Specialist Professional and Technical Services (SPATS) Framework
Lot 1 & Lot 2

Task 1127
Smart Motorway Incident and Infrastructure Investigation – M1 Junction 30 to 35

July 2021

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Executive Summary

This report has been prepared as part of Highways England's response to the Government's Smart Motorway Safety Evidence Stocktake and Action Plan. It delivers on the commitment of Smart Motorway Stocktake Action to investigate road user safety on the M1 Junctions 30 to 35 (Sheffield) section.

The section of the M1 between Junction 30 and Junction 35 comprises elements of M1 Junction 28-31 and M1 Junction 32-35a smart motorway all lane running schemes, and the M1 Junction 31 to 32 smart motorway infill scheme, which provided mandatory signaling on an existing 4 lane section with a permanent hard shoulder. The scheme was completed in two stages, Junction 28 to 31 and Junction 31 to 32 schemes being opened by April 2016 and Junction 32 to 35A opening by April 2017.

In order to identify interventions in a robust way, this investigation is evidence-led. Analysis of a wide data set sign-posted possible areas of interest. Road safety analysis was applied to determine potential interventions, which answer the question posed for the investigation of, "what more could be done to improve road safety?".

This section of the M1 has a number of operational regimes with Junction 30 to 31 being all lane running including through the junctions, Junction 31 to 32 having four lanes and a permanent hard shoulder and Junction 32 to 35 being all lane running. Junction 32, 33 and 34 have three lanes and a hard shoulder through the junctions; Junction 32 comprises the M1 / M18 interchange and extends for approximately 1.7km. The mainline is unlit, as it was prior to the smart motorway scheme construction.

Collision data has been analysed from the three years prior to the scheme construction date and the latest available data from the scheme opening date to December 2019. Given the different operational regimes the collisions have been considered in three sections:

- Junction 30 to Junction 31 including through Junction 31, all lane running section;
- Junction 31 to Junction 32 including through Junction 32, four lanes / three lanes with permanent hard shoulder (controlled motorway); and
- Junction 32 to 35, all lane running section.

Overall the average numbers of injury collisions per year have decreased in the after period for all sections, due to a fall in the number of slight injury collisions. However, the number of serious injury collisions per year have increased across both of the all lane running sections, and fatal injury collisions have increased from one in three years to three in three years for the Junction 32 to Junction 35 section. Accordingly, the ratio of fatal and serious injury collisions has increased in the after period for both all lane running sections.

Whilst there has been an overall reduction in collision numbers, there has been a slight increase in the number of collisions occurring in darkness, indicating that the overall reduction in collisions from the introduction of the scheme is only being realised in daytime collisions. All sections report an increase in the proportion of goods vehicles involved in collisions during the after period.

Highways England-recorded incident data has been assessed for the all lane running and controlled motorway sections separately. In 2018 there were 1,047 live lane breakdowns in the all lane running sections, a rate of 0.11 per mile per day. This aligns with reported average live lane breakdown rates from other all lane running smart motorway schemes and is less than one third the value of expected tolerances from the programme safety analysis.

Feedback from Operations highlighted a challenge with message sign and signal availability and that this could compromise signal setting (although there is no evidence of it directly causing or exacerbating an incident). It also identified that this part of the network is approximately 13 miles from the nearest outstation (Sprotbrough, A1), which could present a challenge to response times.

Injury collisions relating to live lane stops have been analysed. Between Junction 30 and Junction 31, six live lane stop collisions have been recorded in the after period, two resulting in fatal and four in serious injuries. Between Junction 32 to Junction 35, nine live lane stop collisions have been recorded in

the after period, one fatal and eight slight injury severity. Eight of these collisions occurred in darkness and six due to a breakdown. No live lane stop related- injury collisions have been identified in the controlled motorway section between Junction 31 and 32.

A cluster of live lane stop related collisions is apparent northbound between Woodall motorway services and Junction 31; apart from the location and live lane stop involvement, no other clear link between the collision factors is identified, although the section is on a sweeping left-hand bend so nearside vegetation has the potential to restrict the ability of approaching drivers to see a stopped vehicle.

A collision cluster is apparent on the northbound approach to Junction 33 with most collisions being shunt type and half occurring during the morning peak. The type and location of the collisions suggest northbound congestion at Junction 33 affects the mainline. Although collisions in wet conditions have increased here, no flooding events appear in incident data in the locality. A package of potential interventions have been identified with this report to address this cluster.

An increase in lane change collisions is noted approaching Junction 31 southbound, where a former lane drop is now through junction running, potential improvements to signing and road marking have been identified. A cluster of shunt collisions at Junction 32 northbound diverge appears to relate largely to 2016 data and numbers have since decreased.

Collisions and incidents involving pedestrians have been reviewed and the range of crossing and potential access points (i.e. via slip roads close to urban areas) is a risk factor. Measures to prevent pedestrian incursion at slip roads are recommended.

The stocktake commitment to enhance emergency areas[1] with orange surfacing and comprehensive approach signing has already been met on this section of the M1. Potential interventions arising from the data review and focussed investigation are given in Table E.1.

[1] An emergency refuge area (ERAs) as defined in the Motorways Traffic (England and Wales) Regulations 1982.

Table E.1 Potential interventions

Key Findings – Data Analysis	M1 30 to 35 Potential interventions
A) J33 northbound diverge cluster of collisions including shunts and on wet road surface	• **Traffic signal timings** to reduce queues at roundabout • **Queue detection** calibration • **Pavement** skid resistance and / or increase Investigatory Level • **Drainage** capacity and maintenance cycle • Alternative **diverge arrangement**
B) J32 to 31 lane change collisions	• **Lane destination markings** on road • **Supplementary ADS** on approach to J31 southbound • Provision of **hazard road markings**
C) J31 to 32 cluster of wet collisions	• **Drainage** capacity and maintenance cycle
D) North of Woodall MSA to J31 - cluster of live lane breakdown collisions	• **Add an emergency area** to reduce spacing between places of relative safety • **Forward visibility**, by further removing vegetation in nearside verge
E) Pedestrian incidents and local risk factors	• Use Walking Cycling and Horse Riding (GG 142) assessment process to **review pedestrian facilities** / access to motorway • Apply Suicide Prevention Toolkit
Key Findings - Operations Feedback	**M1 J30 to 35 Potential interventions**
F) Technology availability (samples by section) Message Sign availability J31-32: 70% June 2020, <75% Aug 2020 J32-35: <75% June 2020, <80% Aug 2020 Signal availability J31-32: <85% June 2020, <85% Aug 2020	• **Investigate wider data set and root causes** behind message sign and signal availability in J31-32 and J32-J35 sections [Note – no evidence of technology availability associated with/or prolonging incidents]

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1. Scope and Purpose

This report has been prepared as part of Highways England's response to the Government's Smart Motorway Safety Evidence Stocktake and Action Plan.

1.15 We have heard the concerns about clusters of incidents on specific sections of the M6 and M1 smart motorway. This includes the M6 Bromford viaduct between Junctions 5 and 6, where places to stop in an emergency are furthest apart. Though Highways England traffic officers are stationed at each end of the viaduct so they are close by, we know that some people remain worried. Concerns have also been raised about sections of the M1 where multiple collisions have occurred. These include M1 Junctions 10 to 13 (Luton) and Junctions 30 to 35 (Sheffield). We have also seen evidence of multiple incidents on the M1 Junctions 39 to 42 (Wakefield).

1.16 We are committing to investigate urgently what more could be done on the M6 Bromford viaduct and on these sections of the M1. Where an intervention is considered likely to make a difference, we will look to make changes to the motorway at these locations.

This report delivers this investigation into what more could be done to improve road user safety on the M1 Junction 30 to 35 (Sheffield) section.

In order to identify interventions in a robust way this investigation is evidence-led. Analysis of a wide data set sign-posted possible areas of interest. Road safety analysis was applied to determine potential interventions. The recommendations provide a robust answer to the question posed for the investigation of, "what more could be done to improve road safety?"

This report sets out the data sources and methodology used, the specific areas of investigation, interpretation and conclusions regarding collision occurrences, incident occurrences, and identifies potential interventions. Figure 1.1 illustrates this process.

