SM-ALR Monitoring

M25 J5-7 Second Year Evaluation Report

Highways England

March 2017

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Background

Smart motorways are a technology-driven approach to the use of our motorways. They increase capacity and improve journey time reliability while maintaining safety.

Expanding evidence base to provide ongoing confidence

The Smart Motorway All Lane Running (SM-ALR) scheme, M25 J5 to J7, converted J5 to J6 to ALR, widening it to 4 lanes. J6 to J7 was upgraded to SM but this section still has a hard shoulder and remains 4 lanes. The scheme has previously been monitored and evaluated for a one year After period. The evidence base is being continually expanded, providing ongoing confidence in the ALR concept. Atkins was therefore commissioned to perform a wide-ranging, comprehensive evaluation of the second year of operation. It is crucial that the performance of the scheme is accurately assessed in order to:

- review the safety performance during the initial period of operation;
- continue to monitor and understand the change in risk to road users and to road workers;
- quantify and provide evidence of the benefits of the concept; and
- provide evidence to help improve the concept of operation and the design requirements.

SM-ALR Objectives

This report presents the results following the second year of After evaluation from May 2015 to April 2016. It is split into sections to cover each of the objectives of SM-ALR as follows:

- flows;
- journey times; and
- safety.

Overview of Year 2 Results compared to Before Period

M25 J5-J7		
Flows	J5-6: Significant (>10%) flow increase achieved with extra lane and capacity for more growth 17% increase CW and 7% ACW. Both higher than national trends.	
Average journey time	JTs returned close to pre-scheme levels but would have been worse if scheme not built. CW 1% increase overall, ACW 2% decrease.	
Journey time reliability	Slight improvement day-to-day on both carriageways	
Safety	J5-6 ALR: Collision rate significantly reduced. Scheme has met its safety objectives. The results are similar for entire scheme J5 to J7.	

Flows

Flow has increased between 3,000 and 10,000 vehicles per day, significantly above national trends

On the widened ALR section between J5 and J6, flows have increased 17% clockwise and 7% anticlockwise. These increases in flow are above the national trends.

J6 to J7, which has not had an increase in number of lanes, had an increase in flow of 5% which is in line with national trends.

The results demonstrate that significant capacity improvements have been achieved, supporting efficient movement of goods and services on this key section of the SRN; in addition that there is still spare capacity to support future growth.

Journey times

Journey times have returned to pre-scheme levels, but would be worse without the scheme

Clockwise, the average journey time to traverse the scheme has increased by 1%, which equates to 10 seconds additional journey time per vehicle; effectively no change from the Before period. Monday to Thursday AM peaks have seen the largest increase of 4%.

It should be noted that if the scheme had not been built, journey times would almost certainly have deteriorated further, without the significant extra capacity being achieved.

Anticlockwise there is a 2% improvement in journey time to traverse the scheme, which equates to a journey time saving of 12 seconds per vehicle, effectively no change in journey times. The Friday PM peak has the largest journey time improvement of 10%.

Overall average journey times have returned to pre-scheme levels following an improvement in the first year of operation (although some periods have experienced some differences). The increase in the second year is probably associated with the increase in flows.

Journey time reliability has improved despite traffic growth

On the whole during the Yr2 After period, day-to-day journey time reliability is improved in both directions and the worst journeys are more reliable in the anticlockwise direction, although not clockwise. So overall journey time reliability has improved while flows have increased more than 10%.

Safety

The J5 to J6 collision rate has reduced by 27% overall, representing a 18% reduction after taking into account the national trend between periods. This result is statistically significant. The results are similar when the whole scheme J5 to J7 is considered.

The scheme has achieved its safety objective

This suggests that the scheme is exceeding its objective of maintaining safety performance, although further monitoring is required due to the small sample size.

KSI rate has increased, while the FWI rate is reduced. These results are based on a small sample size, so no conclusions should be drawn.

No collisions were reported involving road workers on ALR.

Compliance with Red X signals was observed on average to be 94% of the total flow on the carriageway during the lane closure. This is a slight improvement on 93% in Yr1 of operation.

79% of ERA stops not an emergency

During ERA monitoring, approximately one stop every 3.5 hours per ERA was observed. Non-emergency use was judged to be 79%. In 4% of all stops the ERT was used and in 3% of all stops a Highways England Traffic Officer attended. Other

ERA observations were:

- no instances of problems with ERA operation were observed; and
- no collisions relating to vehicles exiting ERAs.

1. Introduction

1.1. Scope of project and purpose of this report

Having completed the monitoring and evaluation of the first year of operation, Highways England has commissioned this project to monitor and evaluate the impact following the second year's operation of the first SM-ALR scheme, the M25 Junction 5 to Junction 7. The evidence base is being continually expanded, providing ongoing confidence in the ALR concept. It is crucial that the performance of the scheme is accurately assessed for a second year of operation in order to:

- review the safety performance during the initial period of operation;
- continue to monitor and understand the change in risk to road users and to road workers;
- quantify and provide evidence of the benefits of the concept; and
- provide evidence to help improve the concept of operation and the design requirements.

As part of the previous SM-ALR Monitoring project, an evaluation methodology was designed. The analysis for the Before period and both Yr1 After and Yr2 After follows this methodology to ensure that all results are comparable.

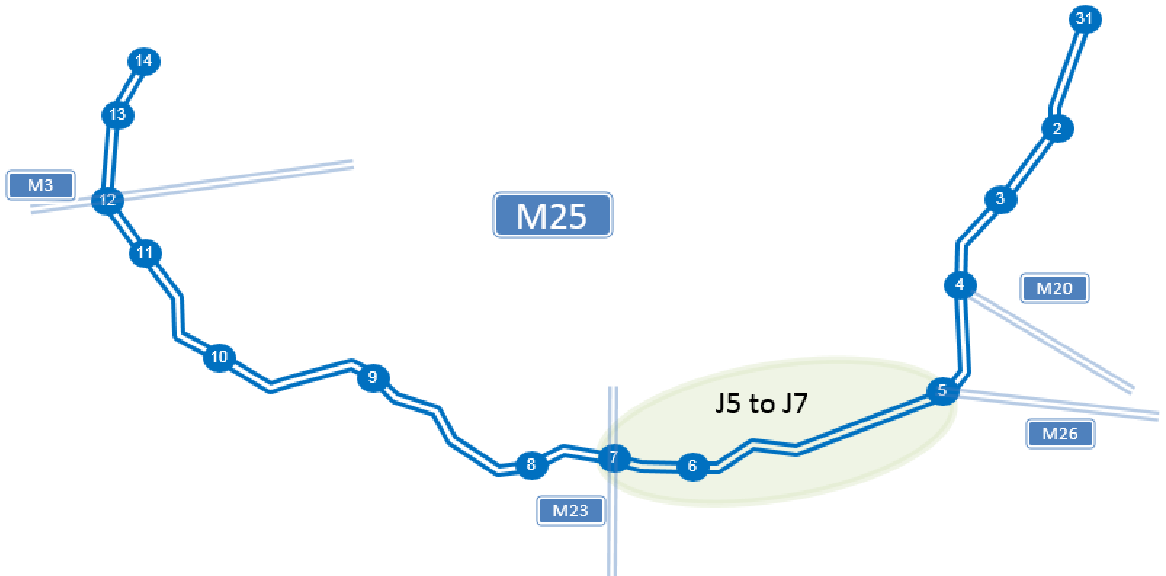
The report is split into sections to cover each of the objectives of SM-ALR: flows, journey times and safety.

1.2. Background of the scheme

1.2.1. Location

M25 Section J5 to J7, is part of the key strategic orbital route around London which forms the hub of the English motorway network and also serves as a commuter route for local traffic. It lies within the counties of Surrey and Kent and is located in the southern segment of the M25. It starts at J5 which is the intersection with the M26, A21 and A25 and finishes at J7; the intersection with the M23.

Figure 1-1 Geographical location of the M25 J5 to J7 SM-ALR scheme



Although constructed as one Smart Motorway scheme, only J5 to J6 is all lane running, while the much shorter J6 to J7 remains four lanes plus hard shoulder on the link and three lanes plus hard shoulder through the junctions.

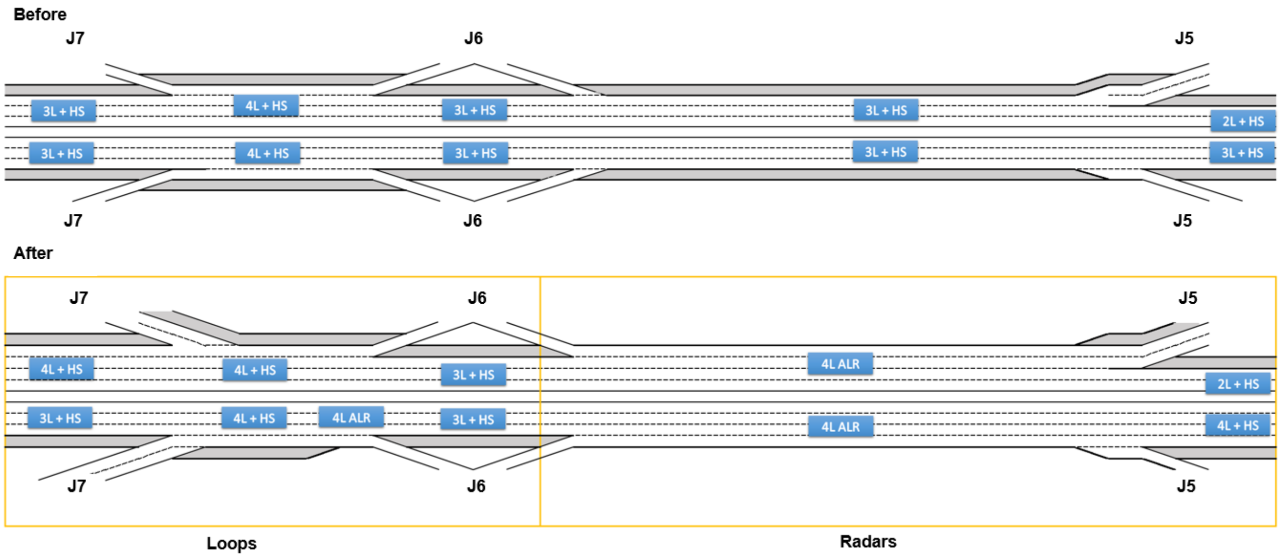
The majority of the M25 is Smart Motorway with hard shoulders which, together with the SM-ALR scheme, form an overall long term strategy to manage the existing motorway network more effectively.

1.2.2. The SM-ALR scheme

SM-ALR is a controlled four lane carriageway with no hard shoulder. This is supported by technology in the form of Motorway Incident Detection and Automatic Signalling (MIDAS) traffic detection and traffic control. The signs and signals can be controlled by operators and by automatic algorithms for Congestion Management (CM) and Queue Protection (QP). Emergency Refuge Areas (ERAs) are available for emergencies.

The M25 J5 to J7 SM-ALR is a mixture of 4 lane ALR and 4 lanes plus hard shoulder, see Figure 1-2. It has been changed from the previous layout which was a mixture of 4 lanes plus hard shoulder and 3 lanes plus Hard Shoulder. As part of the upgrade to Smart Motorway, radar detectors were installed at 500m intervals from J5 to J6. Loop detectors were retained from J6 to J7.

Figure 1-2 M25 J5 to J7 layout schematic



1.3. Evaluation timescales

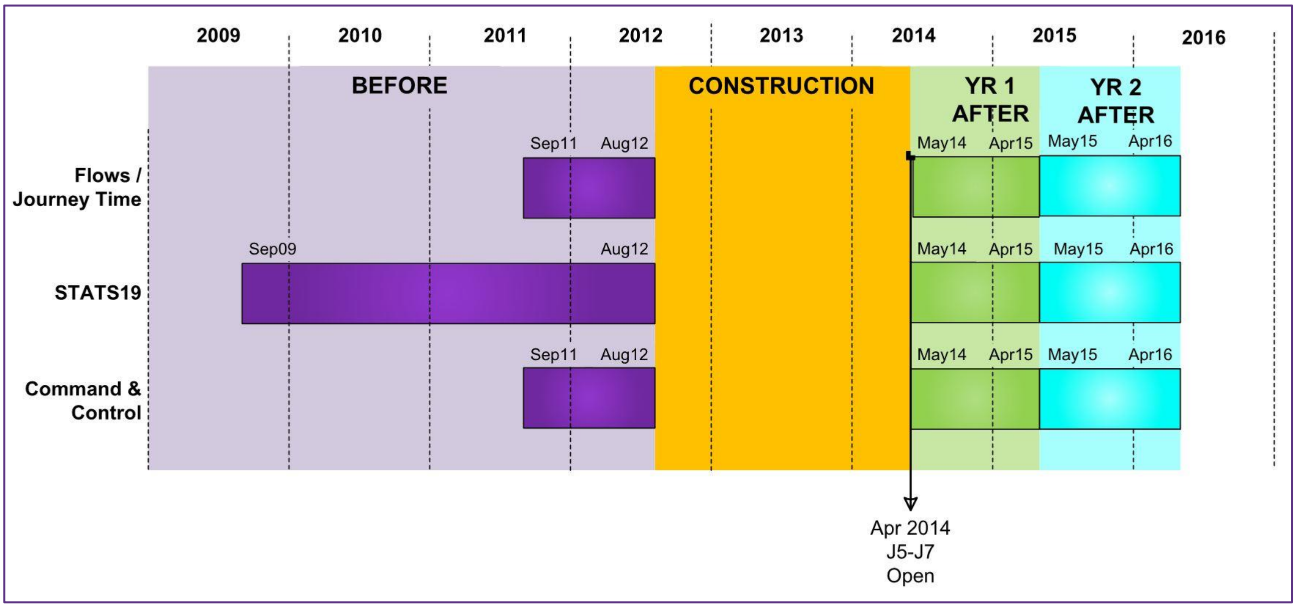
This report presents the results of evaluation and monitoring following two years' operation of the scheme from May 2014 to April 2016. For clarity and efficiency, the evaluation periods will be referred to as follows throughout this report:

- Before - Baseline;
- Yr1 After - First year after opening;
- Yr2 After - Second year after opening; and
- After Period - Entire after period.

The evaluation makes comparisons between the Before and After periods, while monitoring has taken place during the After periods only. The monitoring results report compliance with Red X and ERA usage.

Figure 1-3 shows the evaluation periods used for the Before and After periods.

Figure 1-3 Data collection & evaluation periods



For the analysis of flows and journey times it is useful to consider the results separately for different day types and time slices. This is because the traffic conditions are different and therefore so are the impacts. Table 1-1 shows the time slices and day types used for the flow and journey time analysis, in accordance with the Monitoring Design Report.

Table 1-1 Day type and time slice definitions

Day type	AM peak	Inter-peak	PM peak
Monday – Thursday	05:30 – 10:30	10:30 – 15:00	15:00 – 20:00
Friday	05:00 – 09:00	09:00 – 13:00	13:00 – 20:00
Saturday - Sunday		08:00 – 20:00	

1.4. Expected effects of SM-ALR

The SM-ALR concept involves increasing the number of running lanes from three to four by re-allocating the space previously used by the hard shoulder. In addition, other infrastructure is provided to deliver a controlled environment to manage the risks associated with converting the hard shoulder to a traffic lane.

The effect of an increase in capacity is that periods of congestion are expected to be less frequent, shorter and less intense leading to reductions in journey time and better journey time reliability. The road effectively becomes more resilient to regular and incident related congestion.

