Smart Motorway
All Lane Running

M25 J23-27 Monitoring Third Year Report

Highways England

8 February 2018

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This document has 57 pages including the cover.

Document history

Job number:			**Document ref: 5150343/04/06**			
Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 1.0	Draft Issue to client.	Joe Castle	Andrew Truscott	Jill Hayden	Jill Hayden	06/12/2017
Rev 2.0	Final Issue	Joe Castle	Andrew Truscott	Jill Hayden	Jill Hayden	08/02/2018

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Background

Smart motorways increase capacity to reduce congestion and improve journey time reliability while maintaining safety, by making the hard shoulder available as a traffic lane and by using variable speed limits to smooth traffic flow, supporting economic growth.

Expanding evidence base to provide confirmation of performance

The Smart Motorway All Lane Running (SMALR) scheme, M25 J23 to J27, has previously been monitored and evaluated for Yr1 and Yr2 After period. This report details the performance after 3 years of operation and confirms that All Lane Running is performing as expected. This report completes the evaluation of the scheme in this format and further monitoring and evaluation will continue as part of Highways England's business as usual monitoring and evaluation processes, including Road Safety Audits and Post Opening Evaluation Reports

The safety data confirms that the concept has met its safety objective of maintaining the very high standards of safety compared to the situation before All Lane Running was introduced.

Atkins was commissioned to perform a wide-ranging, comprehensive evaluation of the third year of operation in order to:

- review the safety performance during the initial period of operation;
- monitor and understand the change in safety 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.

SMALR objectives

This report presents the results following a third year of after evaluation from May 2016 to April 2017. It is split into sections to cover each of the objectives of SMALR assessed in this report:

- flows;
- journey times; and
- safety.

Overview of Year 3 Results

M25 J23-J27		
Flows	Significant increase (16%) in flow. Capacity for more growth. Largest growth (23%) was has been at the weekends. All higher than national trends.	
Average journey time	JTs returned close to pre-scheme levels but would have been worse if the scheme was not built. Clockwise 0.4% increase overall, anticlockwise 1.4% decrease.	
Journey time reliability	Slight improvement in journey time reliability overall.	
Safety	Scheme has met its safety objective of maintaining high levels of safety.	

Flows

Flow has increased by 16%, significantly above national trends

The SMALR section has experienced traffic growth of 16% between the Before and Yr3 After periods, which is far higher than regional motorway growth of 7% over the same period. The largest growth from the Before period has been at weekends, up to 23%, while other days have seen increases between 6% and 19%. This growth may be due to suppressed demand taking advantage of the increased capacity and better journey time reliability of the scheme.

Journey Times

Clockwise journey times are unchanged

Overall clockwise journey times are effectively unchanged since the Before period in Yr3 After. In the anticlockwise direction journey times have improved by 15 seconds (1.4%).

Anticlockwise journey times are improved

Journey time reliability clockwise remains similar between the Before and Yr3 After periods. However, there are some delayed journeys in weekday PM peaks. Anticlockwise there is a good improvement on the Monday to Thursday AM peak, while times of day remain similar to before the scheme.

Journey time reliability has improved slightly

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.

Safety

Against a background of increasing flows, the scheme has met its safety objective[1]:

- no increase in number or rate of fatal and weighed injury (FWI) casualties;
- based on the data in the analysis, no user group has been adversely affected.

The scheme has achieved its safety objective

There has been no change in collision rate after taking account the national background trend of improvement.

Severity index, FWI and KSI rates have improved, although these changes are not directly attributable to the scheme.

Red X compliance is 94%

Monitoring of Red X compliance revealed that across all events analysed, an average of 94% of vehicles complied with Red X signals in the Yr3 After period.

[1] Defined as required by Smart Motorways Interim Advice Note 161, http://www.standardsforhighways.co.uk/ha/standards/ians/pdfs/IAN161_15.pdf

1. Introduction

1.1. Scope of project and purpose of this report

Having completed the monitoring and evaluation of the second year of operation, Highways England commissioned this project to monitor and evaluate the impact following a third year's operation of this SMALR scheme, M25 Junction 23 to Junction 27. 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 third 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.

With a third year of data available it is possible to conclude whether the collision rate metric has changed with a level of statistical significance that demonstrates it is the result of SMALR. If the change is not statistically significant it can be concluded that the SMALR objective of maintaining a high level of safety has been achieved.

As part of the previous SMALR Monitoring project, an evaluation methodology was designed. The analysis for the Before period, Yr1, Yr2 and Yr3 After follow this methodology to ensure that all results are comparable.

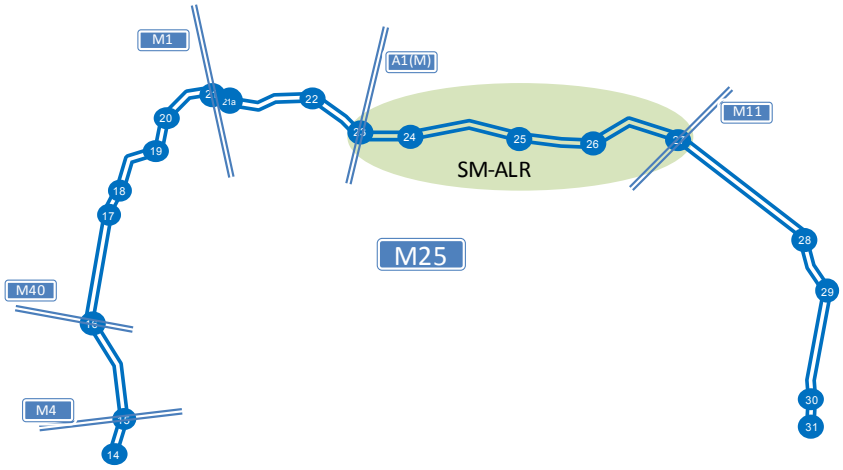
The report is split into sections to cover each of the objectives of SMALR: flows, journey times and safety.

1.2. Background of the scheme

1.2.1. Location

This scheme, M25 J23 to J27, is part of the key strategic orbital route around London which forms the hub of the English motorway network; it is also a commuter route for local traffic. It lies within the counties of Hertfordshire, Essex and the Greater London Authority and is located in the northern segment of the M25. J23 is the intersection with the A1(M) and J27 the intersection with the M11.

Figure 1-1 Geographical location of the M25 J23 to J27 SMALR scheme



The SMALR scheme encompasses two tunnels, Holmesdale located between J25 and J26 and Bell Common between J26 and J27.

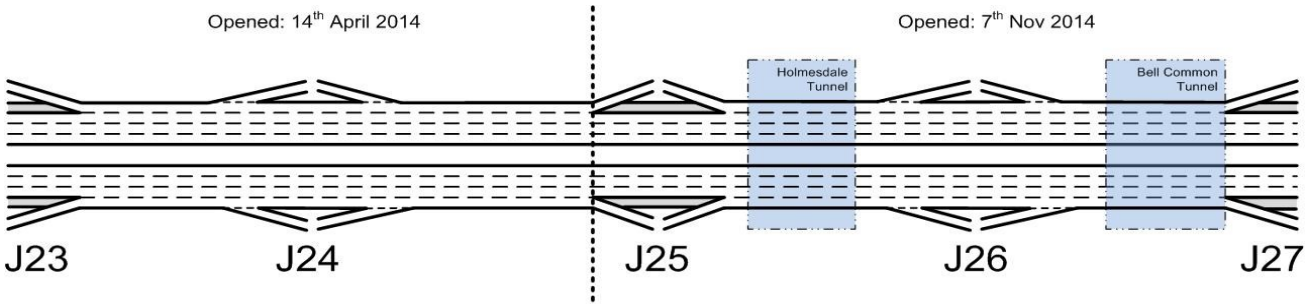
The majority of the M25 is Smart Motorway with hard shoulders which, together with the SMALR scheme, form an overall long term strategy to manage the existing motorway network more effectively.

1.2.2. The SMALR scheme

SMALR 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 Areas (EAs) are available for emergencies.

This scheme was opened in two stages, J23 to J25 opening in May 2014 and J25 to J27 opening in November 2014, see Figure 1-2.

Figure 1-2 M25 J23 to J27 SMALR scheme split



1.3. Evaluation timescales

This report presents the results of evaluation and monitoring following three years' operation of the scheme from May 2014 to April 2017. 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;
- Yr3 After – Third year after opening; and
- After - Entire after period.

The evaluation makes comparisons between the Before and After periods, while operational monitoring has taken place for Red X compliance analysis during the After periods only.

Figure 1-3 shows the evaluation periods used for the Before and After periods. This scheme was opened in two stages, J23 to J25 opening in May 2014 and J25 to J27 opening in November 2014. Consequently, the After period for Yr1 is based on the data for J23 to J25 only until November 2014.

The flow and journey time evaluations compare the Before with Yr2 and Yr3 After; the last 6 months of Yr1 After are not comparable due to the different duration so are not included in this evaluation. The results for Before vs Yr1 and Yr2 can be found in the respective reports.

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.

Figure 1-3 Data collection & evaluation periods

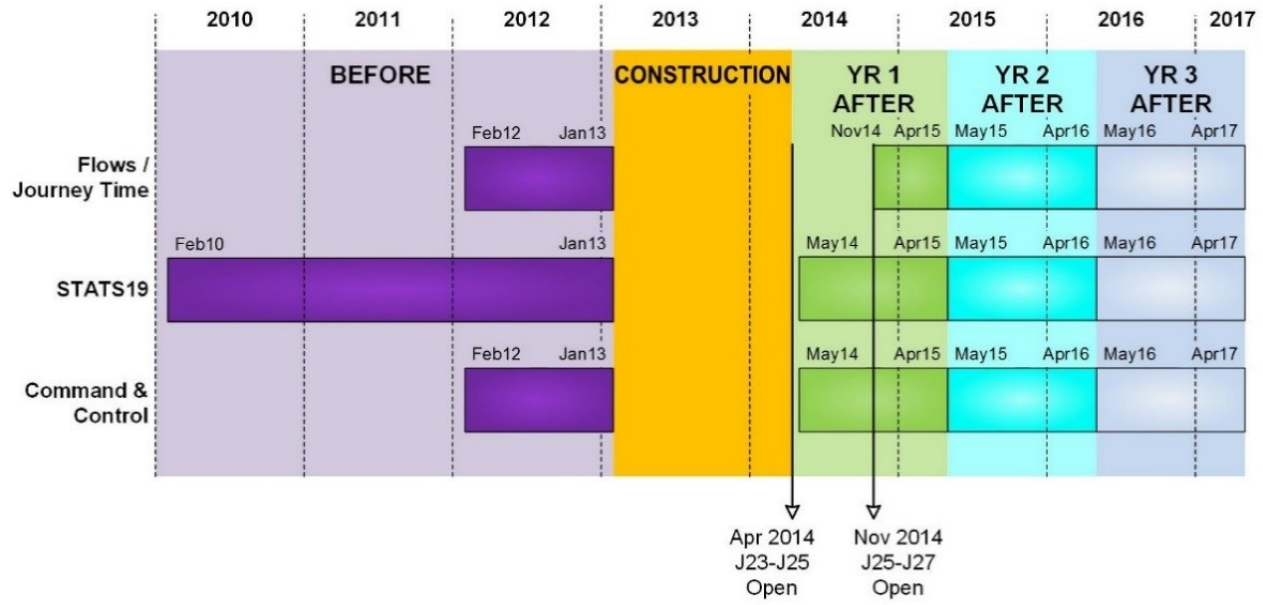


Table 1-1 Day type and time slice definitions

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 SMALR

The SMALR 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 non-emergency hard shoulder stops should also be reduced.

These effects can be seen by looking at traffic performance on a daily basis. The following subsections show speed by lane, flow by lane, speed distribution and speed flow curves for typical days in the Before and Yr3 after periods. The plots show a snapshot of just one location and one day, to demonstrate the impacts.

1.4.1. Speed by lane

Figure 1-4 shows a snapshot of data from Before and Yr3 After collected during the evaluation process. The 15-minute average speed for each lane is also plotted on the same chart to emphasise the daily trend.

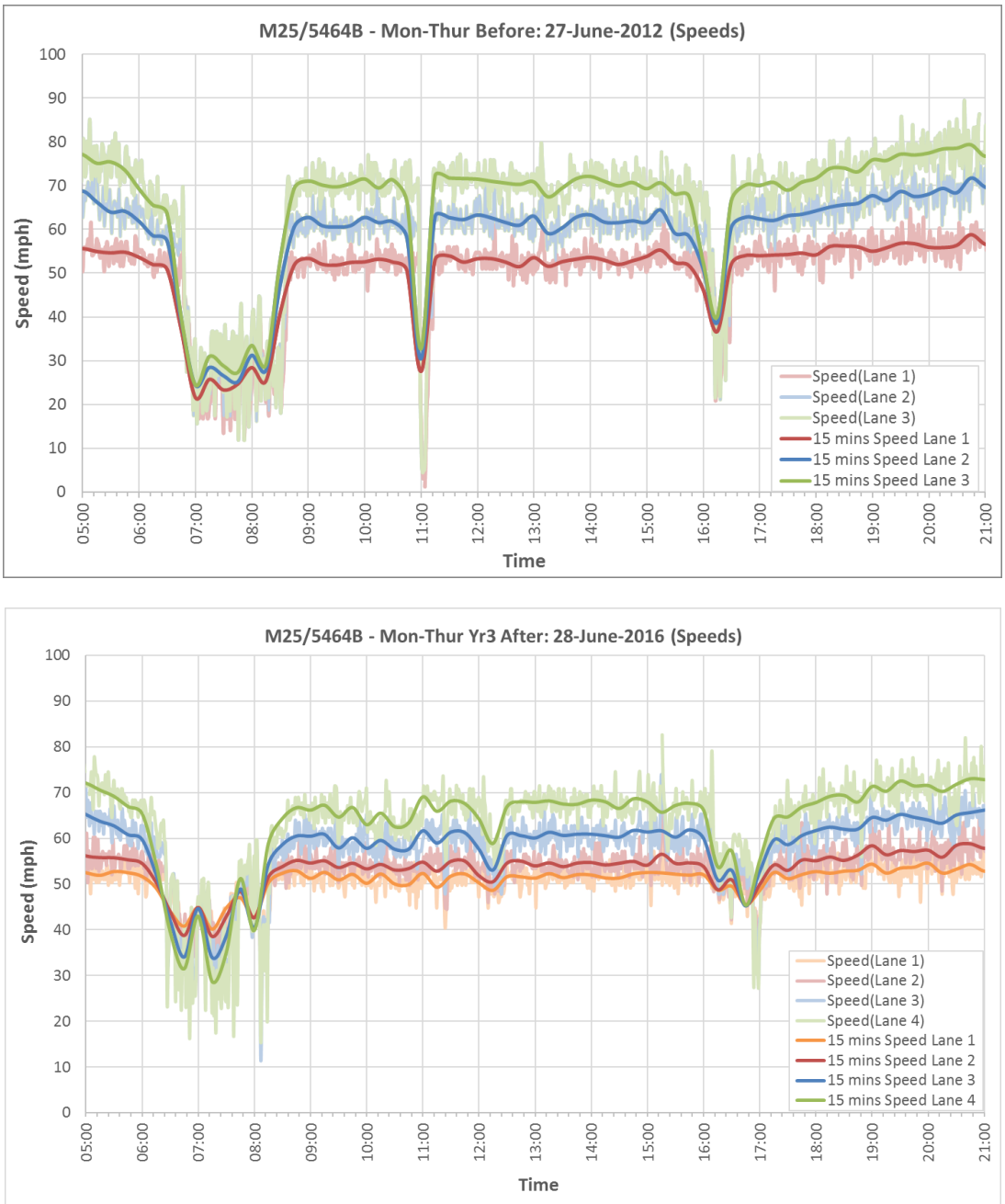
Before the scheme, congestion was present in the morning peak where there was a drop in speeds at 06:30. The average speed in each lane fell to about 25mph which is representative of stop-and-go traffic. This lasted over an hour before recovering to free flow speeds. The speed differential was about 10mph between lanes. Two more breakdowns occur throughout the day, one during the inter-peak (likely to be caused by an

incident) and the other in the PM peak corresponding to average speed of 30 and 40mph, respectively. However, speeds recovered much more quickly.

In the Yr3 After period, although the duration of congestion was similar to that of the Before period, the congestion was less intense, with the 15-minute average speed in the AM peak approximately 40mph as opposed to 25mph.

It appears that the congestion benefits seen in the Yr1 and Yr2 After periods have been eroded, although there is still some benefit due to the higher speeds during congestion. The congestion is thought to be the result of queueing from the Junction 25 off-slip causing tailbacks.

Figure 1-4 Snapshot of speeds by lane Before and Yr3 After

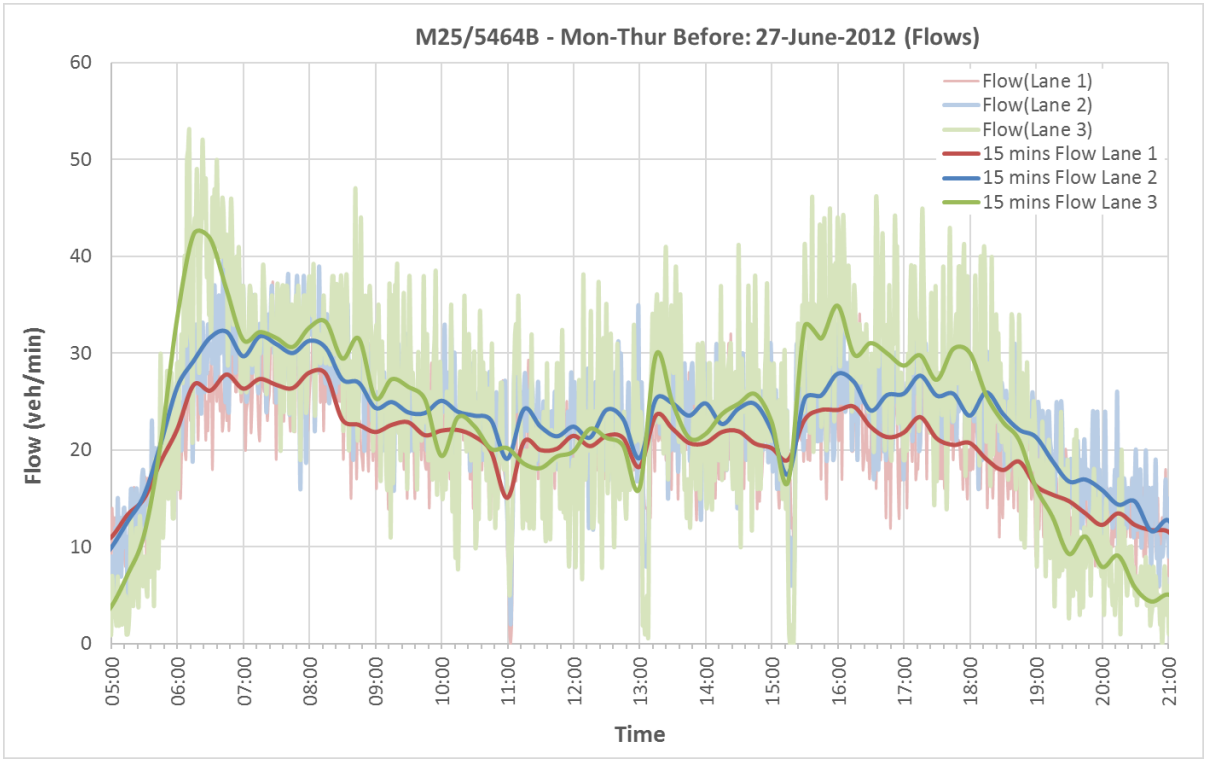


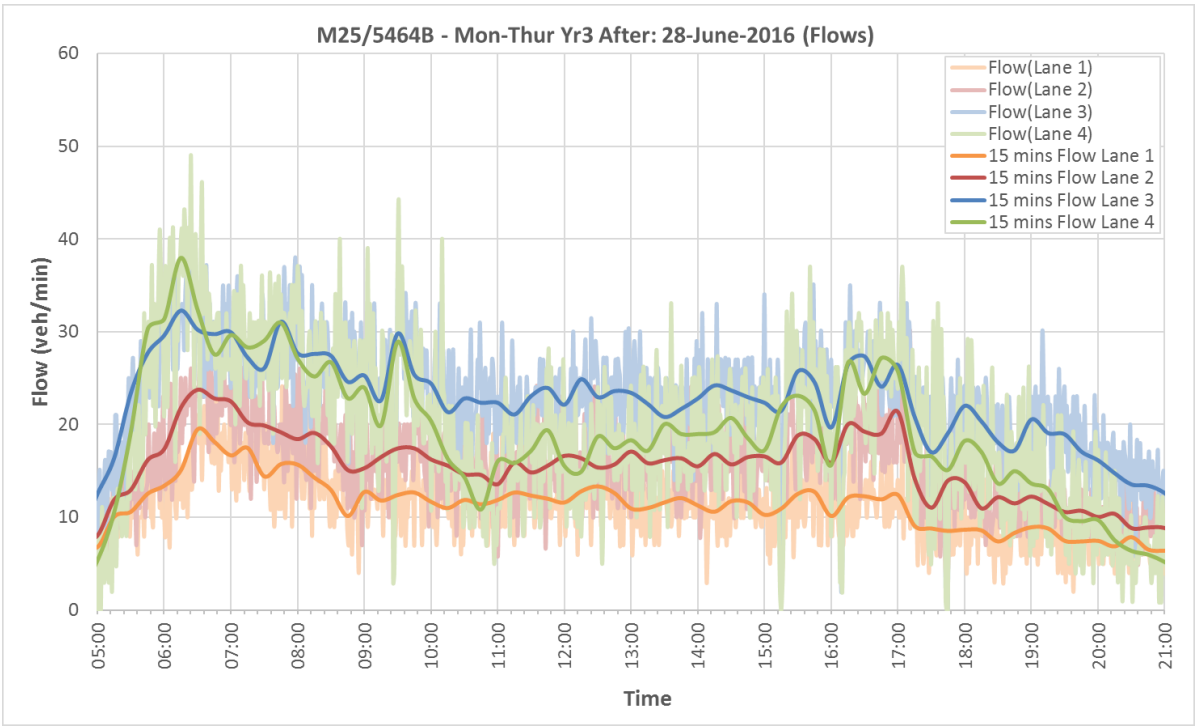
1.4.2. Flow by lane

Figure 1-5 shows the flow by lane for the Before and Yr3 After periods. The motorway experiences high volumes of traffic throughout the day. In the Before period, the peak 15-minute average flow across the carriageway was approximately 99vpm, whereas that of the Yr3 After period had increased to 114vpm.

