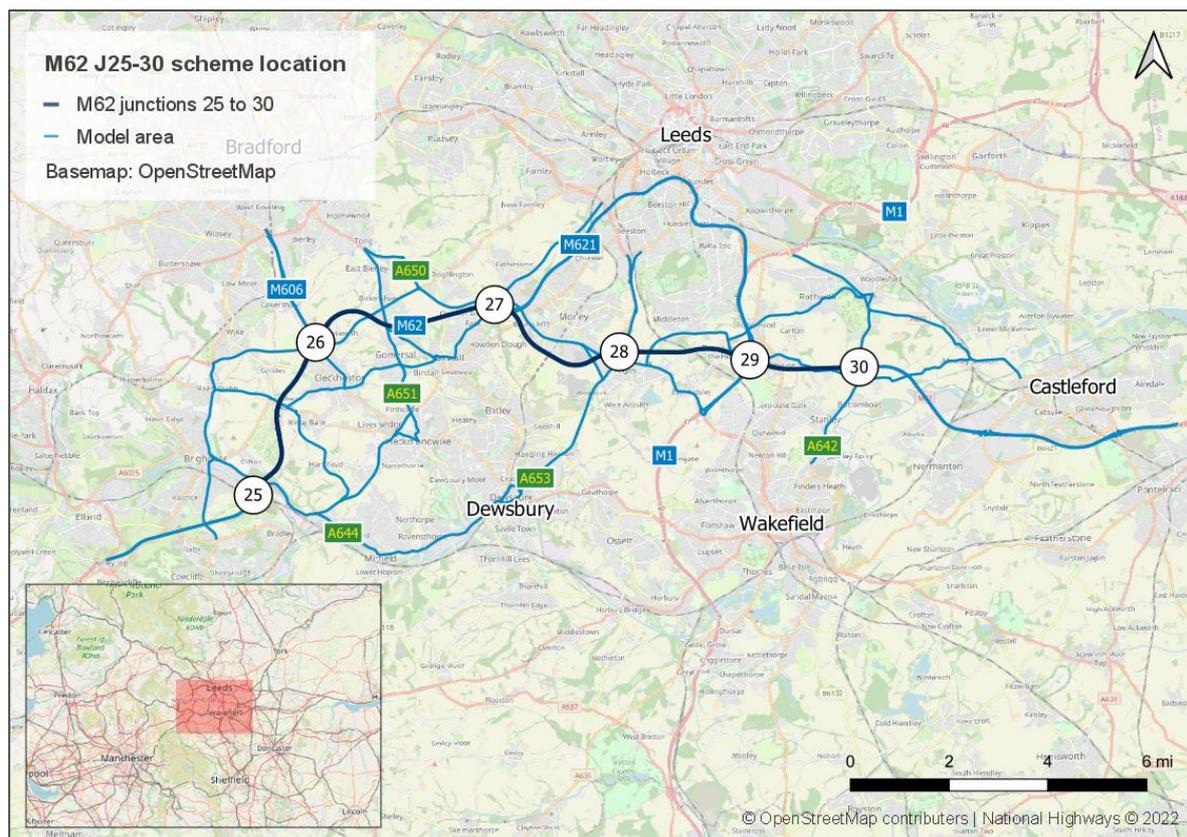
Safety study area

The safety study area, shown in Figure 16 was defined as the project extent on the M62 between junctions 25 and 30, and a wider area including adjacent roads on the local road network. This area has been considered to allow us to determine the impacts on safety that the project had on both the project extent and the wider area.

¹⁸ The FWI weights Collisions based on their severity. A fatal collision is 1, a serious collision is 0.1 and a slight collision is 0.01. The combined measure is added up. A full number is the equivalent to a fatality.

¹⁹ Projects are appraised over a 60-year period. This conclusion is based on the findings at five years after the project opened for traffic

Figure 16 Safety study area



Source: National Highways and OpenStreetMap contributors

Road user safety on the project extent

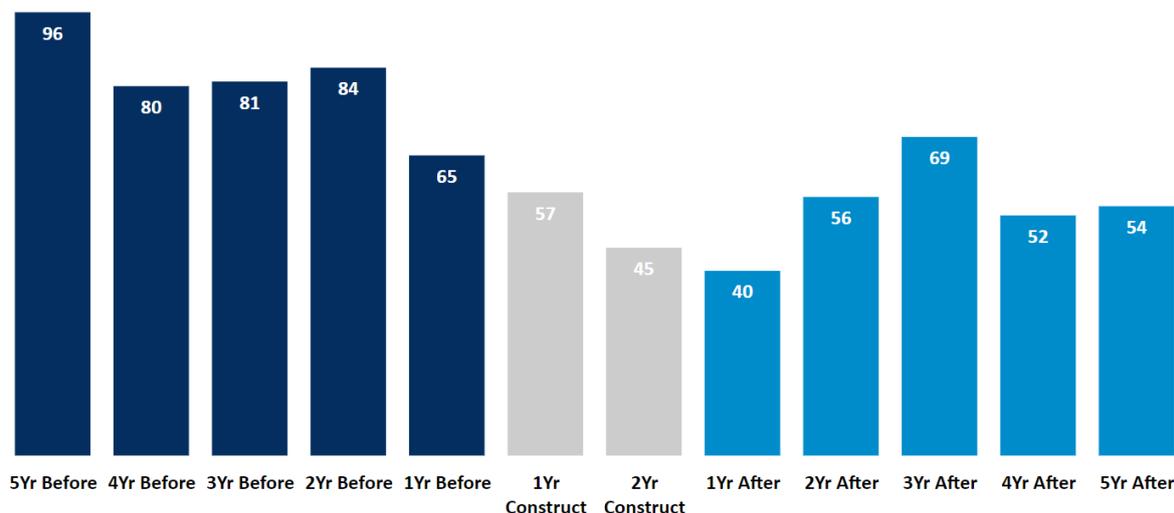
What impact did the project have on road user safety?

We found the project reduced the number of personal injury collisions on the project extent, junctions 25 to 30 (impacts on the wider area are discussed in *Road user safety in the wider area*).

Over the five years after the project opened, there were an average of 54 personal injury collisions per year, 27 fewer than the average 81 per year over the five years before the project was constructed.²⁰

²⁰ Based on data from 1st June 2004 to 31st May 2009 (before opening) 13th October 2011 to 2nd October 2013 (during construction) and 3rd October 2013 to 3rd October 2018 (post-opening). Due to central barrier works undertaken between June 2009 and 2010 means that this period has been excluded from the evaluation. A full five consecutive year period has been taken as representative of the before opening period.

Figure 17 Personal Injury Collisions



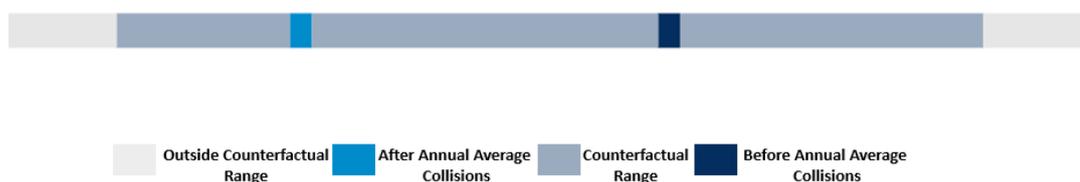
Source: STATS19: 1st June 2004 to 2nd October 2018

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 Annex 2: Safety Counterfactual Methodology). This is based on changes in regional safety trends for conventional motorways with a high volume of roads users.