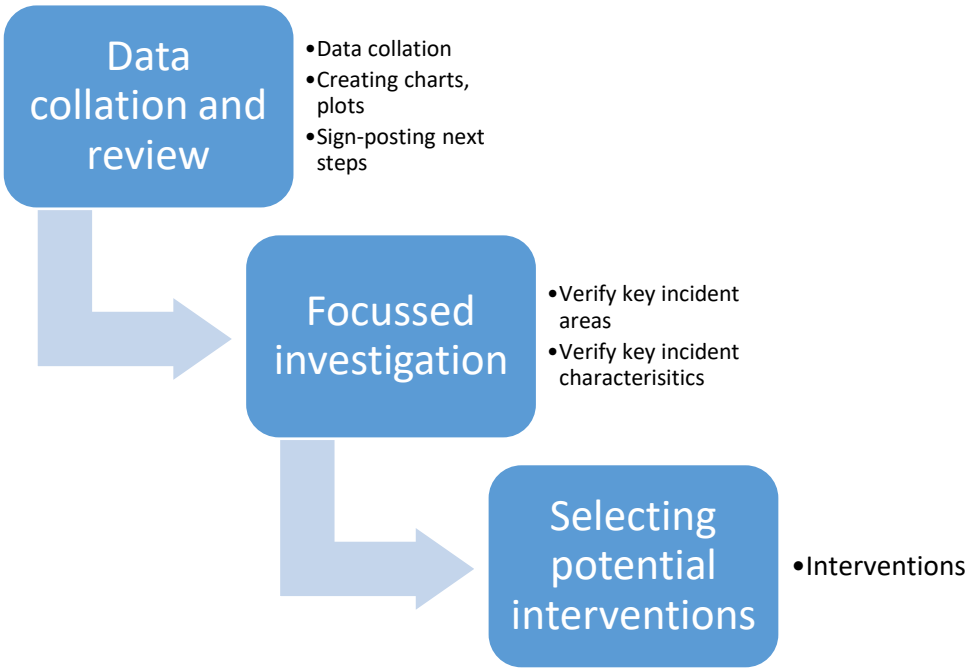


Figure 1.1 Structure of investigation

2. Methodology

2.1 Stage 1 - Data collation and review

A variety of data types and means of analysis will form the first stage of assessment used to inform this report. Data and information inputs were reviewed with the initial objective of sign-posting trends, findings or areas of interest that warrant further analysis.

The Stage 4 (post-opening) road safety audits were reviewed to understand road safety observations made after the scheme was opened to traffic and how these were resolved. If appropriate, earlier road safety audits were also reviewed (prior to scheme opening) to investigate trends or continuity in the types of observations raised in Stage 4.

Collision data from the three years prior to the scheme construction date and the latest available data since the scheme opening date were analysed; these sets were compared as the average number of collisions per year. Only injury collisions are captured in this data set (often referred to as 'STATS 19 data') with the data obtained via regional or area teams from police records. The data was considered by location and by trend, illustrated using data plots. The trends reviewed included collision and casualty severity, proportion of collisions that have occurred in darkness or daylight, weather conditions, vehicle type and collision type (e.g. nose to tail, side swipe etc).

Approximately half of English police forces adopted the CRASH (Collision Recording and Sharing) system of collision reporting, including South Yorkshire Police (the police force local to this section of the M1) who adopted CRASH in January 2016. This report shows the data as reported to or by the police and does not make any adjustments.

CRASH is an injury-based severity reporting systems where the officer records the most severe injury for the casualty. The injuries are then automatically converted to a severity level from 'slight' to 'serious'. This system eliminates the uncertainty in determining severity that arises from the officer having to make their own judgement and means that the new severity level data observed from these systems using injury based methods are expected to be more accurate than the data from other systems. Further reading on the potential impacts of changes to the reporting system is available on the gov.uk website[2].

In addition to collision data, Operations' incident data was reviewed for this section of the road network, with the aim of giving insight into the occurrence of breakdowns and the proportion of stops in live and non-live lanes. Incidents are characterised as having impact on the operational performance of a section (e.g. congestion / formation of queues) these but do not necessarily result in injury but have the potential to do so.

Design information for this scheme, including the design strategy record and departures from standard checklist were reviewed to understand the philosophy and rationale behind the road layout. The potential operational impact of the departures from standard was assessed and summarised.

To gain an understanding of the operation of the scheme in practice, feedback from consultation with local Operations stakeholders and high quality dashcam video and still images from a recent drive-through was reviewed.

The outcome of the review may identify emerging areas and aspects that warrant further investigation and road safety analysis (Stage 2 of the methodology).

2.2 Stage 2 - Focussed investigation

Road safety analysis drew upon the sign-posted elements from the initial data analysis in Stage 1, considering their relative significance in both isolation and potential combination. Key points for identifying issues for further consideration included whether:

[2] https://www.gov.uk/government/statistics/reported-road-casualties-great-britain-main-results-2018

- the number of a particular collision type has increased since the smart motorway opened.
- there is a location where a number of collisions and/or incidents have occurred.
- there may be a trend of common factors in collision occurrence.
- an issue has become more noticeable or frequent over the years of operation.

In addition to the specifically identified elements, the analysis included a detailed review of:

- all serious injury and fatal collisions occurring post-opening;
- all collisions involving a live lane stop; and
- for any further areas of interest identified in the data review stage, injury collisions of all severities.

Where the analysis identified prospective links between collisions and/or incidents, either spatially (i.e. a cluster) or by common factor (e.g. collisions in wet conditions), these were taken forward for identification of potential interventions.

The outputs from this stage of the investigation were:

- data on all prospective issues.
- sifting of issues with no clear pattern, trend or appropriate treatment.
- issues possibly linked to collisions and/or incidents taken forward for intervention recommendations.

2.3 Stage 3 – Potential interventions

This element of the methodology considered prospective interventions or control measures for the specific issues that have been linked to collisions and/or incidents. These were specific to the section and the issues identified.

The output from this stage of the investigation will address what more could be done to mitigate future collisions and/or incidents. Potential interventions will be recommended in context of other Stocktake Action Plan measures, including the roll-out of stopped vehicle detection technology by September 2021.

3. M1 Junction 30 to Junction 35 section outline

The section of the M1 between Junction 30 and Junction 35 comprises elements of three smart motorway schemes: M1 J28-31; M1 J31-32; and M1 J32-35a. Figure 3.1 illustrates the extents of the study area.

These schemes were Highways England major projects to improve approximately 33 miles (54km) of the M1 through the implementation of:

- Smart motorway between Junction 28 and 31 and Junction 32 and 35a; conversion of the hard shoulder for use as a permanent traffic lane (known as all lane running) and introduction of enhanced on-road technology, including variable mandatory speed limits (VMSL) to manage traffic flow.
- Installation of VMSL between Junctions 31-32 to manage traffic flows. This link has four running lanes and a hard shoulder with the exception of approximately 600m at Junction 31 where the hard shoulders were converted into running lanes to enable through junction running.

Smart motorways convert the hard shoulder to add capacity without the need for land take, introducing speed limits to manage congestion at peak and non-peak times, as well as support incident management. Further points of note:

- The Junction 28 to 31 and Junction 32 to 35 schemes were designed using the Highways England Interim Advice Note 161/13. The Junction 31 to 32 scheme was designed using the Highways England Interim Advice Note 149/11, however also applied Highways England Interim Advice Note 161/13.
- The smart motorway schemes between Junction 28 and 35a became operational at different times with Junction 28 to 31 becoming operational in April 2016, prior to which the Junction 31 to 32 scheme was completed. The Junction 32 to 35a scheme was completed in April 2017 bringing the full 33 miles of smart motorway into operation.
- Junction 32 is the interchange between the M1 and M18. The intra-junction length of approximately 1.7km has three running lanes and a permanent hard shoulder in both directions. Signalling and VMSL are in place.
- Junction 34 incorporates the Tinsley Viaduct between the north and south facing slip roads. The intra-junction length of approximately 1.9km has three running lanes and a permanent hard shoulder in both directions. Signalling and VMSL are in place.
- The information in Table 3.1 sets out some key elements of the layout between Junctions 30-35.