In the Before period, the flow in the offside lane was higher than the other lanes for most of the day, which is indicative of the motorway reaching its capacity. In the Yr3 After period, the flow in the offside lane was lower than that of its adjacent lane (Lane 3) for most of the day, suggesting that there is still spare capacity.

Figure 1-5 Flow by lane Before and Yr3 After

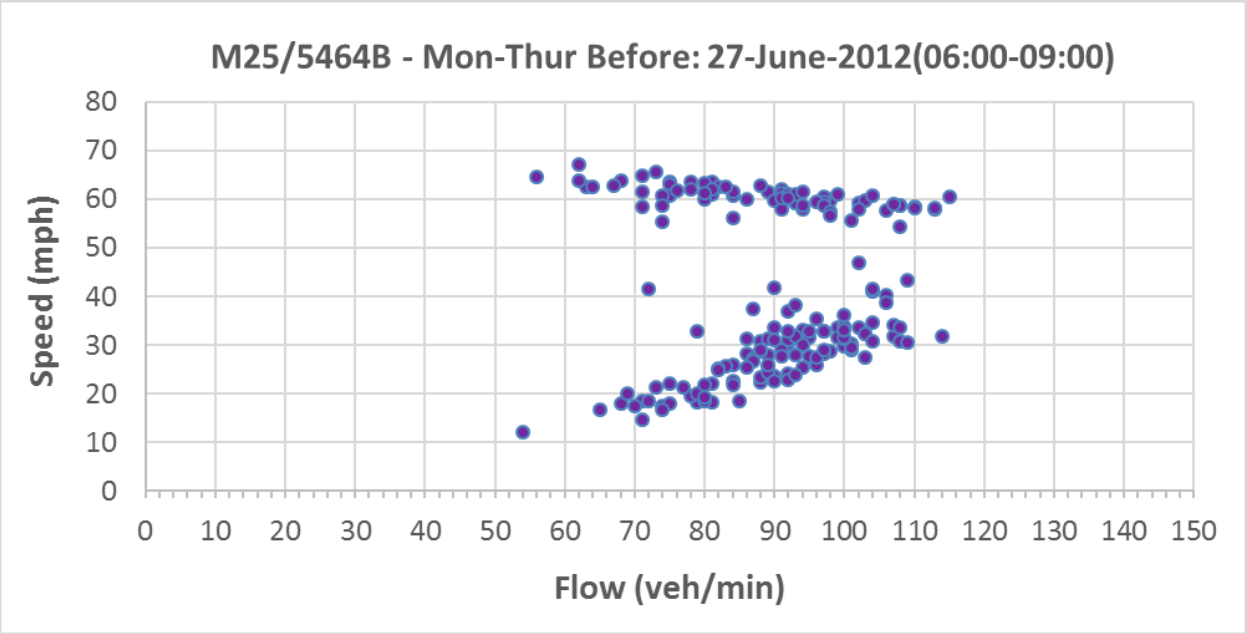


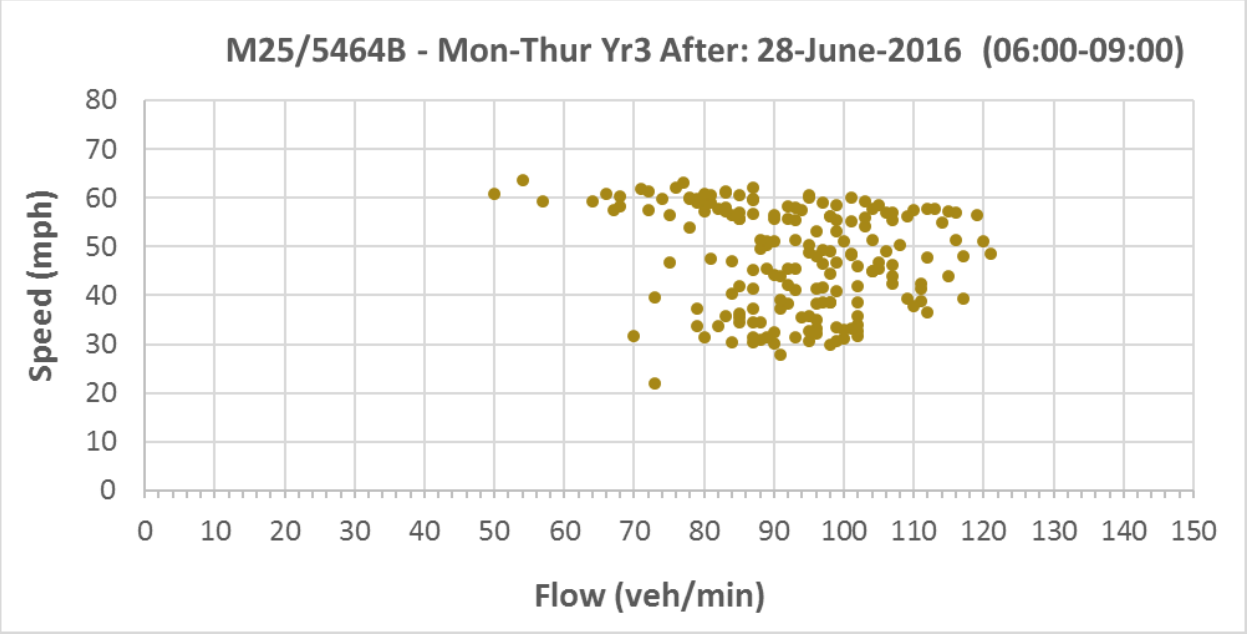


1.4.3. Speed flow curve

The weighted speed across the whole carriageway was plotted against the total flow to give the speed-flow curves in Figure 1-6. In the Before period, traffic flow peaked at 115vpm. The corresponding value in the Yr3 After period was 121vpm. This demonstrates the increase in capacity from the additional lane.

Figure 1-6 Speed flow curves Before and Yr3 After





In the Before period, the congestion caused flow breakdown, reducing the speeds and the flows to 10mph and 54vpm. This demonstrates the significant capacity drop caused by severe congestion. In the Yr3 After period, despite the congestion duration being similar, it was less intense with the lowest speeds and flows in the region of 25mph and 71vpm.

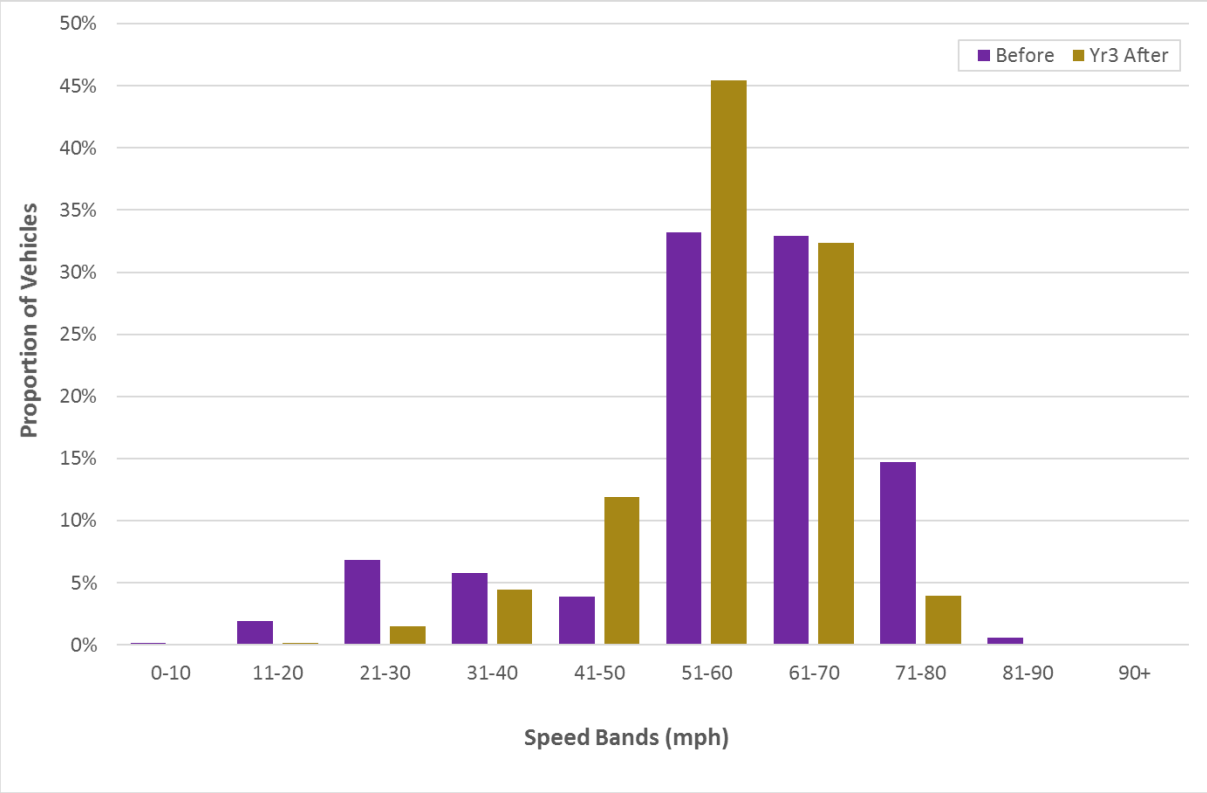
1.4.4. Speed distribution

Figure 1-7 shows the approximate proportions[2] of vehicles travelling at speeds in different 10mph 'bands', over a 24 hour period in the Before and Yr3 After. The key points of interest are:

When comparing the Yr3 After period against the Before period, the proportion of vehicles travelling at 41-60mph has increased by approximately 20 percentage points, whereas the proportion of vehicles travelling at 21-40mph and 61-80mph has decreased by approximately 7 and 12 percentage points, respectively. This shift in speeds can be explained by the higher speeds observed during congestion in the AM peak. The reduction in the highest speeds is likely to be the result of drivers' perception of speed enforcement.

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

Figure 1-7 Speed distribution Before and Yr 3 After



2. Flows

2.1. Introduction

This section presents the results of the Yr3 After traffic flow analysis for the full length of the scheme. Results are compared with the Before and Yr2 data where possible (see Section 2.1.1). The traffic data has been taken from Highways England's MIDAS database.

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 has been underway to improve it. This has allowed the full length of the scheme to be assessed for the first time in this report. The radar data is now sufficiently good that, with some outliers removed, the remaining radars are considered sufficiently representative of traffic conditions in Yr3 to be reported here.

In Yr1, the radar data issues meant that only J23 to J25 could be reported. The Yr1 After report covered only six months following the opening of J25 – J27; these results are not comparable with the 12 month sample so have not been included in this report.

In Yr2, flows from an extra link (J25 to J26) were presented using a bespoke methodology which compared data from all detector sites against publicly available Manual Classified Counts (MCCs) to determine which sites were considered to be more reliable. However, now that the data for this link has improved in Yr3, we have identified that the flows recorded using this methodology in Yr 2 were too high. We have therefore reanalysed Yr2 flows using the information available to us now.

2.2. Daily flows per link

The average daily traffic for the Before and After periods is compared in Figure 2-1 to Figure 2-8, with the 24 hour Average Daily Traffic (ADT) flows between each junction plotted for the different day types. The percentage change form Before is shown above the Yr3 After bar in each case. The corresponding values are shown in Appendix A.1 with changes shown in bold text.

Flows have increased year on year across the After period for all day types and all time slices. In the clockwise direction compared to Before, Mon-Thu Yr3 flows have increased as follows:

- J23 to J24: 11%
- J24 to J25: 10%
- J25 to J26: 13%
- J26 to J27: 17%

Friday flows have also increased, but very slightly less, ranging from 9% to 15%. Weekends have seen the greatest increases between 21% and 25%. The ADTs reflect the overall growth in traffic, with increases ranging from 13% to 18%.

In the anticlockwise direction compared to Before, Mon-Thu Yr3 flows have increased as follows:

- J23 to J24: 13%
- J24 to J25: 13%
- J25 to J26: 17%
- J26 to J27: 15%

Friday flows have again increased slightly less, ranging between 12% and 14%. Weekends have seen the greatest increases between 21% and 24%. The ADTs reflect the overall growth in traffic, with increases ranging from 16% to 17%.

This is the first year in which the impact on J26 to J27 has been reported; clockwise flows appear to have increased slightly more on this link than others, whereas anti-clockwise are similar to other links.