Figure 18 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:

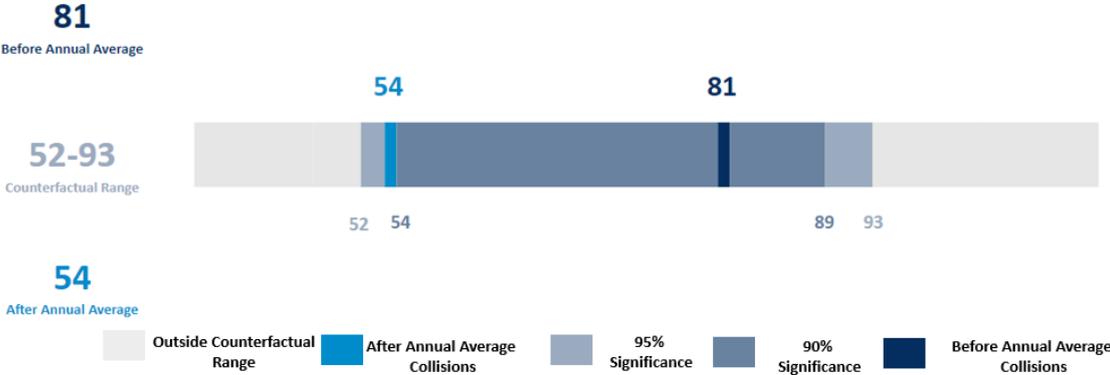
1. Annual average number of collisions from before the project
2. Annual average number of collisions after the project
3. Estimated counterfactual range, which comes from a X^2 hypothesis test on one degree of freedom using a significance level of 0.05. More details can be found in the [POPE Methodology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



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 have increased, and collision rates would remain stable as shown in Figure 19 below.

A range of between 52 and 93 personal injury collisions²¹ during the five-year post project period would be expected, as shown in Figure 19.

Figure 19 Observed and expected range of personal injury collisions (annual average)



Source: STATS19: 1st June 2004 to 2nd October 2018

An annual average of 54 personal injury collisions were observed over the five-year post-opening period. This falls within the counterfactual range but is closer to the lower limit of 52 than the upper limit of 93. Therefore, whilst it is suggestive of safety improving²², we cannot be fully confident that it has.

How were traffic flow 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 annual hundred million vehicle miles (hmvm).

Prior to the project, there was an annual average of 16 personal injury collisions per hmvm. After the project improvements were made there was a decrease to 10 per hmvm. A decrease of 6 personal injury collisions for every hundred million vehicle miles travelled.

The distance travelled before a personal injury collision occurred increased from 6 to 11 million vehicle miles per personal injury collision.

A counterfactual test was undertaken. It found that the collision rate would likely have been 12 collisions per hmvm in the counterfactual scenario. This indicates that we predicted a decrease in the number of collisions and a reduction in the rate that they occur despite increased traffic flows. The reduction in collision rates suggest that safety has improved but we are less confident in this conclusion.

What impact did the project have on the severity of collisions?

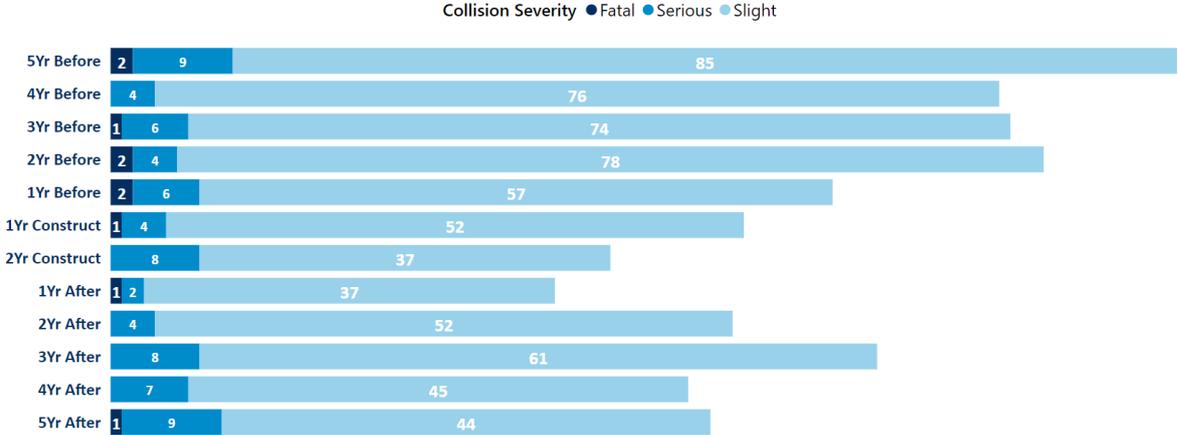
Collisions which result in injury are recorded by severity as either fatal, severe or slight. The severity of collisions reported uses unadjusted severity information.

²¹ The safety methodology is different from one-year to five-year evaluation. We still have confidence in the accuracy of the previous methodology but have made suitable changes that will ensure a methodology fit for purpose for the future.

²² We have tested the results at 90% confidence interval. The critical value at 90% confidence interval is 54, the observed collision savings for the project extent is the same as this value of 54. We believe that the collisions savings observed for the project extent and wider safety area ensure that the project has met its safety objective

The evaluation found, after the project there was an average of 27 fewer collisions resulting in slight injuries per year (the annual average before the project was 78, compared to 51 after), serious incidents have slightly increased (as the annual average before the project was five, compared to six after). There was a reduction of fatal incidents (with eight (average 1.6) before the project, and two (average 0.4) after). Figure 20 shows the severity of personal injury collisions.

Figure 20 Severity of personal injury collisions within the project extent



Source: STATS19: 1st June 2004 to 2nd October 2018

How were traffic flow impacted collision severity?

Like other transport authorities across the UK, the key measure we use to assess the safety of roads, is Fatal and Weighted Injuries (FWI). This gives a fatality 10 times the weight of a serious casualty, and a serious casualty 10 times the weight of a slight casualty²³. In effect, it takes all non-fatal injuries and adds them up using a weighting factor to give a total number of fatality equivalents²⁴. This is represented by an annual average and a rate that standardise casualty severities against the number of road users to show the likelihood of a fatality equivalent occurring per distance travelled.

A reduction of two fatality equivalents were observed annually as the severity of casualties occurring after the project became operational was reduced on the route. Before the project an annual average four fatality equivalents were observed. After the project this had reduced to an annual average of two fatality equivalents.

The combined measure showed an extra 155 million vehicle miles was travelled before a fatality equivalent. Before the project, there was one fatality equivalent for every 134 million vehicle miles (0.7 fatality equivalents per hmvm²⁵). After the project this increased to one fatality equivalent for every 289 million vehicle kms (0.3 fatality equivalents per hmvm). This suggests that taking into account changes in traffic the project is having a positive safety impact on the severity of casualties within the project extent.