Table 3.1 M1 J30-35 layout and features

Link / Junction	Lanes / Refuges	Lighting provision	
		Before	After
J30	NB: Through junction running SB: Through junction running Hard shoulders on diverge slips	Unlit	Unlit
J30 to J31 – 8.7km between junction centres	NB: Four lane all lane running, 3 mainline emergency areas and Woodall motorway service area SB: Four lane all lane running, 3 mainline emergency areas and Woodall motorway service area	Unlit	Unlit
J31	NB: Through junction running SB: Through junction running Hard shoulders on diverge slips	Unlit	Unlit
J31 to J32 – 2.4km centre of J31 to J32 south-facing diverge	NB: Dual four lane lane motorway with permanent hard shoulder SB: Dual four lane lane motorway with permanent hard shoulder.	Unlit	Unlit
J32 (M18 Interchange)– 1.7km	NB: Lane drop, lane gain, dual three lane motorway with permanent hard shoulder SB: Lane drop, lane gain, dual three lane motorway with permanent hard shoulder	Unlit	Unlit
J32 to J33 – 4.0 km from J32 north facing diverge to J33 centre	NB: Four lane all lane running, one mainline emergency area. SB: Four lane all lane running, one mainline emergency area	Unlit	Unlit
J33	NB: Lane drop, lane gain SB: Lane drop, lane gain	Unlit	Unlit
J33 to J34 – 3.8km centre of J33 to J34 diverges	NB: Four lane all lane running, one mainline emergency area SB: Four lane ALR, one mainline emergency areas	Unlit	Unlit
J34 (Tinsley Viaduct) - 1.9km	NB: Lane drop, lane gain, dual three lane motorway with permanent hard shoulder SB: Lane drop, lane gain, dual three lane motorway with permanent hard shoulder	Unlit	Unlit
J34 to J35 – 4.2km J34 diverge to J35 centre	NB: Four lane all lane running, one mainline emergency area SB: Four lane all lane running, one mainline emergency area	Unlit	Unlit
J35	NB: Through junction running SB: Through junction running Hard shoulders on diverge slips	Unlit	Unlit

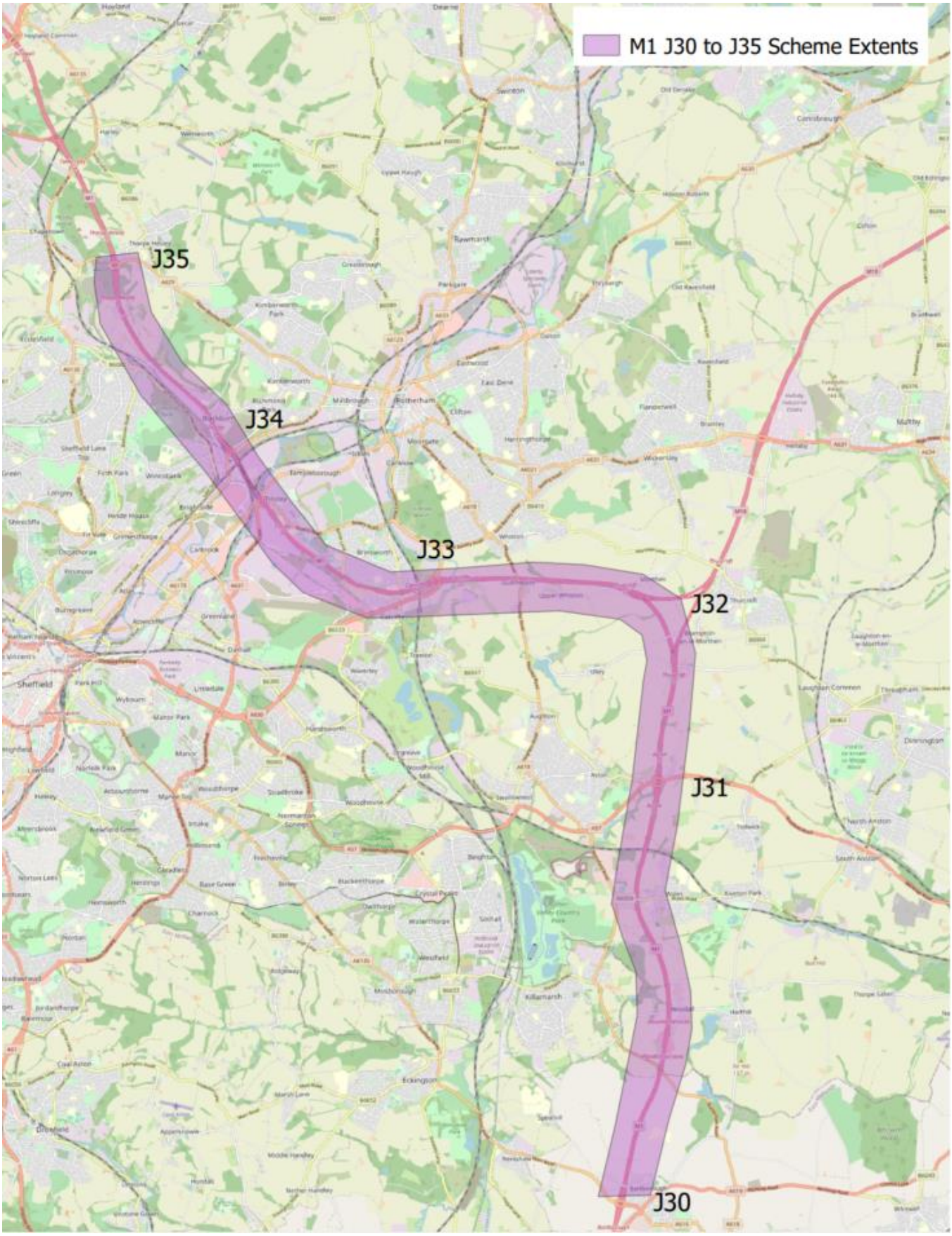


Figure 3.1 M1 Junction 30-35 extents and location

4. Data collation and review

This section contains the results of the initial review and analysis of the key data sources. Outputs from this section are taken forward to the following section for full safety analysis.

4.1 Road Safety Audit Stage 4 review

Stage 4 road safety audit documents were reviewed with key points identified in Table 4.1 for the M1 Junction 28 to 31 smart motorway project and Table 4.2 for M1 Junction 32 to 35 smart motorway project. No stage 4 road safety audit was available for review for the M1 Junction 31 to 32 scheme.

Table 4.1 M1 J28-31 Smart Motorway (SM) Project Road Safety Audit Stage 4

	Summary of stage 4 road safety audit	Relevance to this investigation
General points	Stage 4 road safety audit was undertaken in November and December 2019. Undertaken in accordance with GG 119 and included a site visit. Reference is made to a Stage 3 road safety audit in April 2016 and a stage 2 road safety audit in April 2014.	The scheme was operational in March/April 2016 and the stage 4 road safety audit completed in February 2020.
Collision analysis	The collision analysis compared an average value of the 3 years pre-scheme with 12 months post scheme. The collision data indicates a decrease from 107 to 44 collisions per year and an increased killed and seriously injured ratio. Of the five serious collisions in the after period three involved a vehicle stopped on the mainline due to vehicle defect or mechanical fault compared to one in the before period. Two of the live lane collisions occurred on the southbound approach to Junction 28 (i.e. out of scope of this study). Dark collisions are slightly above the national average. Contributory factors have remained broadly the same in the before and after period and are connected with rear shunt and lane change collisions.	No clusters have been identified and the analysis has focused on the recorded serious live lane stops, two of which occurred on the southbound approach to Junction 28 (i.e. not within scope of this investigation).
Traffic conditions	No traffic flow data provided.	None
Review of previous road safety audits	**Road safety audit 2 issues remaining at road safety audit 4:** Post and rail fencing in close proximity to the nosing at Woodall motorway service area remains a hazard.	Noted, whilst this relates to specific location vegetation may have worsened and this has been considered where lane change, shunt and live lane stop collisions identified.

	Summary of stage 4 road safety audit	Relevance to this investigation
	Road safety audit 3 issues remaining at road safety audit 4: Vegetation partially restricting stopping sight distance (SSD) and visibility of sign faces but noted that the road safety audit was carried out in November when there was minimum leaf coverage. The stopping sight distance issue was noted on the southbound carriageway Marker Post 245/9 to 245/5 and the visibility of signs related to three signs. **Post opening road safety audit 3 issues remaining at road safety audit 4:** Uneven transverse joint at marker post 221/6A Possible faulty MS4 at marker post 238/1 B	
Identified road safety problems	Risk of stranded/broken down vehicles being struck by other vehicles. Recommendations include increased monitoring to improve response times, provision of emergency areas, improvements to warning of live lane incidents, improved driver education.	Investigated further herein.
Conclusions	Executive summary at the start of the RSA report provides the general conclusions of the stage 4 road safety audit including an increase in the number of collisions involving stranded/broken down vehicles. Further investigation into the circumstances of these collisions is recommended.	The number of collisions per year has decreased and while the number of killed and seriously injured has remained similar this represents a greater percentage of the total and therefore an increased killed and seriously injured ratio. The stage 4 road safety audit has identified live lane stops but has not drawn out any other specific concerns.

Table 4.2 M1 J32-35 Smart Motorway (SM) Project Road Safety Audit Stage 4

	Summary of road safety audit 4	Observations and next steps
General points	Stage 4 road safety audit undertaken in Nov 2019. Undertaken in accordance with GG 119 and included a site visit. Reference is made to a stage 1 in 2012, an interim stage 2 in 2013, a Stage 2 in 2014 and a Stage 3 in December 2016 for Junctions 34-35A and a further stage 3 in April 2017 for Junctions 32 to 34, separate audits were completed due to	The scheme was operational in March 2017 and the stage 4 road safety audit completed in February 2020. Hard shoulder retained through Junction 34.