Figure 2-1 Average daily traffic by day type J23-J24 clockwise

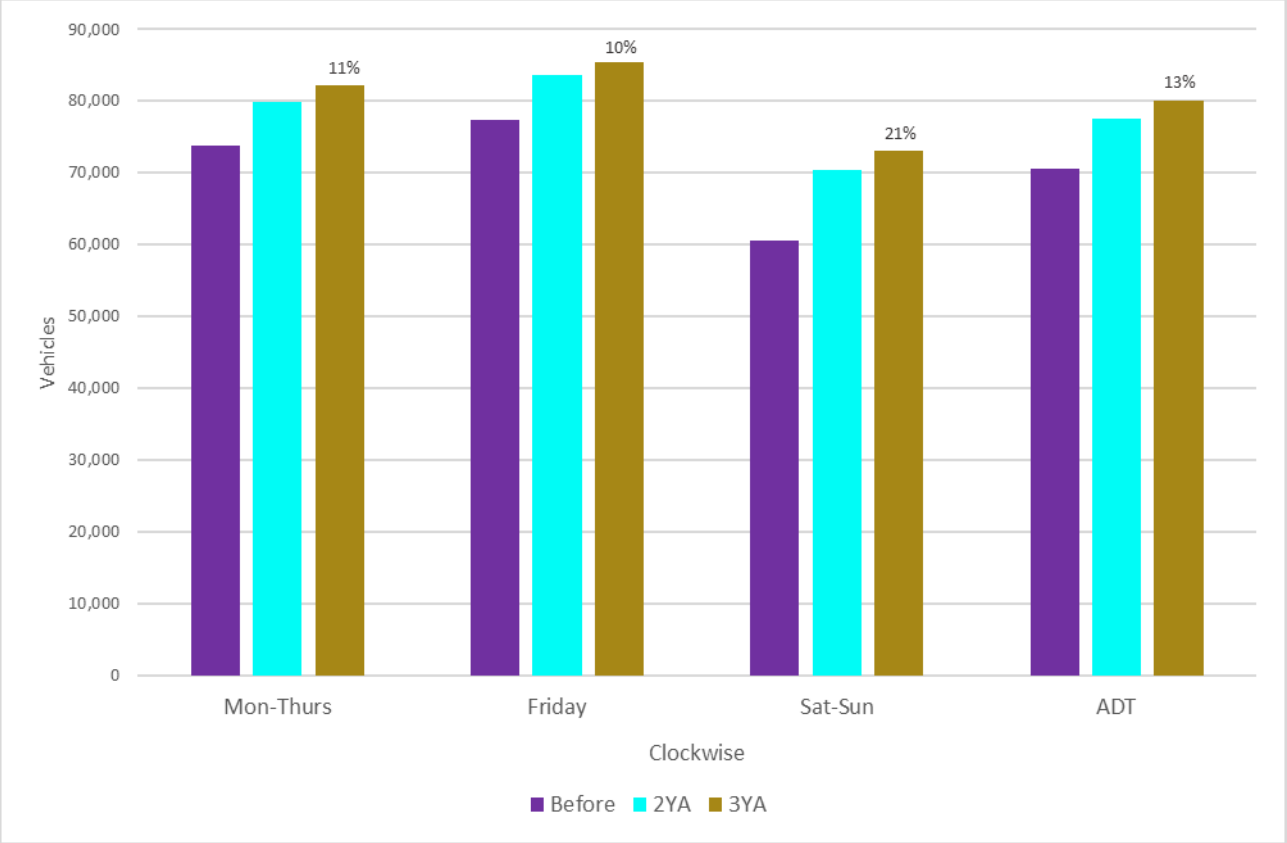


Figure 2-2 Average daily traffic by day type J24-J25 clockwise

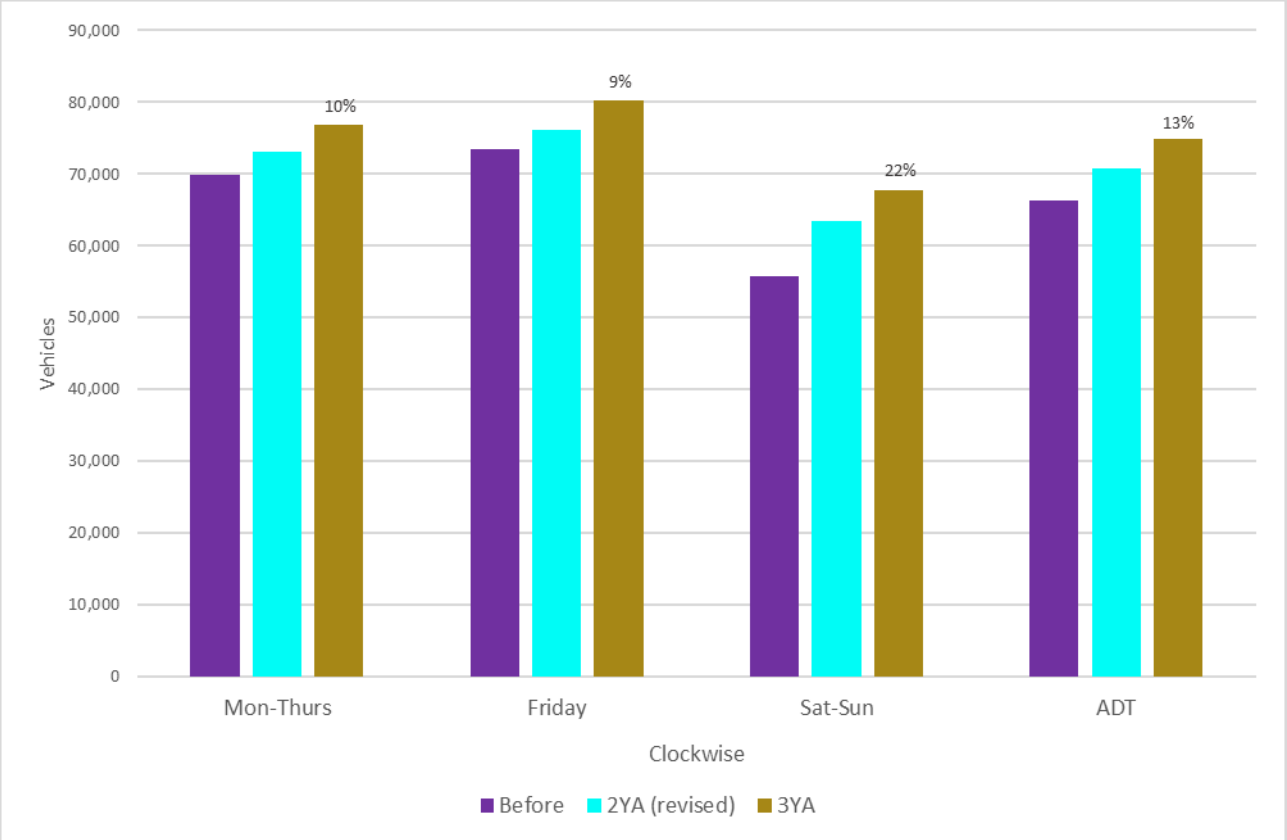


Figure 2-3 Average daily traffic by day type J25-J26 clockwise

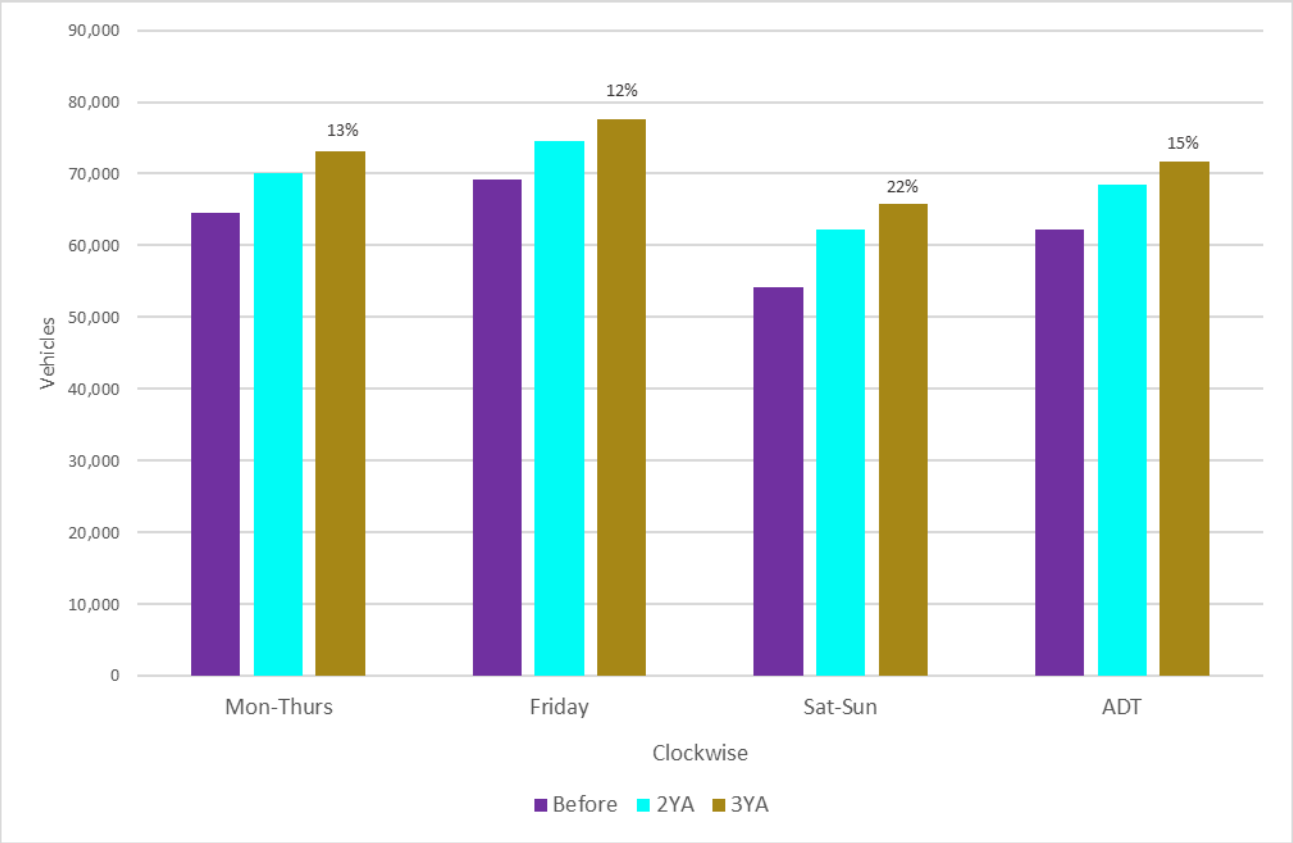


Figure 2-4 Average daily traffic by day type J26-J27 clockwise

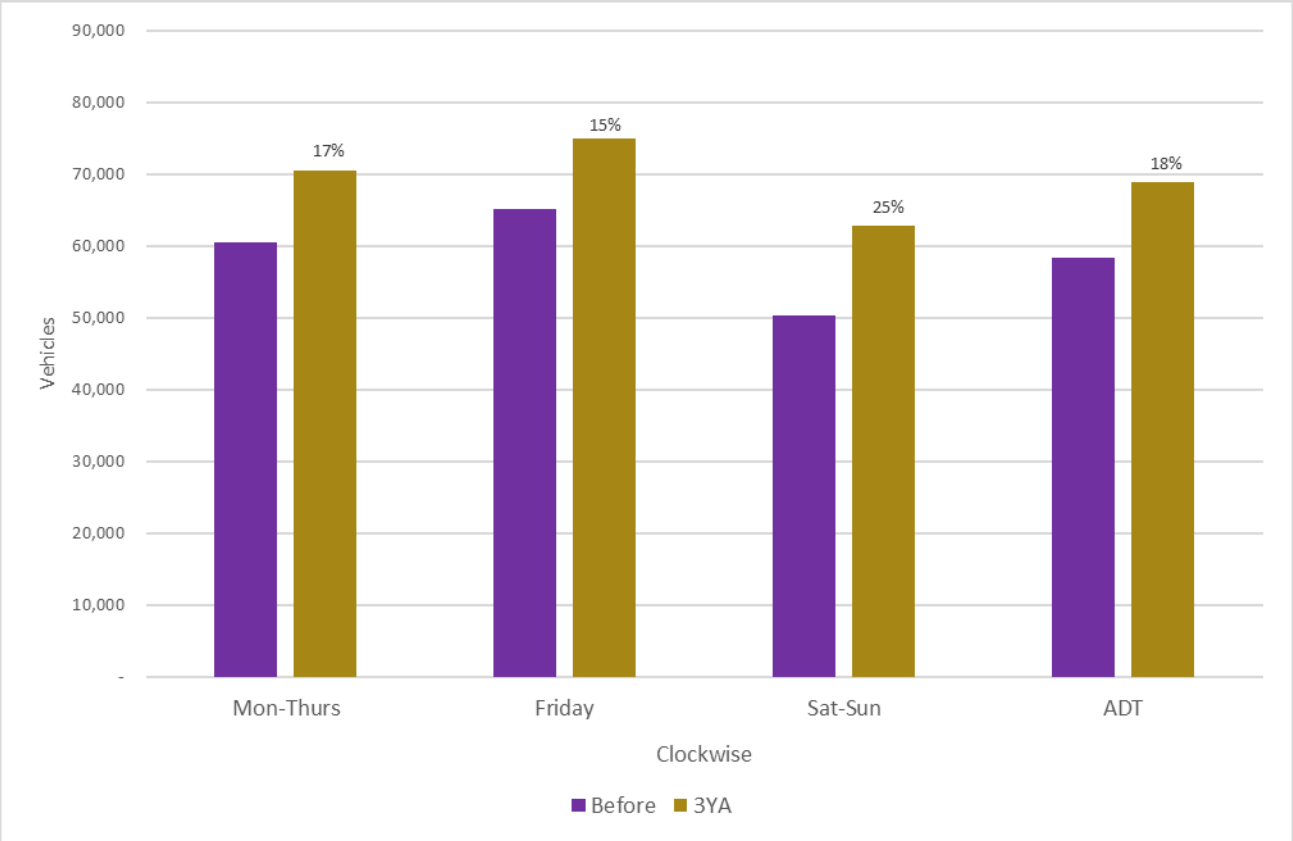


Figure 2-5 Average daily traffic by day type J23-J24 anticlockwise

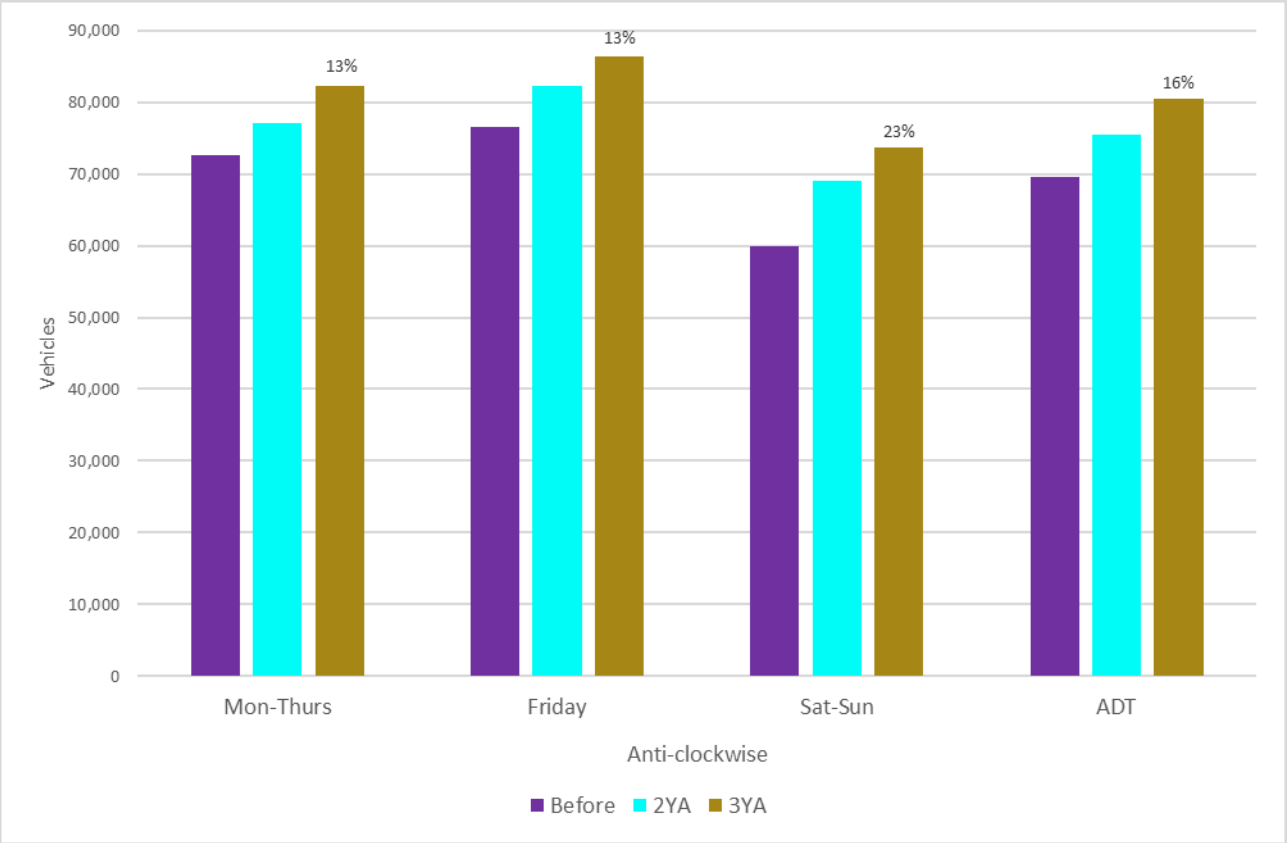


Figure 2-6 Average daily traffic by day type J24-J25 anticlockwise

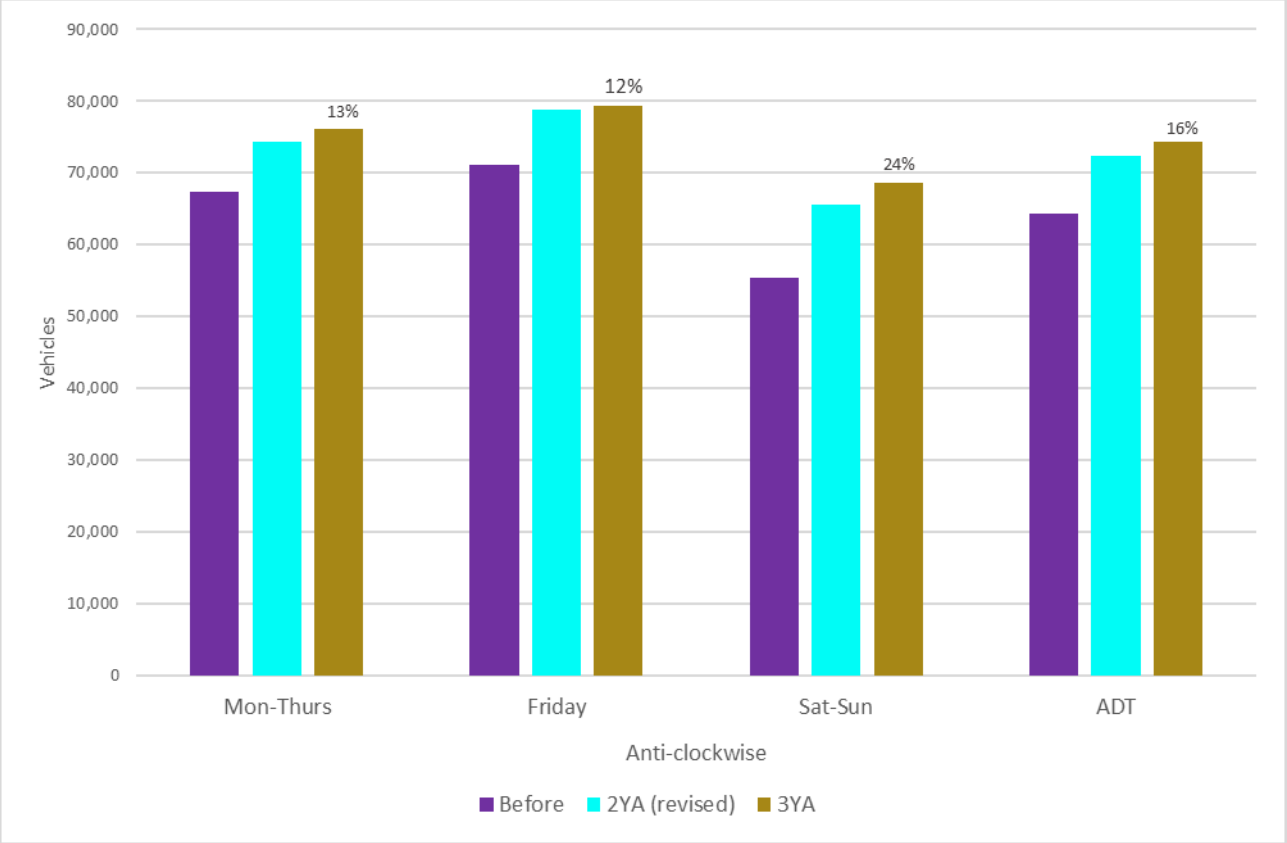


Figure 2-7 Average daily traffic by day type J25-J26 anticlockwise

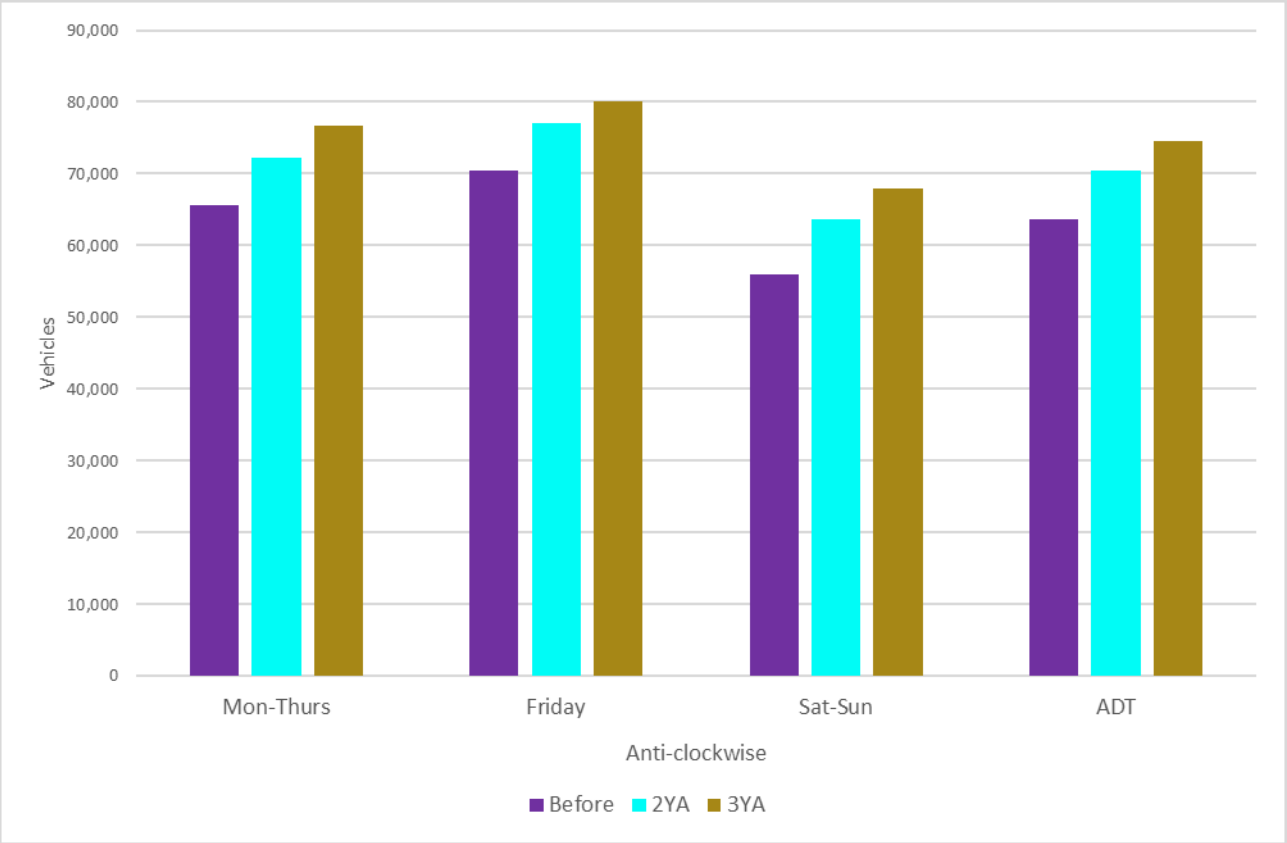
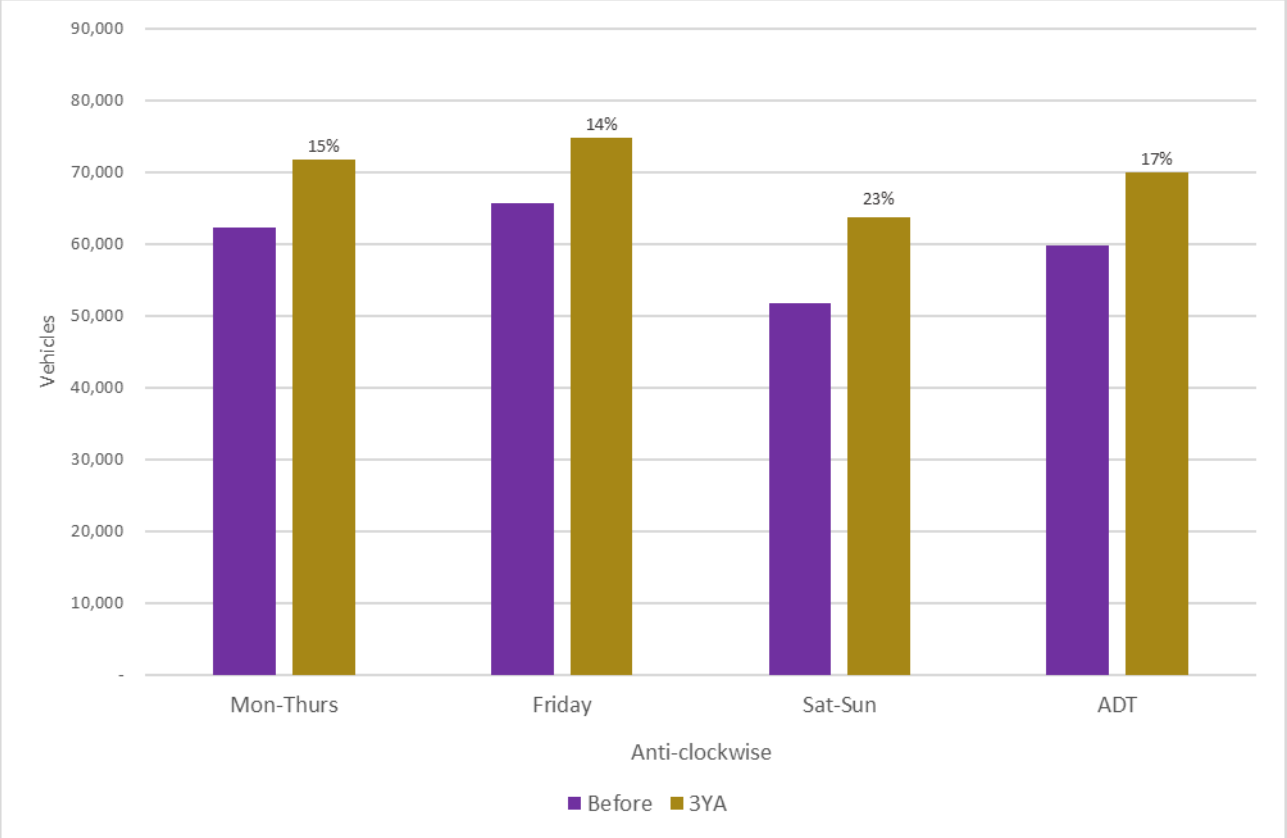


Figure 2-8 Average daily traffic by day type J26-J27 anticlockwise



The overall AADT over the 12 months of Before and Yr3 After traffic data has increased by between 13% (J24-2J25 clockwise) and 18% (J26-J27 clockwise), with all the other sections/directions experiencing an increase in traffic flow of between 15% and 17%.

South East regional motorway traffic increased between 2013 and 2016 by around 7%[3]. The growth along the scheme is far above that observed in the regional trends. Although the increase in traffic flows on the M25, facilitated by the scheme, will in itself contribute to the regional traffic trends, this is still a useful point to note when looking at link by link flow increases.

2.3. Flow over each time slice per link

Figure 2-9 to Figure 2-16 compare the average Before, Yr2 After and Yr3 After flows by time slice for each link. The percentage change is shown above the Yr3 After bar in each case. The corresponding values are shown in Appendix A.2, with changes shown in bold text.

Clockwise, there are flow increases in each year, on all links in all time slices. Flows are highest in the PM peaks and these have seen the highest weekday growth between J25 and J27. Growth has been more evenly spread across the periods between J23 and J25. The smallest increase is during the Mon-Thu AM Peak between J24 and J25 at 6%. The Fri AM peak and Inter-peak increases for this link are also smaller than other links with increases of 8% and 7%, respectively. In general, the largest increases in traffic flow can be seen between J26 and J27. The largest increase can be seen on the weekends, ranging from 19 to 23%.