²³ The FWI weights Collisions based on their severity. A fatal collision is 1, a serious collision is 0.1 and a slight collision is 0.01. So 10 serious collisions, or 100 slight collisions are taken as being statistically equivalent to one fatality.

²⁴ Unadjusted casualty severities have been used in this report

²⁵ Hundred million vehicle miles

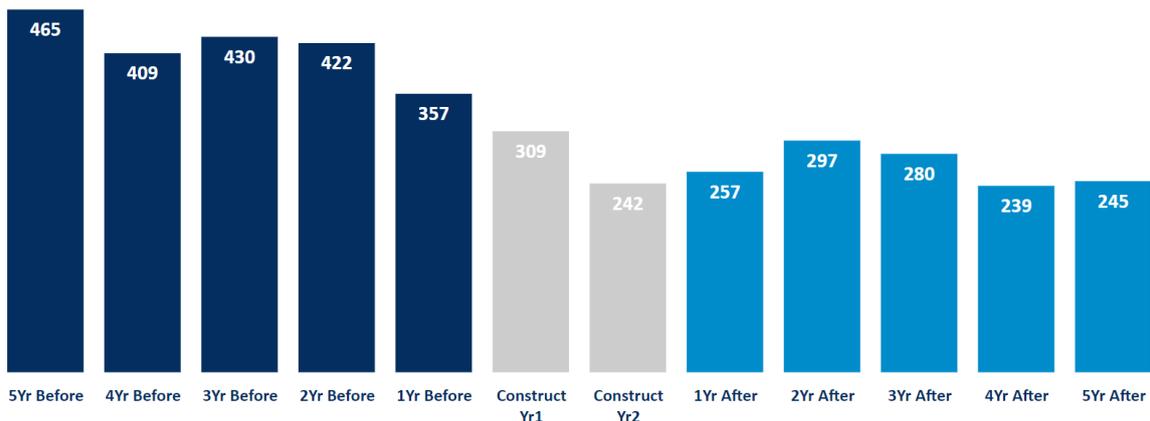
Road user safety in the wider area

What impact did the project have on safety for the wider area?

Personal injury collisions were observed for a wider impact area which is derived from safety appraisal for the project. This is to determine if the project is successful in improving safety for a wider area. For the purposes of this report, we have observed personal injury collisions that have been recorded on the local road network.

Before the project an annual average of 417 collisions were observed. After the project, this had fallen to 264, a reduction of 153.

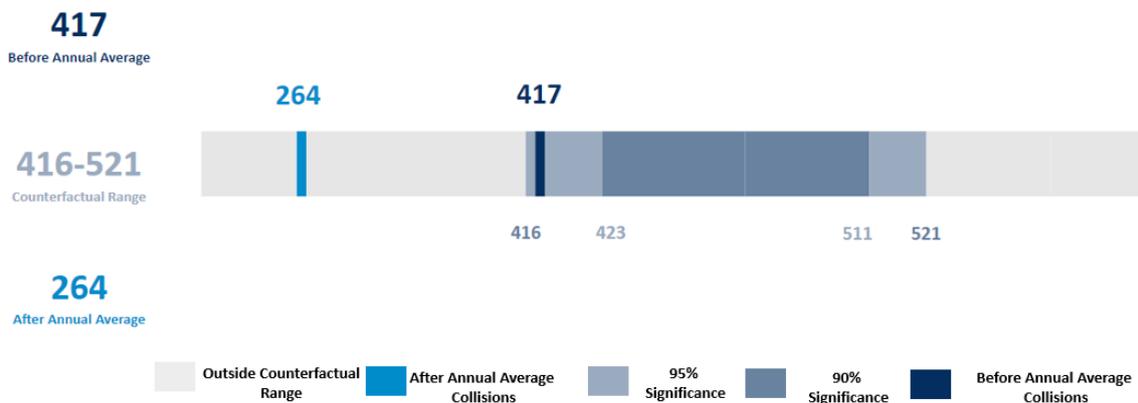
Figure 21 Personal injury collisions in the wider area



Source: STATS19: 1st June 2004 to 2nd October 2018

The counterfactual analysis indicated that it is likely that an annual average of between 417 and 521 personal injury collisions would have occurred. The observed annual average of 264 personal injury collisions falls below the range. We can be confident that the observed reduction is significant and is likely due to the project.

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



Source: STATS19: 1st June 2004 to 2nd October 2018

How were traffic flow impacted collision severity in the wider area?

A reduction of one fatality equivalents was observed annually as the severity of casualties occurring after the project became operational was reduced on the route. Before the project an annual average 19 fatality equivalents were observed. After the project this had reduced to an annual average of 12 fatality equivalents.

The combined measure showed an extra 52 million vehicle miles was travelled before a fatality equivalent. Before the project, there was one fatality equivalent for every 46 million vehicle miles (2.2 fatality equivalents per hmvm²⁶). After the project this increased to one fatality equivalent for every 98 million vehicle kms (1 fatality equivalents per hmvm).

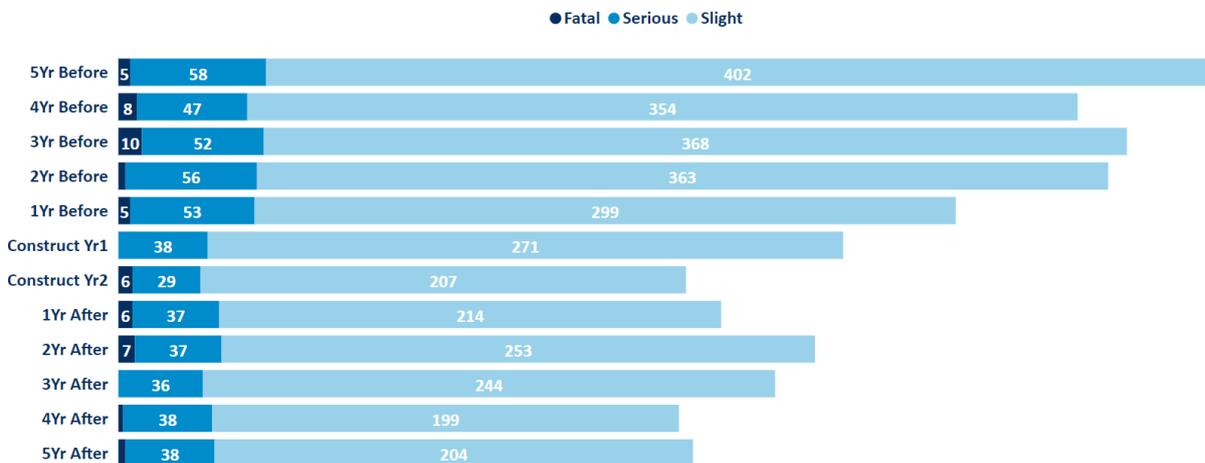
What impact did the project have on the severity of collisions in wider area?

For slight collisions it was found there had been a reduction from 358 to 223 personal injury collisions, for killed or seriously injured personal injury collisions there had been a reduction from 59 to 41 personal injury collisions per year.