	Summary of road safety audit 4	Observations and next steps
	sectional opening of the scheme, with the final audit considering the overall operations of the scheme.	
Collision analysis	The collision analysis compared an average value of the 3 years pre scheme with 12 months post scheme. The collision data indicates a decrease from 32.7 to 14 collisions per year and an increased killed and seriously injured ratio. A review of the fatal and serious collisions in the after period indicate that they are not related to the motorway being converted to a smart motorway. In both the before and after period the number of dark collisions exceeds the national average. Half of the after collisions occurred on a wet road surface. Rear shunts were the predominant collision type in the before and after period. Two slight collisions involving a live lane stop in lane 1 were recorded in the after period. Contributory factors have remained broadly the same in the before and after period.	No mainline clusters have been identified although slip road collisions have been reviewed where over 50% of the rear shunts in the after period have occurred. This amounts to 4 injury collisions, recorded at three separate locations so doesn't indicate a trend. Dark collisions and wet collisions are a recurring theme. The two live lane stops were all recorded in lane 1.
Traffic conditions	No traffic flows provided.	None
Review of previous road safety audits	Twelve issues were raised in total in the two stage 3 road safety audit reports and all were resolved.	None
Identified road safety problems	Adequacy of monitoring to capture queuing on slip roads and lane drop for Meadowhall. Ongoing maintenance of drainage. Investigate possible pattern of live lane stops. Investigate increase in dark and wet collisions as part of annual collision review.	Investigated further herein.
Conclusions	Executive summary at the start of the RSA report provides the general conclusions of the road safety audit 4 including a decrease in injury collisions	None

	Summary of road safety audit 4	Observations and next steps
	but an increase in severity. The fatal and serious collisions recorded in the after period did not appear to be as a result of the conversion to smart motorway although two slight collisions were recorded as a result of a live lane stop.	

Key findings

Stage 4 Road Safety Audits were available for the Junction 28 to 31 and Junction 32 to 35 schemes, an Audit for the Junction 31 to 32 was not available for review.

The Stage 4 road safety audits identified a number of road safety problems focussing on:

- collisions occurring in darkness and collisions occurring on a wet road surface;
- collisions relating to live lane stops;
- over representation of rear shunt collisions.

4.2 Collision data review

4.2.1 Section data

The M1 Junction 30 to 35 section consists of three schemes: Junction 28 to 31 Smart Motorway, Junction 31 to 32 Smart Motorway infill and Junction 32 to 35a Smart Motorway. The Junction 31 to 32 scheme retained the permanent hard shoulder between the Junctions and through Junction 32. Given the different operational regimes, the collisions have been considered in three sections:

- Junction 30 to 31 including through Junction 31, all lane running section;
- Junction 31 to 32 including through Junction 32, four lanes / three lanes with permanent hard shoulder (controlled motorway); and
- Junction 32 to 35, all lane running section.

The above sections are based on the predominant operational regime on the section, although there is approximately 600m of the Junction 31 to 32 link without a hard shoulder and on the Junction 32 to 35 section hard shoulders are present through the Junctions.

The construction of the schemes commenced at different times with Junction 28 to 31 starting in 2013, Junction 31 to 32 in 2014 and Junction 32 to 35a starting in 2015. The Junction 28 to 31 and Junction 31 to 32 schemes were opened by April 2016 and the Junction 32 to 35a scheme opened by April 2017. The Junction 28 to 31 scheme included works between Junction 31 to 32 therefore its construction period has also been used to determine the before and after period for the Junction 31 to 32 link.

Given the above, the Junction 30 to 31 and Junction 31 to 32 before data comprises three full years of collision data from 1st March 2010 to 28th February 2013, approximate average traffic (annual average daily traffic) in this period was 129,000 vehicles per day.

The Junction 30 to 31 and Junction 31 to 32 after period data comprises since opening to traffic in April 2016. The tables below run April to April with year 4 being April to December 2019; whilst year 4 is not a complete year it has been used to ensure as much collision data was considered as possible. Average traffic in this period is 133,000 vehicles per day, approximately a 3% increase over the before period.

For Junction 32 to 35, before data[3] compromises three full years from 30th January 2012 to 29th January 2015, approximate average traffic (annual average daily traffic) in this period was 112,000 vehicles per day.

For the Junction 32 to 35 section the after period comprises collision data since opening to traffic in April 2017. The tables below run April to April with year 3 being April to December 2019; whilst year 3 is not a complete year it has been used to ensure as much collision data was considered as possible. Average traffic in this period is 124,000 vehicles per day, approximately a 10% increase over the before period.

The operational data used is considered unvalidated data. Using this data rather than validated data meant the most recent collisions could be included and meant the investigation could include the full description of the collision circumstances. As the final year of after data for both sections is not a complete 12 months it has been excluded from the per year calculation, but is considered within the commentary on the results. Trends and changes within national collision statistics have not been reviewed, with only direct comparisons between the before and after period completed.

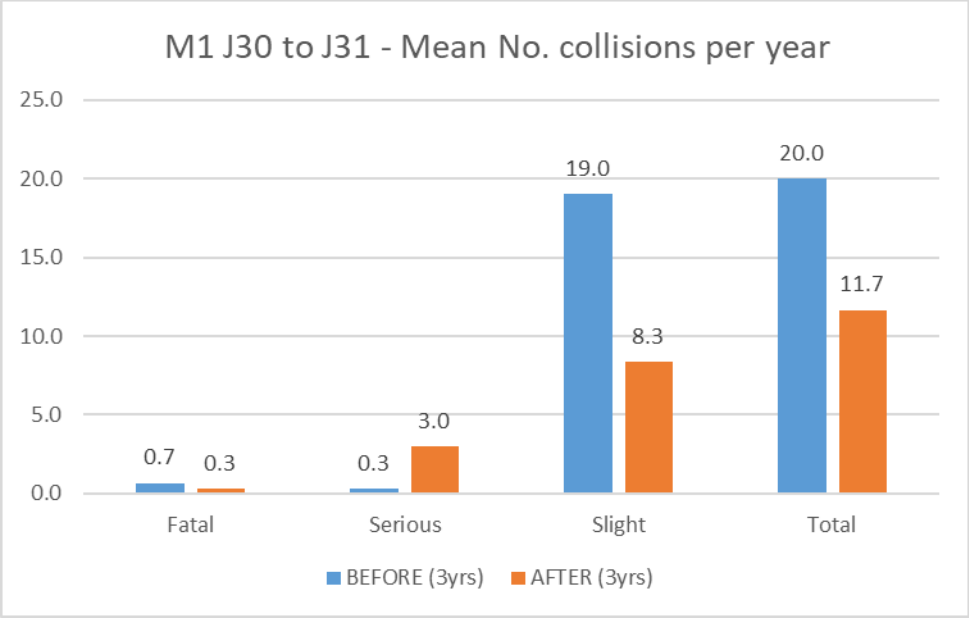
4.2.2 Severity

This section compares the number and severity of collisions before and after the scheme construction.

Table 4.3 Junction 30 to 31 collision severity for the before and after data periods

Collision Severity	Before				After					Average number of collisions /yr	
	Year 1	Year 2	Year 3	Total	Year 1	Year 2	Year 3	Year 4*	Total	Before	After
Fatal	0	1	1	**2**	0	0	1	1	**2**	**0.7**	**0.3**
Serious	1	0	0	**1**	1	4	4	1	**10**	**0.3**	**3.0**
Slight	19	20	18	**57**	11	8	6	4	**29**	**19.0**	**8.3**
All	**20**	**21**	**19**	**60**	**12**	**12**	**11**	**6**	**41**	**20.0**	**11.7**

*Partial year excluded from average number of collisions per year calculation



[3] The collision data included two collisions (reference 18346991 and 18346706), which occurred at the same time and location with similar descriptions; the latter was removed from the collision data as it was considered a duplicate.

Figure 4.1 Junction 30 to 31 collision severity for the before and after data periods

Table 4.3 and Figure 4.1 show that overall the average number of collisions per year have reduced between Junction 30 to 31, however the number resulting in serious injuries has increased. The above shows a reduction in the number of collisions per year resulting in fatal injuries, however a fatal collision has occurred in year 4. Therefore inclusion of this year in the average data would present a smaller reduction as the rate would be 0.5 fatal collisions per year.