Anticlockwise, there are flow increases in each year, in all time slices, on all links apart from J24 to J25. This link has seen slight reductions since Yr2 although still higher than in the Before. For Mon-Thu, the AM peaks generally have the highest flows in this direction and have seen the largest increases. On Fridays, the highest flows are in the PM peaks but the largest increases occur in the AM peaks. The largest increases are on weekends where they range from 21% to 23%.

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

Figure 2-9 Average flow by time slice J23-J24 clockwise

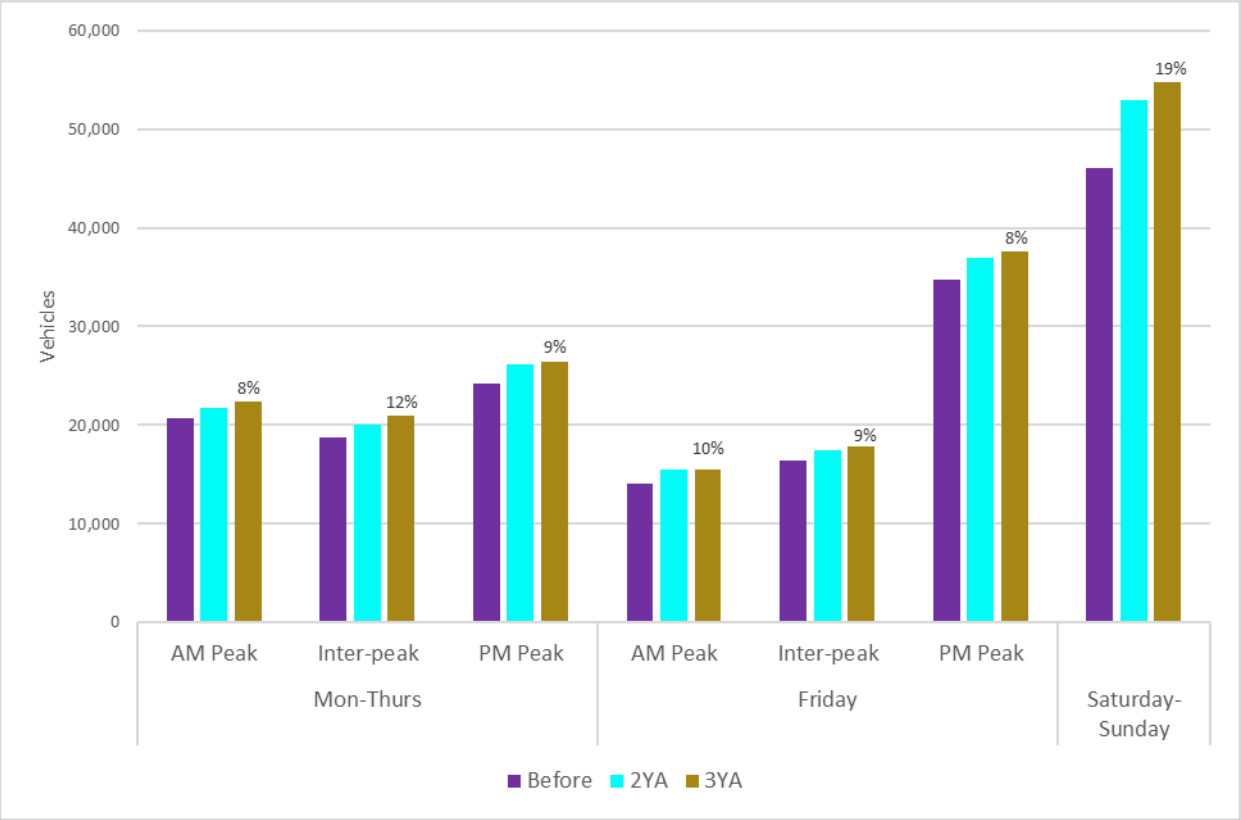


Figure 2-10 Average flow by time slice J24-J25 clockwise

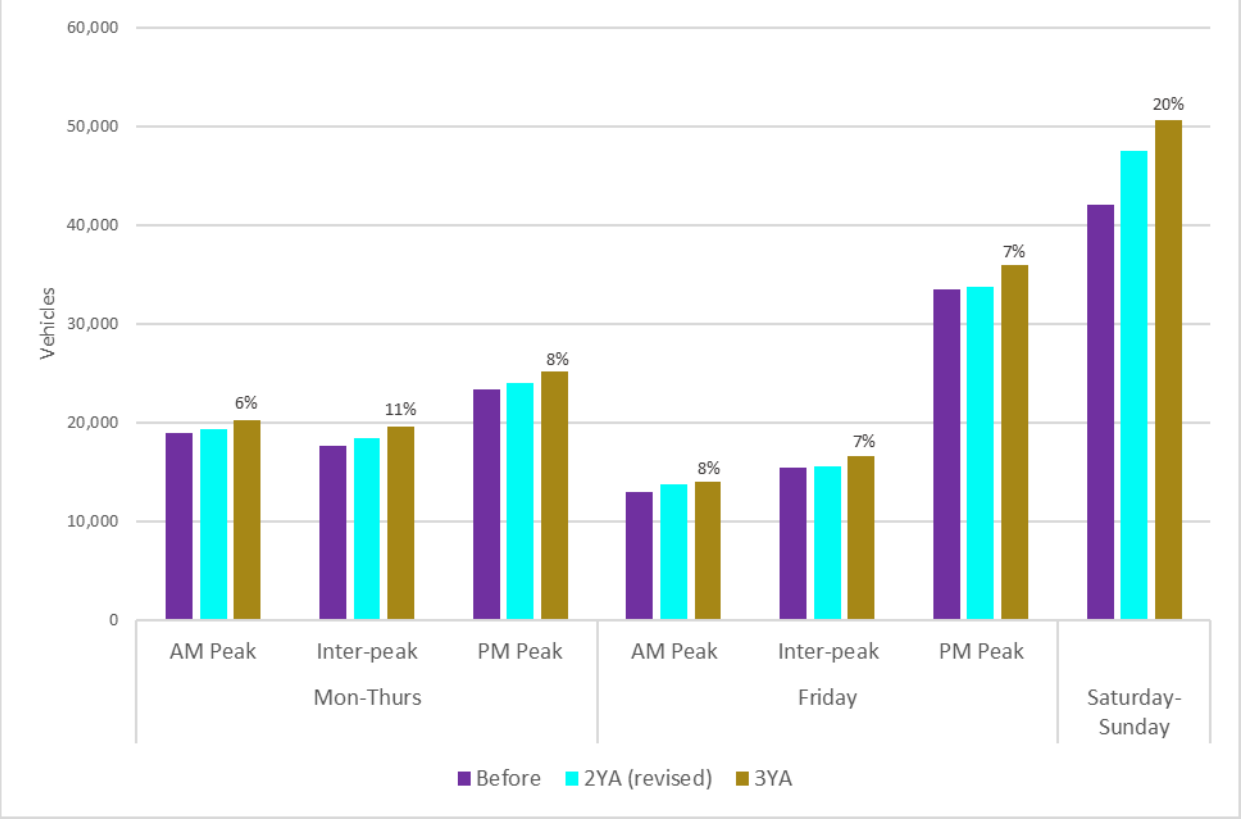


Figure 2-11 Average flow by time slice J25-J26 clockwise

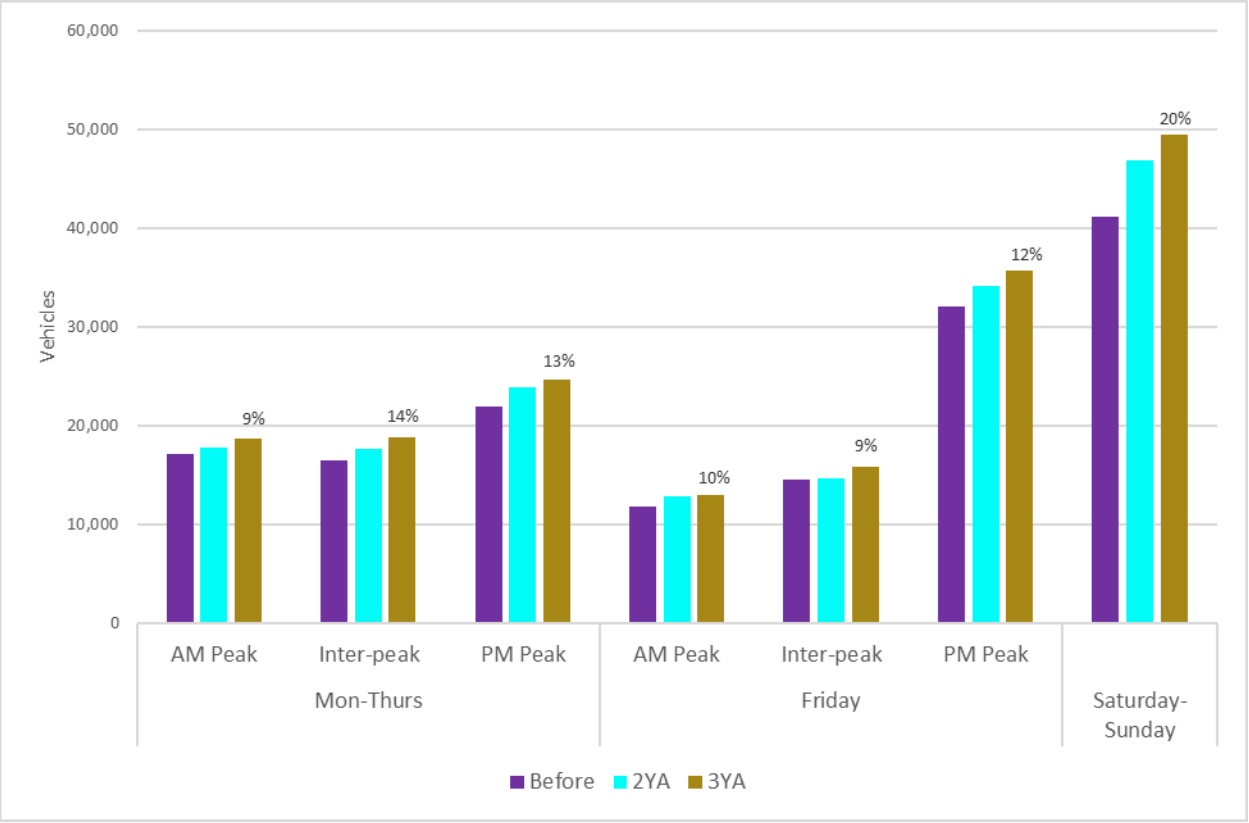


Figure 2-12 Average flow by time slice J26-J27 clockwise

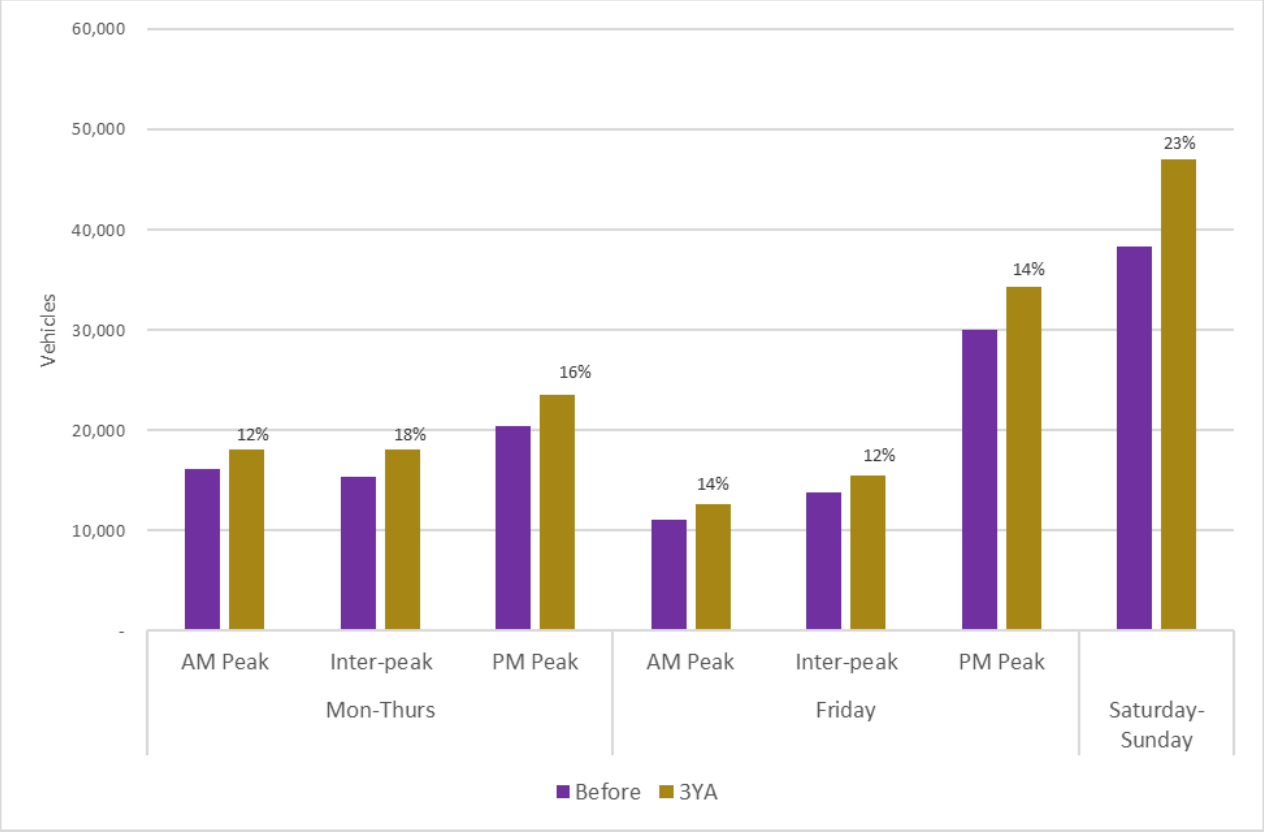


Figure 2-13 Average flow by time slice J23-J24 anticlockwise

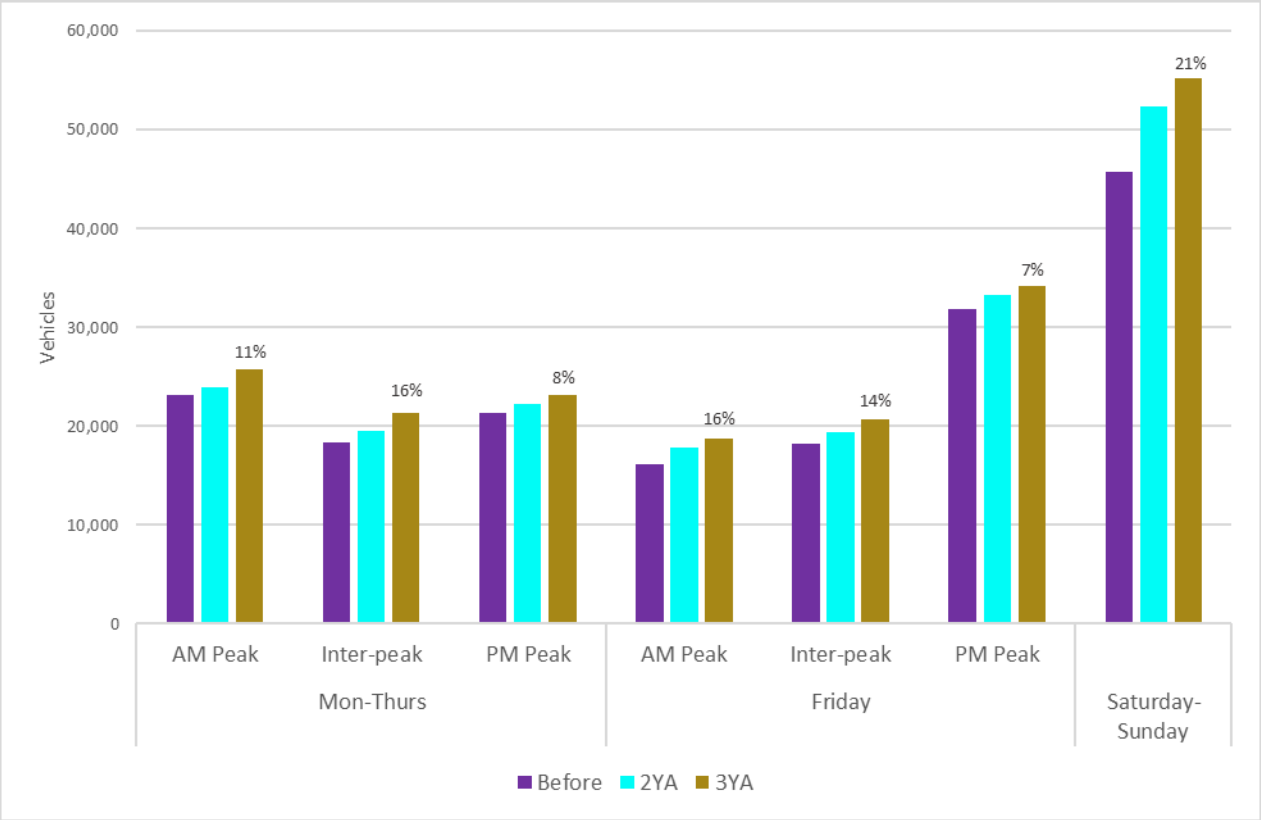


Figure 2-14 Average flow by time slice J24-J25 anticlockwise

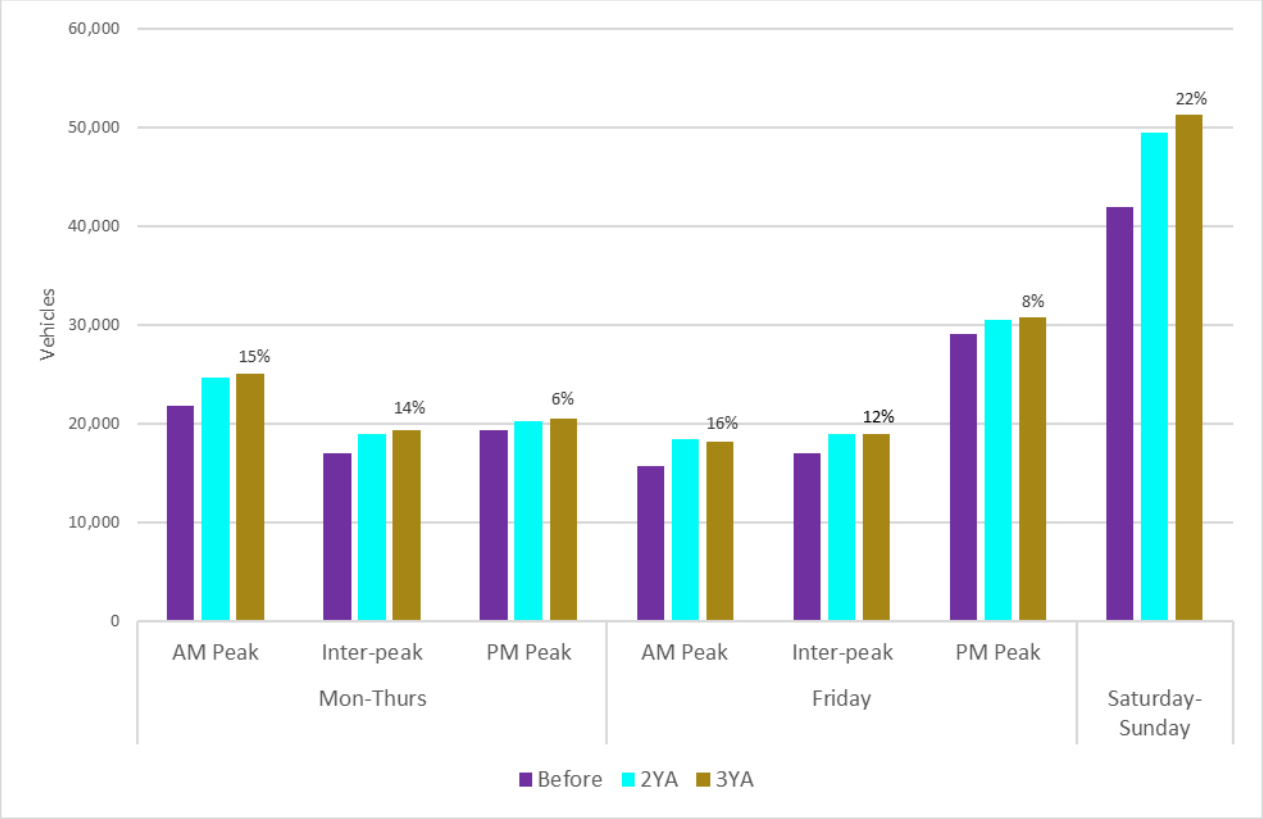


Figure 2-15 Average flow by time slice J25-J26 anticlockwise

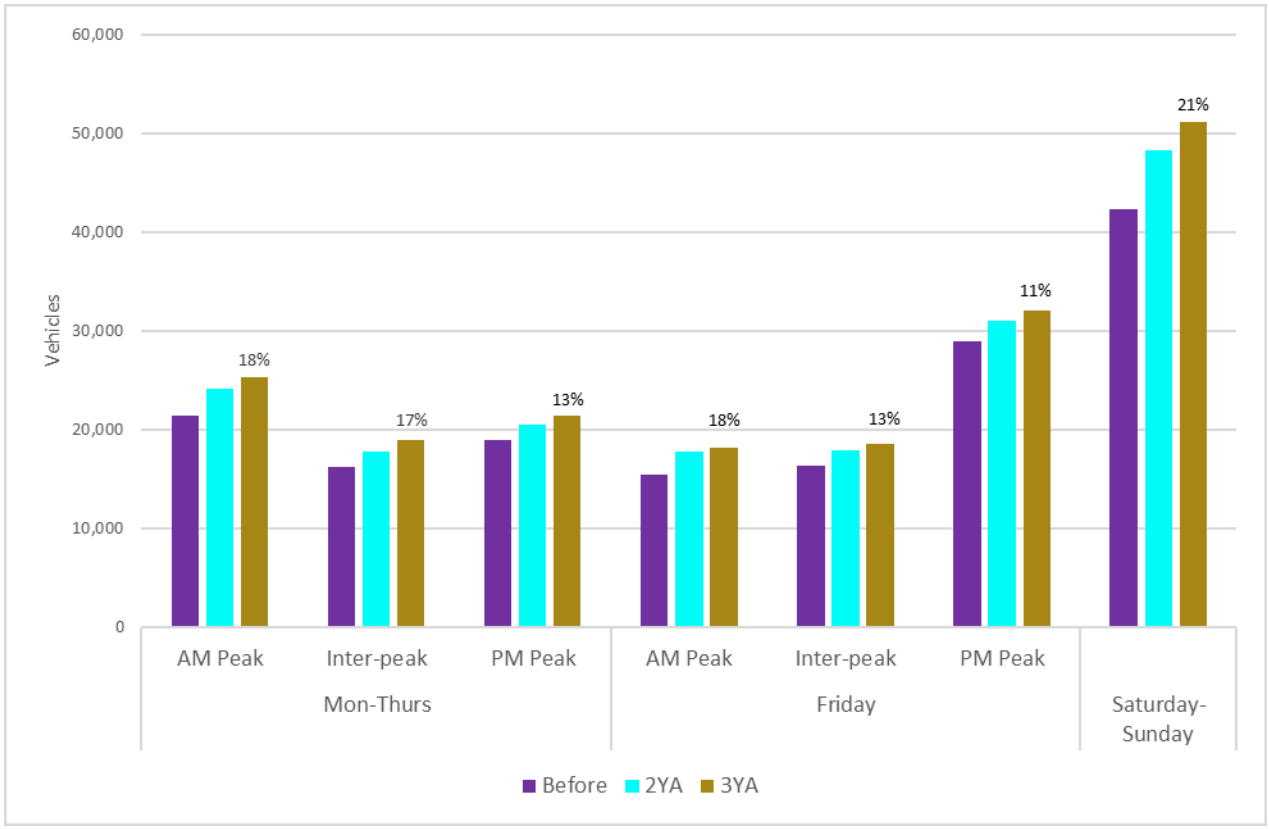
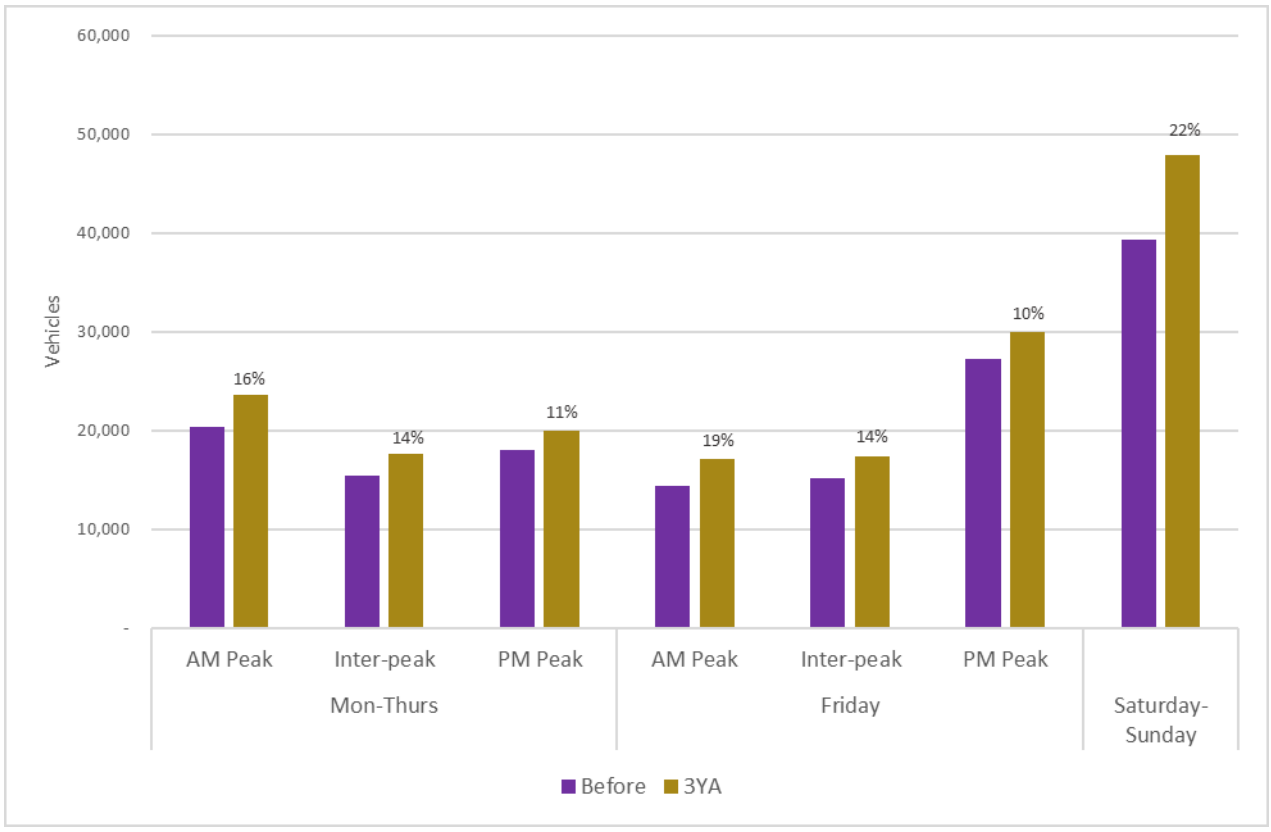


Figure 2-16 Average flow by time slice J26-J27 anticlockwise



2.4. Summary

The SMALR section has experienced traffic growth of 16% between the Before and Yr3 After periods, which is far higher than regional motorway growth over the same period. The largest growth has been at weekends, up to 23%, while other days have seen increases between 6% and 19%.

3. Journey times

3.1. Introduction

This section outlines the changes in journey times and reliability on the M25 J23-27 SMALR between the Before and Yr3 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 three 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 Yr3 After periods, there has been effectively no change on average, across all day types and time slices from the average Before journey time of 15 minutes 47 seconds (an increase of 0.4%, i.e. 3 seconds). However there is some variation between time slices. The most congested periods were the Mon-Thu PM peaks and they have experienced worsened journey times of 7%. Other periods have seen improvements of up to 2%.