Collision severity analysis was undertaken for the wider area using the same method as for the project extent.

After the project we have observed a reduction of 13 collisions resulting in fatalities (the total before the project was 31, compared to 18 after). There was an average of 16 fewer collisions resulting in serious injuries per year (the annual average before the project was 53, compared to 37 after). There was an average of 135 fewer collisions resulting in slight injuries per year (the annual average before the project was 358, compared to 223 after). Figure 23 shows the severity of personal injury collisions.

Figure 23 Personal injury collisions by severity in the wider area



Source: STATS19: 1st June 2004 to 2nd October 2018

How has traffic flow impacted casualty severity in the wider area?

To understand the impact of the increased traffic flow on casualty severity, the measure we use is fatalities and weighted injuries²⁷ (FWI).

A decrease of 7 FWI has been observed. Before the project the average 19 FWI were observed. After the project this had decreased to 12 FWI.

²⁶ Hundred million vehicle miles

²⁷ FWI is explained above.

The combined measure showed an increase of 52 million vehicle miles was travelled before a FWI. Before the project, 46 million vehicle miles needed to be travelled before a FWI (2.2 FWI per hmvm). After the project this increased to 98 million vehicle miles (1 FWI per hmvm).

Has the project achieved its safety objectives?

The project's safety objective was to reduce the number and severity of accidents per vehicle-kilometre. The evaluation found personal injury collisions and rates have both decreased for both project extent and wider area.²⁸ The counterfactual scenario suggests that safety has improved and we are confident in this conclusion.

We have observed an improvement when comparing the severity of collisions before and after the project became operational.

Appraised expectation for the project forecast an annual saving of 22 personal injury collisions for the project extent and wider area. The evaluation found that the appraisal underestimated collisions savings for this project with an average of 27 collisions saved annually.

The evaluation found there has been a reduction in the number, and rate of personal injury collisions. The five-year evaluation concludes that the objective has been met²⁹.

²⁸ We have tested the safety results for the project extent and wider safety area combined and found the results significant at a 90% confidence level.

²⁹ Projects are appraised over a 60-year period. This conclusion is based on the findings at five years after the project opened for traffic

6. Environmental evaluation

Summary

The evaluation of environmental impacts used information on the predicted impacts gathered from the environmental appraisal and the environmental assessment report. Information from one-year after was also used for this evaluation and compared with findings observed at five-years after the project opened for traffic. Observed impacts were determined during a site visit in July 2019 and supported by desktop research. The results of the evaluation are recorded against each of the Transport Appraisal Guidance (TAG)³⁰ environmental sub-objectives and are presented in Table 2. Townscape and water environment were scoped out of the evaluation at five-years after. This was because no impacts to townscape were predicted, and none observed at one-year after. For water, no new drainage assets were required by the project and there were no outstanding issues following the one-year after report. The three society sub-objectives of physical activity, severance and journey quality were also scoped out as there were no outstanding issues since the one-year after evaluation and no new information had arisen.

Our five-year after evaluation confirmed many of the initial findings reported at one-year. The impact of the project on the sub objectives were restricted to within the highway boundary and were either neutral or slight adverse as expected by the assessment.

At five-years after, traffic flows were lower than predicted and, so it was anticipated that impacts on air quality may be better than expected. The predicted slight adverse impacts on landscape were observed to be as expected as much of the project was within cutting or screened by existing or new mitigation planting along the highway boundary. We did see examples where visual impacts were likely to be better than expected because additional mitigation was provided. However, we also encountered other locations where new gantries and signs were causing impacts to be worse than expected. Impacts on biodiversity were predicted to be neutral as only a small area of highway verge of low ecological value was going to be lost. However, the species rich grasslands included in the mitigation planting had not been maintained and those seen were overgrown. The ecological benefits won't be achieved if maintenance is not improved. We considered biodiversity impacts to be worse than expected.

Noise

Noise impacts were caused by changes in traffic and the extra capacity the project was designed to provide. The assessment predicted the smoothing of traffic flows and alleviation of congestion would lead to noise increases along sections where the speed increased, and noise decreases where the speed was reduced. In the opening year it was predicted that noise would increase to the east of junction 26 and decrease between junctions 27 to 28. The impacts were not predicted to be significant, and no project specific mitigation was proposed. By the design year (2028) it was predicted that there would be an overall improvement in the noise environment. However, this was attributed to the application of lower noise

³⁰ TAG provides guidance on appraising transport options against the Government's objective for transport.

surfaces undertaken as part of routine resurfacing work and not by the project itself.

No new noise monitoring was undertaken as part of our evaluation. Instead, we considered the impact on the outcome of the noise assessment had the actual five-years after traffic data been used. The one-year after evaluation reported that the observed traffic flows were lower than the forecast flows used in the environmental assessment to predict the project impacts. However, they weren't low enough to change the overall impacts predicted and the outcome was as expected. We repeated this analysis at five-years after and this identified that observed flows were between 8% and 17% lower than forecast. For some sections average speeds were up to 11mph higher than forecast but in others up to 6mph lower. The slight increase in speeds on some sections may lead to increase in noise but these were unlikely to outweigh noise decrease caused by the lower than forecast flows. No HGV data was available to allow further analysis. As observed flows were lower than forecast but not by more than the 20% that would be required for noise reductions to arise, we considered that the impacts were as expected.

Air quality

The environmental assessment predicted that the implementation of hard shoulder running along the M62 would be beneficial for local air quality. An overall reduction in the number of properties with concentrations above the air quality thresholds was predicted. Overall, the effect of the project would be an improvement in local air quality.

No new air quality monitoring was undertaken as part of our evaluation. Instead we considered the impact on the outcome of the air quality assessment had the actual five-years after traffic data been used.

The one-year after evaluation reported that observed traffic flows were lower than the forecasts flows used in the environmental assessment to predict the project impacts. As the flows were lower, overall pollutant concentration were considered likely to be lower than expected by the environmental assessment. At five-years after we repeated our analysis and considered traffic data along the project and monitoring data available from local authorities and National Highways. We had limited monitoring data but what we did have did not suggest that any significant adverse air quality effects had arisen. Wakefield Council had revoked their air quality management area³¹ along the M62 because air quality had improved. Monitoring data from 2019 for Kirklees Council's air quality management area in Birkhenshaw adjacent to the M62 was also below the UK air quality objective. We did not have HGV traffic data but observed 2019 traffic flows were between 14,000 and 26,000 lower than forecast. Overall, we considered that at five-years after as traffic flows were lower than forecast, air quality impacts were likely to be better than expected.

Greenhouse gases

The environmental appraisal forecast that the project would increase carbon emissions in the opening year of 2013. However, from 2018 onwards carbon emissions would be lower with the project than without it. Overall, there would be

³¹ Areas where a local authority considers air quality objectives may not be met. <https://uk-air.defra.gov.uk/aqma/>

an increase in carbon emissions over time, but these would be less with the project in place. Over the 60-year appraisal period, there would be a net benefit.

It is not possible to evaluate all the greenhouse gas emissions of the project. This is because to replicate the extent of the appraisal we would require forecast and observed traffic data for all the road links used in the appraisal study area and not just the project extent. This data was not available. Instead we would normally calculate a new forecast emission and an observed emission for the extent where traffic data was available. This is usually just the project extent. We would then comment on the accuracy of the forecast and observed emission along this section.