Table 4.4 Junction 31 to 32 collision severity for the before and after data periods

Collision Severity	Before				After					Average number of collisions /yr	
	Year 1	Year 2	Year 3	Total	Year 1	Year 2	Year 3	Year 4*	Total	Before	After
Fatal	0	0	0	**0**	0	0	0	0	**0**	**0.0**	**0.0**
Serious	1	0	1	**2**	1	0	1	0	**2**	**0.7**	**0.7**
Slight	17	6	9	**32**	11	5	9	1	**26**	**10.7**	**8.3**
All	**18**	**6**	**10**	**34**	**12**	**5**	**10**	**1**	**28**	**11.3**	**9.0**

*Partial year excluded from average number of collisions per year calculation

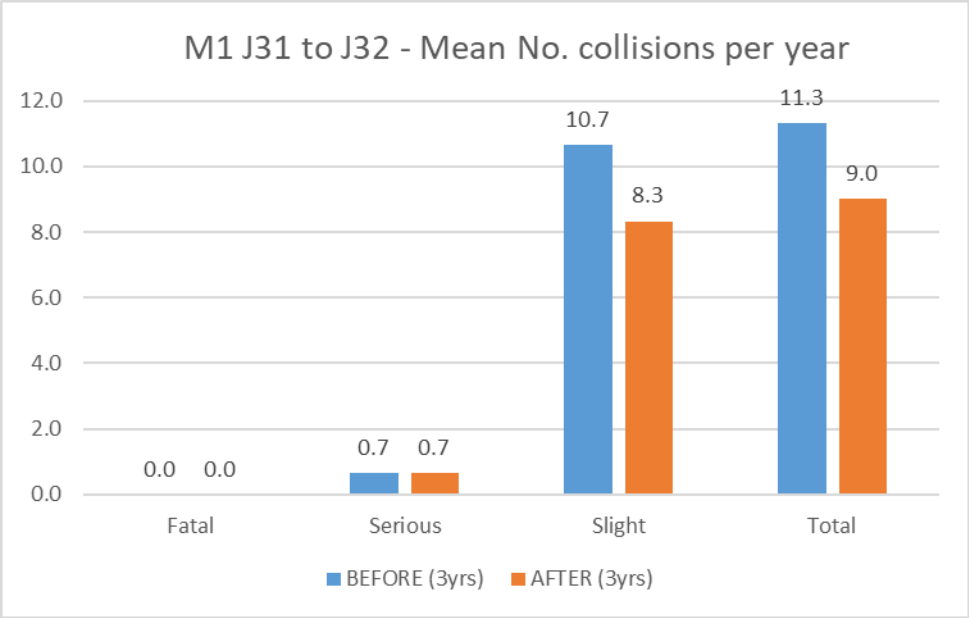


Figure 4.2 Junction 31 to 32 collision severity for the before and after data periods

Table 4.4 and Figure 4.2 show that overall the average number of collisions per year have reduced between Junction 31 to 32, and the number of collisions involving serious collisions has remained unchanged. No fatal collisions were recorded on this link.

Table 4.5 Junction 32 to 35 collision severity for the before and after data periods

Collision Severity	Before				After				Average number of collisions /yr	
	Year 1	Year 2	Year 3	Total	Year 1	Year 2	Year 3*	Total	Before	After
Fatal	1	0	0	**1**	1	1	1	**3**	**0.3**	**1.0**
Serious	2	1	1	**4**	3	4	3	**10**	**1.3**	**3.5**
Slight	34	36	17	**87**	10	29	12	**51**	**29.0**	**19.5**
All	**37**	**37**	**18**	**92**	**14**	**34**	**16**	**64**	**30.7**	**24.0**

*Partial year excluded from average number of collisions per year calculation

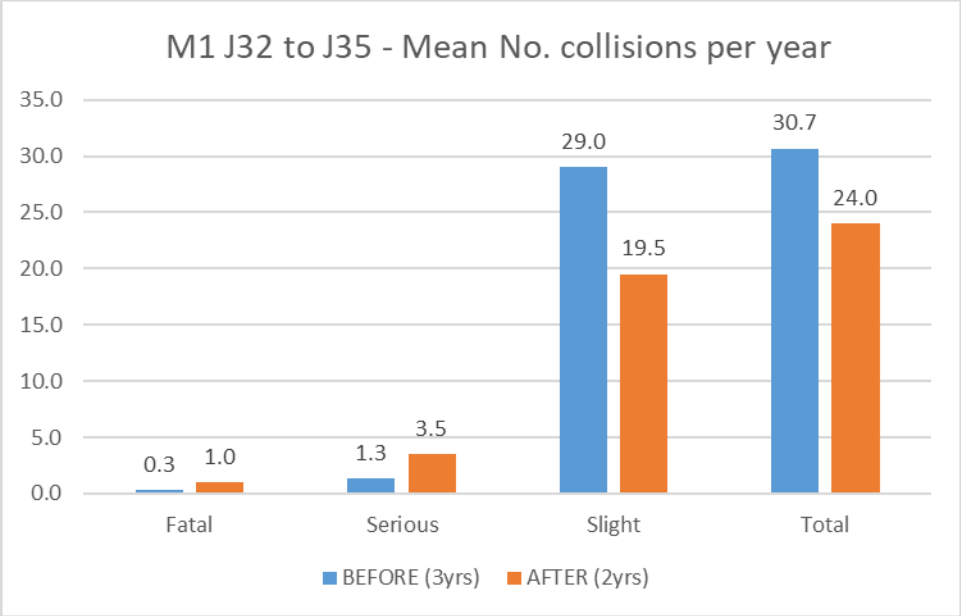


Figure 4.3 Junction 32 to 35 collision severity for the before and after data periods

Table 4.5 and Figure 4.3 show that overall the average number of collisions per year have reduced between Junction 32 to 35, however the number of collisions resulting in deaths or serious injuries has increased. During the partial year 3 data, one fatal collision has been reported and three serious collisions suggesting a consistent pattern.

For both all lane running sections the above indicates a higher ratio of fatal and serious collisions than in the before period. During the after period 29% and 21% of collisions resulted in fatal or serious injuries on the Junction 30 to 32 and Junction 32 to 35 sections, respectively. Both of these sections showed a reduction in slight collisions which led to an increase in this ratio, however, there is also a recorded increase in absolute numbers of serious injury collisions. For both sections the fatal and seriously injured ratio is above average for a motorway (the 2018 SRN Casualty Report indicates 17% of all motorway collisions were fatal or serious in 2018). Further consideration of the collisions resulting in fatal or serious injuries can be found in section 5. Refer to Appendix A for plots of the after period collision locations.

4.2.3 Lighting condition

This section compares the collisions before and after the scheme by lighting condition. No mainline lighting is present on the M1 between Junction 30 to 35, with the only lighting being provided at junctions. None of the schemes changed the lighting provision (i.e. this length was entirely unlit prior to smart motorway construction). Collisions by lighting condition are set out for each section in Figure 4.4, Figure 4.5 and Figure 4.6.

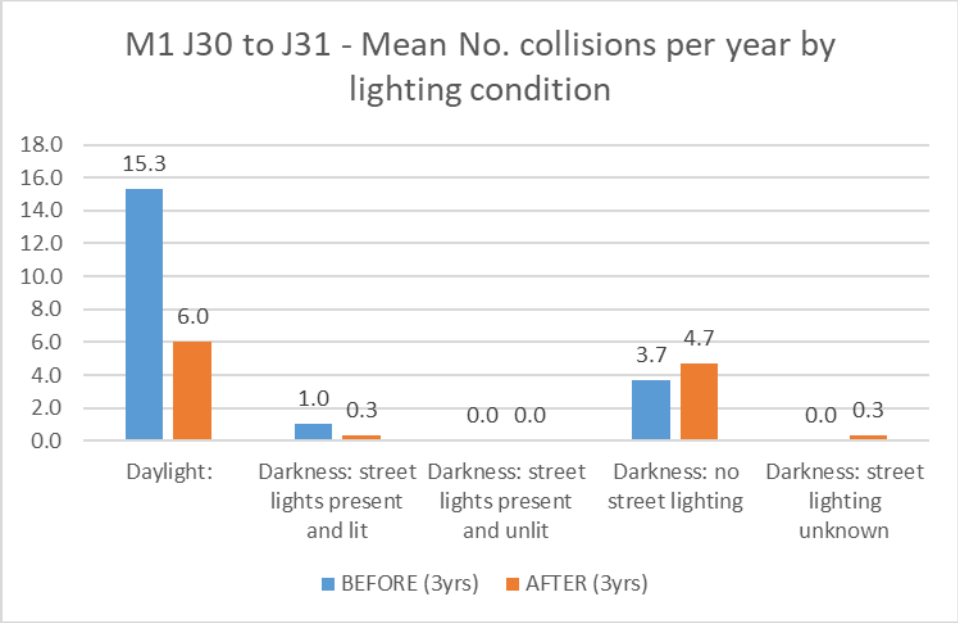


Figure 4.4 Junction 30 to 31 collisions by lighting condition for the before and after data periods