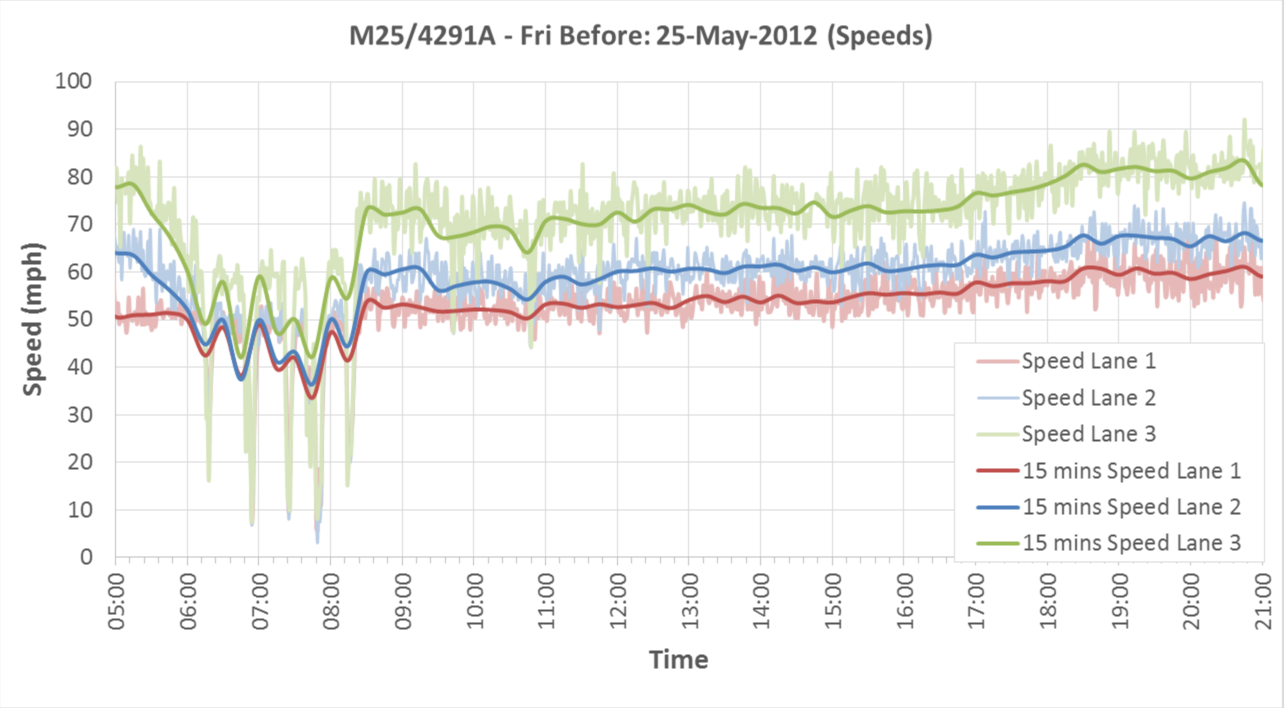
In addition safety benefits could be realised because traffic speeds become more consistent and the speed differential between lanes reduces. The number of unnecessary hard shoulder stops is also reduced.

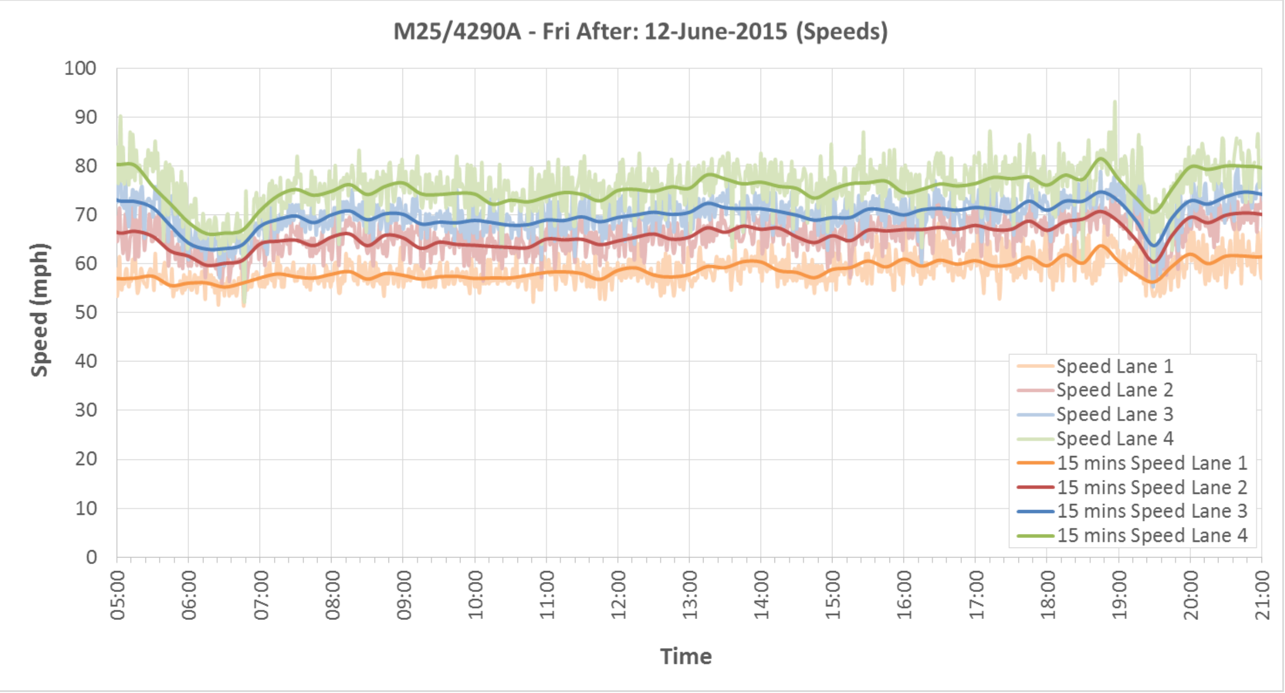
These effects can be seen by looking at traffic performance on a daily basis. The following subsections show speeds by lane, flows by lane, speed distribution and speed flow curves for typical days in the Before and Yr2 after periods. The plots show a snapshot of just one location and one day, to demonstrate the positive impacts.

1.4.1. Speed by lane

The effect on speeds has been positive as demonstrated by Figure 1-4, which shows a snapshot of data from Before and Yr2 After collected during the evaluation process. It can be seen that in the Before period, there was significant congestion in the AM peak. There was a speed differential of approximately 12mph between lanes. The Yr2 After snapshot shows significant improvement in the AM peak, and the speed differential between lanes is also lower, in the order of 6mph.

Figure 1-4 Speed by lane Before and Yr2 After

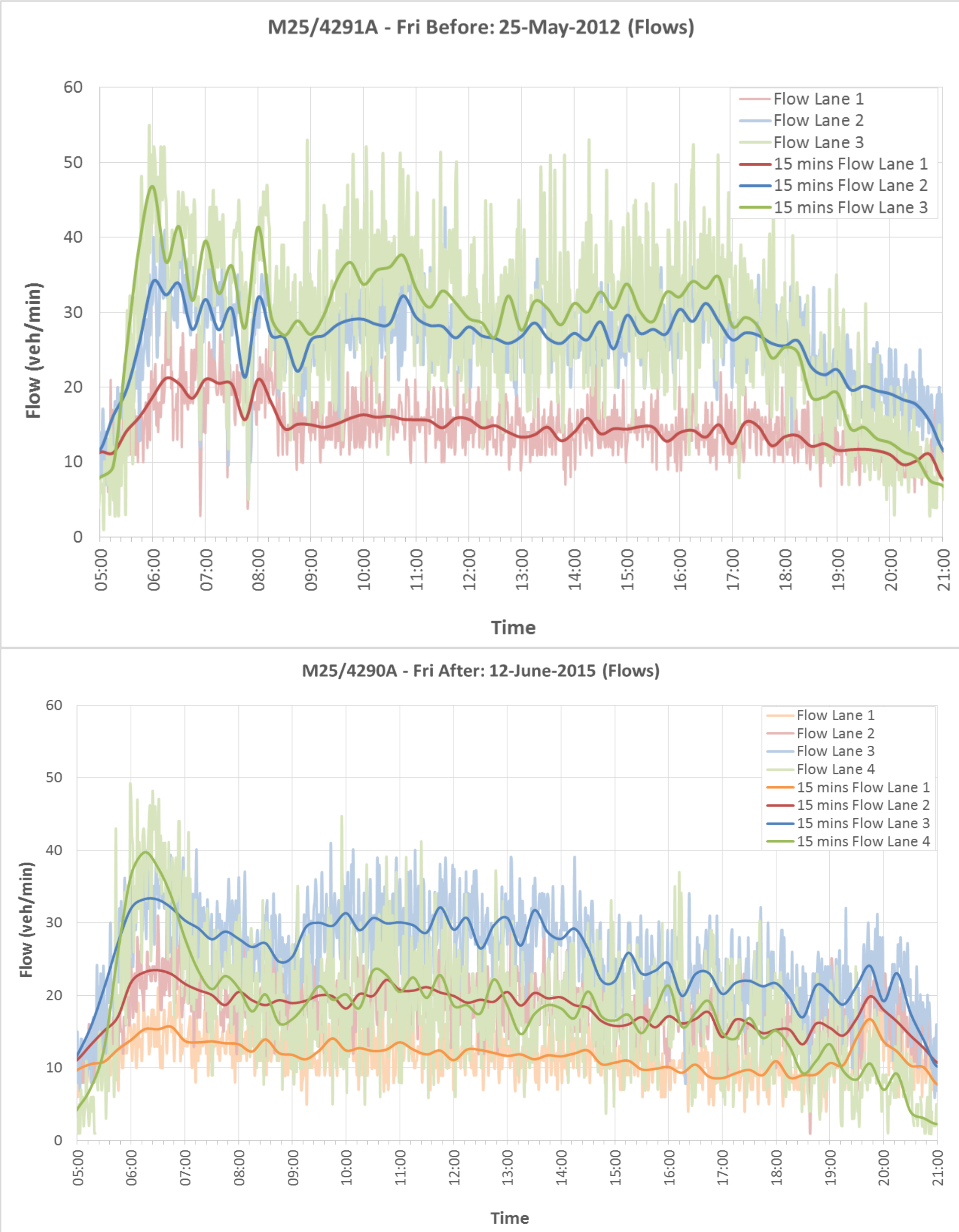




1.4.2. Flow by lane

Figure 1-5 shows the flow by lane for the Before and Yr2 After periods. In both periods, lane 1 flows are much lower than the other lanes; this could be because there is a lane drop arrangement which can make lane 1 less likely to be used.

Figure 1-5 Flow by lane Before and Yr2 After



Also in both periods, the offside lane flow is the highest in the peak periods and the lowest during the night.

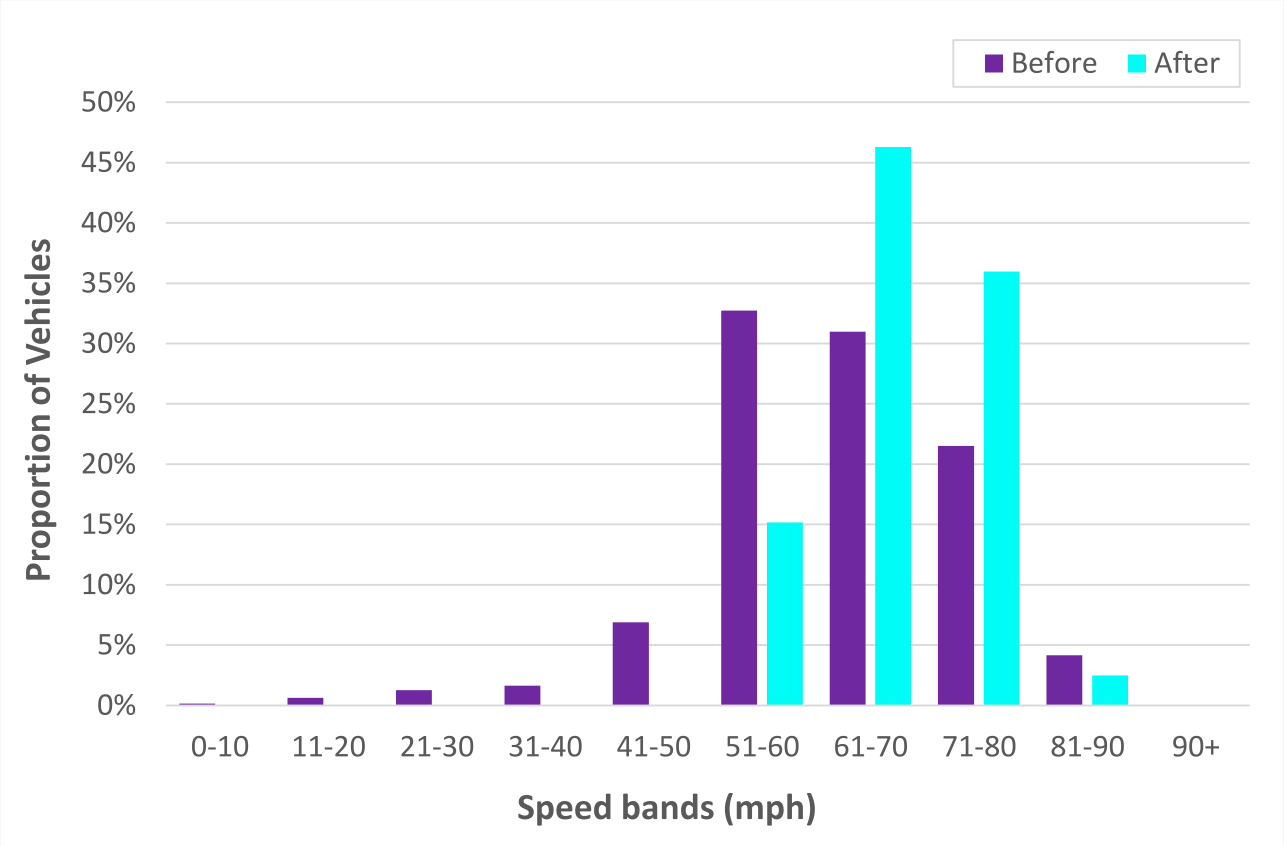
Another useful finding demonstrated by these graphs is that although total flow is higher, the peak flow per lane is lower in Yr2 After compared to the Before; this indicates that there is still significant spare capacity for future growth.

1.4.3. Speed distribution

Figure 1-6 shows the approximate proportions[1] of vehicles travelling at speeds in different 10mph 'bands', over a 24 hour period in the Before and Yr2 After. The key points of interest are:

In the Yr2 After period, fewer vehicles were travelling at less than 60mph. A larger proportion of vehicles were doing low speeds in the Before period due to greater levels of congestion. However there is an indication that more vehicles are exceeding the speed limit by up to 10mph in the 71mph to 80mph band; this is likely to be a result of the more free-flowing conditions. The proportion of vehicles travelling in excess of 80mph is reduced in Yr 2 compared to Before, probably due to the perception of enforcement.