We were unable to calculate a new forecast emission as we didn't have the necessary HGV data to do this. No quantification was possible. The overall traffic flows along the project extent at five-years after were between 8 and 17% lower than forecast. This suggested that there had been a smaller increase in traffic than predicted and so a lower rate in increase in carbon emissions along the project extent was likely.

Landscape

The environmental assessment reported that the M62 runs through the green belt, although the project was not located in any sensitive landscape areas. It was estimated that approximately 58% of the project length was within a cutting and so impacts to the landscape caused by new gantries and emergency refuge areas would be minimal. Existing mature vegetation within the highway boundary would be cleared only where this was needed to accommodate the new infrastructure. This was expected to open up some new views and cause new visual impacts to nearby residential properties. Many of these views would be partial or at oblique angles. Landscape and visual impacts would be minimised by limiting tree clearance to the lower slopes of the cuttings and new planting would be provided. Much of the route was already lit and no new lighting other than low level lighting at emergency refuge areas was proposed. Overall it was predicted that once the mitigation planting had matured impacts would be slight adverse.

Our evaluation focused on a sample of key impacts including the viewpoint locations reported in the environmental assessment. We also revisited many of the locations evaluated at one-year after stage to see how the mitigation planting was establishing.

Our site visit confirmed that the impacts had been limited to within the highway boundary and that the retention of mature vegetation along the tops of embankments meant that there had been no perceptible impacts to townscape or overall landscape character.

Image 1 Views from Rein Road overbridge showing the M62 in a cutting, new gantry and retained vegetation



Source: National Highways

Existing mature vegetation had been lost to accommodate new gantries and emergency refuge areas, but new planting was in place. Our visit identified that the expected maintenance regime did not appear to have been followed. However, the mitigation planting did still appear to be establishing and should achieve its design outcome. The construction of new gantries had opened up new views to visual receptors such as residential properties. This was predicted but we did find locations where the outcomes were better than expected and some where they were worse than expected. Examples where better than expected outcomes were identified included locations where gantries were not installed or at Aspen Court where an additional visual screen was provided. Visual impacts were likely to be worse than expected at Howden Clough Road where residents had open views of the back of a new gantry.

Image 2 Views from Howden Clough Road and back of new gantry and signage on the M62



Source: National Highways

Whilst there were better than expected outcomes at some locations, there were worse than expected outcomes too. Overall, on balance the outcome was likely to be as expected by the design year.

Heritage of historic resources

The environmental assessment predicted that there would be no adverse effects on buried archaeology because all works were within the existing highway boundary. This land had already been disturbed by the construction of the original M62. There were listed buildings within half a mile of the project boundary but no other designated cultural heritage assets nearby. The assessment considered that there would be no material change to the settings of these buildings. This was because a lot of the project was within a cutting and existing planting along the highway boundary would be retained or replaced. Overall impacts were predicted to be neutral.

The one-year after evaluation confirmed that no buried archaeology was encountered. The proposed gantries were constructed within half a mile of the four listed buildings but because of the distance, intervening woodlands and screen planting along the highway boundary, no adverse impacts on the setting of these buildings were noted. At five-years after we revisited these listed building to verify the finding at one-year after. We could not directly access all the buildings but observations from nearby confirmed that there were either no views of the gantries or partial distant views. We considered that the settings of these buildings had not been affected and the outcome was as expected.

Biodiversity

The environmental assessment predicted that the construction of the project, including gantries and emergency refuge areas, would cause the loss of a small area of highway verge. The highway verge comprised mostly of open grassland, scrub and linear belts of trees and bushes. The habitats were reported to be of low ecological value and the surveys done did not detect any protected species. Standard mitigation measures would be adopted to prevent disturbance to any badgers, birds or other species that may be present. New replacement planting including species rich grasslands would be provided in areas disturbed by the works which, it was predicted, would provide some slight benefits. Overall the impacts were predicted to be neutral.

Our five-years after evaluation site visit was undertaken to observe the biodiversity impacts of the project. Access to the soft estate (highway verge) was limited due to health and safety reasons and so observations were restricted to two locations where safe access was possible. This included near Hartsmoor Motorway Service Area and near Scotchman Lane. General observations on the condition of the soft estate were also made whilst driving and from overbridges along the route.

Image 3 Species rich grassland near Scotswood Lane. Some teasel and knapweed seen but plot overgrown with brambles, ragwort and other weeds



Source: National Highways

The impacts we observed were consistent with both those predicted in the environmental assessment and those observed during our one-year after evaluation. Impacts were limited to within the highway boundary and were associated with the loss of verge habitats. However, the species rich grasslands that were provided by the project had not been maintained and were overgrown. These species rich grasslands were predicted in the environmental assessment to provide a slight benefit however this benefit had been lost. Changes in the maintenance regime was needed if the overall biodiversity outcome is to be met by the design year. We considered the biodiversity outcome was worse than expected.

Overview

The results of the evaluation are summarised against each of the Transport Appraisal Guidance (TAG)³² environmental sub-objectives and presented in Table 2. In the table we report the evaluation as expected if we believed that the observed impacts at five years after were as predicted in the appraisal. We report them as better or worse than expected if we feel the observed impacts were better or worse than expected. Finally, we report impacts as too soon to say if we feel that at five years after there was insufficient evidence to draw firm conclusions.

Table 2 Environmental impacts for M62 junctions 25 to 30

Sub objective	Appraisal score	Five-year evaluation	Summary
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³² TAG provides guidance on appraising transport options against the Government's objective for transport.

Noise	People annoyed by noise 2031: 2,890 without scheme, 2,784 with scheme	As expected	Observed flows were lower than forecast along the project extent but not by more than the 20% required to change the predicted outcome.
Air quality	Nitrogen dioxide: 3010 properties with improvement, 2440 with deterioration, 4211 with no change	Better than expected	We had limited monitoring data but what we did have did not suggest any significant air quality impacts had arisen. Observed traffic flows were lower than forecast on average by between 14,000 and 26,000 vehicles per day. Overall air quality impacts were likely to be better than expected.
Greenhouse gases	Change in emissions Opening Year +1,633 tonnes. 60 year appraisal period: -370,096 tonnes	-	We were unable to quantify the change in greenhouse gases caused by the project as we did not have enough data. At 5YA there had been a smaller increase in traffic than predicted and so a lower rate of carbon increase along the project extent was likely.
Landscape	Slight adverse	As expected	The number and scale of gantries had been reduced from those predicted and mature vegetation along the tops of embankments had been retained in many locations. Whilst there were locations with better than expected outcomes there were locations where impacts were worse than expected. Overall, the impact was likely to be as expected by design year.
Heritage of historic resource	Neutral	As expected	The one-year after evaluation confirmed that the four listed properties were within 500m of the proposed gantries as expected. At five-years the site visit could not access all four buildings but based on the observations possible it was unlikely that the settings had been affected by the project.