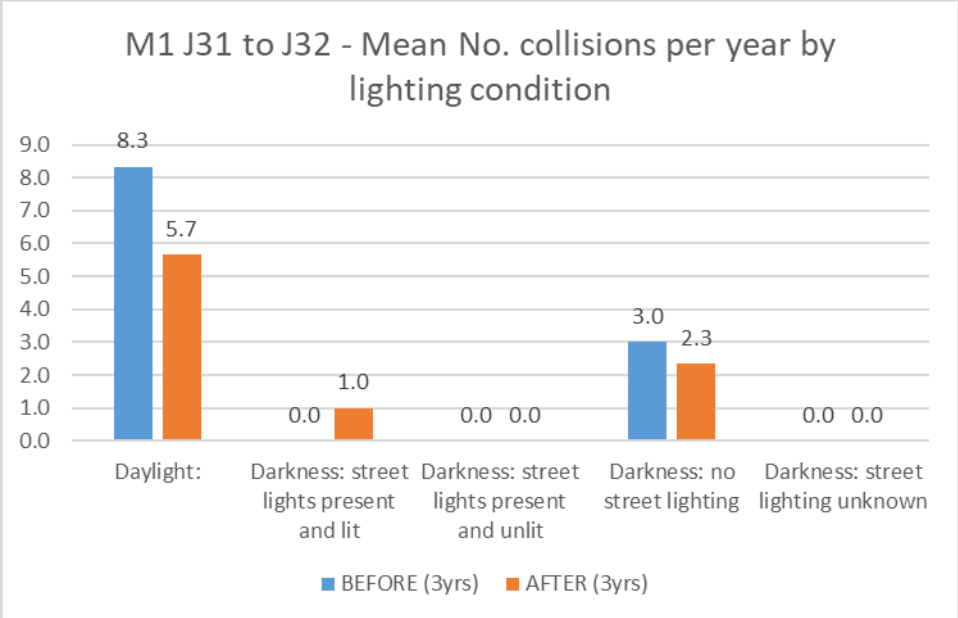


Figure 4.5 Junction 31 to 32 collisions by lighting condition for the before and after data periods

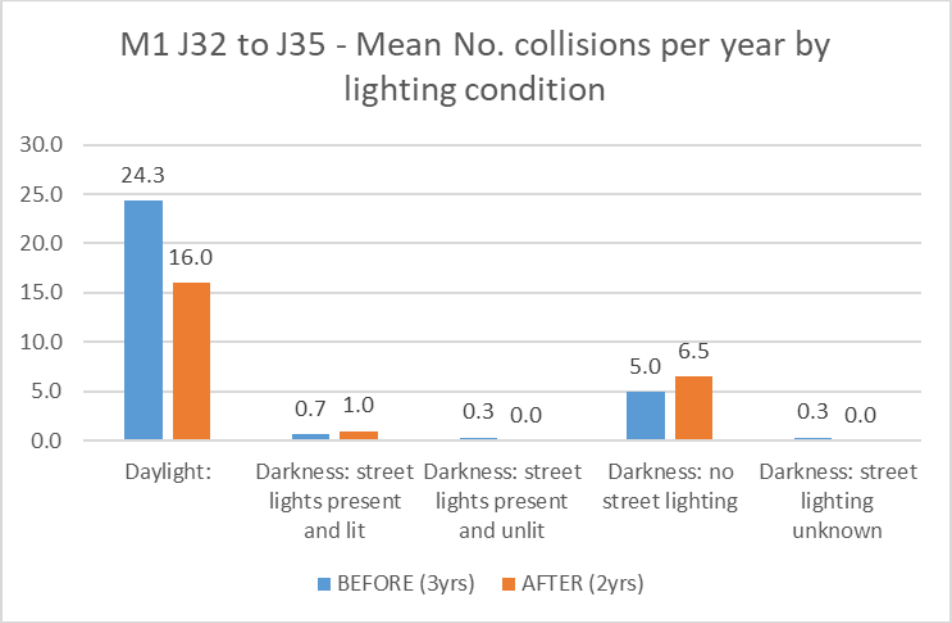


Figure 4.6 Junction 32 to 35 collisions by lighting condition for the before and after data periods

All the sections show a reduction in the number of collisions occurring during daylight with small increases in the collisions occurring in darkness, indicating that the overall reduction in collisions is occurring during the day. Whilst the Junction 32 to 35 section shows an increase of 1.5 collisions per year during darkness with no street lighting the before figure is influenced by year 3 during which only one collision of this type was reported, during the preceding two years seven of this collision type occurred. During the incomplete final year of after data only three collisions have been reported in darkness with no street lighting, however this is likely to be influenced by the missing months being winter.

For Junction 30 to 31, Junction 31 to 32 and 32 to 35 approximately 49%, 36% and 28% of collisions in the after period are reported in hours of darkness respectively, which is comparable or above the average for collisions recorded on the Highways England motorway network of 30% in the *2018 SRN Casualty Report*. As the number of collisions occurring in darkness is broadly consistent with the before data further detailed investigation has not been undertaken as part of this investigation.

4.2.4 Collisions by road conditions (weather related)

This section compares collisions before and after by road condition.

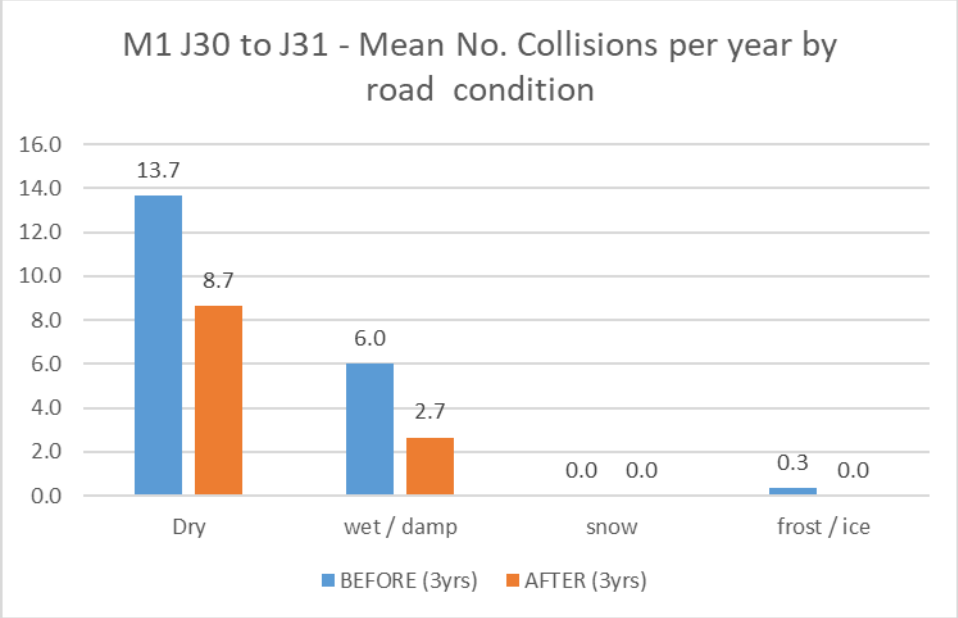


Figure 4.7 Junction 30 to 31 collisions by road condition (weather related) for the before and after data periods

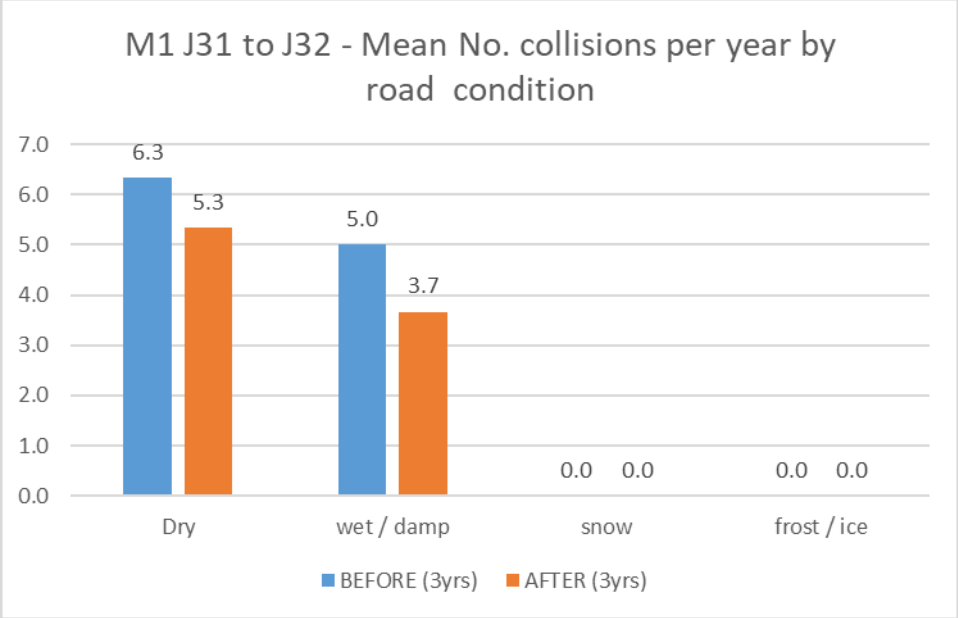


Figure 4.8 Junction 31 to 32 collisions by road condition (weather related) for the before and after data periods