Figure 1-6 Speed distribution Before and Yr2 After

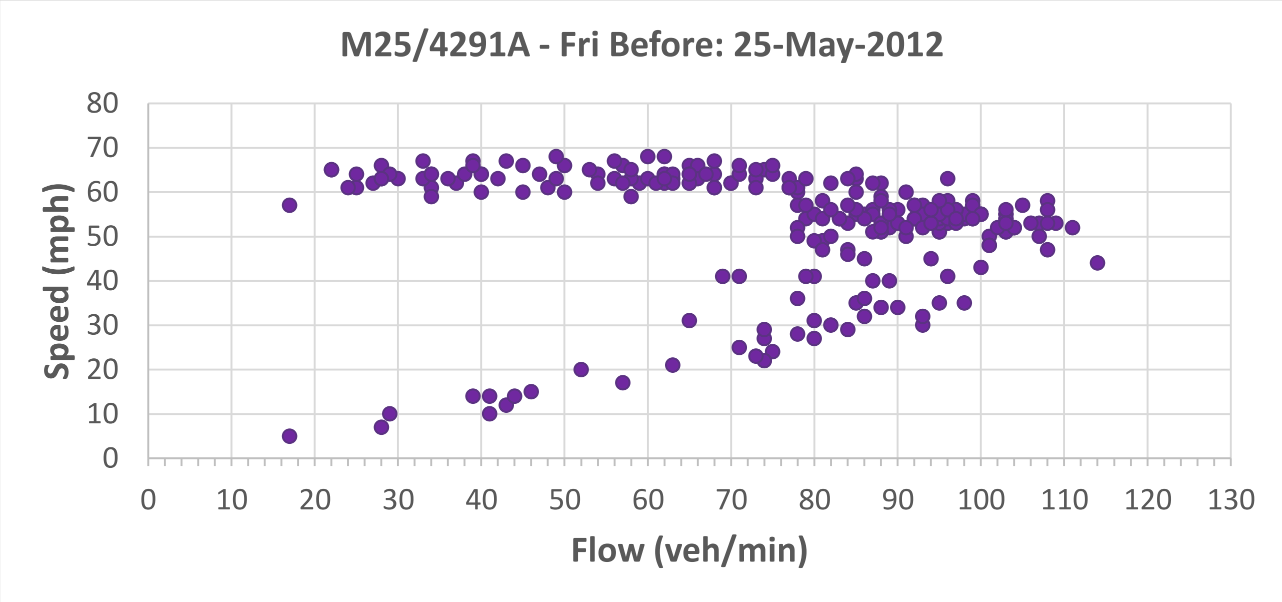


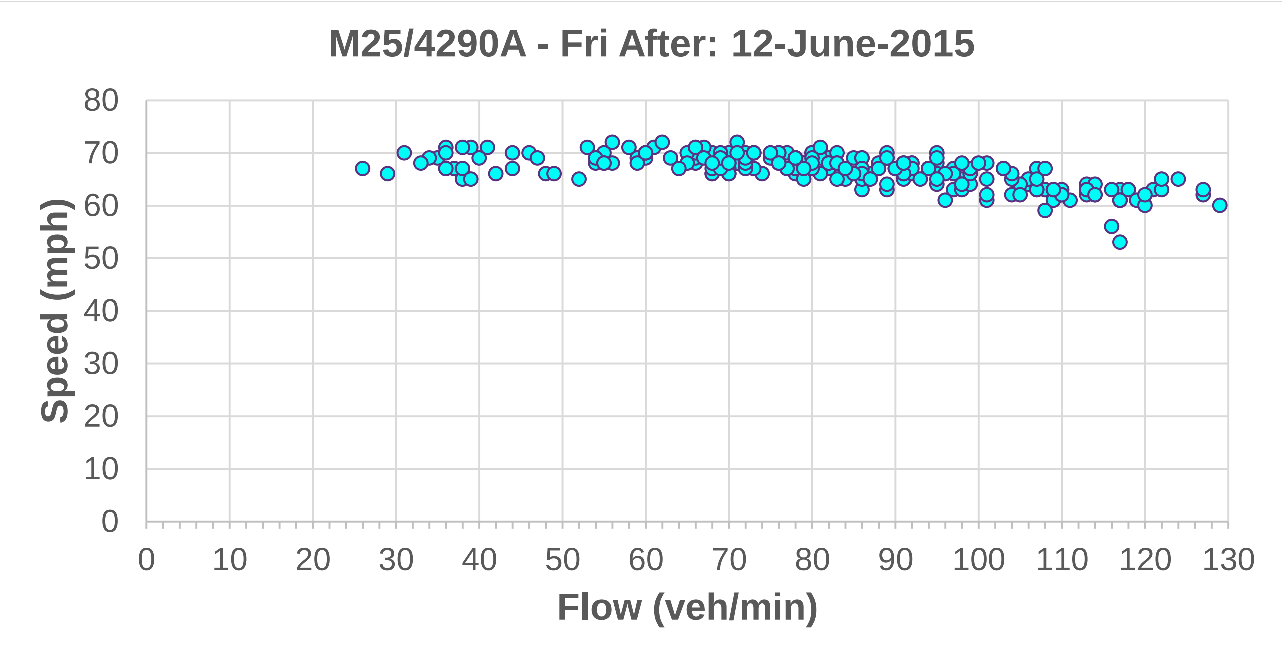
[1] TCD data has been used providing the average speed minutely per lane.

1.4.4. Speed flow curves

In the Before period, it can be seen that traffic flow reaches 114 vehicles per minute before the flow breaks down causing congestion, while in the After Yr2 sample flows go up to 130 vehicles per minute without any discernible flow breakdown.

Figure 1-7 Speed flow curves Before and Yr2 After





2. Flows

2.1. Introduction

This section presents the traffic flow analysis for the first two years of operation of the SM-ALR scheme between J5 and J7 of the M25. The Yr2 After traffic data has been taken from Highways England's MIDAS database[2]. The Before and Yr1 After traffic data was taken from Highways England's, now superseded, TRADS database[3]. The Yr2 After traffic data has been processed to replicate the calculations as performed at the Yr1 After stage. A full year of data for each of the Before and After periods has been used for the analysis[4]. The results include comparisons of daily flows, flows by day type and time period and percentage of long vehicles in the vehicle fleet.

2.1.1. Data availability and quality

Highways England and their suppliers are investigating a known issue with the quality of flow data from radar detectors and work is underway to improve it. To overcome the issue at the Yr1 After stage the flows for J5 to J6 were calculated using the J6 to J7 flows and the J6 slip road flows. Further analysis at the Yr2 After stage has been completed to determine the accuracy of the radar detectors. It has been concluded that the Yr1 After methodology of using the J6 to J7 traffic flows combined with the J6 slip road flows to determine the J5 to J6 traffic flow is still preferable to using the radar based MIDAS data on this section. From November 2015 onwards there were data availability issues in the clockwise direction, so the data for this period has been supplemented with the radar based MIDAS data uplifted to reflect the observed difference between the slip road method and mainline radar based flows.

2.2. Daily flows per link

The average daily traffic for the Before, Yr1 After and Yr2 After periods are compared in Figure 2-1 to Figure 2-4, with the 24 hour Average Daily Traffic (ADT) flows on each link plotted for the different day types. The percentage change between the Before and Yr2 After is shown above the Yr2 After bar in each case. The corresponding values are shown in Appendix A.1. Appendix A.2 shows the monthly ADTs; there has not been any significant change to the seasonal trend of traffic flows; lower flows in the winter months are consistent with the national picture.

Clockwise, there has been a 17% increase in ADT between J5 and J6, where the number of lanes has increased from 3 to 4 as part of the scheme. The largest increase between J6 and J7, which was already 4 lanes, is at the weekend; a 7% increase. Before the scheme, J5 to J6 flows were far lower than J6 to J7 but now the flows on both links are similar (around 70,000 ADT).

Anticlockwise, the increase in flows are similar between J5 to J6 and J6 to J7. Overall there is an increase of 7% and 6% for the two sections respectively. The greatest increase is over the weekends at 11% and 10% for the two sections respectively. Weekday increases are between 5% and 6%. It can be seen that the traffic flows have increased above the previous increase observed at the Yr1 After stage, which was around 2% for weekdays and 5% for weekends.

[2] https://www.midas-data.org.uk/
[3] https://trads.hatris.co.uk/
[4] The Christmas, Boxing Day, New Year and other bank holidays have been removed from the data used in both Before and After periods.

Figure 2-1 Average daily traffic by day type J5-J6 clockwise (lane increase)

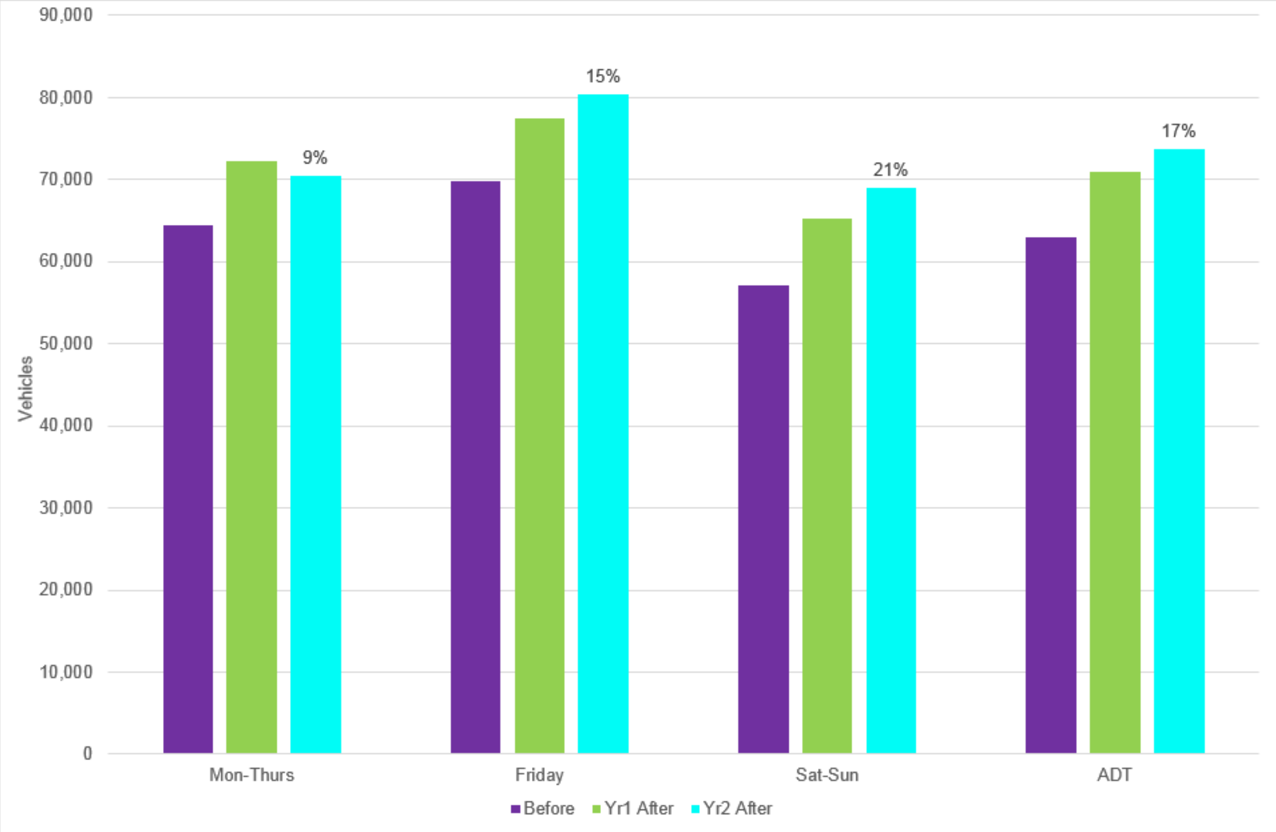


Figure 2-2 Average daily traffic by day type J6-J7 clockwise

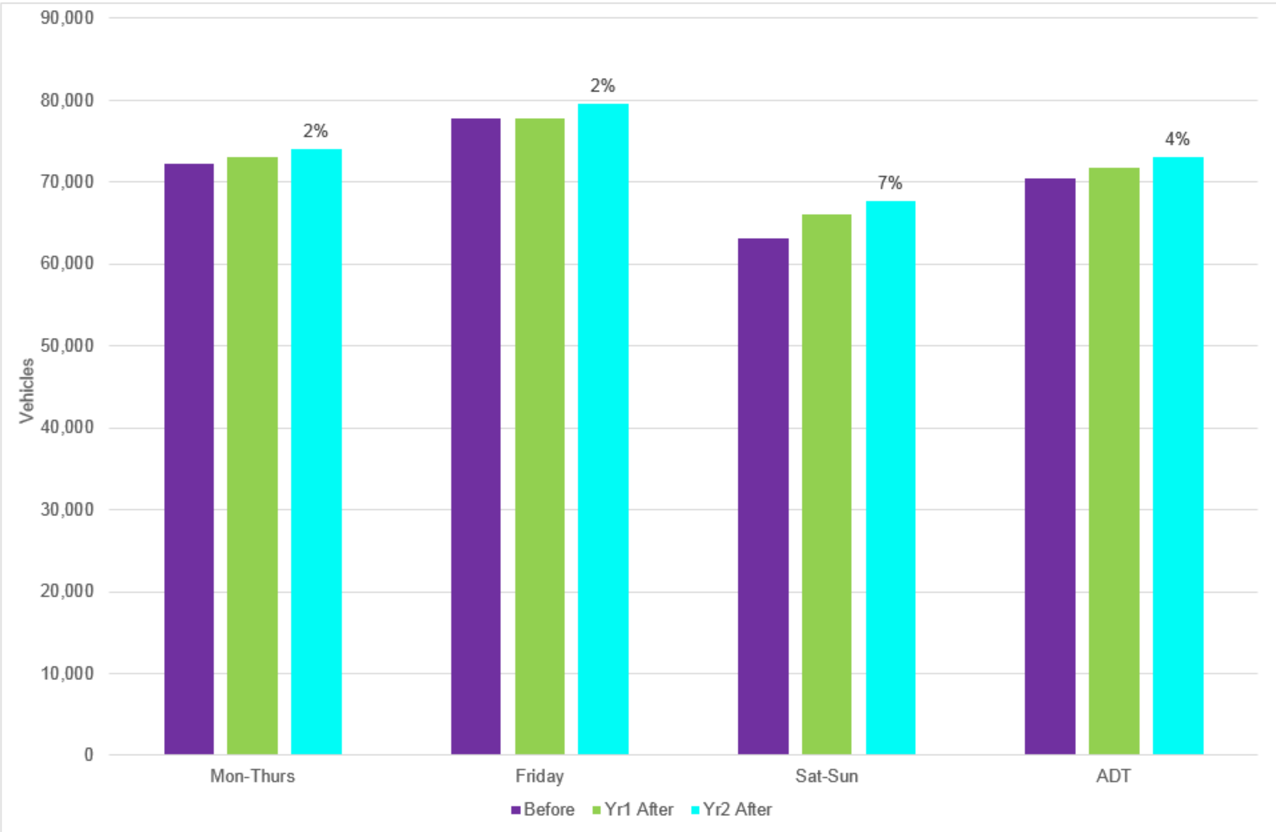


Figure 2-3 Average daily traffic by day type J5-J6 anticlockwise (lane increase)