Biodiversity	Neutral	Worse than expected	Impacts to the low value habitats along the corridor were as expected, however the species rich grasslands had not been maintained and so the slight benefit they were predicted to provide had been lost. Changes to the maintenance regime will be required if the design year outcome is to be met.
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7. Value for money

Summary

As part of the business case, an economic appraisal was conducted to determine the project's value for money. This assessment was based on an estimation of costs and benefits over a 60-year period.

The project was delivered within the original construction budget, at a cost of £122million³³. Five years after opening, the M62 junctions 25 to 30 supported an additional 12% of road users on an average weekday³⁴, whilst delivering £75.9million worth of safety benefits, higher than expected. The section was very close to capacity prior to the project, so without the improvement this additional traffic could not have been accommodated without the road being over capacity³⁵. Although use of the hard shoulder during peak times only increased slightly in the past five years, signs set at 60mph and 50mph have seen greater usage, likely contributing to the increase in journey times across the route (refer to section 4 *How was the smart motorway operated?*).

Journey time benefits accounted for most of the anticipated monetised impacts of this project. The appraisal forecast traffic growth and improving journey times; the observed data suggested traffic growth higher than background trends accompanied by slower journey times, and this affected the projected value for money. Safety is at the forefront of every decision we make. Monetised safety benefits were reforecast to be better than expected, but these only contributed a small proportion of the value for money case.

Overall, the evaluation indicated that in the first five years this investment is not on track to deliver the value for money anticipated over the 60-year life of the project. If the journey time trends observed within the first five years continue, the project is expected to deliver 'low' value for money³⁶.

Forecast value for money

An economic assessment is undertaken prior to construction to determine a project's value for money and inform the business case. The assessment is based on an estimation of costs and benefits. The impacts of project such as journey time savings, changes to user costs, safety impacts and some environmental impacts are able to be monetised. This is undertaken using standard values which are consistent across government. The positive and negative impacts over the life of the project³⁷ are summed together and compared against the investment cost to produce a benefit cost ratio (BCR). The monetised impacts are considered alongside additional impacts which are not able to be monetised, to allocate the project a 'value for money' category.

³³ Present value of costs in 2010 prices and values.

³⁴ This compares to just over 3% more at one year after (Figure 3).

³⁵ Before the conversion, road users experienced high levels of congestion. During the peak hours traffic flow was at 5,700 vehicles per hour, as a three-lane motorway this was at capacity. After the conversion traffic flow was 6,600 vehicles per hour. Had the route remained a three-lane motorway this would be above capacity.

³⁶ The value for money categories referenced are defined by the Department for Transport <https://www.gov.uk/government/publications/dft-value-for-money-framework>

³⁷ Typically project life is taken to be 60 years.

The monetised benefits forecast by the appraisal which supported M62 junctions 25 to 30 smart motorway business case are set out in Table 3. We have also included an indication of what proportion of the monetised benefits each impact accounted for and a summary of how we have treated the monetisation of each impact in this evaluation.

Table 3 Monetised benefits of the project (£million)

	Forecast (£m)	% of forecast monetised benefits	Evaluation approach
Journey times	1,164	80%	Re-forecast for the project area only (not the wider area) using observed and counterfactual ³⁸ traffic flow and journey time data
Vehicle operating costs	-47	-3%	Re-forecast using observed and forecast traffic flow and journey time data
Journey time & VOC during construction and maintenance	-70	-5%	Not evaluated (assumed as forecast)
Journey time reliability	293	20%	Re-forecast using observed traffic flow data
Safety	54	4%	Re-forecast using observed and counterfactual safety data
Carbon	25	2%	Monetised benefits assumed as forecast
Air quality	0	0%	Monetised benefits assumed as forecast
Noise	5	0%	Monetised benefits assumed as forecast
Indirect tax revenues	31	2%	Re-forecast using observed and forecast traffic flow and journey time data
Total present value benefits	1,456	100%	

Note: 2010 prices discounted to 2010. Due to rounding the numbers and percentages may not always add up exactly to the presented totals.

The anticipated costs from the appraisal are set out in Table 4. Based on this information, the project was anticipated to deliver high value for money over a 60-year appraisal period.

³⁸ We calculated the vehicle hours saved by comparing outturn journey times with an estimate of how journey times would have continued to deteriorate had the project not been implemented (ie a 'counterfactual').

Table 4 Forecast cost of the project (£millions)

	Forecast (£m)	Evaluation approach
Construction costs	173	Current estimate of project cost
Maintenance costs	63	Not evaluated (assumed as forecast)
Total present value costs	236	

Note: 2010 prices discounted to 2010. Due to rounding the numbers and percentages may not always add up exactly to the presented totals.

Evaluation of costs

We obtained an up-to-date estimate of the project construction cost which came in slightly under budget at £146million³⁹.

The appraisal expected that the project would result in an increase in maintenance costs over the life of the project. As the vast majority of this maintenance is still in the future, we did not have any information with which to update the estimate for this part of the cost and therefore the forecast from the appraisal remains our best estimate.

Evaluation of monetised benefits

Once a project has been operating for five-years, the evaluation monitors the construction costs and the trajectory of benefits to reforecast these for the 60-year project life. It is not proportionate to replicate modelling undertaken at the appraisal of a project or to monitor benefits over the entire lifecycle, so we take an assessment based on the trends observed over the first five years of operation and estimate the trend over the project life, based on these observations. This provides a useful indication and help to identify opportunities for optimising benefits. In instances where it was not feasible to robustly compare forecast and observed impacts, the findings have been presented with relevant caveats.

Monetised journey time benefits

Monetised benefits were primarily driven by forecasted reductions in journey times over the modelled period compared to a 'do-minimum' scenario, what would be expected to happen if the smart motorway were not built. Therefore, in this section of our study, we have compared the 'after' journey times to an estimate of the 'counterfactual' - what journey times are likely to have been without the project. This allows for the deterioration in journey times that we would have expected to have happened due to growth in background traffic levels causing additional congestion.

The evaluation of this project identified that journey times, while becoming more reliable, have increased slightly since the road was converted to a smart motorway. This was likely due to several factors, including, supporting an increase in the number of road users, as well as speed restrictions when the hard shoulder is opened as a running lane. When the hard shoulder is used as a live traffic lane

³⁹ Present value of costs in 2010 prices and values

during the busiest periods, the speed limit for the carriageway is reduced to a maximum of 60mph, slowing journeys but adding capacity.

We estimated a reforecast journey time disbenefit of £34million. We are only presenting journey time benefits observed on the project area, not the wider area which would have been considered in the appraisal⁴⁰. The reason for this is that our findings relating to the project area are very different to those forecast for that area. We therefore we did not feel we had sufficient confidence in the forecasts to use them to make an estimate of the outturn impact in the wider area (where we did not have observed journey time data). Our observations of flows in the wider area showed mixed evidence for decongestion effects on the wider network. The project extent saw an average growth in traffic of 12%, with local roads just below this at 10-11%. Other strategic routes around the M62 also had similar levels of traffic growth. We acknowledge that the monetised value presented above does not represent the full impact of the project.