On individual links, the scheme has provided a slight journey time benefit between J23-24 and J25 to J26 with an overall improvement in average journey time of 13 seconds across all day types and time slices. The J24-25and J26-27 links have seen average journey time increases of 15 seconds and 1 second respectively. It appears that the J24-25 link has caused most of the additional delay in the After period. The roundabout at J25 has been identified as a possible cause and is currently being upgraded with new traffic signals equipment which could reduce the congestion in this area in the future.

Anticlockwise, between the Before and Yr3 After periods, there has been an average percentage improvement of 1.4% (i.e. 15 seconds) across all day types and time slices from the average Before journey time of 16 minutes 37 seconds. The Mon-Thu AM peak period experiences the worst congestion; there has been a 6% journey time improvement, equating to 1 minute 16 second improvement. However, there has been a 2% increase in the Mon-Thu inter-peak.

On individual links, there has been a very slight increase overall on the J24 to J23 link which can be attributed to weekday AM peaks. Slight journey time benefits in the order of a few seconds on average are still being seen on all other links compared to Before.

In summary, average journey times are effectively unchanged in the clockwise direction and 15 seconds shorter in the anticlockwise.

Figure 3-1 Clockwise journey time comparison

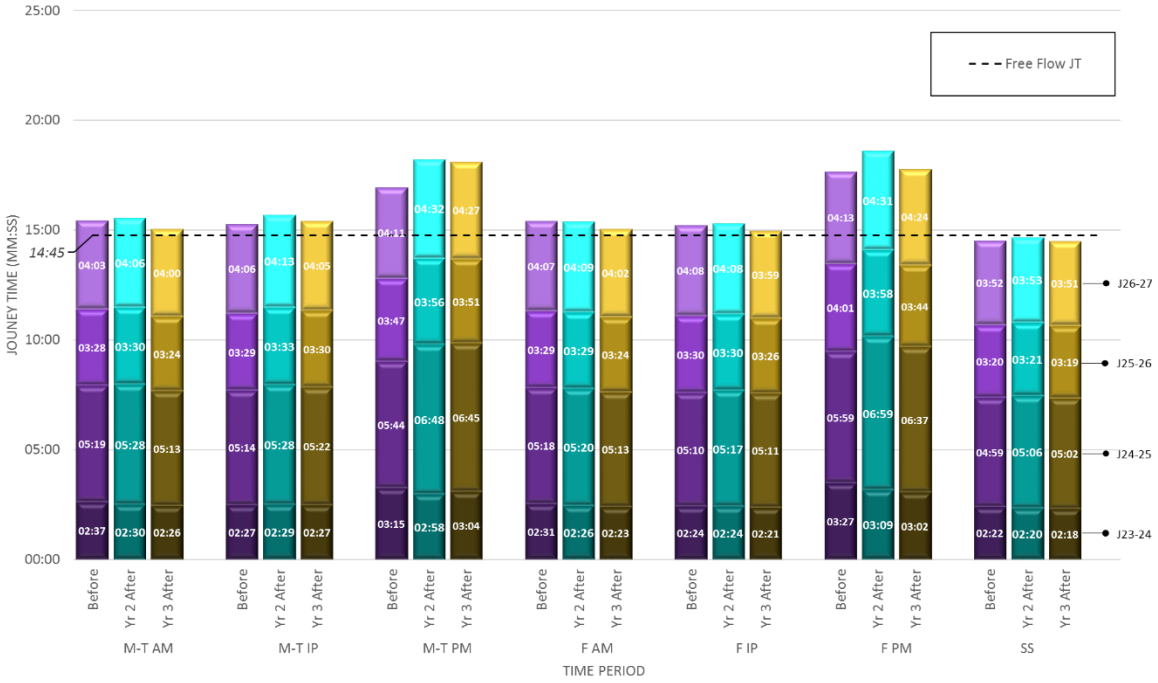
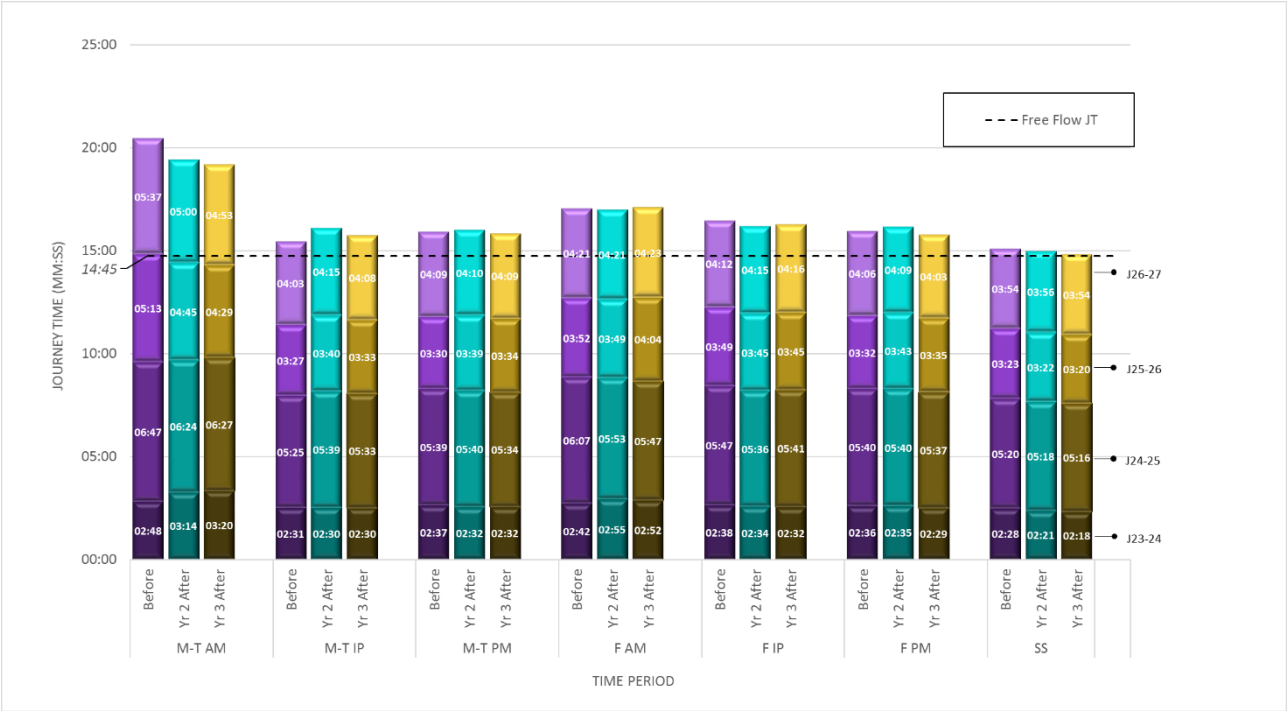


Figure 3-2 Anticlockwise journey time comparison



3.3. Speed by distance analysis

To understand how the journey times accrue, analysis of average speed along the scheme has been carried out. Figure 3-3 and Figure 3-4 show the average speed every 100m along the scheme by time slice[4]. Junction numbers are shown so it can be seen where performance improvements have been made and whether they relate to on or off slip locations. When the After line is above the Before line, benefits are being accrued.

[4] In mph; speed in kph by distance plots are contained in Appendix B.2.2.

Figure 3-3 Clockwise speed over distance plots

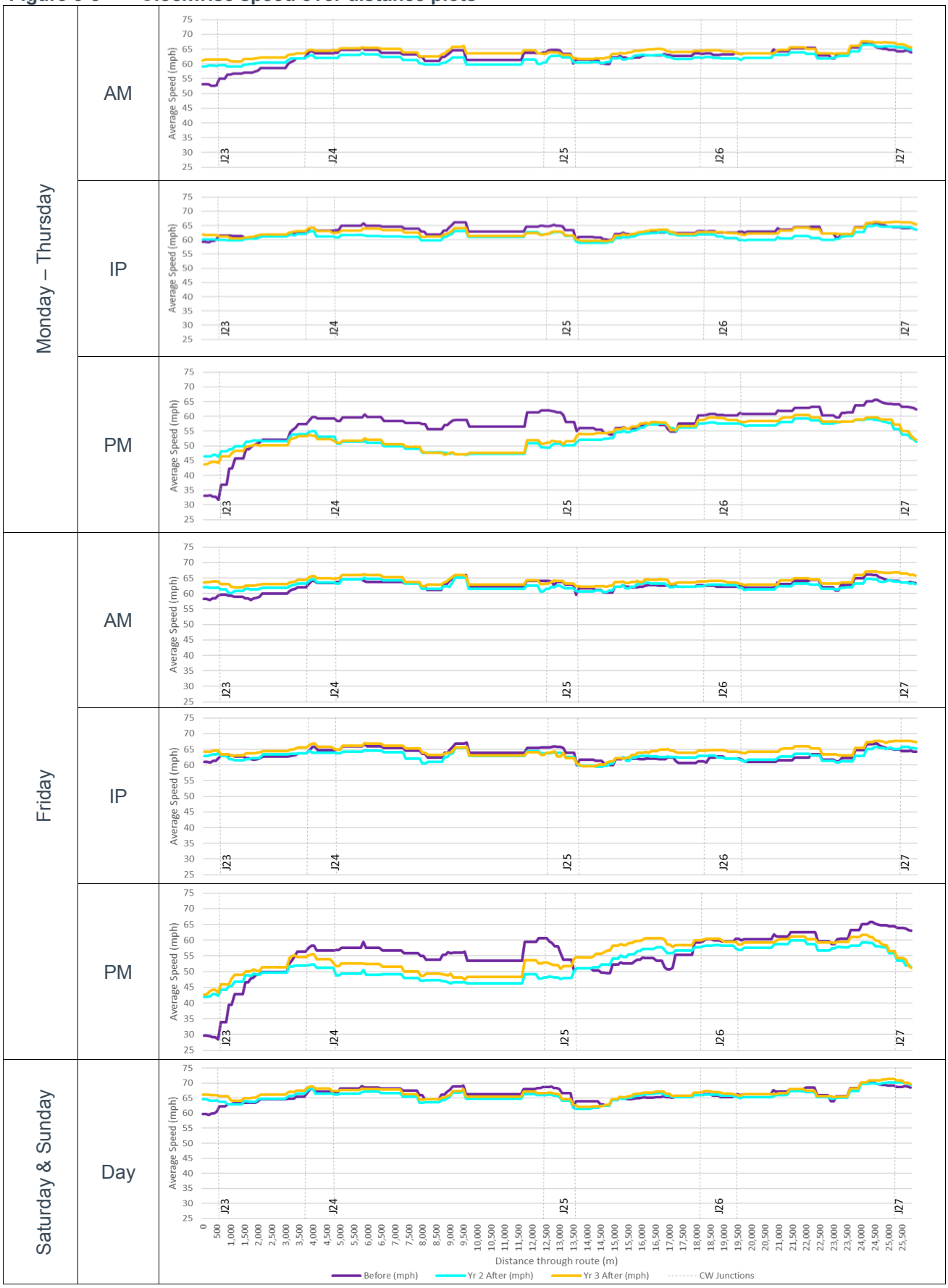
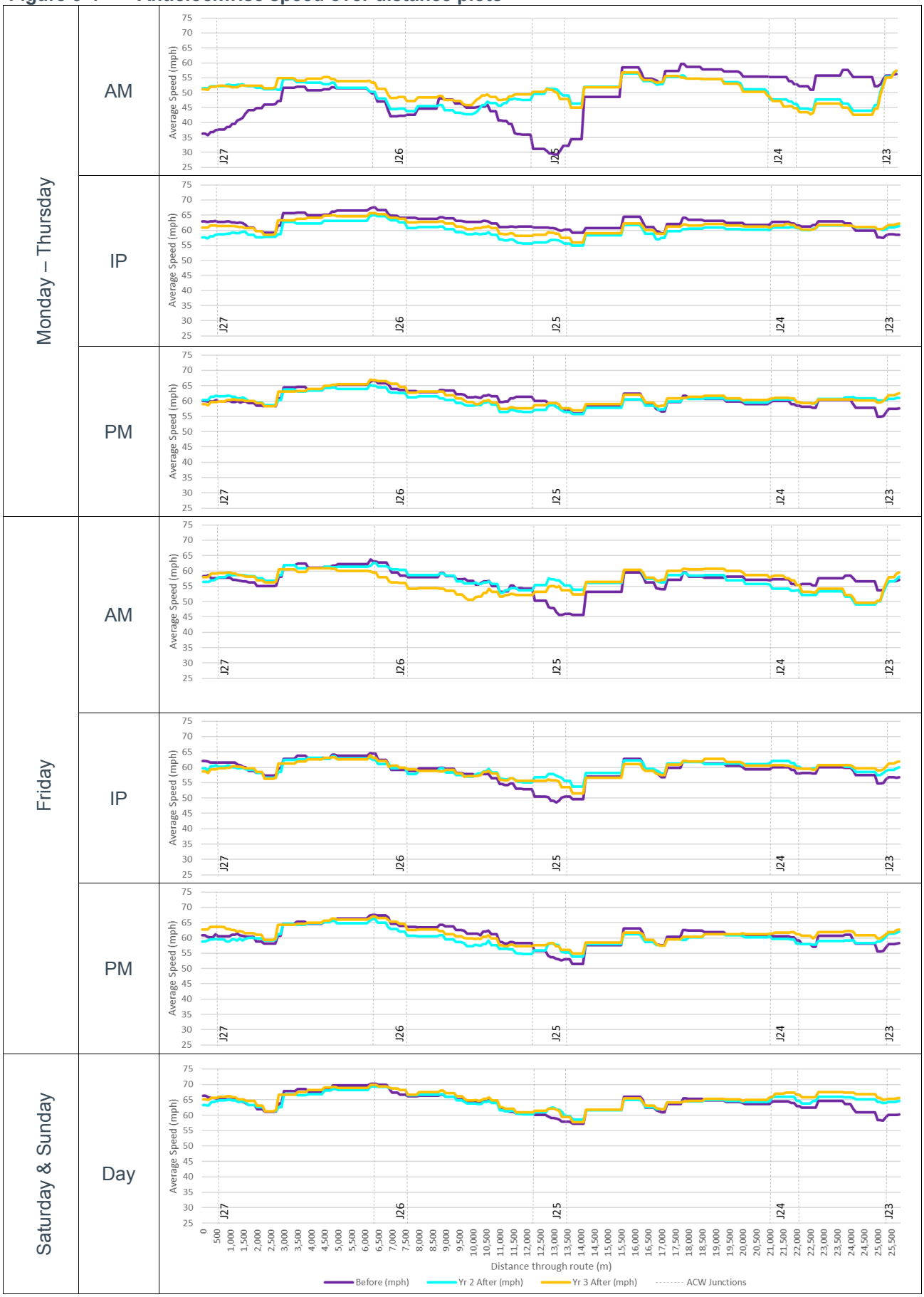


Figure 3-4 Anticlockwise speed over distance plots



The key findings clockwise are:

- Average speeds are consistently higher through J23 in Yr3 After – accruing benefits. In all other links, speeds are lower or similar; and
- The largest difference in average speeds can be seen during the weekday PM peaks in the vicinity of J25, where the Yr3 After average speed is consistently lower (around 50mph or less) than in the Before period. This is in accordance with the journey time findings.