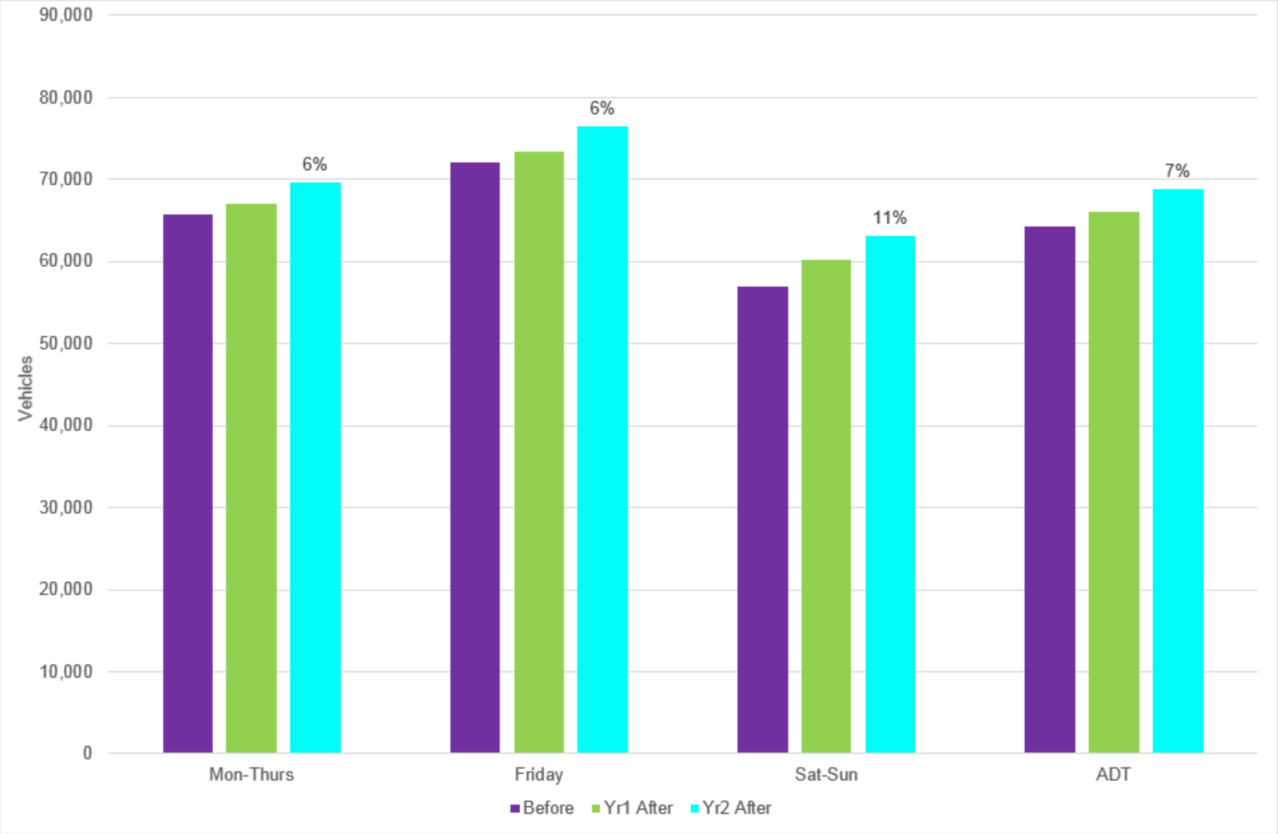
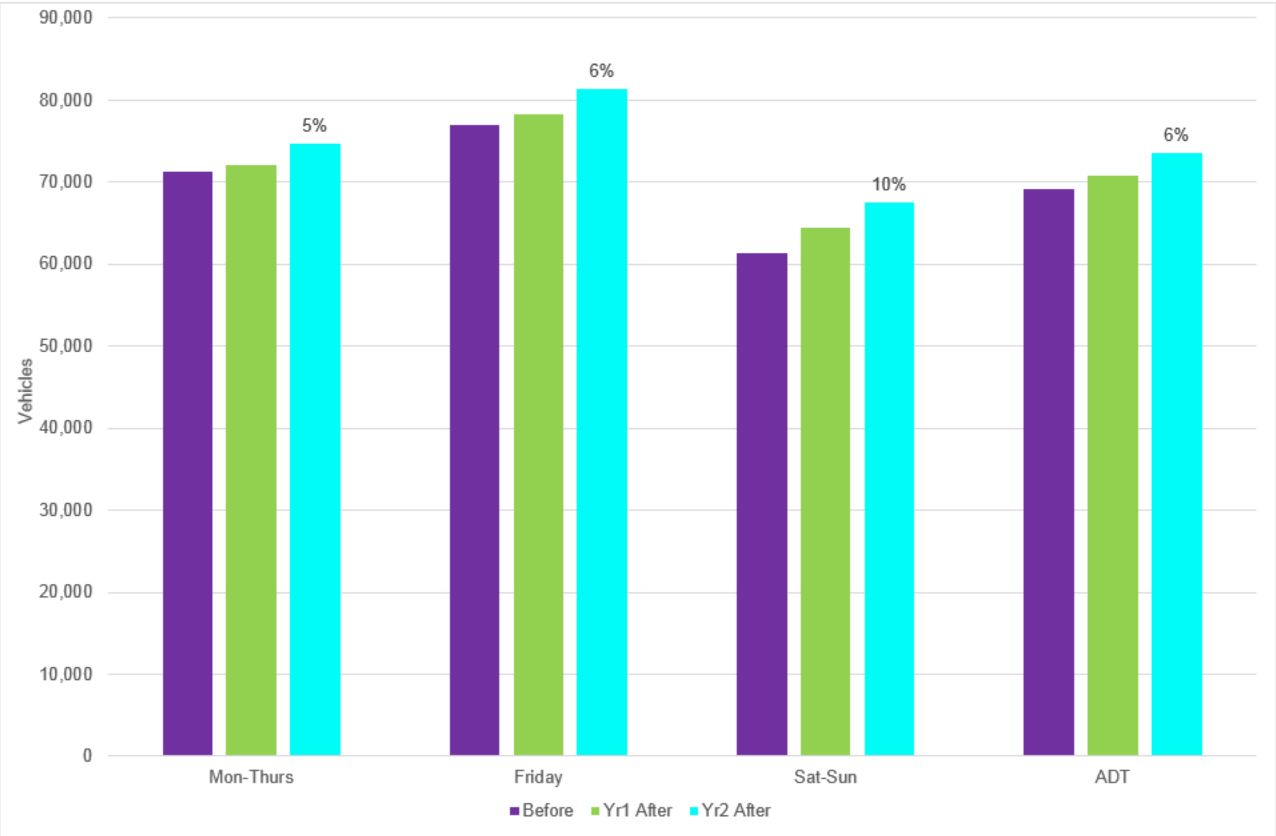


Figure 2-4 Average daily traffic by day type J6-J7 anticlockwise



The Annual Average Daily Traffic (AADT) has increased by 4% (J6 to J7 clockwise) and 17% (J5 to J6 clockwise), with the anticlockwise increase between 6% and 7%.This can be considered against an increase motorway traffic in the South East between 2012 and 2015 of around 5%[5]. The growth in the scheme is roughly in line with regional trends, apart from J5 to J6 clockwise where it is significantly higher as a result of the additional capacity provided. Whilst the increase in traffic flows on the M25, facilitated by the scheme, will contribute to the regional traffic trends this still serves as a useful reference.

2.3. Flow over each time slice per link

Figure 2-5 to Figure 2-8 compare the average flow Before, Yr1 After and Yr2 After in each time slice for each link. The percentage change is shown above the Yr2 After bar in each case. The corresponding values are shown in Appendix A.3.

Clockwise, there have been significant increases in all periods between J5 and J6 where the number of lanes has increased. However PM peak weekday flows have remained effectively unchanged between J6 and J7, which, whilst unexpected, is consistent with the observations at the Yr1 After stage.

Anticlockwise, there appear to have been large increases in all time slices between J5 and J6 where the number of lanes has increased. The traffic flow increase between J6 and J7 is typically slightly lower than between J5 and J6, though the increase on this link is much greater than that observed at the Yr1 After stage. Weekend flows have increased on both links, by around 9% to 10%.