Monetised journey reliability benefits

Journey time reliability was a main objective of this project. Our evaluation showed an improvement in reliability (as measured by the average delay experienced in the worst 10% of journeys) on the westbound carriageway, with the slowest journeys taking over four minutes less than before during the evening peak (Figure 8). The gap between the middle 50% of journeys and the slowest journeys on the eastbound stretch were either the same or worse than before (Figure 9).

Monetisation of journey reliability benefits is calculated differently to those shown in chapter 4. It uses the Department for Transport's (DfT) Incident Cost Benefit Assessment (INCA)⁴¹ program and is re-run using observed traffic flow data obtained in the evaluation. Our estimate of the monetised journey reliability is £300million, slightly higher than what was forecast.

Other reforecast benefits

Our evaluation of outturn safety benefits is based on the forecast 60-year appraisal period and a comparison between the forecast and observed number of collisions saved at five years after. A monetary benefit of £53.9million over the 60-years appraisal period was forecast. This was estimated by assuming a 15% reduction in personal injury accidents and assigning monetary benefits to the predicted reduction in the number and severity of personal injury collisions over the 60-year appraisal period. If the project section had remained as a conventional motorway, safety on the project extent and surrounding network would most likely have seen an increase in accidents. Fewer personal injury collisions (PICs) were observed, and there was a reduction in the rate and severity of PICs compared to before the project. The evaluation concluded there were fewer personal injury collisions than expected (Figure 19), and this produced a monetary outturn benefit of £75.9million, a greater benefit than the appraisal expected.

There are two further impacts associated with the changes in numbers and speeds of vehicles – indirect tax revenues and vehicle operating costs. Indirect tax revenues are the benefit to the government (and therefore society) of the additional

⁴⁰ We estimate that the expected monetised benefit on the project section in the fifth year was £0.9M, compared with an estimated disbenefit of £1M based on our observations.

⁴¹ Incident Cost Benefit Assessment can be used to estimate the benefits of reduce delay and travel time variability caused by unforeseen incidents that reduce capacity such as breakdowns, accidents and debris on the carriageway and major disruptions such as spillages.

tax income from the additional fuel consumed due to increased speeds and distances travelled. This was forecast to be positive, and we have evaluated it to be slightly higher at £38million. The impact is higher because our evaluation has shown that although the absolute volumes of traffic are lower than forecast, the percentage change was slightly more. Vehicle operating costs refer to the fuel and other costs borne by the user (such as the wear and tear on vehicles). This generally increases with increased distance travelled. There was a small disbenefit forecast. Based off the changes we have seen in our estimate of fuel consumption and indirect tax revenue, we estimate the outturn impact to be a disbenefit of £56million.

Impacts assumed as forecast

The evaluation has not been able to reforecast the monetary value of noise, air quality and carbon benefits⁴², and instead these were reported as forecast. For these impacts, this assumption is conservative because lower than forecast traffic flows are likely to mean that these impacts are better than forecast⁴³.

Journey times and vehicle operating costs during construction and maintenance are not evaluated and therefore assumed as forecast. As the vast majority of this maintenance is still in the future, we did not have any information with which to update the estimate for this and therefore the forecast from the appraisal remains our best estimate.

Overall value for money

The main reason for the overall reduced level of benefits from this project is the lack of journey time savings. The appraisal forecast significant more traffic with an improvement in journey times; the observed data suggested although traffic has seen more growth, this has been accompanied by slower journeys which has affected the projects' value for money.

When considering an investment's value for money we also take into account benefits which we are not able to monetise. Although not included in the appraisal, wider economic benefits might be relevant given the project's proximity to multiple functional urban areas, but these are usually dependent on delivering journey time savings. Positive impacts on local decongestion and wider economic impacts could improve the value for money category, but as these are not currently evaluated, it is likely that this project has offered 'low' value for money⁴⁴.

Based on the evidence from the first five years, this project is not on track to realise the anticipated value for money. However, there have been benefits delivered - construction of the project was delivered under budget, it is delivering safety and journey reliability benefits to road users and most of the environmental benefits are as expected, or better.

⁴² We do not have a method for reforecasting the monetised impact of noise or carbon impacts. These generally have a small contribution to the monetised benefits of projects and therefore the impact of assuming as forecast is unlikely to impact on the value for money rating of the project.

⁴³ Refer to chapter 6 for further detail on noise and greenhouse gas impacts.

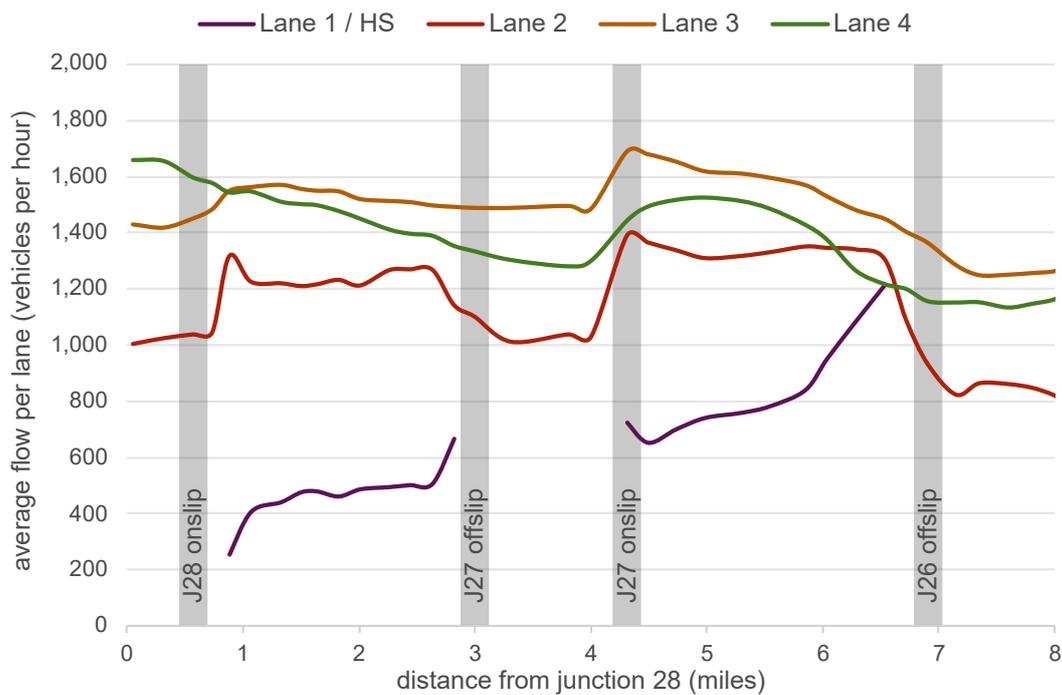
⁴⁴ The value for money categories referenced are defined by the Department for Transport <https://www.gov.uk/government/publications/dft-value-for-money-framework>