The key findings anticlockwise are:

- In the After period, average speeds are improved, both higher and more consistent through J25 during the weekday AM peaks; and
- Elsewhere the speeds in Yr3 After are generally lower than or similar to the Before.

3.4. Journey time reliability

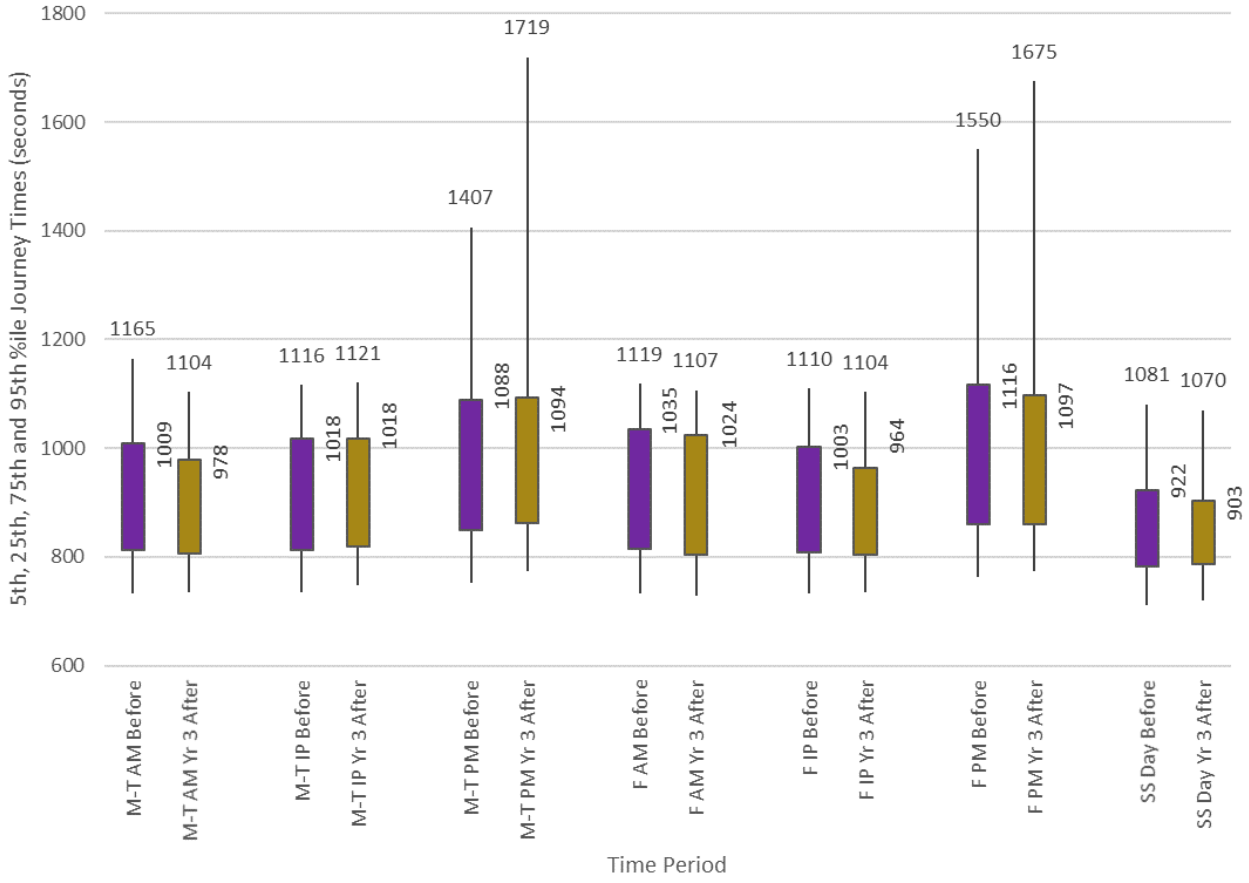
Reliability of journey times is a critical measure of a road's utility and function for road users. Percentile data has been used to understand the distribution of journey times through the scheme. Four metrics have been used, as shown in Table 3-1.

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 3-5 and Figure 3-6 as 'box and whisker' diagrams for each time slice, Before and Yr3 After. The box contains the 25th to 75th percentile range and the whiskers show the 5th and 95th percentile values. The 75th percentile and 95th percentile journey times are annotated on the plots.

Figure 3-5 Clockwise journey time reliability



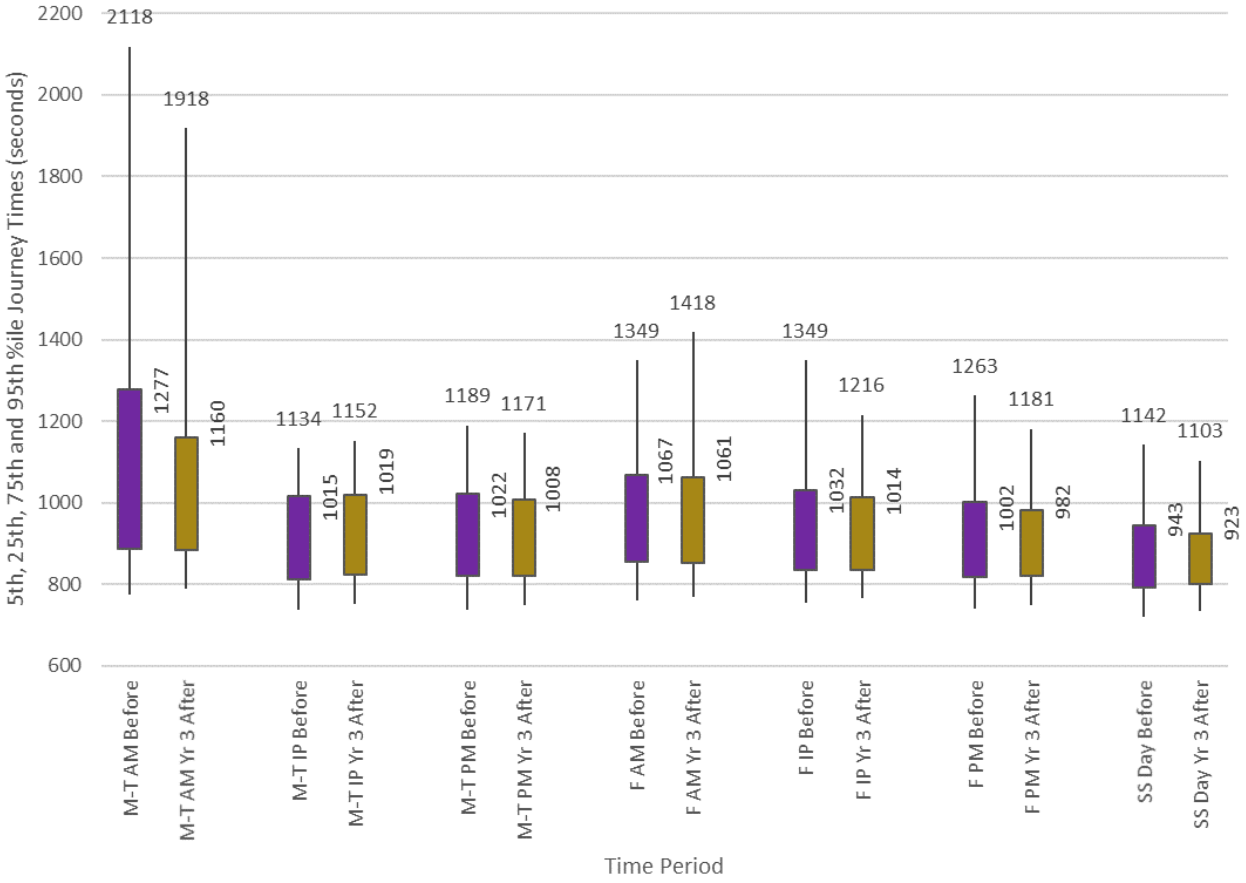
Clockwise, the most unreliable journey times, Before and Yr3 After, are during the weekday PM peaks. Although the 95th percentile values of the weekday PM peaks worsened, the variability in journey time experienced by the majority of road users during these periods has improved (i.e. a reduced difference between the 25th and 75th percentile, the interquartile range). So journeys in the PM peaks are longer but more reliable; possibly due to the action of the variable mandatory speed limits.

Apart from Friday AM peak where reliability was unchanged, in all other weekday periods, the interquartile range has decreased very slightly, in the range of seven to 34 seconds.

Anticlockwise, the most unreliable journey time, Before and Yr1 After, is in the Monday-Thursday AM peak. This has experienced improvements in both the 95th percentile and the 75th percentile as well as the interquartile range. This shows better journey time reliability with the all lane running scheme.

In other (previously uncongested) periods, the interquartile range is similar between the Before, Yr1 After and Yr2 After periods, showing no change in day-to-day reliability.

Figure 3-6 Anticlockwise journey time reliability



3.5. Summary

Overall clockwise journey times are effectively unchanged since the Before period (increase of 3 seconds, 0.4%) in Yr3 After compared to Before. In the anticlockwise direction journey times have improved by 15 seconds (1.4%).

Journey time reliability clockwise remains similar between the Before and Yr3 After periods. However, there are some delayed journeys in weekday PM peaks. Anticlockwise there is a good improvement on the Monday to Thursday AM peak, while times of day remain similar to before the scheme.

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 safety performance of the M25 J23 to J27 SMALR scheme. STATS19 data has been used to identify the number and rate of personal injury collisions and it should be noted that the After period is three years for J23 to J25 and 30 months for J25 to J27. The minimum desirable sample period for collision analysis is three years, due to the fact that motorways are the safest roads with relatively few collisions occurring compared to the total vehicle mileage travelled.

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.

Further analysis includes the user groups involved based on the STATS19 data and the compliance with Red X lane closure signals.

Note that the methodology for flow calculations between J25 and J27 for the Yr2 After period has been updated due to better information becoming available during the Yr3 After flow analysis. This means the rates calculated for Yr2 After differ slightly from previous reports issued; the impact is a 0.5% reduction in total vehicle kilometres travelled.

4.1.1. Changes in STATS19 reporting of collisions

The recent release of 2016 STATS19 data by DfT[5] has highlighted that there has been a national trend of increasing Killed and Seriously Injured (KSI) incidents across all the roads in England, including the strategic road network, which is counter to the historic trend of increasing safety. This increase affects 3 lane motorways with continuous hard shoulders as well as smart motorways, including all lane running.

A contributing factor for this increase is the change in the way incidents are automatically classified using the CRASH database. CRASH has been implemented during the After period of our evaluation. Since this change, it has become noticeable that there are subtle differences in the way the data is recorded that have made comparisons between the two datasets more challenging. Previously Police forces would have determined if somebody's injuries were slight / serious / fatal. The exact injury is now recorded by Police but categorised by the CRASH system. This has resulted in reported increases in the severity of collisions, known as 'the CRASH effect'.

The CRASH effect, the increase in the proportion of non-fatal casualties recorded as serious, occurs due to the CRASH system deciding severity based on injury instead of the Officer in Charge (OIC) deciding severity. There are rules within the system that auto-fill some of the data, such as severity, based on other inputs. The recorded severity appears to have worsened in some cases as a result. This means the two data sets cannot be compared like-for-like, so it is likely that the severity improvements reported in this chapter would have been greater under the previous recording system.

4.2. Number and rate of collisions

Table 4-1 shows the number of collisions during the Before and After periods, and the rate of collisions. Numbers of collisions cannot be directly compared due to the staged opening in Yr1 After but it can be seen that the annual numbers for other years are relatively similar; with the higher After flow this has resulted in a reduction in collision rate. To fully understand the results we also need to take into account the background trend in collisions, see Section 4.2.1.

[5] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/648081/rrcgb2016-01.pdf

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

Period		Fatal	Serious	*Fatal & serious*	Slight	Total
Before	Year 1	1	11	12	85	97
	Year 2	2	11	13	88	101
	Year 3	1	5	6	87	93
	Total	4	27	31	260	291
	Collision rate (collisions per hmvm) (22.6 hmvm)	0.177	1.194	1.371	11.500	12.871
	Collision rate (collisions per mvkm) (3,641 mvkm)	0.001	0.007	0.009	0.071	0.080
After*	Year 1	2	3	5	55	60
	Year 2	1	9	10	93	103
	Year 3	0	11	11	81	92
	Total	3	23	26	229	255
	Collision rate (collisions per hmvm) (22.7 hmvm)	0.132	1.013	1.145	10.089	11.234
	Collision rate (collisions per mvkm) (3,653 mvkm)	0.001	0.006	0.007	0.063	0.070

*Due to staged opening this is based on 36 months of data for J23 to J25 and 30 months of data for J25 to J27. Total values cannot be compared between Before and After periods, but rates can be compared.

The four fatal collisions in the Before period include:

- A car transporter losing control for unknown reasons and striking street lighting;
- A motorcyclist weaving through traffic and colliding with a vehicle;
- A vehicle drifting across lanes and losing control; and
- A suspected suicide where a pedestrian ran out into the carriageway.

There were three fatal collisions in the After period, as follows:

- A stowaway incident where a pedestrian climbed out from underneath a vehicle and was run over;
- A suspected suicide attempt where a car pulled out from the nearside verge (actually a very short length of hard shoulder) into the path of an HGV in lane 1 causing the HGV to swerve and collide with another HGV causing a crossover and ultimately the fatality of an HGV occupant on the opposite carriageway; and
- A slow moving / stationary vehicle in lane 1 was struck by another vehicle.

There were a total of 23 serious collisions in the After period (description not available for one of those), as follows:

- Seven nose to tail collisions:
  - A bus or coach braked and was hit from behind by an HGV;
  - An HGV collided with a van in front for unknown reasons;
  - Two cars were braking and the second vehicle was hit from behind by a third car which pushed the second vehicle into the first vehicle; and
  - A car was hit from behind by an HGV which pushed it into a car in front. The front vehicle lost control, striking the central reserve barrier and rebounded across the carriageway into the nearside barrier and off the motorway. A toddler in the middle vehicle was being carried on the lap of a pregnant passenger and suffered serious injuries;
  - Three vehicles queueing on a slip road when a fourth vehicle collided with the back of the queue pushing the vehicles into one another;
  - A car slowed down in traffic and was hit by the car following;
  - A car hit the car in front;
- Five collisions associated with lane changing and/or failing to look:
  - An HGV moved from lane 1 into lane 2, colliding with a van in lane 2;
  - A car moved from lane 3 into lane 2, colliding with a car in lane 2. The first car left the scene; and

  - A car moved from lane 1 of the slip road for the M11 Northbound into lane 2 for the M11 Southbound. A motorbike already in lane 2 could not stop and hit the rear of the car, unseating the rider;
  - A car travelling at excessive speed attempted to undertake a vehicle which was changing lanes to the left. The car changing lanes was struck, overturning and hitting a third car;
  - A goods vehicle was travelling in lane 1 and a car in lane 2, as the goods vehicle moved into lane 2 hit the car making it to spin into the central reservation, bounce off and spin back across the carriageway coming to rest sideways across lane 1 and the verge.
- Seven single vehicle collisions:
  - A driver who had fallen asleep woke as their car was about to collide with an HGV, panicked and lost control, striking the nearside and then offside tunnel walls;
  - A vehicle left the motorway to the offside for unknown reasons, struck the central reserve barrier and caught fire;
  - A vehicle left the motorway to the nearside, struck the tunnel wall and came to rest in the hard shoulder;
  - An HGV lost control and turned onto its side.;
  - A car driver felt pain in the left shoulder veered to the offside colliding with central barrier and overturned
  - A car was travelling in torrential rain, the driver lost control due to the excessive water and struck the nearside and offside barriers;
  - A car took the exit at J27 towards M11, the car then swerved back onto the M25 across the chevroned area, at that point it suffered a front-off-side tyre blow out which caused the vehicle to cross all lanes and hit the concrete central barrier coming to a stop in lane 4.
- One other collision where a car entered a slip road which was closed for recovery work and collided with a road worker. The car failed to stop at the scene.
- Due to driver's fatigue, a car travelling in lane 4 veered right into the concrete crash barrier and then left into lane 3 colliding with another car. The other car then swerved across into lane 4 also colliding with the concrete crash barrier.
- Due to driver's suspected bleed on the brain a car stopped in lane 3 of the 4, another car was presented with the stationery vehicle in lane 3 during rush hour traffic and could not avoid a collision.

It can be seen that these serious collisions could have occurred on any stretch of motorway so are not attributable to ALR.

The relevant stakeholder Transport for London was not able to provide contributory factor data and accident descriptions for 13 of the 92 collisions in Yr3, one of these was of serious severity. Contributory factors by severity for the collisions are shown in Appendix C.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 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 small decrease in the collision rate over and above the background reduction in collisions (compared to the 13% absolute reduction in Table 4-1).

[6] The counterfactual factor is calculated using the national collision data for motorway class roads in the middle year of the 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.

Table 4-2 Number of collisions and collision rates following national trends

Period	Number of collisions	Collision rate (collisions per hmvm)	Collision rate (collisions per mvkm)
Annual average Before period	97.00	12.87	0.080
Counterfactual Before period	92.52	11.41	0.071
After*	255	11.23	0.070

*Due to staged opening this is based on 36 months of data for J23 to J25 and 30 months of data for J25 to J27. Total values cannot be compared between Before and After periods, but rates can be compared.

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 change in the collision rate is not statistically significant and therefore not necessarily a direct impact of the scheme. This means that after three years of operation, it can be concluded that the scheme has not had a significant impact on collision rates, i.e. there has been no significant change.

4.3. Severity and severity index

The severity index is calculated based on fatal and serious collisions as a proportion of all collisions. The results in Table 4-3 show a slight improvement in the severity index.

Table 4-3 Collisions by severity and severity index

Period	Number of collisions by severity				Severity index
	Fatal	Serious	Slight	Total	
Before (36 months)	4	27	260	291	0.11
After*	3	23	229	255	0.10

*Due to staged opening this is based on 36 months of data for J23 to J25 and 30 months of data for J25 to J27. Total values cannot be compared between Before and After periods, but rates can be compared.

4.4. Casualties, FWI and KSI rate

Fatal and weighted injury (FWI)[7] is calculated based on the number of fatal, serious and slight casualties as weighted proportions, to adjust for the severity. The FWI rate allows a comparison between road sections of different flows and lengths and is used to define the scheme's safety objective[8].

Table 4-4 shows that both the number and rate of FWIs in the After period is lower than in the Before period, although this change could be due to natural variation, so is not attributable to the scheme. This means that the scheme has met the FWI aspects of its safety objective (no increase in number or rate of FWIs).

Table 4-4 Number of casualties and FWI rate

Period	Severity			Total	FWI	FWI rate per hmvm	FWI rate per bvkm
	Fatal	Serious	Slight				
Before (36 months) (22.6 hmvm, 3.64 bvkm)	4	36	401	441	11.61	0.51	3.19
After* (22.7 hmvm, 3.65 bvkm)	3	28	373	404	9.53	0.42	2.61

*Due to staged opening this is based on 36 months of data for J23 to J25 and 30 months of data for J25 to J27. Total values cannot be compared between Before and After periods, but rates can be compared.

[7] FWI equals (number of fatalities) + 0.1 x (number of serious) + 0.01 x (number of slight casualties).
[8] As required by http://www.standardsforhighways.co.uk/ha/standards/ians/pdfs/IAN161_15.pdf

There has been a reduction in the KSI rate, shown in Table 4-5, which is due to the lower number of fatalities and serious casualties in the After period. The improvement could be a result of natural variation, so is not directly attributable to the scheme.

Table 4-5 Total KSI and KSI rate

Period	Total KSI	KSI rate per hmvm	KSI rate per bvkm
Before (36 months) (22.6 hmvm, 3.64 bvkm)	40	1.77	10.99
After* (22.7 hmvm, 3.65 bvkm)	31	1.37	8.49

*Due to staged opening this is based on 36 months of data for J23 to J25 and 30 months of data for J25 to J27. Total values cannot be compared between Before and After periods, but rates can be compared.

4.5. User groups

The number of casualties from different user groups are shown in Appendix C.2. The sample sizes of casualties are too small to draw any conclusions in the changes between periods for each user group. Based on the data in the analysis, no user group has been adversely affected by the scheme, which meets this aspect of the safety objective. The two pedestrian casualties in the Before period are suspected suicides (one fatal, one serious). There were also two pedestrian casualties in the After period, including a stowaway incident resulting in a fatality and a serious collision involving a vehicle colliding with a pedestrian trying to stop traffic on a slip road.