Figure 2-5 Average flow by time slice J5-J6 clockwise

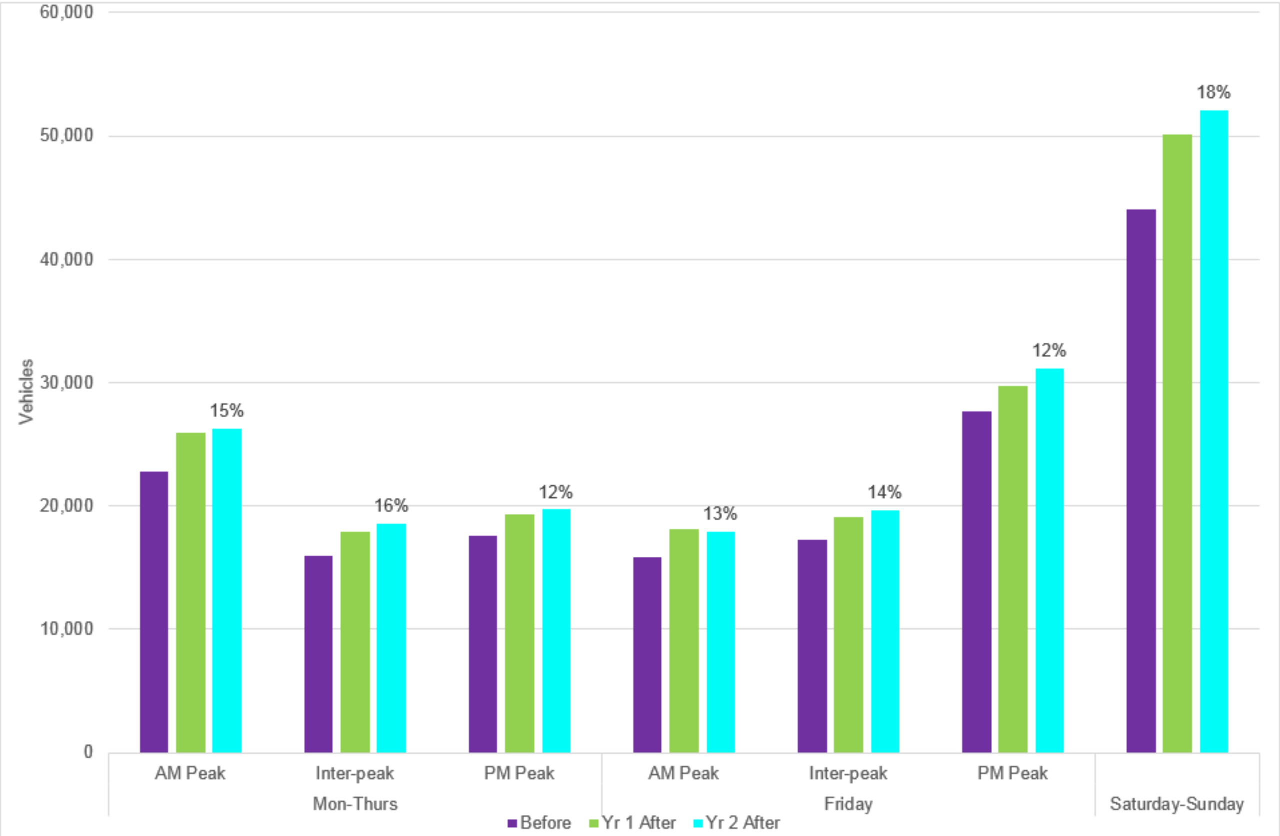


Figure 2-6 Average flow by time slice J6-J7 clockwise

[5] https://www.gov.uk/government/collections/road-traffic-statistics

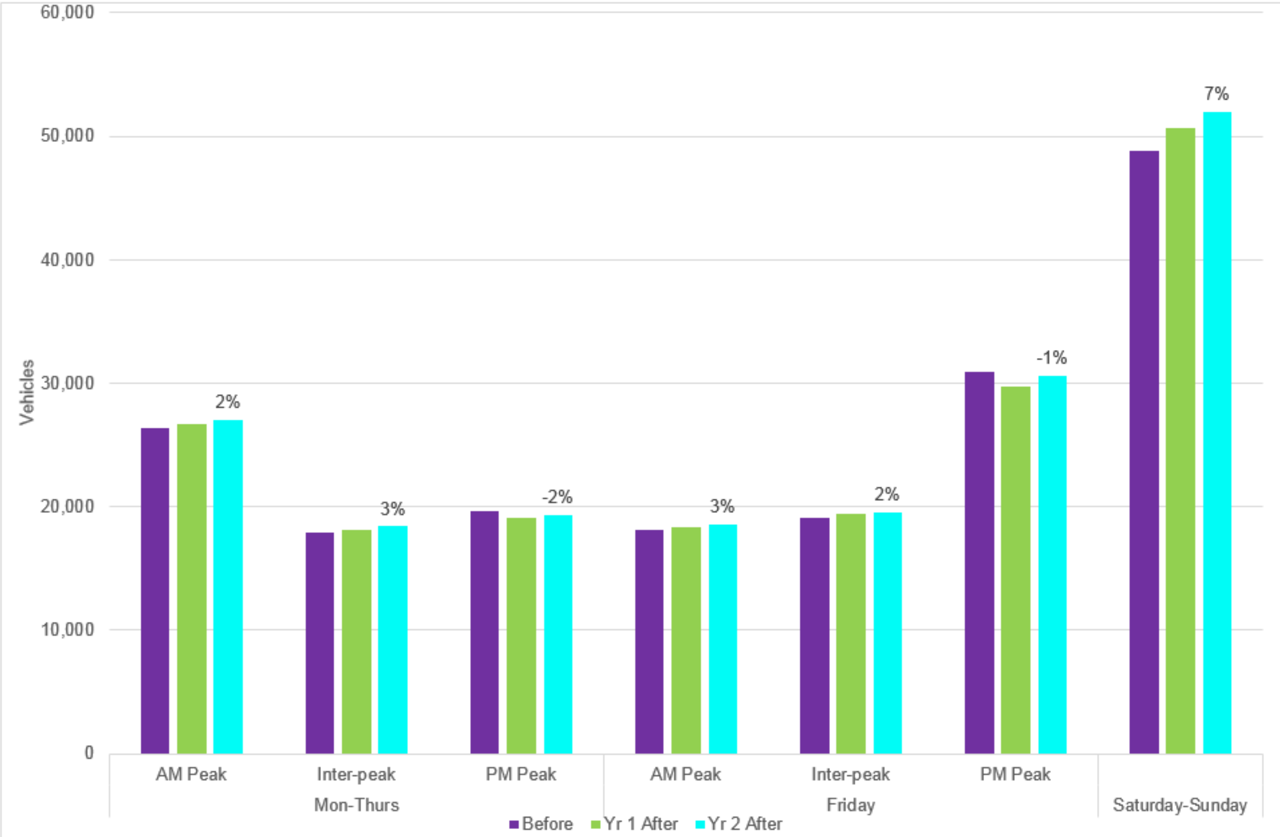


Figure 2-7 Average flow by time slice J5-J6 anticlockwise

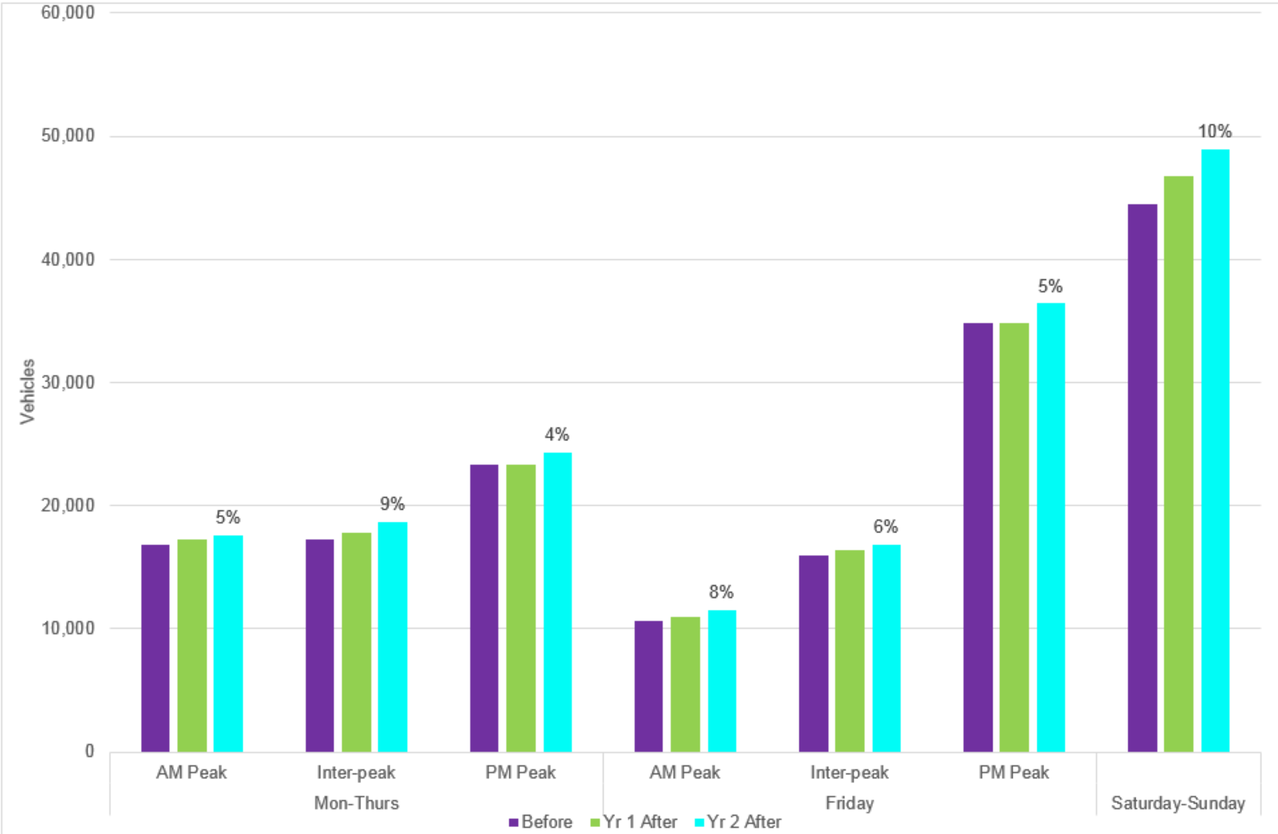
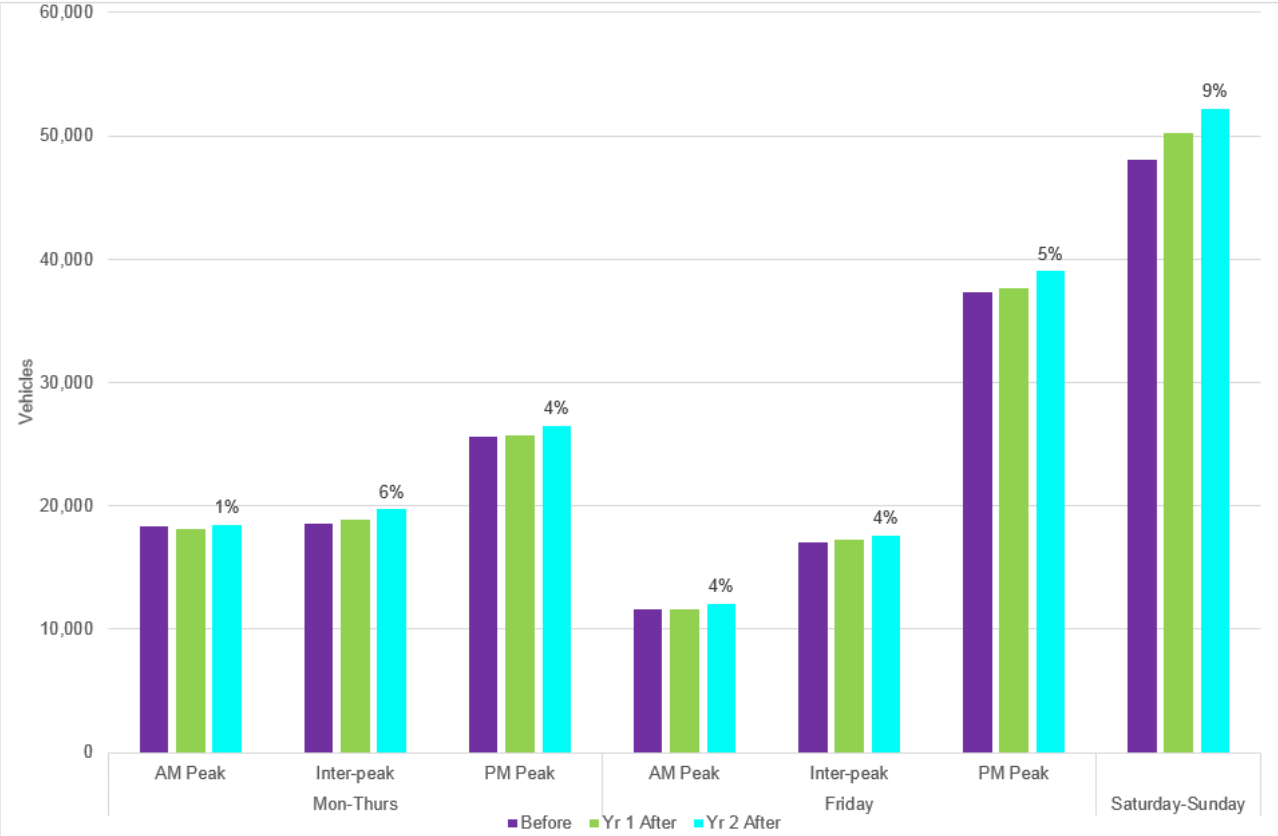


Figure 2-8 Average flow by time slice J6-J7 anticlockwise



2.4. Long vehicles percentage

The percentage of long vehicles by time slice for J6-J7 anticlockwise is shown in Appendix A.4. There has been a slight increase in the percentage of long vehicles in the anticlockwise direction but a slight decrease in the clockwise direction. Given the relatively minor and generally inconsistent change in the percentage of long vehicles, it is unlikely that the scheme has had a significant impact on the composition of traffic.

2.5. Tests for statistical significance of the results

A sequence of t-tests was performed in order to assess whether the changes in the flows measured has been significant. In order to carry out these t-tests, the standard deviation, average flow and number of observations were calculated for each link in the section. An observation was considered to be a full day of data for each site on the link which was considered. This was required as the data has had to be collected and averaged for a number of sites in order to address the variability in the observations. The t-tests assumed that there was no change in the flow and tested for a statistically significant change using a two-tailed test at a 95% confidence level.

Unfortunately the method used to calculate the J5 to J6 flows means the t-tests could not be performed for this link. The results for J6 to J7 are presented in Table 2-1 for the flows by time slice and in Table 2-2 for the ADTs; a series of arrows denote the type of change experienced in that time period. An up arrow denotes a statistically significant increase in flow, a down arrow denotes a statistically significant decrease, and a dash denotes no significant change in the time period.

Table 2-1 Flow by time slice t-tests

Direction	Location	Mon-Thurs			Friday			Saturday -Sunday
		AM peak	Inter-peak	PM peak	AM peak	Inter-peak	PM peak	
Clockwise	J6 - J7	–	↑	–	↑	–	–	↑
Anticlockwise	J6 - J7	–	↑	↑	↑	↑	↑	↑

Table 2-2 ADT t-tests

Direction	Location	Mon-Thurs	Friday	Sat-Sun	ADT
Clockwise	J6 - J7	↑	–	↑	↑
Anticlockwise	J6 - J7	↑	↑	↑	↑

There have been significant changes in flows for some time slices, particularly in the anticlockwise direction. The ADT has seen a significant increase in both directions, suggesting that there has been an overall increase in traffic along the section.

2.6. Summary

For J5 to J6, the SM-ALR section where an additional running lane is now available, flows have increased by 17% clockwise and 7% anticlockwise. The scheme has experienced traffic growth of between 4% and 6% between J6 and J7, which was not previously at capacity and has not received an additional running lane; this is in line with regional growth trends.

The percentage of long vehicles has increased in the anticlockwise direction but decreased in the clockwise direction. Increases and decreases are typically 1 to 2 percent, so effectively unchanged.

3. Journey times

3.1. Introduction

This section outlines the changes in journey times and reliability on the M25 J5-7 SM-ALR between the Before and After periods.

The data used was supplied by TomTom who provide anonymised data of journeys through the scheme during the Before and After periods. The journey time data is at a very spatially disaggregate level, allowing speed analysis to be undertaken at regular intervals along the scheme.

Before interrogating the TomTom database, a review of severe incidents and road works was undertaken to identify any days that should be removed from the analysis because they would not represent normal operating conditions. No such days were identified in the samples, therefore all days within the year are included in the dataset.

The journey time results presented in this section form the latest conclusions on journey time performance for the scheme following two years of operation.

3.2. Average journey time

The analysis of average journey times from junction to junction demonstrates the change in journey times at link level. The headline results are summarised in Figure 3-1 for clockwise and Figure 3-2 for anticlockwise with more detail provided in Appendix B.

Clockwise, between the Before and Yr2 After periods, there has been an overall increase between J5 and J7 of just over 1% (i.e. 10 seconds). This means effectively no change from the Before journey time of 12 minutes 40 seconds. It appears that following an improvement in some journey times during Yr1 After, they have now returned to pre-scheme values.

The weekday AM peaks are the most congested and they have seen the biggest journey time increases (4% Mon-Thu). In periods where the journey times were close to free-flow speeds the increase has been very slight.

Anticlockwise, between the Before and After Periods, there has been an overall improvement of 8 seconds on the J5-6 link and 4 seconds on J6-7. This is an average percentage improvement of less than 2% (i.e. 12 seconds), effectively no change, from the Before Journey time of 11 minutes 59 seconds.

The PM peak periods which were the most congested in the Before period, saw larger journey time improvements in the Yr2 After results (3% Mon-Thu and 10% Friday). Although this benefit has eroded since Yr1 After, it is still better than the Before period. For previously uncongested periods the journey times have remained fairly constant.

Figure 3-1 Clockwise journey time comparison

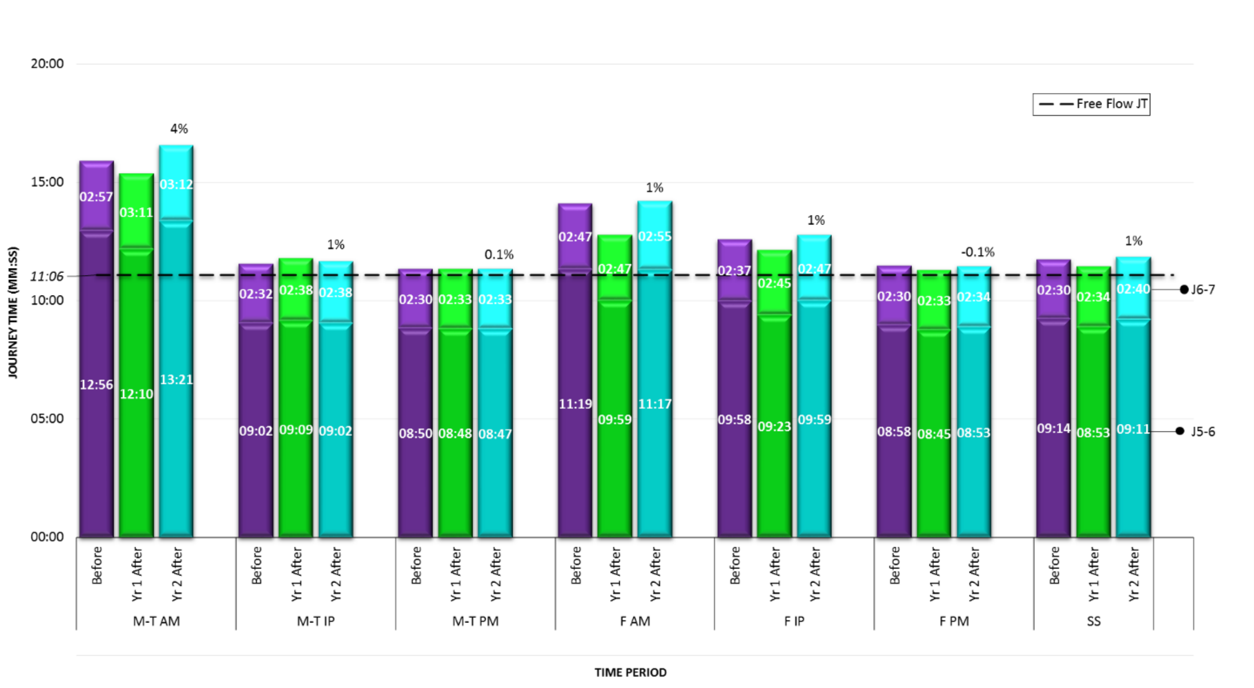
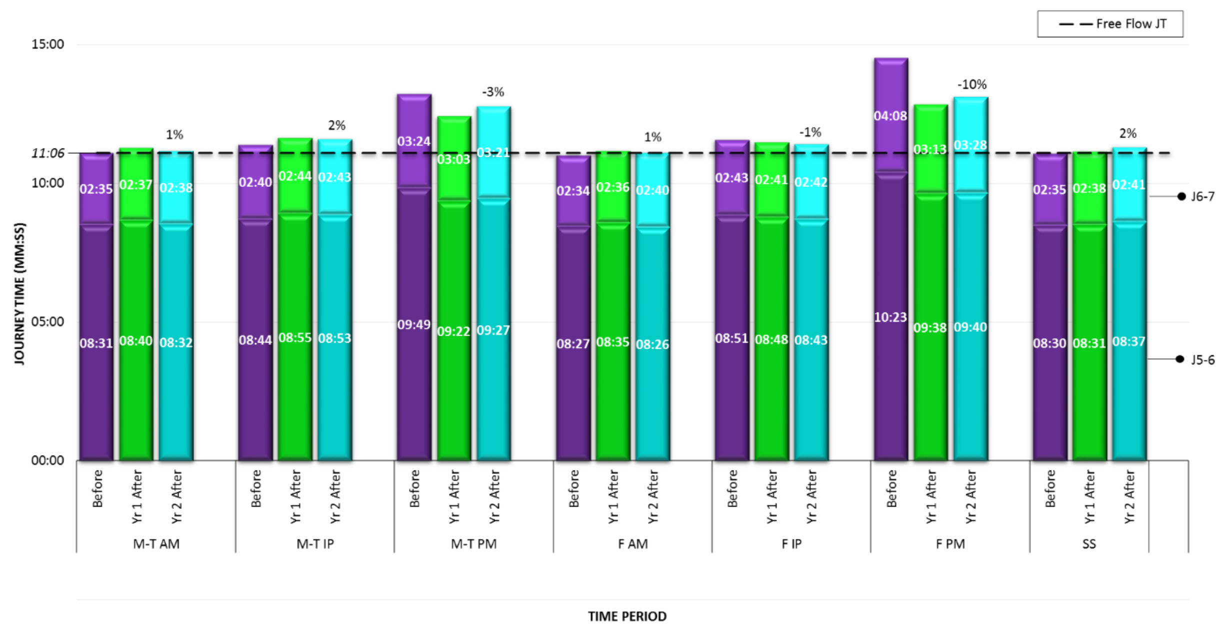


Figure 3-2 Anticlockwise journey time comparison



Congestion has been reviewed using MTV plots from the period and it has been identified that there is a significant congestion problem caused in the vicinity of the merge at J6 clockwise. Where flow has reduced between J6 and J7 clockwise during the weekday PM peaks, no congestion is observed.

In summary, journey times have increased slightly in the clockwise direction and reduced slightly anticlockwise; effectively no change in journey times from the Before period.

3.3. Journey time reliability

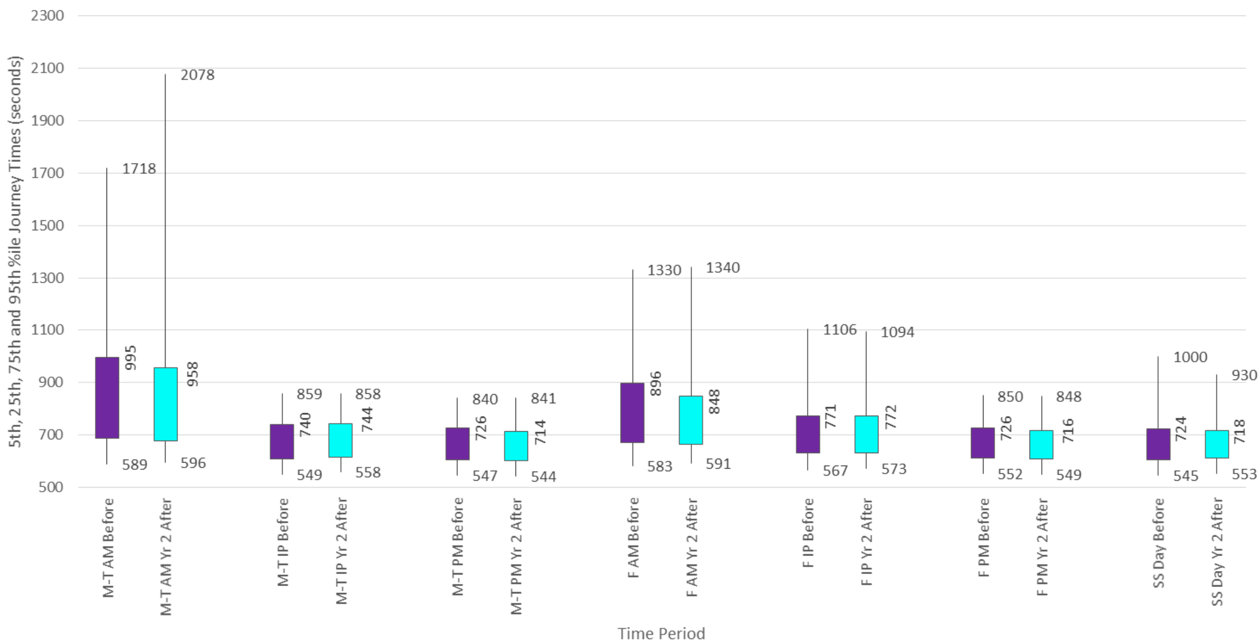
Reliability of journey times is a critical measure of a road's utility and function for road users. Percentile data has been used to understand the distribution of journey times through the scheme. Four metrics have been used, as shown in Table 3-1.