Appendix A

Lane utilisation of the smart motorway

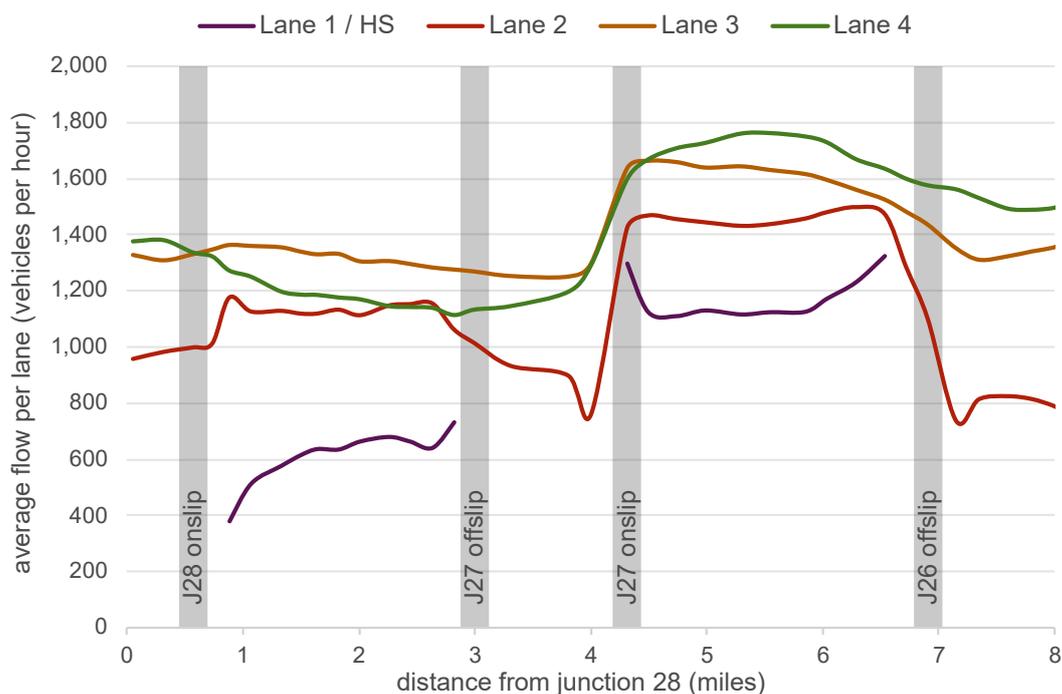
The following graphs contain the average flow per hour for each lane in the core section, junctions 26 to 28 at five-years after.

Figure 24 Lane utilisation of J26-28 westbound 7-10am at five-years after



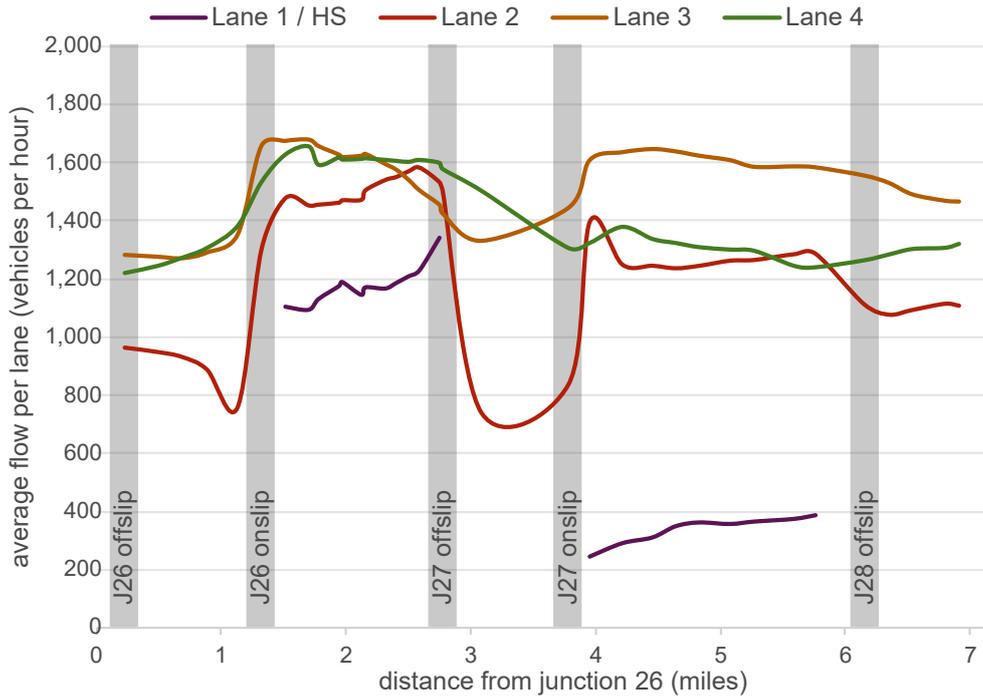
Source: National Highways MIDAS traffic data

Figure 25 Lane utilisation of J26-28 westbound 4-7pm at five-years after



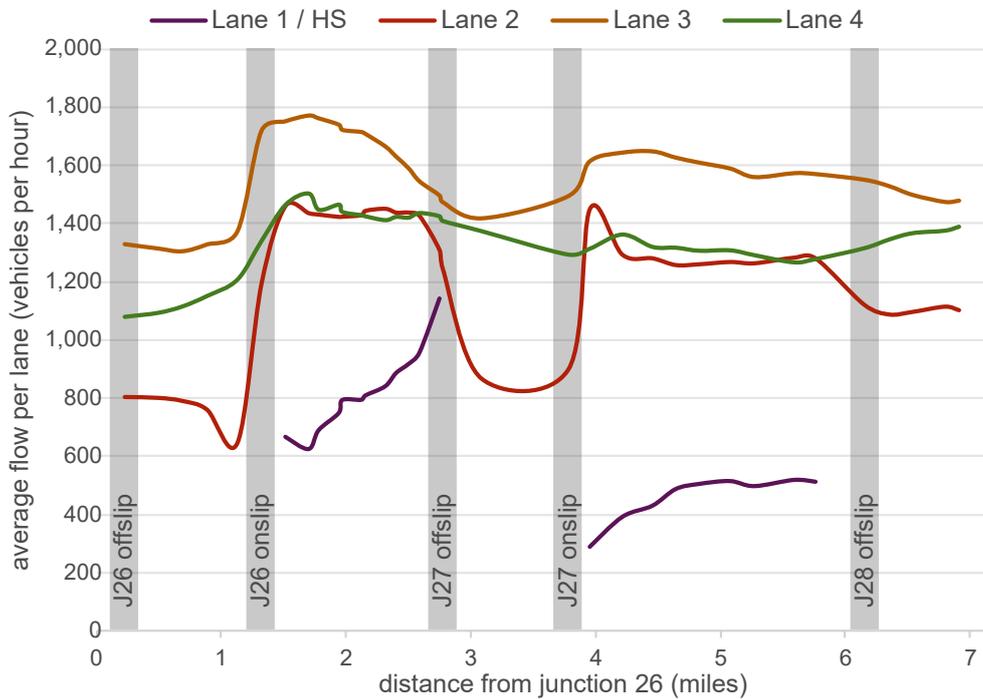
Source: National Highways MIDAS traffic data

Figure 26 Lane utilisation of J26-28 eastbound 7-10am at five-years after



Source: National Highways MIDAS traffic data

Figure 27 Lane utilisation of J26-28 eastbound 4-7pm at five-years after



Source: National Highways MIDAS traffic data

Appendix B

Safety counterfactual 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 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 likely 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 an important 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 different 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.

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