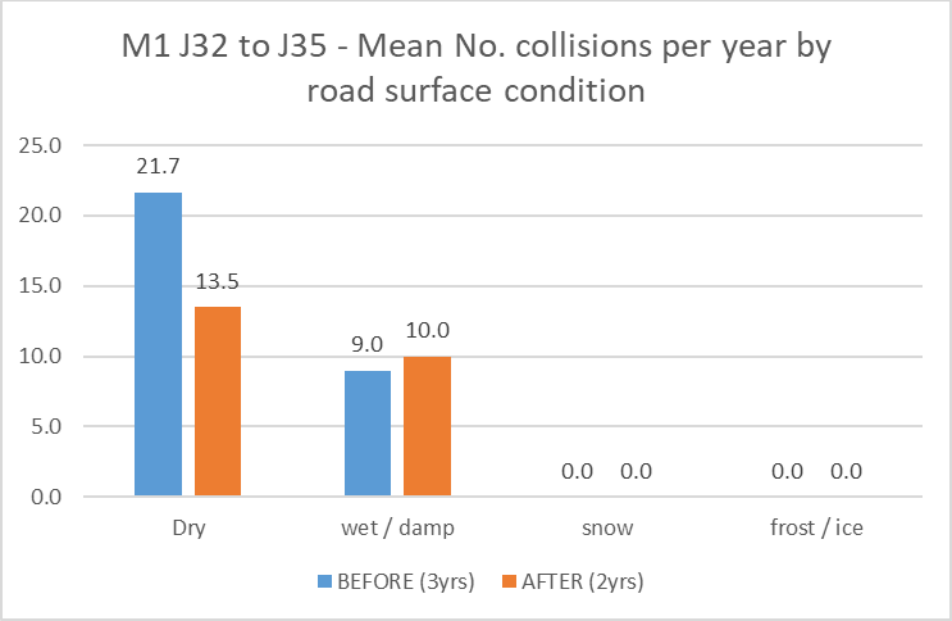


Figure 4.9 Junction 32 to 35 Collisions by road condition (weather related) for the before and after data periods

Figures 4.7 and 4.8 demonstrate a reduction in the number of collisions with a wet road surface for Junction 30 to 32. The proportion of collisions occurring on a wet road surface is 29% for Junction 30 to 31 and 39% for Junction 31 to 32 over the full period of after data including the partial year 4. Both of these are above the national average for motorways of 25%[4]. For Junction 30 to 31, given the overall reduction, this aspect is not considered for further detailed investigation. Junction 31 to 32 wet collisions are considered further in section 5.

Figure 4.9 demonstrates for Junction 32 to 35 an increase in collisions with a wet road surface. Only four collisions on a wet road surface have been reported in the partial year 3 data, however this is likely to be influenced by the missing winter months. The proportion of collisions occurring on a wet road surface is 38% over the full period of after data including the partial year 3. This is above the national average for all motorways of 25%[4]. Given the increase of wet collisions, set against an overall reduction of collisions, this factor is investigated further in section 5.

[4]Reported road accidents, Great Britain,2018, England, Motorways

4.2.5 Vehicles involved in collisions

This part of the analysis considered the vehicles involved in collisions.

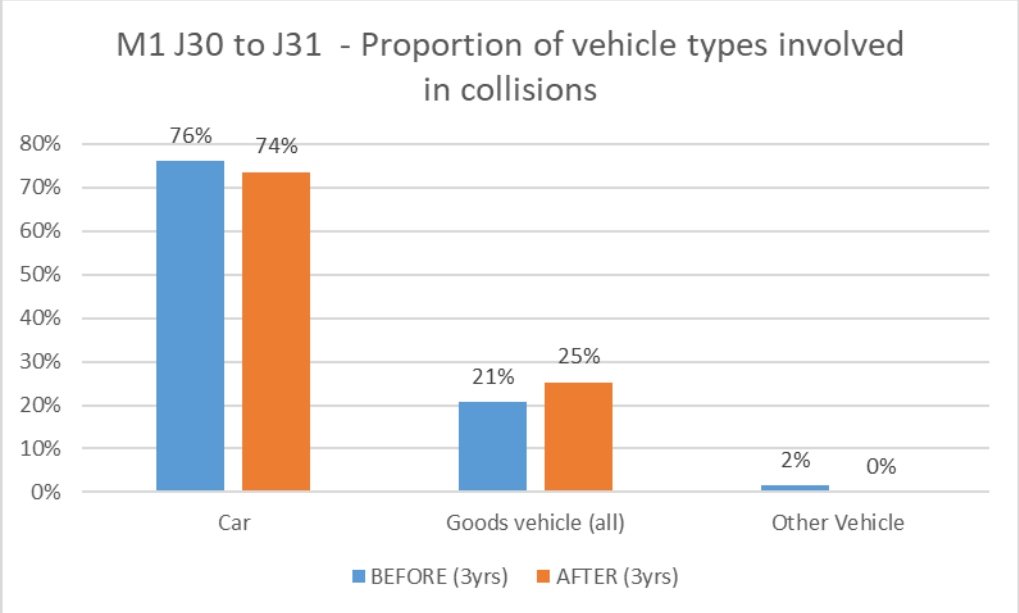


Figure 4.10 Junction 30 to 31 Vehicle types involved in collisions for the before and after data periods

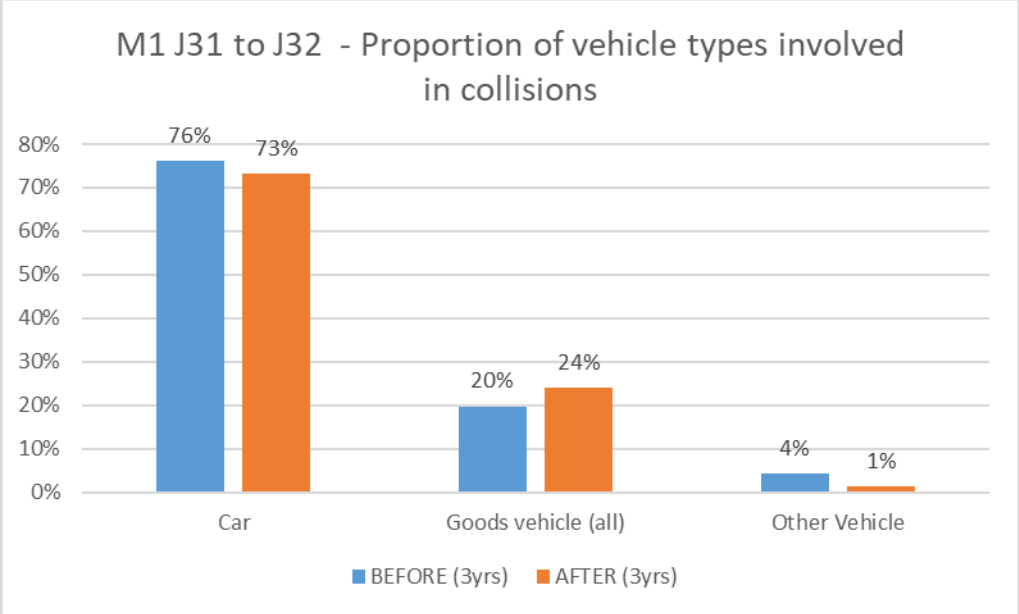


Figure 4.11 Junction 31 to 32 Vehicle types involved in collisions for the before and after data periods

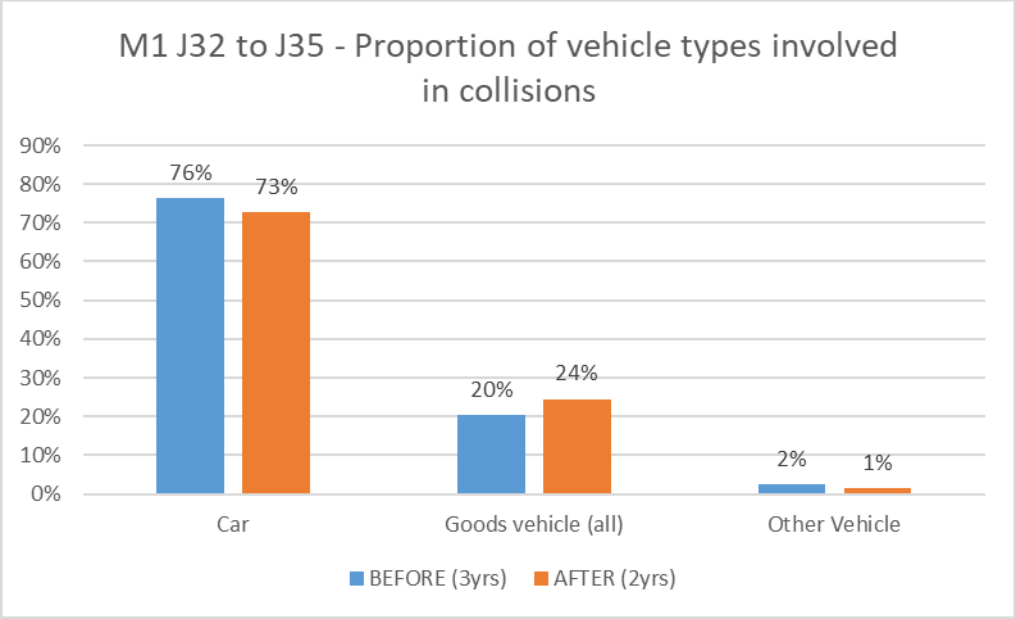


Figure 4.12 Junction 32 to 35 Vehicle types involved in collisions for the before and after data periods

Figures 4.10, 4.11 and 4.12 demonstrate that the proportion of goods vehicles involved in collisions has increased by 4 percentage points for all sections.