Table 3-1 Journey time metrics

Metric	Description
5th percentile	One in 20 vehicles are completing the journey faster than this, so it is a good measure of the best time achievable.
25th percentile	One in four vehicles are completing the journey faster than this and it is known as the lower quartile. The further this value is from the 5th percentile the more variability there is in the fastest journeys. It is an indicator that delays are experienced by a high proportion of all users
75th percentile	Three quarters of vehicles complete the journey faster than this and it is a good measure of general variability from day to day of journey times.
95th percentile	95% of vehicles complete the journey faster than this, the remaining journeys are likely to be affected by incidents or heavy congestion. The further the 95th percentile journey time is from the 75th percentile the more heavily congested a journey is. This is an indication of incident related variability.

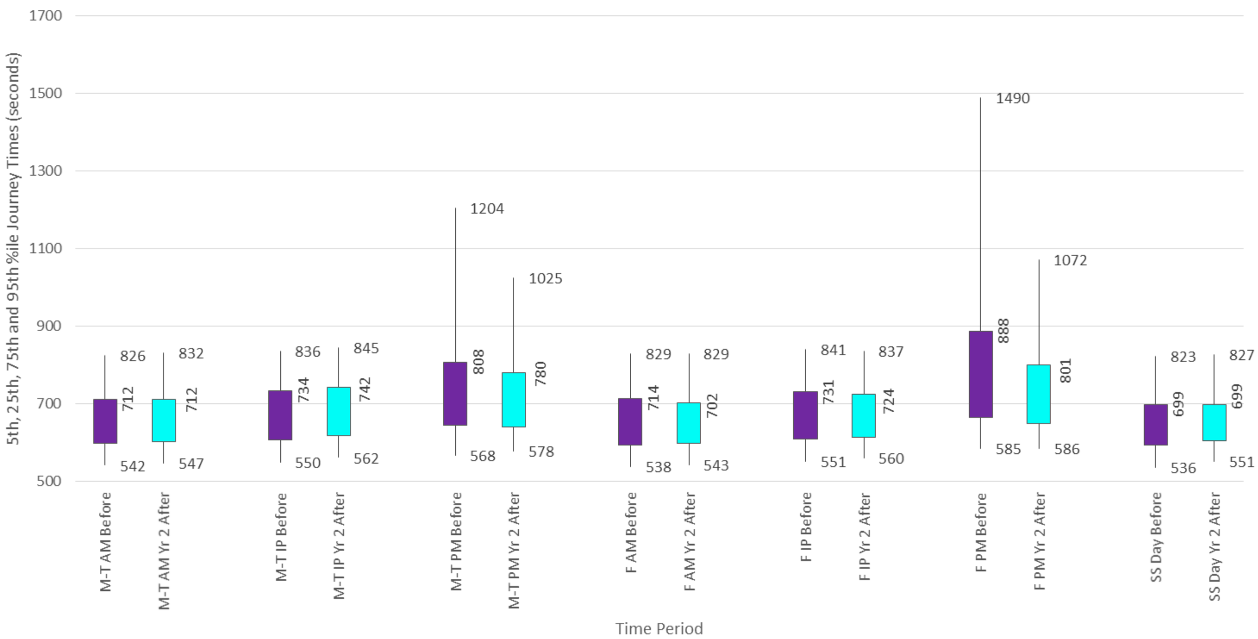
These four metrics are shown below in Figure 3-3 and Figure 3-4 as 'box and whisker' diagrams for each time slice, Before and Yr2 After. The box contains the 25th to 75th percentile range and the whiskers show the 5th and 95th percentile values. The 5th, 75th and 95th percentile journey times are annotated on the plots.

Figure 3-3 Clockwise journey time reliability comparison Before and Yr2 After



Clockwise, the variability in the day to day journey times has improved across all periods apart from the Friday inter-peak where it stayed the same. This can be seen from the reduction in the length of the solid bars in the figure (i.e. a reduced difference between the 75th and 25th percentile). The most unreliable journey times are in the AM peaks and the worst 5% of journey times have got longer in Yr2 After Monday to Thursday AM peak; the 95th percentile increasing by 6 minutes. This has not occurred in any other period.

Figure 3-4 Anticlockwise journey time reliability analysis



Anticlockwise, the most unreliable journey times, Before and Yr2 After, are in the weekday PM peaks. These periods have experienced an improvement in reliability, e.g. 95th percentile journey times reduced by 3 minutes Mon-Thu and 7 minutes on Friday. The uncongested time slices have similar results Before and After.

The difference between the 75th and 25th percentile has reduced across all day types and time slices in the anticlockwise direction, meaning that the day to day journey times are more resilient with all lane running.

3.4. Summary

In the clockwise direction, average journey times where there is no congestion have remained similar between Before, Yr1 After and Yr2 After where free flow speeds are maintained. During congested times, (Monday to Thursday AM peaks and Friday AM peak and inter-peak) where journey times had improved in Yr1 After, the benefit has eroded and they are now marginally higher than the Before period. Anticlockwise journey times are still achieving reductions, particularly in the congested PM peak periods. So overall journey times are effectively unchanged from the Before period.

On the whole during the Yr2 After period, day-to-day journey time reliability is better in both directions and the worst journeys are more reliable in the anticlockwise direction although not clockwise.

These results show that increases in capacity have been achieved, moving more goods, people and services, while maintaining journey times at pre-scheme levels and slightly improving reliability

4. Safety

4.1. Introduction

This section compares the Before and After Period safety performance of the M25 J5-7 SM-ALR scheme. Detailed results for J5 to J6, the ALR part of the scheme are presented the main report. Headline findings for the whole scheme, J5-7, which are broadly similar, are presented in Appendix C.1.

The results from the STATS19 data have been used to identify the number and rate of personal injury collisions. For this analysis two years' of data have been used for the After Period which is generally considered not a sufficiently large sample size due to collisions being rare events. In this case, the results are actually statistically significant due to the size of the change; however further monitoring will still be performed to provide additional confidence.

STATS19 collates all injury collision data in a consistent manner each year and is a generally reliable source for numbers of injury collisions. Damage-only collisions are not recorded in STATS19 so it is not a record of all collisions. Recording collision details relies on police input at the collision scene, therefore there is some scope for inconsistencies when the information is recorded. This data is robust to the extent that it is unlikely to change significantly when the validated results are produced.

This section also contains analysis of Red X and speed limit compliance and ERA usage in the After period.

4.2. Number and rate of collisions

Table 4-1 shows the number of collisions during the Before and After periods, the rate of collisions and the percentage change. Overall the results show a 27% reduction in the collision rate. To fully understand the results we also need to take into account the background trend in collisions described in Section 4.2.1.

Table 4-1 Number of collisions by severity and collision rates

Period		Fatal	Serious	*Fatal & serious*	Slight	Total
Before	Year 1	2	7	9	57	66
	Year 2	0	4	4	54	58
	Year 3	0	2	2	45	47
	Total	2	13	15	156	171
	Collision rate (collisions per hmvm) (13.0 hmvm)	0.154	0.999	1.153	11.993	13.146
	Collision rate (collisions per mvkm) (2,093 mvkm)	0.001	0.006	0.007	0.075	0.082
After	Year 1	0	9	9	39	48
	Year 2	0	4	4	39	43
	Total	0	13	13	78	91
	Collision rate (collisions per hmvm) (9.5 hmvm)	0.000	1.373	1.373	8.237	9.610
	Collision rate (collisions per mvkm) (1,524 mvkm)	0.000	0.009	0.009	0.051	0.060

The two fatal collisions in the Before period included a vehicle losing control before leaving the carriageway and a vehicle colliding with an overbridge. Both were single vehicle accidents. There were a total of 13 serious collisions in the Before period.

There have been no fatalities in the After period, however there have been a total of 13 serious collisions. These are described as follows:

- Five collisions involving motorcycles:
  - Two due to loss of control for unknown reasons;
  - One due to a tyre blow out;
  - One where a motorcycle filtering through lanes in stationary traffic lost control as a result of a driver opening a vehicle door; and
  - One due to either a motorbike filtering through traffic or a vehicle abruptly changing lanes. The cause of this collision is unclear as there are different accounts given at the scene and recorded in the STATS19 entry;
- Two collisions associated with lane changing and/or failing to look;
- One single vehicle collision involving a vehicle losing control on a bend and colliding with the central barrier;
- One single vehicle collision due to a vehicle aquaplaning and losing control;
- One collision as a result of a vehicle hitting debris (tyre) in the road;
- Two nose to tail collisions:
  - One where a vehicle braked sharply for an unknown reason causing a nose to tail collision involving a total of three vehicles, the vehicle at the front and back left the scene; and
  - One nose to tail collision in a 40mph temporary speed limit involving four vehicles. (It is not stated whether the temporary 40mph speed limit was due to roadworks or the queue protection); and
- One other collision where a vehicle swerved to avoid an animal in the carriageway, striking the crash barrier. A second vehicle collided with a section of crash barrier that had become detached and was in the carriageway.

The above collisions could have happened on any section of motorway and cannot be attributed to ALR.

The contributory factors by severity for the collisions are shown in AppendixC.2.

4.2.1. Background trend in collisions

There is a trend over time leading to a reduction in the number of personal injury collisions against a trend of increasing traffic volumes. The reasons for the reduction are wide ranging and include improved safety measures in vehicles and on the road. This trend needs to be accounted for when comparing the Before and After periods.

The best way to take into account the national trend is to assume that, if the scheme had not been built, the number of collisions on the roads in the study area here would have dropped at the same rate as they did nationally during the same time period. This provides what is known as a counterfactual ‘without scheme’ scenario and can be compared on a like-for-like basis with the observed After data which is the ‘with scheme’ scenario[6]. The difference between the numbers of collisions in these two scenarios can then be attributed to the scheme rather than the wider national trends.

Table 4-2 shows that there has been a reduction in the collision rate of 18% over and above the background reduction in collisions (compared to the 27% absolute reduction in Table 4-1).

Table 4-2 Number of collisions and collision rates taking into account national trends

Period	Number of collisions	Collision rate (collisions per hmvm)	Collision rate (collisions per mvkm)
Annual average Before period	57.00	13.15	0.082
Counter factual Before period	54.37	11.66	0.072
After (24 months)	91	9.61	0.060
Annual average After period	45.5		

4.2.2. Statistical significance

A Chi squared test compared the number of Before and After collisions and Annual Average Daily Traffic flows (AADTs) against expected values if there was no change. The test result indicates that the reduction in

[6] The counterfactual factor is calculated using the national collision data for motorway class roads After period (2015) and for the middle year in the Before period (2011). The calculated factor between these years is 0.95 for the number of collisions and 0.89 for the collision rate.

the collision rate is statistically significant at the 95% level: We can be 95% confident that the change in collision rate is not a result of chance alone and therefore the scheme has had a direct impact on collision rates.

4.3. Casualties, FWI and KSI rate

Fatal weighted injury (FWI)[7] is calculated based on the numbers of fatal, serious and slight casualties as weighted proportions, to adjust for the severity. The FWI rate allows a comparison between road sections with different flows and lengths.

The 39% reduction of FWI shown in Table 4-3 is attributable to the smaller number of fatal casualties recorded in the After period. The small After sample size means that no conclusions should be drawn at this stage.

Table 4-3 Number of casualties and FWI rate

Period	Severity			Total	FWI	FWI rate per hmvm	FWI rate per bvkm
	Fatal	Serious	Slight				
Before (36 months) (13.0 hmvm, 2.09 bvkm)	2	14	279	295	6.19	0.48	2.96
After (24 months) (9.5 hmvm, 1.52 bvkm)	0	15	126	141	2.76	0.29	1.81

The results indicate an increase in the Killed and Seriously Injured (KSI) rate, shown in Table 4-4; this is attributable to the proportionally larger number of serious casualties recorded but the relatively small sample means no conclusions should be drawn.

Table 4-4 Total KSI and KSI rate

Period	Total KSI	KSI rate per hmvm	KSI rate per bvkm
Before (36 months) (13.0 hmvm, 2.09 bvkm)	16	1.23	7.64
After (24 months) (9.5 hmvm, 1.52 bvkm)	15	1.58	9.84

4.4. Additional analysis

4.4.1. Red X (lane closed) analysis

An analysis of Red X compliance was undertaken using HALOGEN data for sign and signal settings and MIDAS TCD files for minutely flows per lane. The two data sets were combined to identify lane closures and flows along the lane during the restriction. An example of a Red X event is presented in Figure 4-1.

[7] FWI is defined as: (number of fatalities) + 0.1 x (number of serious casualties) + 0.01 x (number of slight casualties).

Figure 4-1 Example lane closure event

	Detector/Signal Location	MS4 Message	Minutely Flow During Lane Closure L1	L2	L3	L4
	M25/4310B		2	15	16	17
MS4 & AMIs	4310B		(60)	(60)	(60)	(60)
	M25/4315B		2	13	13	15
MS4	4315B	Accident xIII (40)				
	M25/4322B		1	14	16	17
	M25/4327B		3	18	21	19
MS4	4329B	Accident xIII (40)				
Direction of travel ↑	M25/4330B		4	20	22	23
	M25/4332B		7	18	23	23
MSA merge	M25/4337B		3	18	23	24
	M25/4342B		3	19	23	23
MS4	4342B	Accident /III (50)				
MSA diverge	M25/4348B		7	19	23	20
	M25/4352B		6	19	22	19
	M25/4358B		10	17	23	18

Key:

5381B	Signal
M25/5381B	Detector site
L1	Lane 1
L2	Lane 2
L3	Lane 3
L4	Lane 4
(60)	60mph VMSL
(50)	50mph VMSL
(40)	40mph VMSL
LDR	Lane Divert Right Arrow
"X"	Red X on gantry indicating closed lane
xIII	Wickets on MS4 Sign showing lane 1 closure
xxII	Wickets on MS4 Sign showing lane 1 and lane 2 closure
/III	Wickets on MS4 Sign showing lane divert right
NR	National Speed Limit

A total of 20 lane closures have been assessed in the Yr2 After period and the results are summarised in Appendix C.3. The per-lane minutely flow is provided to give an indication of how busy the motorway was; a flow of 30 vehicles per minute per lane is a high flow (one vehicle every 2 seconds).

Non-compliance in this sample ranges from 1 to 10 vehicles per minute, 1% to 13% of total flow; across all Red X events analysed the minutely average flow of non-compliance vehicles was 3 per minute. Compliance with Red X as a percentage of total flow was 94%, which is similar to 93% in the Yr1 After period.

The percentage of non-compliance was compared to the incident duration and traffic flow; no correlation was found with either. This suggests that the subset of drivers who choose not to comply with Red Xs do so regardless of how busy the motorway is or how long the incident duration is.