4.6. Red X (lane closed) analysis

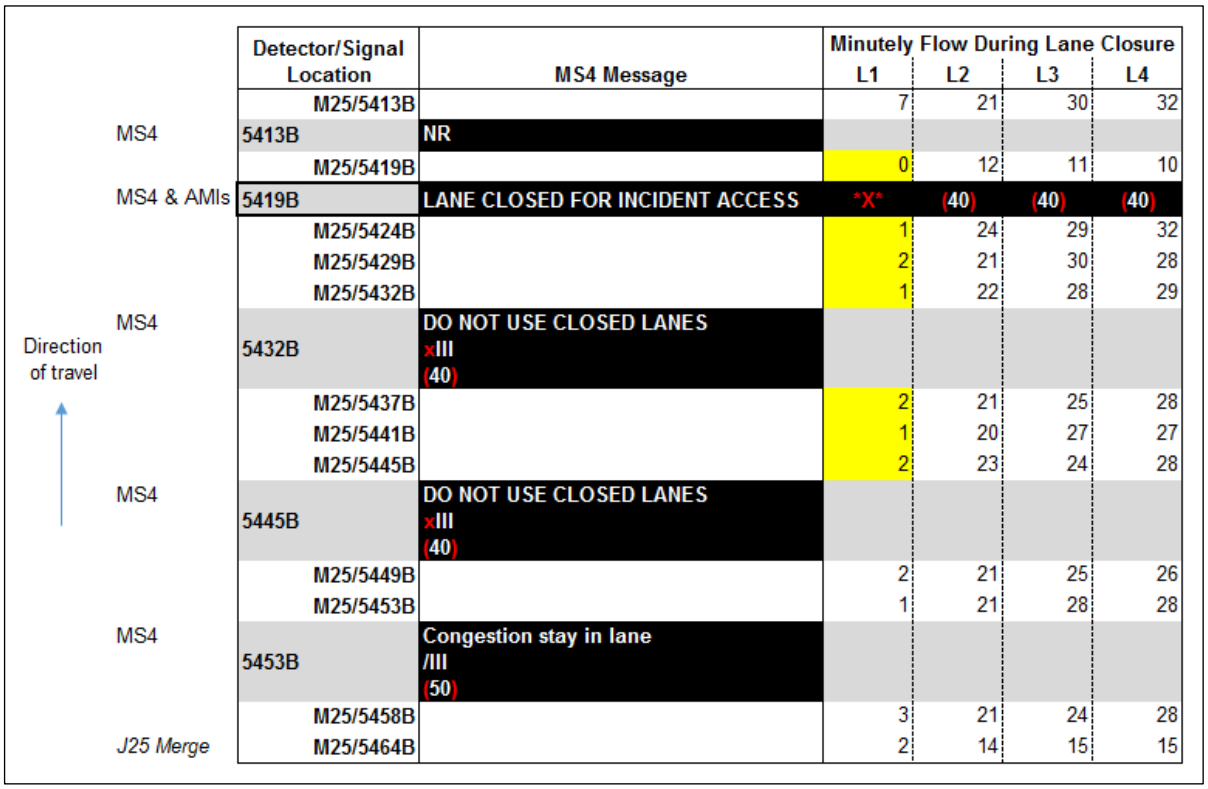
An analysis of Red X compliance was undertaken using HALOGEN data for Sign and Signal settings and MIDAS TCD files for minutely flows per lane. The two data sets were combined to identify lane closures and flows along the lane during the restriction. An example of a Red X event is presented in Figure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

A total of 119 lane closures have been assessed in the Yr3 After period and the results are summarised in Appendix 0. 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 15 vehicles per minute, 0% to 20% of total flow; across all Red X events analysed the minutely average flow of non-compliant vehicles was 4 per minute. Compliance with Red X as a percentage of total flow was 94%, which appears to show a slight worsening, from the 96% in the Yr2 After period, but still a slight improvement from the 93% in the Yr1 After period.

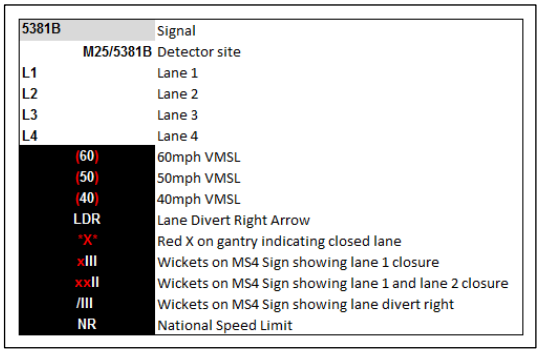
The percentage non-compliance was compared to the incident duration and traffic flow; no correlation was found with either. This suggests that the subset of drivers who choose not to comply with Red Xs do so regardless of how busy the motorway is or how long the incident duration is.

Figure 4-1 Example lane closure event



		Detector/Signal Location	MS4 Message	Minutely Flow During Lane Closure L1	L2	L3	L4
		M25/5413B		7	21	30	32
	MS4	5413B	NR				
		M25/5419B		0	12	11	10
	MS4 & AMIs	5419B	LANE CLOSED FOR INCIDENT ACCESS	*X*	(40)	(40)	(40)
		M25/5424B		1	24	29	32
		M25/5429B		2	21	30	28
		M25/5432B		1	22	28	29
	MS4	5432B	DO NOT USE CLOSED LANES xIII (40)				
Direction of travel		M25/5437B		2	21	25	28
		M25/5441B		1	20	27	27
		M25/5445B		2	23	24	28
	MS4	5445B	DO NOT USE CLOSED LANES xIII (40)				
		M25/5449B		2	21	25	26
		M25/5453B		1	21	28	28
	MS4	5453B	Congestion stay in lane /III (50)				
		M25/5458B		3	21	24	28
	J25 Merge	M25/5464B		2	14	15	15

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

4.7. Summary

Against a background of increasing flows, the scheme has met its safety objective:

- no increase in number or rate of FWIs;
- based on the data in the analysis, no user group has been adversely affected.

There has been no change in collision rate after taking account the national background trend of improvement.

Severity index, FWI and KSI rates have improved, although these changes are not directly attributable to the scheme, as they could have occurred as a result of natural variation.

Monitoring of Red X compliance revealed that across all events analysed, an average of 94% of vehicles complied with Red Xs in the Yr3 After period.

5. Conclusions

5.1. Flow

The SMALR section has experienced traffic growth of 16% between the Before and Yr3 After periods, which is far higher than regional motorway growth over the same period. The largest growth has been at weekends, up to 23%, while other days have seen increases between 6% and 19%.

5.2. Journey time

Overall clockwise journey times are effectively unchanged since the Before period (increase of 3 seconds, 0.4%) in Yr3 After compared to Before. In the anticlockwise direction journey times have improved by 15 seconds (1.4%).

Journey time reliability clockwise remains similar between the Before and Yr3 After periods. However, there are some delayed journeys in weekday PM peaks. Anticlockwise there is a good improvement on the Monday to Thursday AM peak, while times of day remain similar to before the scheme.

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.

5.3. Safety

Against a background of increasing flows, the scheme has met its safety objective[9]:

- no increase in number or rate of FWIs;
- based on the data in the analysis, no user group has been adversely affected.

There has been no change in collision rate after taking account the national background trend of improvement.

Severity index, FWI and KSI rates have improved, although these changes are not directly attributable to the scheme, as they could have occurred as a result of natural variation.

Monitoring of Red X compliance revealed that across all events analysed, an average of 94% of vehicles complied with Red Xs in the Yr3 After period.

[9] As required by http://www.standardsforhighways.co.uk/ha/standards/ians/pdfs/IAN161_15.pdf

Appendices

Appendix A. Flows additional information

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

The table below shows the values for ADTs Before and After.

Location	Value	Clockwise				Anticlockwise			
		Mon-Thurs	Friday	Sat-Sun	ADT	Mon-Thurs	Friday	Sat-Sun	ADT
J23 - J24	Before	73,700	77,300	60,500	70,500	72,600	76,500	60,000	69,600
	Yr2 After	79,800	83,600	70,300	77,600	77,000	82,300	69,100	75,500
	Yr3 After	82,100	85,400	73,000	80,000	82,300	86,400	73,700	80,400
	Change	8,400	8,100	12,500	9,500	9,700	9,900	13,700	10,800
	% Change (against Before)	**11%**	**10%**	**21%**	**13%**	**13%**	**13%**	**23%**	**16%**
J24 - J25	Before	69,800	73,500	55,700	66,300	67,300	71,100	55,400	64,400
	Yr2 After	73,100	76,200	63,500	70,800	74,400	78,700	65,500	72,400
	Yr3 After	76,900	80,300	67,800	74,800	76,100	79,300	68,600	74,400
	Change	7,100	6,800	12,100	8,500	8,800	8,200	13,200	10,000
	% Change (against Before)	**10%**	**9%**	**22%**	**13%**	**13%**	**12%**	**24%**	**16%**
J25 - J26	Before	64,600	69,200	54,100	62,300	65,700	70,400	55,900	63,600
	Yr2 After	70,100	74,600	62,200	68,500	72,300	77,100	63,600	70,500
	Yr3 After	73,200	77,500	65,800	71,700	76,700	80,100	67,900	74,600
	Change	8,600	8,300	11,700	9,400	11,000	9,700	12,000	11,000
	% Change (against Before)	**13%**	**12%**	**22%**	**15%**	**17%**	**14%**	**21%**	**17%**
J26 - J27	Before	60,500	65,100	50,400	58,300	62,300	65,600	51,800	59,800
	Yr2 After	-	-	-	-	-	-	-	-
	Yr3 After	70,600	75,000	62,900	69,000	71,800	74,800	63,700	69,900
	Change	10,100	9,900	12,500	10,700	9,500	9,200	11,900	10,100
	% Change (against Before)	**17%**	**15%**	**25%**	**18%**	**15%**	**14%**	**23%**	**17%**

A.2. 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	
J23 - J24	Before	20,700	18,700	24,200	14,100	16,400	34,700	46,000
	Yr2 After	21,700	20,000	26,100	15,500	17,400	36,900	53,000
	Yr3 After	22,400	20,900	26,400	15,500	17,800	37,600	54,800
	Change	1,700	2,200	2,200	1,400	1,400	2,900	8,800
	% Change	**8%**	**12%**	**9%**	**10%**	**9%**	**8%**	**19%**
J24 - J25	Before	19,000	17,700	23,300	13,000	15,500	33,500	42,000
	Yr2 After	19,300	18,400	24,000	13,700	15,600	33,700	47,500
	Yr3 After	20,200	19,600	25,200	14,000	16,600	36,000	50,600
	Change	1,200	1,900	1,900	1,000	1,100	2,500	8,600
	% Change	**6%**	**11%**	**8%**	**8%**	**7%**	**7%**	**20%**
J25 - J26	Before	17,200	16,500	21,900	11,800	14,600	32,000	41,200
	Yr2 After	17,800	17,600	23,900	12,800	14,700	34,200	46,800
	Yr3 After	18,700	18,800	24,700	13,000	15,900	35,700	49,400
	Change	1,500	2,300	2,800	1,200	1,300	3,700	8,200
	% Change	**9%**	**14%**	**13%**	**10%**	**9%**	**12%**	**20%**
J26 - J27	Before	16,100	15,400	20,400	11,100	13,800	30,100	38,400
	Yr2 After	-	-	-	-	-	-	-
	Yr3 After	18,100	18,100	23,600	12,600	15,500	34,300	47,100
	Change	2,000	2,700	3,200	1,500	1,700	4,200	8,700
	% Change	**12%**	**18%**	**16%**	**14%**	**12%**	**14%**	**23%**

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	
J23 - J24	Before	23,200	18,400	21,300	16,100	18,200	31,900	45,700
	Yr2 After	24,000	19,500	22,300	17,900	19,400	33,300	52,400
	Yr3 After	25,700	21,300	23,100	18,700	20,700	34,200	55,200
	Change	2,500	2,900	1,800	2,600	2,500	2,300	9,500
	% Change	**11%**	**16%**	**8%**	**16%**	**14%**	**7%**	**21%**
J24 - J25	Before	21,800	17,000	19,300	15,700	17,000	29,100	41,900
	Yr2 After	24,600	18,900	20,300	18,400	18,900	30,500	49,500
	Yr3 After	25,100	19,400	20,500	18,200	19,000	30,700	51,300
	Change	3,300	2,400	1,200	2,500	2,000	1,600	9,400
	% Change	**15%**	**14%**	**6%**	**16%**	**12%**	**5%**	**22%**

J25 - J26	Before	21,400	16,200	19,000	15,400	16,400	29,000	42,300
	Yr2 After	24,100	17,800	20,500	17,800	17,900	31,000	48,300
	Yr3 After	25,300	19,000	21,400	18,200	18,600	32,100	51,100
	Change	3,900	2,800	2,400	2,800	2,200	3,100	8,800
	% Change	**18%**	**17%**	**13%**	**18%**	**13%**	**11%**	**21%**
J26 - J27	Before	20,300	15,400	18,000	14,400	15,200	27,200	39,300
	Yr2 After	-	-	-	-	-	-	-
	Yr3 After	23,600	17,600	20,000	17,100	17,400	29,900	47,900
	Change	3,300	2,200	2,000	2,700	2,200	2,700	8,600
	% Change	**16%**	**14%**	**11%**	**19%**	**14%**	**10%**	**22%**

Appendix B. Journey times 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 Feb 12	1 Feb 12
	To	31 Jan 13	31 Jan 13
	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
Yr3 After	From	1 May 16	1 May 16
	To	30 Apr 17	30 Apr 17
	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.

Clockwise Journey Time Comparison

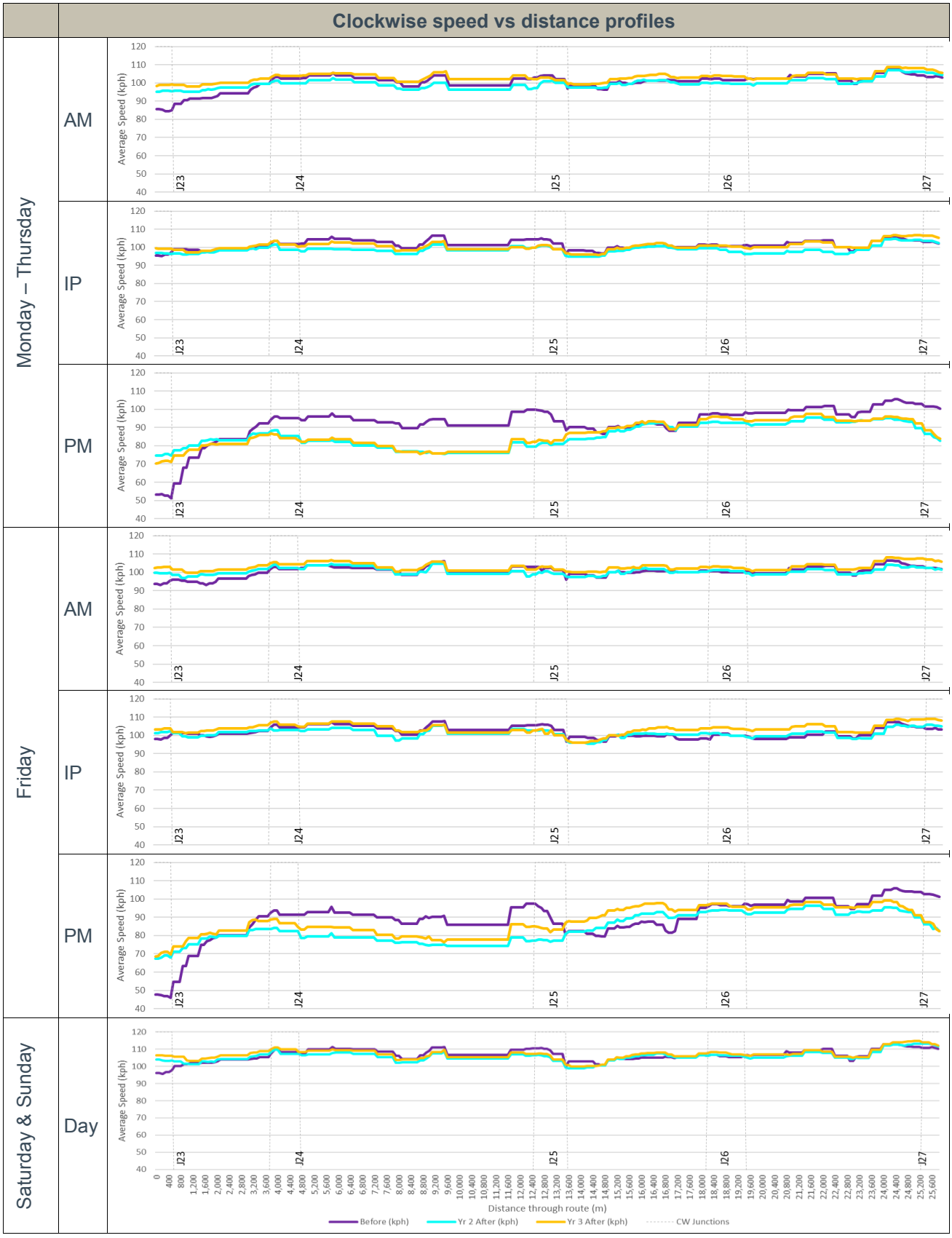
	Section	Distance (miles)	M-T AM	M-T IP	M-T PM	F AM	F IP	F PM	SS	Period average % change
Before	J23 to J24	2.5	00:02:37	00:02:27	00:03:15	00:02:31	00:02:24	00:03:27	00:02:22	
	J24 to J25	5.6	00:05:19	00:05:14	00:05:44	00:05:18	00:05:10	00:05:59	00:04:59	
	J25 to J26	3.6	00:03:28	00:03:29	00:03:47	00:03:29	00:03:30	00:04:01	00:03:20	
	J26 to J27	4.3	00:04:03	00:04:06	00:04:11	00:04:07	00:04:08	00:04:13	00:03:52	
	Total	16.0	00:15:26	00:15:17	00:16:57	00:15:24	00:15:13	00:17:40	00:14:32	
Yr2 After	J23 to J24	2.5	00:02:30	00:02:29	00:02:58	00:02:26	00:02:24	00:03:09	00:02:20	-4%
	J24 to J25	5.6	00:05:28	00:05:28	00:06:48	00:05:20	00:05:17	00:06:59	00:05:06	7%
	J25 to J26	3.6	00:03:30	00:03:33	00:03:56	00:03:29	00:03:30	00:03:58	00:03:21	1%
	J26 to J27	4.3	00:04:06	00:04:13	00:04:32	00:04:09	00:04:08	00:04:31	00:03:53	3%
	Total	16.0	00:15:33	00:15:42	00:18:14	00:15:24	00:15:19	00:18:36	00:14:40	3%
Yr3 After	J23 to J24	2.5	00:02:26	00:02:27	00:03:04	00:02:23	00:02:21	00:03:02	00:02:18	-5%
	J24 to J25	5.6	00:05:13	00:05:22	00:06:45	00:05:13	00:05:11	00:06:37	00:05:02	4%
	J25 to J26	3.6	00:03:24	00:03:30	00:03:51	00:03:24	00:03:26	00:03:44	00:03:19	-2%
	J26 to J27	4.3	00:04:00	00:04:05	00:04:27	00:04:02	00:03:59	00:04:24	00:03:51	1%
	Total	16.0	00:15:03	00:15:24	00:18:07	00:15:03	00:14:58	00:17:47	00:14:29	0%
	% Change		**-2%**	**1%**	**7%**	**-2%**	**-2%**	**1%**	**0%**	**-2%**