4.4.2. ERA monitoring

The ERA monitoring was undertaken to identify the causes of ERA stops, vehicle types and risks of entering, stopping or exiting the ERA. Six ERAs between J5 and J6 were identified for continuous monitoring covering both peaks and inter-peak. (There are no ERAs between J6 and J7 because there is hard shoulder on this section.) A total of 240 hours was divided between the following ERAs:

- ERA 1 – M25 anticlockwise between J5 and J6 at 4288B;
- ERA 2 – M25 clockwise between J5 and J6 at 4286A;
- ERA 3 – M25 anticlockwise between J5 and J6 at 4313B;
- ERA 4 – M25 clockwise between J5 and J6 at 4311A;
- ERA 5 – M25 anticlockwise between J5 and J6 at 4328B; and
- ERA 6 – M25 clockwise between J5 and J6 at 4365A.

In total during the ERA monitoring 67 unique ERA stops were observed. This means stops by a lead vehicle; further related vehicle activity such as Highways England Traffic Officer services or recovery vehicles are not counted. A summary of ERA activity can be seen in Table 4-5.

Table 4-5 Summary of ERA activity

Activity	Number	Percentage of all stops
Emergency Refuge Telephone (ERT) used	3	4%
Highways England Traffic Officer attended	2	3%
Non-emergency (e.g. drove off without exiting vehicle, comfort break etc.)	53	79%
Genuine reason (e.g. problem with vehicle)	14	21%

The 67 unique ERA stops over 240 hours of ERAs monitored gives a rate of approximately 0.28 stops per hour per ERA. From the sample observed it was judged that 79% were non-emergency. This has slightly decreased from the 81% of non-emergency stops in Yr1 After.

Other ERA observations were:

- no instances of problems with ERA operation were observed; and
- no collisions relating to vehicles exiting ERAs.

A breakdown of the types of lead vehicles which stopped in ERAs and whether they were genuine emergencies is shown in Table 4-6. It can be seen that cars make the majority of ERA stops. HGVs and LGVs represented the highest non-emergency use of ERAs, both at 100%. This compares with 86% of HGVs stopping for a non-emergency reason in Yr1 After. This variability is likely to be because of small sample sizes; for the entire After period, the non-emergency stops for HGVs is 93%.

Table 4-6 Vehicle types using ERAs

Vehicle type	Number of ERA stops	Percentage of total	Non-emergency	Genuine emergency
Car	37	55%	70%	30%
Van	8	12%	63%	38%
HGV	21	31%	100%	0%
LGV	1	1%	100%	0%
Total	67		79%	21%

4.5. Summary

There was a statistically significant reduction in collisions as a result of the scheme; 27% reduction and 18% over and above the national background trend of improved safety. This is positive news, showing that the scheme has exceeded its safety objective based on the results after two years.

There is a reduction in the FWI rate due to the smaller number of fatal casualties, but an increase in the KSI rate due to the proportionally large number of serious casualties; these are based on small sample sizes so conclusions should not be drawn at this stage.

Monitoring of Red X compliance revealed that across all events analysed, an average of 6% of vehicles did not comply with Red X's in the Yr2 After period.

Approximately 0.28 ERA stops per hour per ERA were observed during monitoring of CCTV, slightly less than the 0.3 rate during Yr1 After. It was judged that 79% were non-emergency. HGVs and LGVs represented the highest non-emergency use of ERAs, both at 100%.

5. Conclusions

5.1. Flows

For J5 to J6, the SM-ALR section where an additional running lane is now available, flows have increased by 17% clockwise and 7% anticlockwise. The scheme has experienced traffic growth of between 4% and 6% between J6 and J7, which was not previously at capacity and has not received an additional running lane; this is in line with regional growth trends.

The percentage of long vehicles has increased in the anticlockwise direction but decreased in the clockwise direction. Increases and decreases are typically 1 to 2 percent, so effectively unchanged.

5.2. Journey times

In the clockwise direction, average journey times where there is no congestion, have remained similar between Before, Yr1 After and Yr2 After where free flow speeds are maintained. During congested times, (Monday to Thursday AM peaks and Friday AM peak and inter-peak) where journey times had improved in Yr1 After, the benefit has eroded and they are now marginally higher than the Before period.

Anticlockwise journey times are still achieving reductions, particularly in the congested PM peak periods.

On the whole during the Yr2 After period, day-to-day journey time reliability is better in both directions and the worst journeys are more reliable in the anticlockwise direction although not clockwise. This shows that journey times have been maintained and reliability has improved while flows have significantly increased, supporting the movement of more goods and services.

5.3. Safety

There was a statistically significant reduction in collisions as a result of the scheme; 27% reduction and 18% over and above the national background trend of improved safety. This is positive news, showing that the scheme has exceeded its safety objective based on the results after two years.

There is a reduction in the FWI rate due to the smaller number of fatal casualties, but an increase in the KSI rate due to the proportionally large number of serious casualties; these are based on small sample sizes so conclusions should not be drawn at this stage.

Monitoring of Red X compliance revealed that across all events analysed, an average of 94% of vehicles complied with Red Xs in the Yr2 After period.

Approximately 0.28 ERA stops per hour per ERA were observed during monitoring of CCTV, slightly less than the 0.3 rate during Yr1 After. It was judged that 79% were non-emergency. HGVs and LGVs represented the highest non-emergency use of ERAs, both at 100%

Appendices

Appendix A. Flow additional information

A.1. 24 hour average daily traffic (ADT)

The table below shows the values for ADTs Before and After. Statistically significant changes are shown in bold for J6 to J7 (see Section 2.5 for a description of the statistical significance testing).

24 Hour Average Daily Traffic (ADT)									
Location	**Value**	**Clockwise**				**Anticlockwise**			
		Mon-Thurs	**Friday**	**Sat-Sun**	**ADT**	**Mon-Thurs**	**Friday**	**Sat-Sun**	**ADT**
J5 - J6	Before	64,400	69,800	57,100	63,000	65,800	72,100	57,000	64,200
	Yr1 After	72,200	77,400	65,300	71,000	67,000	73,300	60,200	66,000
	Yr2 After	70,400	80,400	69,000	73,700	69,700	76,400	63,200	68,800
	Change	6,000	10,600	11,900	10,700	3,900	4,300	6,200	4,600
	% Change (against Before)	**9%**	**15%**	**21%**	**17%**	**6%**	**6%**	**11%**	**7%**
J6 - J7	Before	72,300	77,700	63,100	70,500	71,200	76,900	61,300	69,200
	Yr1 After	73,100	77,800	66,000	71,700	72,100	78,200	64,500	70,800
	Yr2 After	74,100	79,600	67,700	73,100	74,700	81,300	67,500	73,600
	Change	1,800	1,900	4,600	2,600	3,500	4,400	6,200	4,400
	% Change (against Before)	**2%**	**2%**	**7%**	**4%**	**5%**	**6%**	**10%**	**6%**

A.2. Monthly Average Daily Traffic (ADT)

The two figures below show the variation in monthly ADT for clockwise and anticlockwise traffic respectively. It can be seen that there has not been a major change to the seasonal trend of traffic flows. The trend of lower flows in the winter months is consistent with the national picture.

Direction	**Location**	**May-15**	**Jun-15**	**Jul-15**	**Aug-15**	**Sep-15**	**Oct-15**
Clockwise	J5 – J6	74,200	75,200	77,500	76,800	76,300	73,100
	J6 – J7	75,800	76,400	78,600	78,300	77,800	73,900
Anti-clockwise	J5 – J6	70,000	71,500	73,700	72,900	72,800	70,200
	J6 – J7	72,300	76,100	77,000	78,900	77,600	77,500
Direction	**Location**	**Nov-15**	**Dec-15**	**Jan-16**	**Feb-16**	**Mar-16**	**Apr-16**
Clockwise	J5 – J6	72,500	72,200	67,700	70,800	72,700	74,900
	J6 – J7	68,900	68,300	64,000	68,400	71,700	74,800
Anti-clockwise	J5 – J6	65,300	65,700	59,600	65,000	68,200	70,500
	J6 – J7	75,000	70,300	70,300	63,400	68,900	72,700

A.3. Flows by time slice

The table below shows the flows for each time slice in the clockwise direction.

Clockwise flows by time slice								
Location	**Value**	**Mon-Thurs**			**Friday**			**Saturday-Sunday**
		AM Peak	**Inter-peak**	**PM Peak**	**AM Peak**	**Inter-peak**	**PM Peak**	
J5 - J6	Before	22,800	16,000	17,600	15,800	17,200	27,700	44,000
	Yr1 After	25,900	17,900	19,300	18,100	19,100	29,700	50,100
	Yr2 After	26,300	18,600	19,700	17,900	19,600	31,100	52,100
	Change	3,500	2,600	2,100	2,100	2,400	3,400	8,100
	% Change (against Before)	**15%**	**16%**	**12%**	**13%**	**14%**	**12%**	**18%**
J6 - J7	Before	26,400	17,900	19,600	18,100	19,100	30,900	48,800
	Yr1 After	26,700	18,100	19,100	18,300	19,400	29,700	50,700
	Yr2 After	27,000	18,400	19,300	18,600	19,500	30,600	52,000
	Change	600	500	-300	500	400	-300	3,200
	% Change (against Before)	**2%**	**3%**	**-2%**	**3%**	**2%**	**-1%**	**7%**

The table below shows the flows for each time slice in the anticlockwise direction.

Anticlockwise flows by time slice								
Location	**Value**	**Mon-Thurs**			**Friday**			**Saturday-Sunday**
		AM Peak	**Inter-peak**	**PM Peak**	**AM Peak**	**Inter-peak**	**PM Peak**	
J5 - J6	Before	16,800	17,200	23,300	10,600	15,900	34,800	44,500
	Yr1 After	17,200	17,800	23,300	11,000	16,400	34,800	46,800
	Yr2 After	17,600	18,700	24,300	11,500	16,800	36,400	48,900
	Change	800	1,500	1,000	900	900	1,600	4,400
	% Change (against Before)	**5%**	**9%**	**4%**	**8%**	**6%**	**5%**	**10%**
J6 - J7	Before	18,300	18,500	25,600	11,600	17,000	37,300	48,100
	Yr1 After	18,100	18,900	25,700	11,600	17,200	37,600	50,200
	Yr2 After	18,500	19,700	26,500	12,100	17,600	39,000	52,200
	Change	200	1,200	900	500	600	1,700	4,100
	% Change (against Before)	**1%**	**6%**	**4%**	**4%**	**4%**	**5%**	**9%**

A.4. Long vehicles percentage

The percentage of long vehicles by time slice for J6 to J7 anticlockwise is shown in the table below. Issues with vehicle classification by radar detectors prevent reporting for J5 to J6. Data was infilled for J6 to J7 clockwise which also prevents reporting.

It can be seen that there has been an increase in the percentage of long vehicles across all time slices in the anticlockwise direction between J7 and J6. It is expected that this would be mirrored on the other three links.

Direction	Location	Mon-Thurs			Friday			Saturday-Sunday
		AM Peak	Inter-peak	PM Peak	AM Peak	Inter-peak	PM Peak	
Clockwise	Before	16%	19%	12%	18%	16%	10%	6%
	Yr2 After	14%	16%	11%	15%	14%	9%	5%
Anti-clockwise	Before	13%	18%	11%	14%	16%	11%	5%
	Yr2 After	16%	22%	14%	18%	19%	13%	6%

Appendix B. Journey time additional information

B.1. Days in sample

The table below shows the date ranges and number of days used in the data set for the analysis:

Period		Clockwise	Anticlockwise
Before	From	1 Sep 11	1 Sep 11
	To	31 Aug 12	31 Aug 12
	Days removed	0	0
	Days in sample	365	365
Yr2 After	From	1 May 15	1 May 15
	To	30 Apr 16	30 Apr 16
	Days removed	0	0
	Days in sample	365	365

B.2. Journey time

B.2.1. Average journey time

The tables below show the results. Where Yr2 After period journey times have become longer they are highlighted in red.

Clockwise journey time comparison

	Section	Distance (miles)	M-T AM	M-T IP	M-T PM	F AM	F IP	F PM	SS	Period average % change
Before	J5 to J6	9.6	12:56	09:02	08:50	11:19	09:58	08:58	09:14	
	J6 to J7	2.9	02:57	02:32	02:30	02:47	02:37	02:30	02:30	
	Total	12.5	15:54	11:34	11:20	14:06	12:36	11:28	11:44	
Yr2 After	J5 to J6	9.6	13:21	09:02	08:47	11:17	09:59	08:53	09:11	0.3%
	J6 to J7	2.9	03:12	02:38	02:33	02:55	02:47	02:34	02:40	5%
	Total	12.5	16:33	11:40	11:21	14:12	12:46	11:27	11:51	1%
	% Change		4.1%	0.9%	0.1%	0.6%	1.4%	-0.1%	1.0%	

Anticlockwise journey time comparison

	Section	Distance (miles)	M-T AM	M-T IP	M-T PM	F AM	F IP	F PM	SS	Period average % change
Before	J5 to J6	9.6	08:31	08:44	09:49	08:27	08:51	10:23	08:30	
	J6 to J7	2.9	02:35	02:40	03:24	02:34	02:43	04:08	02:35	
	Total	12.5	11:07	11:23	13:13	11:02	11:34	14:31	11:05	
Yr2 After	J5 to J6	9.6	08:32	08:53	09:27	08:26	08:43	09:40	08:37	-2%
	J6 to J7	2.9	02:38	02:43	03:21	02:40	02:42	03:28	02:41	-2%
	Total	12.5	11:10	11:36	12:47	11:06	11:25	13:08	11:18	-2%
	% Change		0.5%	1.8%	-3.2%	0.7%	-1.3%	-9.6%	2.1%	

Appendix C. Safety additional information

C.1. Number and rate of collisions (J5-7)

The table below shows the number of collisions in the Before and After periods, the rate of collisions and the percentage change for the whole scheme, J5 to J7.

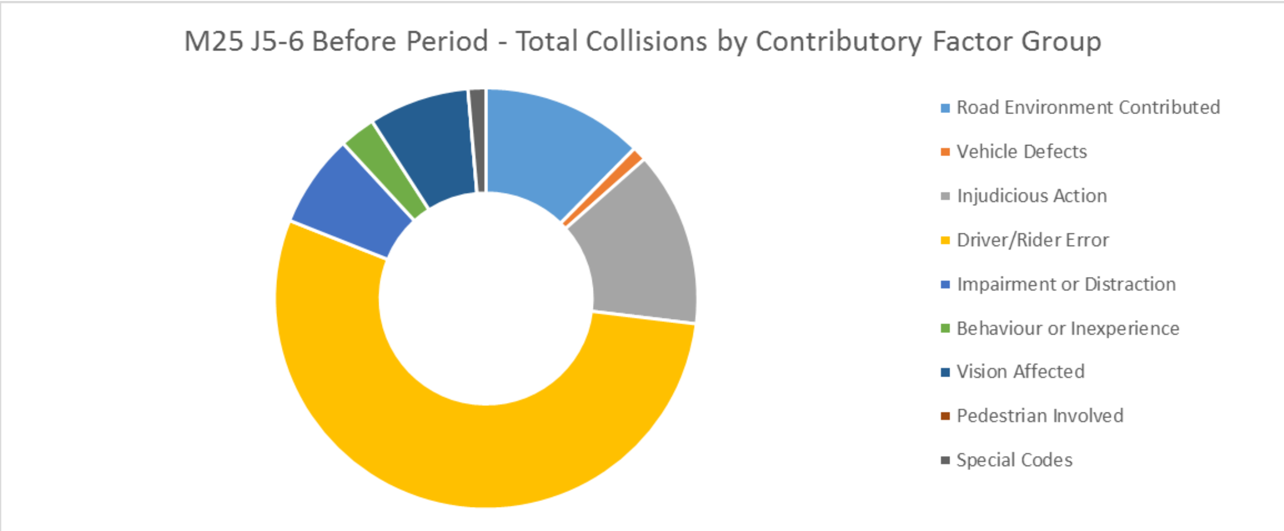
Number of collisions by severity and collision rates

Period		Fatal	Serious	*Fatal & serious*	Slight	Total
Before	Year 1	2	7	9	74	83
	Year 2	0	4	4	79	83
	Year 3	0	4	4	62	66
	Total	2	15	17	215	232
	Collision rate (collisions per hmvm) (18.0 hmvm)	0.111	0.831	0.942	11.914	12.856
	Collision rate (collisions per mvkm) (2,906 mvkm)	0.001	0.005	0.006	0.074	0.080
After	Year 1	0	12	12	56	68
	Year 2	0	6	6	56	62
	Total	0	18	18	112	130
	Collision rate (collisions per hmvm) (12.8 hmvm)	0.000	1.406	1.406	8.746	10.151
	Collision rate (collisions per mvkm) (2,061 mvkm)	0.000	0.009	0.009	0.054	0.063

C.2. Contributory factors

Contributory factors by severity Before period

Code	Contributory factor group	Fatal	Serious	Slight	Total
101-109	Road environment contributed	1	9	35	45
201-206	Vehicle defects	0	0	4	4
301-310	Injudicious action	2	1	46	49
401-410	Driver/rider error	1	10	186	197
501-510	Impairment or distraction	0	1	25	26
601-607	Behaviour or inexperience	0	0	10	10
701-710	Vision affected	0	3	25	28
801-810	Pedestrian involved	0	0	0	0
901-999	Special codes	0	3	2	5
Total		**4**	**27**	**333**	**364**



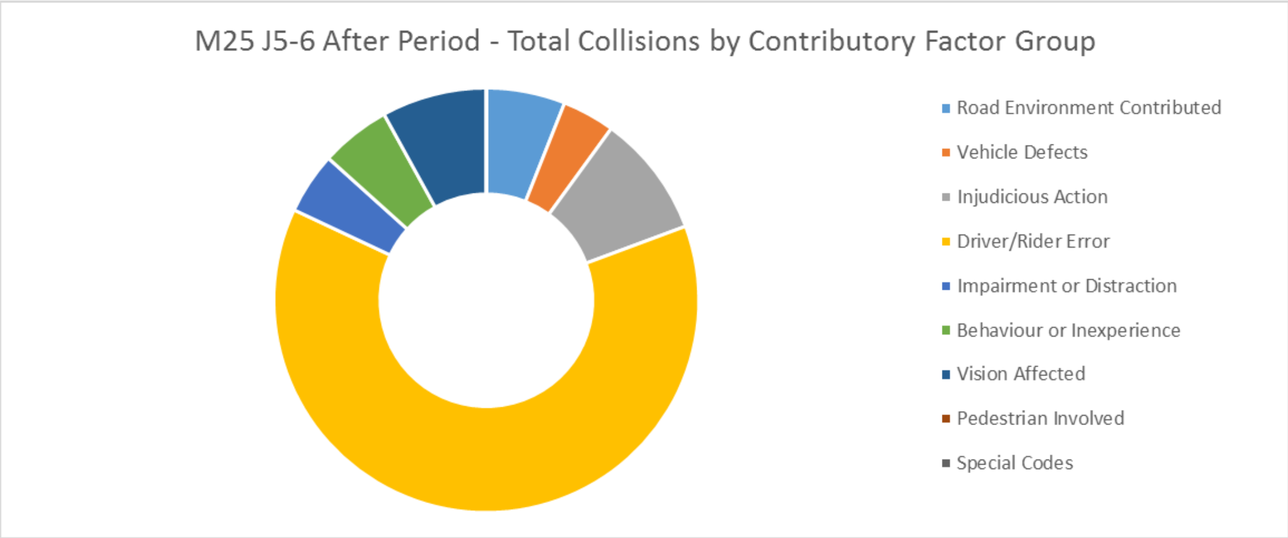
Rank	1 to 10
	11 to 15

Code	Contributory factors	Fatal	Serious	Slight	Total	Rank
Road environment contributed		**1**	**9**	**35**	**45**	
101	Poor or defective road surface	0	2	1	3	15
102	Deposit on road (e.g. oil, mud, chippings)	0	1	0	1	26
103	Slippery road (due to weather)	1	6	32	39	**3**
104	Inadequate or masked signs or road markings	0	0	0	0	
105	Defective traffic signals	0	0	0	0	
106	Traffic calming (e.g. speed cushions, road humps, chicanes)	0	0	0	0	
107	Temporary road layout (e.g. contraflow)	0	0	0	0	
108	Road layout (e.g. bend, hill, narrow carriageway)	0	0	0	0	
109	Animal or object in carriageway	0	0	2	2	18
Vehicle defects		**0**	**0**	**4**	**4**	
201	Tyres illegal, defective or under-inflated	0	0	2	2	18
202	Defective lights or indicators	0	0	0	0	
203	Defective brakes	0	0	0	0	
204	Defective steering or suspension	0	0	1	1	26
205	Defective or missing mirrors	0	0	0	0	
206	Overloaded or poorly loaded vehicle or trailer	0	0	1	1	26
Injudicious action		**2**	**1**	**46**	**49**	
301	Disobeyed automatic traffic signal	0	0	0	0	
302	Disobeyed 'Give Way' or 'Stop' sign or markings	0	0	0	0	
303	Disobeyed double white lines	0	0	0	0	
304	Disobeyed pedestrian crossing facility	0	0	0	0	
305	Illegal turn or direction of travel	0	0	0	0	
306	Exceeding speed limit	1	0	0	1	26
307	Travelling too fast for conditions	1	1	17	19	**7**
308	Following too close	0	0	29	29	**6**
309	Vehicle travelling along pavement	0	0	0	0	
310	Cyclist entering road from pavement	0	0	0	0	
Driver/rider error		**1**	**10**	**186**	**197**	
401	Junction overshoot	0	0	1	1	26
402	Junction restart (moving off at junction)	0	0	0	0	
403	Poor turn or manoeuvre	0	0	12	12	**10**
404	Failed to signal or misleading signal	0	0	2	2	18
405	Failed to look properly	0	2	57	59	**1**
406	Failed to judge other person's path or speed	0	0	33	33	**5**
407	Passing too close to cyclist, horse rider or pedestrian	0	0	0	0	
408	Sudden braking	0	2	39	41	**2**
409	Swerved	0	0	11	11	11
410	Loss of control	1	6	31	38	**4**
Impairment or distraction		**0**	**1**	**25**	**26**	
501	Impaired by alcohol	0	0	3	3	15
502	Impaired by drugs (illicit or medicinal)	0	0	0	0	
503	Fatigue	0	1	16	17	**9**
504	Uncorrected, defective eye sight	0	0	0	0	
505	Illness or disability, mental or physical	0	0	2	2	18
506	Not displaying lights at night or in poor visibility	0	0	0	0	
507	Cyclist wearing dark clothing at night	0	0	0	0	
508	Driver using mobile phone	0	0	1	1	26

509	Distraction in vehicle	0	0	2	2	18
510	Distraction outside vehicle	0	0	1	1	26
Behaviour or inexperience		**0**	**0**	**10**	**10**	
601	Aggressive driving	0	0	0	0	
602	Careless, reckless or in a hurry	0	0	2	2	18
603	Nervous, uncertain or panic	0	0	1	1	26
604	Driving too slow for conditions or slow vehicle (e.g. tractor)	0	0	2	2	18
605	Learner or inexperienced driver / rider	0	0	0	0	
606	Inexperience of driving to the left	0	0	4	4	14
607	Unfamiliar with model of the vehicle	0	0	1	1	26
Vision affected		**0**	**3**	**25**	**28**	
701	Stationary or parked vehicle(s)	0	0	0	0	
702	Vegetation	0	0	0	0	
703	Road layout (e.g. bend, winding road, hill crest)	0	0	0	0	
704	Buildings, road signs, street furniture	0	0	0	0	
705	Dazzling headlights	0	0	0	0	
706	Dazzling sun	0	1	1	2	18
707	Rain, sleet, snow or fog	0	0	3	3	15
708	Spray from other vehicles	0	1	4	5	12
709	Visor or windscreen dirty or scratched	0	0	0	0	
710	Vehicle blind spot	0	1	17	18	8
Pedestrian involved		**0**	**0**	**0**	**0**	
801	Crossing road masked by stationary or parked vehicle	0	0	0	0	
802	Failed to look properly	0	0	0	0	
803	Failed to judge vehicle's path or speed	0	0	0	0	
804	Wrong use of pedestrian crossing facility	0	0	0	0	
805	Dangerous action in carriageway (e.g. playing)	0	0	0	0	
806	Impaired by alcohol	0	0	0	0	
807	Impaired by drugs (illicit or medicinal)	0	0	0	0	
808	Careless, reckless or in a hurry	0	0	0	0	
809	Pedestrian wearing dark clothing at night	0	0	0	0	
810	Disability or illness, mental or physical	0	0	0	0	
Special codes		**0**	**3**	**2**	**5**	
901	Stolen vehicle	0	0	0	0	
902	Vehicle in course of crime	0	0	0	0	
903	Emergency vehicle on a call	0	0	0	0	
904	Vehicle door opened or closed negligently	0	0	0	0	
999	Other	0	3	2	5	12

Contributory factors by severity After period

Code	Contributory factor group	Fatal	Serious	Slight	Total
101-109	Road environment contributed	0	2	7	9
201-206	Vehicle defects	0	2	4	6
301-310	Injudicious action	0	0	14	14
401-410	Driver/rider error	0	11	83	94
501-510	Impairment or distraction	0	1	6	7
601-607	Behaviour or inexperience	0	0	8	8
701-710	Vision affected	0	1	11	12
801-810	Pedestrian involved	0	0	0	0
901-999	Special codes	0	0	0	0
Total		**0**	**17**	**133**	**150**



Rank	1 to 10
	11 to 15

Code	Contributory factors	Fatal	Serious	Slight	Total	Rank
Road environment contributed		**0**	**2**	**7**	**9**	
101	Poor or defective road surface	0	0	0	0	
102	Deposit on road (e.g. oil, mud, chippings)	0	0	0	0	
103	Slippery road (due to weather)	0	0	6	6	6
104	Inadequate or masked signs or road markings	0	0	0	0	
105	Defective traffic signals	0	0	0	0	
106	Traffic calming (e.g. speed cushions, road humps, chicanes)	0	0	0	0	
107	Temporary road layout (e.g. contraflow)	0	0	1	1	20
108	Road layout (e.g. bend, hill, narrow carriageway)	0	0	0	0	
109	Animal or object in carriageway	0	2	0	2	14
Vehicle defects		**0**	**2**	**4**	**6**	
201	Tyres illegal, defective or under-inflated	0	1	1	2	14
202	Defective lights or indicators	0	0	0	0	
203	Defective brakes	0	1	1	2	14
204	Defective steering or suspension	0	0	1	1	20
205	Defective or missing mirrors	0	0	0	0	
206	Overloaded or poorly loaded vehicle or trailer	0	0	1	1	20
Injudicious action		**0**	**0**	**14**	**14**	
301	Disobeyed automatic traffic signal	0	0	0	0	
302	Disobeyed 'Give Way' or 'Stop' sign or markings	0	0	0	0	
303	Disobeyed double white lines	0	0	0	0	
304	Disobeyed pedestrian crossing facility	0	0	0	0	
305	Illegal turn or direction of travel	0	0	2	2	14
306	Exceeding speed limit	0	0	2	2	14
307	Travelling too fast for conditions	0	0	6	6	6
308	Following too close	0	0	4	4	9
309	Vehicle travelling along pavement	0	0	0	0	
310	Cyclist entering road from pavement	0	0	0	0	
Driver/rider error		**0**	**11**	**83**	**94**	
401	Junction overshoot	0	0	1	1	20
402	Junction restart (moving off at junction)	0	0	0	0	
403	Poor turn or manoeuvre	0	0	5	5	8
404	Failed to signal or misleading signal	0	0	1	1	20
405	Failed to look properly	0	4	38	42	1
406	Failed to judge other person's path or speed	0	4	24	28	2
407	Passing too close to cyclist, horse rider or pedestrian	0	0	0	0	
408	Sudden braking	0	1	6	7	5
409	Swerved	0	0	1	1	20
410	Loss of control	0	2	7	9	3
Impairment or distraction		**0**	**1**	**6**	**7**	
501	Impaired by alcohol	0	0	3	3	11
502	Impaired by drugs (illicit or medicinal)	0	0	0	0	
503	Fatigue	0	1	1	2	14
504	Uncorrected, defective eye sight	0	0	0	0	
505	Illness or disability, mental or physical	0	0	1	1	20
506	Not displaying lights at night or in poor visibility	0	0	0	0	

507	Cyclist wearing dark clothing at night	0	0	0	0	
508	Driver using mobile phone	0	0	0	0	
509	Distraction in vehicle	0	0	1	1	20
510	Distraction outside vehicle	0	0	0	0	
Behaviour or inexperience		**0**	**0**	**8**	**8**	
601	Aggressive driving	0	0	3	3	11
602	Careless, reckless or in a hurry	0	0	4	4	9
603	Nervous, uncertain or panic	0	0	1	1	20
604	Driving too slow for conditions or slow vehicle (e.g. tractor)	0	0	0	0	
605	Learner or inexperienced driver / rider	0	0	0	0	
606	Inexperience of driving to the left	0	0	0	0	
607	Unfamiliar with model of the vehicle	0	0	0	0	
Vision affected		**0**	**1**	**11**	**12**	
701	Stationary or parked vehicle(s)	0	0	0	0	
702	Vegetation	0	0	0	0	
703	Road layout (e.g. bend, winding road, hill crest)	0	0	0	0	
704	Buildings, road signs, street furniture	0	0	0	0	
705	Dazzling headlights	0	0	0	0	
706	Dazzling sun	0	0	0	0	
707	Rain, sleet, snow or fog	0	0	3	3	11
708	Spray from other vehicles	0	0	1	1	20
709	Visor or windscreen dirty or scratched	0	0	0	0	
710	Vehicle blind spot	0	1	7	8	4
Pedestrian involved		**0**	**0**	**0**	**0**	
801	Crossing road masked by stationary or parked vehicle	0	0	0	0	
802	Failed to look properly	0	0	0	0	
803	Failed to judge vehicle's path or speed	0	0	0	0	
804	Wrong use of pedestrian crossing facility	0	0	0	0	
805	Dangerous action in carriageway (e.g. playing)	0	0	0	0	
806	Impaired by alcohol	0	0	0	0	
807	Impaired by drugs (illicit or medicinal)	0	0	0	0	
808	Careless, reckless or in a hurry	0	0	0	0	
809	Pedestrian wearing dark clothing at night	0	0	0	0	
810	Disability or illness, mental or physical	0	0	0	0	
Special codes		**0**	**0**	**0**	**0**	
901	Stolen vehicle	0	0	0	0	
902	Vehicle in course of crime	0	0	0	0	
903	Emergency vehicle on a call	0	0	0	0	
904	Vehicle door opened or closed negligently	0	0	0	0	
999	Other	0	0	0	0	

C.3. Red X compliance

Summary of Red X events analysed

Duration (mins)	Total number of non-compliant vehicles	Per-lane average minutely flow during lane closure	Average minutely flow of non-compliant vehicles	Percentage non-compliance
20	31	4	2	9%
5	2	5	0	2%
55	202	15	4	6%
6	7	2	1	12%
5	29	23	6	6%
8	62	19	8	10%
21	103	18	5	7%
25	103	17	4	6%
28	31	5	1	5%
51	503	19	10	13%
17	13	5	1	4%
9	18	15	2	3%
4	20	13	5	9%
13	65	15	5	8%
6	2	8	0	1%
15	7	3	0	4%
13	3	3	0	2%
11	22	13	2	4%
4	4	5	1	5%
5	13	17	3	4%
Average: 16	Average: 62	Average: 11	Average: 3	Average: 6%