Anticlockwise journey time comparison

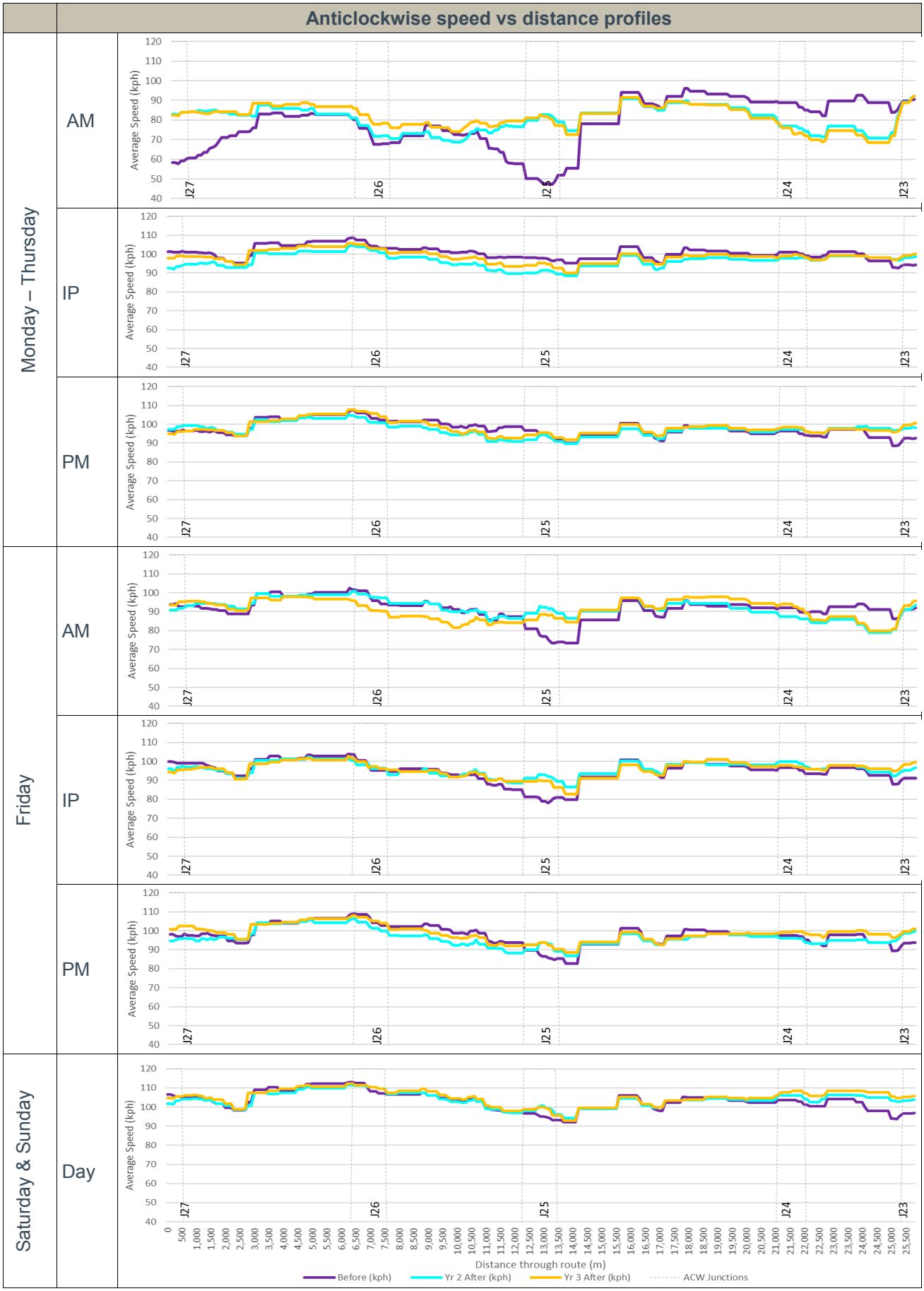
	Section	Distance (miles)	M-T AM	M-T IP	M-T PM	F AM	F IP	F PM	SS	Period average % change
Before	J27 to J26	4.3	00:05:37	00:04:03	00:04:09	00:04:21	00:04:12	00:04:06	00:03:54	
	J26 to J25	3.6	00:05:13	00:03:27	00:03:30	00:03:52	00:03:49	00:03:32	00:03:23	
	J25 to J24	5.6	00:06:47	00:05:25	00:05:39	00:06:07	00:05:47	00:05:40	00:05:20	
	J24 to J23	2.5	00:02:48	00:02:31	00:02:37	00:02:42	00:02:38	00:02:36	00:02:28	
	Total	16.1	00:20:25	00:15:27	00:15:55	00:17:02	00:16:27	00:15:55	00:15:05	
Yr2 After	J27 to J26	4.3	00:05:00	00:04:15	00:04:10	00:04:21	00:04:15	00:04:09	00:03:56	-1%
	J26 to J25	3.6	00:04:45	00:03:40	00:03:39	00:03:49	00:03:45	00:03:43	00:03:22	0%
	J25 to J24	5.6	00:06:24	00:05:39	00:05:40	00:05:53	00:05:36	00:05:40	00:05:18	-1%
	J24 to J23	2.5	00:03:14	00:02:30	00:02:32	00:02:55	00:02:34	00:02:35	00:02:21	2%
	Total	16.1	00:19:24	00:16:06	00:16:00	00:16:58	00:16:11	00:16:08	00:14:57	-0.5%
Yr3 After	J27 to J26	4.3	00:04:53	00:04:08	00:04:09	00:04:23	00:04:16	00:04:03	00:03:54	-2%
	J26 to J25	3.6	00:04:29	00:03:33	00:03:34	00:04:04	00:03:45	00:03:35	00:03:20	-2%
	J25 to J24	5.6	00:06:27	00:05:33	00:05:34	00:05:47	00:05:41	00:05:37	00:05:16	-2%
	J24 to J23	2.5	00:03:20	00:02:30	00:02:32	00:02:52	00:02:32	00:02:29	00:02:18	1%
	Total	16.1	00:19:09	00:15:44	00:15:50	00:17:06	00:16:15	00:15:45	00:14:48	-1%
	% Change		**-6%**	**2%**	**-1%**	**0%**	**-1%**	**-1%**	**-2%**	**-6%**

B.2.2. Speed (kph) over distance

Clockwise speed (kph) over distance plot



Anticlockwise speed (kph) over distance plot



Appendix C. Safety

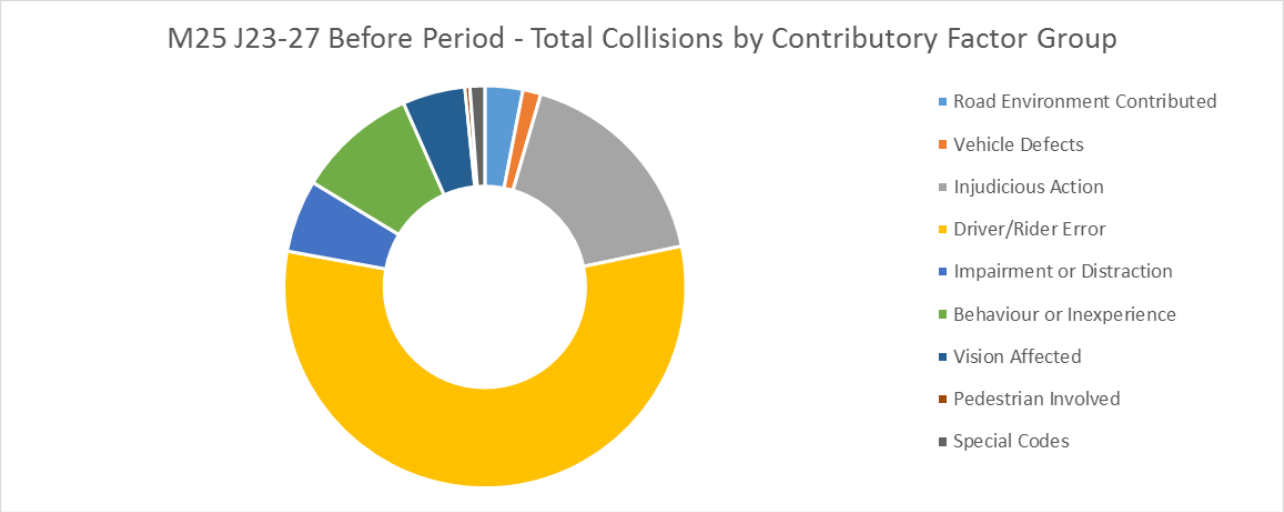
C.1. Injury collisions by user group

User Group	Before (36 months data)		After (36 months data)	
	Number	% of total casualties (441)	Number	% of total casualties (404)
Pedestrians	2	0.5%	2	0.5%
Motorcyclists	16	3.6%	3	0.7%
Car occupants	363	82.3%	323	80.0%
Taxi / Private hire vehicles occupants	5	1.1%	7	1.7%
Van occupants	29	6.6%	21	5.2%
HGV occupants	25	5.7%	22	5.4%
Public service vehicles	0	0.0%	0	0.0%
Road worker - On road resources (ORR)	0	0.0%	0	0.0%
Road worker - Maintenance workers	0	0.0%	0	0.0%
Emergency services	0	0.0%	0	0.0%
Private recovery organisations	0	0.0%	0	0.0%
Minibus (8-16 passenger seats)	0	0.0%	1	0.2%
Bus or Coach (17 or more passenger seats)	0	0.0%	5	1.2%
Other (type of vehicle not specified in STATS19 data)	1	0.2%	0	0.0%
Disabled drivers or passengers	4	0.9%	5	1.2%
Not classified	0	0.0%	20	5.0%

C.2. Contributory factors

Contributory factors by severity before period

Code	Contributory factor group	Fatal	Serious	Slight	Total
101-109	Road environment contributed	0	2	21	23
201-206	Vehicle defects	2	3	6	11
301-310	Injudicious action	0	7	123	130
401-410	Driver/rider error	8	41	374	423
501-510	Impairment or distraction	0	7	37	44
601-607	Behaviour or inexperience	1	5	67	73
701-710	Vision affected	0	3	35	38
801-810	Pedestrian involved	2	0	1	3
901-999	Special codes	0	1	8	9
Total		**13**	**69**	**672**	**754**



Rank	1 to 10
	11 to 15

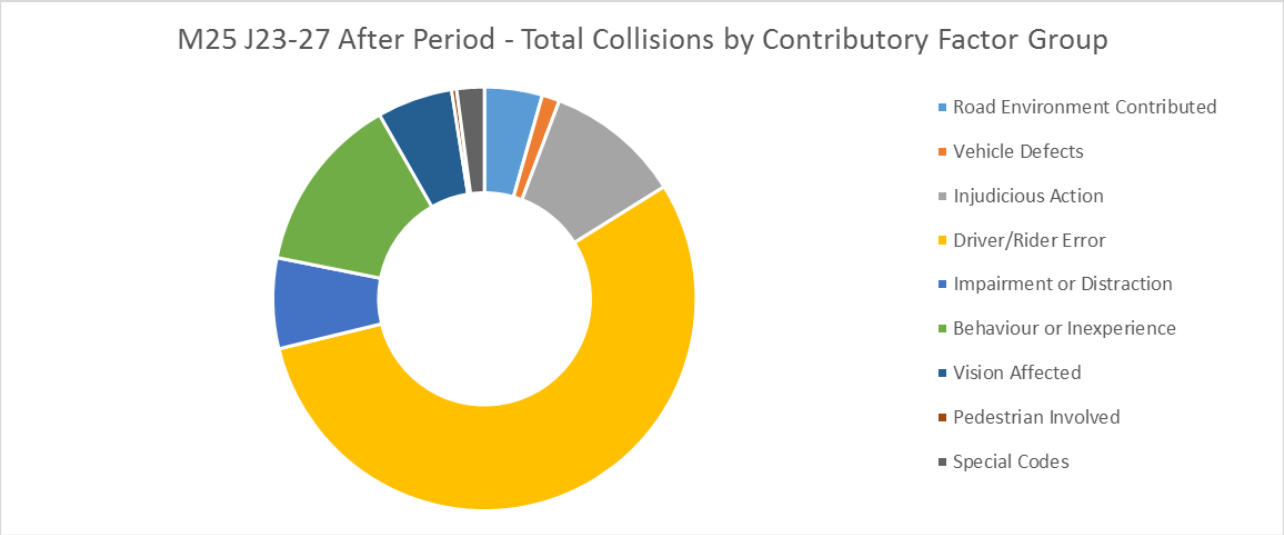
Code	Contributory factors	Fatal	Serious	Slight	Total	Rank
Road environment contributed		**0**	**2**	**21**	**23**	
101	Poor or defective road surface	0	0	0	0	
102	Deposit on road (e.g. oil, mud, chippings)	0	0	1	1	34
103	Slippery road (due to weather)	0	2	15	17	11
104	Inadequate or masked signs or road 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	3	3	24
109	Animal or object in carriageway	0	0	2	2	28
Vehicle defects		**2**	**3**	**6**	**11**	
201	Tyres illegal, defective or under-inflated	0	1	2	3	24
202	Defective lights or indicators	0	0	0	0	

203	Defective brakes	1	0	1	2	28
204	Defective steering or suspension	1	0	1	2	28
205	Defective or missing mirrors	0	0	0	0	
206	Overloaded or poorly loaded vehicle or trailer	0	2	2	4	21
Injudicious action		**0**	**7**	**123**	**130**	
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	1	1	34
306	Exceeding speed limit	0	0	6	6	16
307	Travelling too fast for conditions	0	5	44	49	**7**
308	Following too close	0	2	72	74	**3**
309	Vehicle travelling along pavement	0	0	0	0	
310	Cyclist entering road from pavement	0	0	0	0	
Driver/rider error		**8**	**41**	**374**	**423**	
401	Junction overshoot	0	1	0	1	34
402	Junction restart (moving off at junction)	0	0	2	2	28
403	Poor turn or manoeuvre	2	4	37	43	**8**
404	Failed to signal or misleading signal	0	0	4	4	21
405	Failed to look properly	2	11	128	141	**1**
406	Failed to judge other person's path or speed	1	5	79	85	**2**
407	Passing too close to cyclist, horse rider or pedestrian	0	0	1	1	34
408	Sudden braking	1	5	57	63	**4**
409	Swerved	0	4	24	28	**9**
410	Loss of control	2	11	42	55	**5**
Impairment or distraction		**0**	**7**	**37**	**44**	
501	Impaired by alcohol	0	3	10	13	12
502	Impaired by drugs (illicit or medicinal)	0	0	0	0	
503	Fatigue	0	3	9	12	13
504	Uncorrected, defective eye sight	0	0	0	0	
505	Illness or disability, mental or physical	0	0	4	4	21
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	1	9	10	14
510	Distraction outside vehicle	0	0	5	5	20
Behaviour or inexperience		**1**	**5**	**67**	**73**	
601	Aggressive driving	0	0	6	6	16
602	Careless, reckless or in a hurry	1	4	48	53	**6**
603	Nervous, uncertain or panic	0	0	3	3	24
604	Driving too slow for conditions or slow vehicle (e.g. tractor)	0	1	0	1	34
605	Learner or inexperienced driver / rider	0	0	7	7	15
606	Inexperience of driving to the left	0	0	3	3	24
607	Unfamiliar with model of the vehicle	0	0	0	0	
Vision affected		**0**	**3**	**35**	**38**	
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	1	1	34

706	Dazzling sun	0	0	1	1	34
707	Rain, sleet, snow or fog	0	2	4	6	16
708	Spray from other vehicles	0	0	2	2	28
709	Visor or windscreen dirty or scratched	0	0	0	0	
710	Vehicle blind spot	0	1	27	28	**9**
Pedestrian involved		**2**	**0**	**1**	**3**	
801	Crossing road masked by stationary or parked vehicle	0	0	0	0	
802	Failed to look properly	0	0	1	1	34
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)	1	0	0	1	34
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	1	0	0	1	34
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**	**1**	**8**	**9**	
901	Stolen vehicle	0	0	0	0	
902	Vehicle in course of crime	0	0	1	1	34
903	Emergency vehicle on a call	0	0	2	2	28
904	Vehicle door opened or closed negligently	0	0	0	0	
999	Other	0	1	5	6	16

Contributory factors by severity after period

Code	Contributory factor group	Fatal	Serious	Slight	Total
101-109	Road environment contributed	0	2	25	27
201-206	Vehicle defects	0	2	7	9
301-310	Injudicious action	0	4	56	60
401-410	Driver/rider error	2	18	292	312
501-510	Impairment or distraction	0	7	31	38
601-607	Behaviour or inexperience	1	6	73	80
701-710	Vision affected	0	3	29	32
801-810	Pedestrian involved	2	0	0	2
901-999	Special codes	0	0	11	11
Total		**5**	**42**	**524**	**571**



Rank	1 to 10
	11 to 15

Code	Contributory factors	Fatal	Serious	Slight	Total	Rank
Road environment contributed		**0**	**2**	**25**	**27**	
101	Poor or defective road surface	0	0	1	1	29
102	Deposit on road (e.g. oil, mud, chippings)	0	0	2	2	26
103	Slippery road (due to weather)	0	2	17	19	**9**
104	Inadequate or masked signs or road markings	0	0	0	0	
105	Defective traffic signals	0	0	1	1	29
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	3	3	22
109	Animal or object in carriageway	0	0	1	1	29
Vehicle defects		**0**	**2**	**7**	**9**	
201	Tyres illegal, defective or under-inflated	0	1	2	3	22
202	Defective lights or indicators	0	0	0	0	
203	Defective brakes	0	0	1	1	29
204	Defective steering or suspension	0	1	3	4	20
205	Defective or missing mirrors	0	0	0	0	
206	Overloaded or poorly loaded vehicle or trailer	0	0	1	1	29
Injudicious action		**0**	**4**	**56**	**60**	
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	0	1	6	7	16
307	Travelling too fast for conditions	0	0	13	13	11
308	Following too close	0	3	37	40	**4**
309	Vehicle travelling along pavement	0	0	0	0	
310	Cyclist entering road from pavement	0	0	0	0	
Driver/rider error		**2**	**18**	**292**	**312**	
401	Junction overshoot	0	1	0	1	29
402	Junction restart (moving off at junction)	0	0	0	0	
403	Poor turn or manoeuvre	0	2	32	34	**6**
404	Failed to signal or misleading signal	0	0	3	3	22
405	Failed to look properly	1	9	98	108	**1**
406	Failed to judge other person's path or speed	1	3	73	77	**2**
407	Passing too close to cyclist, horse rider or pedestrian	0	0	0	0	
408	Sudden braking	0	2	31	33	**7**
409	Swerved	0	0	19	19	**9**
410	Loss of control	0	1	36	37	**5**
Impairment or distraction		**0**	**7**	**31**	**38**	
501	Impaired by alcohol	0	1	5	6	18
502	Impaired by drugs (illicit or medicinal)	0	0	0	0	
503	Fatigue	0	2	5	7	16
504	Uncorrected, defective eye sight	0	0	0	0	

505	Illness or disability, mental or physical	0	3	9	12	12
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	29
509	Distraction in vehicle	0	1	8	9	14
510	Distraction outside vehicle	0	0	3	3	22
Behaviour or inexperience		**1**	**6**	**73**	**80**	
601	Aggressive driving	0	2	6	8	15
602	Careless, reckless or in a hurry	1	4	56	61	**3**
603	Nervous, uncertain or panic	0	0	4	4	20
604	Driving too slow for conditions or slow vehicle (e.g. tractor)	0	0	1	1	29
605	Learner or inexperienced driver / rider	0	0	5	5	19
606	Inexperience of driving to the left	0	0	0	0	
607	Unfamiliar with model of the vehicle	0	0	1	1	29
Vision affected		**0**	**3**	**29**	**32**	
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	1	1	29
704	Buildings, road signs, street furniture	0	0	0	0	
705	Dazzling headlights	0	0	0	0	
706	Dazzling sun	0	0	1	1	29
707	Rain, sleet, snow or fog	0	1	1	2	26
708	Spray from other vehicles	0	0	2	2	26
709	Visor or windscreen dirty or scratched	0	0	0	0	
710	Vehicle blind spot	0	2	24	26	**8**
Pedestrian involved		**2**	**0**	**0**	**2**	
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)	1	0	0	1	29
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	1	0	0	1	29
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**	**11**	**11**	
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	1	1	29
904	Vehicle door opened or closed negligently	0	0	0	0	
999	Other	0	0	10	10	13

C.3. Red X compliance

Table C-1 Summary of Red X events

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
8	8	7	1	3%
27	310	16	11	17%
11	1	6	0	0%
16	161	19	10	14%
5	5	8	1	3%
96	10	14	10	18%
19	83	11	4	10%
86	14	18	14	19%
9	10	3	1	9%
25	2	2	0	1%
18	56	18	3	4%
15	22	16	1	2%
17	186	23	11	12%
15	15	16	1	2%
15	27	18	2	2%
5	3	10	1	2%
22	328	24	15	16%
5	4	15	1	1%
4	2	14	1	1%
20	7	7	0	1%
22	45	20	2	3%
8	0	8	0	0%
4	1	8	0	1%
31	9	17	0	0%
21	63	23	3	3%
3	6	4	2	12%
23	12	7	1	2%
16	7	19	0	1%
18	9	2	0	6%
1	1	14	1	1%
13	3	2	0	3%
10	6	15	1	1%
3	1	16	0	0%
23	19	7	1	3%
28	63	14	2	4%
11	20	12	2	4%
2	3	18	1	2%
14	63	15	4	7%

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
31	2	9	0	0%
9	67	22	7	9%
11	18	12	2	3%
18	168	20	9	12%
11	40	16	4	6%
15	92	20	6	8%
15	6	14	0	1%
8	29	18	4	5%
1	13	22	12	14%
86	304	13	4	7%
11	46	21	4	5%
8	1	18	0	0%
6	11	9	2	5%
25	182	18	7	10%
9	3	8	0	1%
2	9	17	5	7%
17	200	24	12	12%
24	21	12	1	2%
108	657	13	6	11%
18	0	18	0	0%
3	4	21	1	1%
17	4	10	0	1%
14	2	11	0	0%
22	92	16	4	6%
17	45	13	3	5%
7	10	17	1	2%
8	23	22	3	3%
20	83	18	4	6%
22	1	13	0	0%
3	2	9	1	2%
31	187	17	6	9%
15	78	11	5	12%
10	60	17	6	9%
80	392	16	5	8%
25	86	7	3	12%
17	136	21	8	10%
19	141	13	7	14%
32	60	16	2	3%
2	5	12	2	5%
41	86	18	2	3%
16	48	13	3	6%

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
13	45	19	3	5%
6	39	21	6	8%
4	9	11	2	5%
18	7	2	0	5%
42	66	17	2	2%
16	44	8	3	9%
3	28	20	9	12%
79	43	7	1	2%
2	14	14	7	13%
12	40	13	3	6%
14	38	14	3	5%
26	31	3	1	9%
2	6	12	3	7%
90	211	20	2	3%
16	72	19	4	6%
3	39	19	13	17%
52	110	17	2	3%
21	80	17	4	6%
12	176	18	15	20%
89	863	17	10	14%
19	79	15	4	7%
28	74	10	3	7%
10	8	8	1	2%
8	55	19	7	9%
5	23	17	5	7%
24	11	3	0	4%
77	274	15	4	6%
11	37	12	3	7%
6	2	1	0	7%
4	0	3	0	0%
18	82	16	5	7%
4	9	20	2	3%
24	119	16	5	8%
13	46	19	4	5%
11	23	16	2	3%
27	25	2	1	11%
3	9	21	3	4%
6	11	20	2	2%
5	34	18	7	9%
25	52	10	2	5%
Average: 20	Average: 67	Average: 14	Average: 4	Average: 6%