The Junction 30 to 31 section has seen a reduction in the number of goods vehicles involved in collisions and the change in proportion results from an overall reduction in the number of cars involved in collisions. Within the partial year 4 data only one collision involving a goods vehicle has been recorded, suggesting the reduced number of collisions is continuing. Given the actual numbers the proportion of goods vehicles involved in collisions is not considered a concern for further detailed investigation.

The Junction 31 to 32 section has seen a small increase in the number of goods vehicles involved in collisions per year from 4.7 to 5.3, however within the partial year 4 data only one collision involving a goods vehicle has been recorded. Given the marginal increase and potential reduction in year 4 this section is not considered a concern for further detailed investigation.

For Junction 32 to 35, the average number of goods vehicles involved in collisions per year has increased from 8.3 to 12.0. This should be read in the context of increased goods vehicle flows, with HGVs increasing 14% and LGVs 35% between 2012 and 2018[5] and this factor is considered in detail within section 5 of this report.

Table 4.6 identifies the number of vehicles per collision for both of the sections, with Junction 32 to 35 showing increases of 1 vehicle per collision. The average number of vehicles per collision on the strategic road network is 2.2[6]. This could be indicative of an increase in multi-vehicle collisions on the section and is considered further in section 5.

[5] Reported Road Casualties on the Strategic Network 2018, Highways England
[6] Reported Road Casualties on the Strategic Network 2018, Highways England

Table 4.6 Number of vehicles per collision

Section	Before				After				
	Year 1	Year 2	Year 3	Total	Year 1	Year 2	Year 3*	Year 4*	Total
M1 J30 to 31	2.1	2.0	2.4	**2.2**	2.3	2.2	2.4	2	**2.2**
M1 J31 to 32	2.2	1.8	2.1	**2.1**	2.8	2.2	2.3	3	**2.5**
M1 J32 to 35	1.3	1.4	1.4	**1.3**	2.3	2.4	2	N/A	**2.3**

*The final year for each section is not a complete 12 months

4.2.6 Collisions by vehicle manoeuvre and point of impact

This section compares collisions before and after, by vehicle movement and manoeuvre (Figure 4.13 to Figure 4.15) and point of impact (Figure 4.16 to Figure 4.18). Figure 4.13 and Figure 4.14 show that vehicles involved in a collision either waiting to go ahead but held up, or slowing and stopping, has broadly stayed the same, with the number of collisions waiting to go ahead and held up reducing and the number of collisions involving slowing or stopping increasing by a similar amount. The collision movements are both indicative of congestion, and the change would suggest this has reduced but is still an issue between Junction 30 and 32. Given the combined number of collisions involving either of these movement has remained broadly comparable is not considered a concern for further detailed investigation.

Overall, vehicles involved in a collision either waiting to go ahead but held up, or slowing and stopping, has increased in the Junction 32 to 35 section (Figure 4.15). Local effects are considered further in section 5.5.

With the exception of Junction 30 to 31, the number of collisions involving vehicles changing lanes has increased and this is considered further in section 5.8.

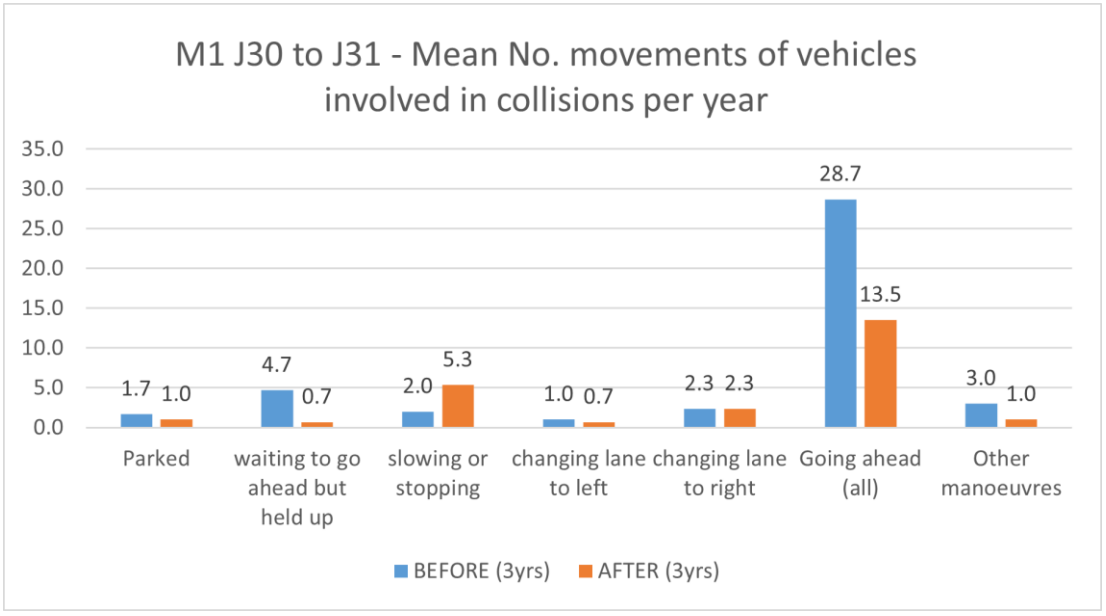


Figure 4.13 Junction 30 to 31 Movements of vehicles involved in collisions for the before and after data periods

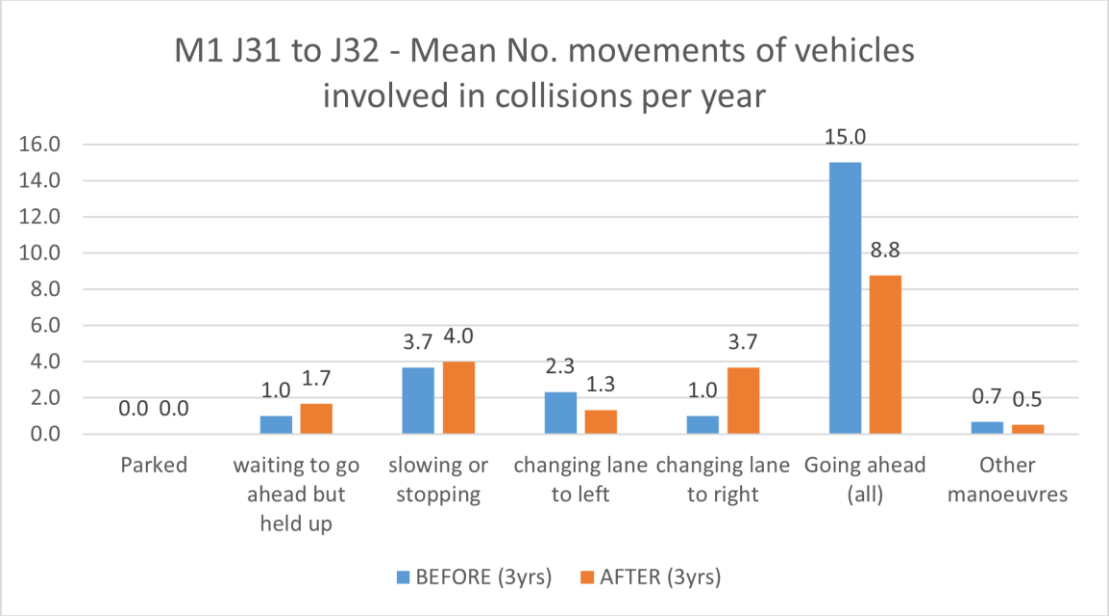


Figure 4.14 Junction 31 to 32 Movements of vehicles involved in collisions for the before and after data periods

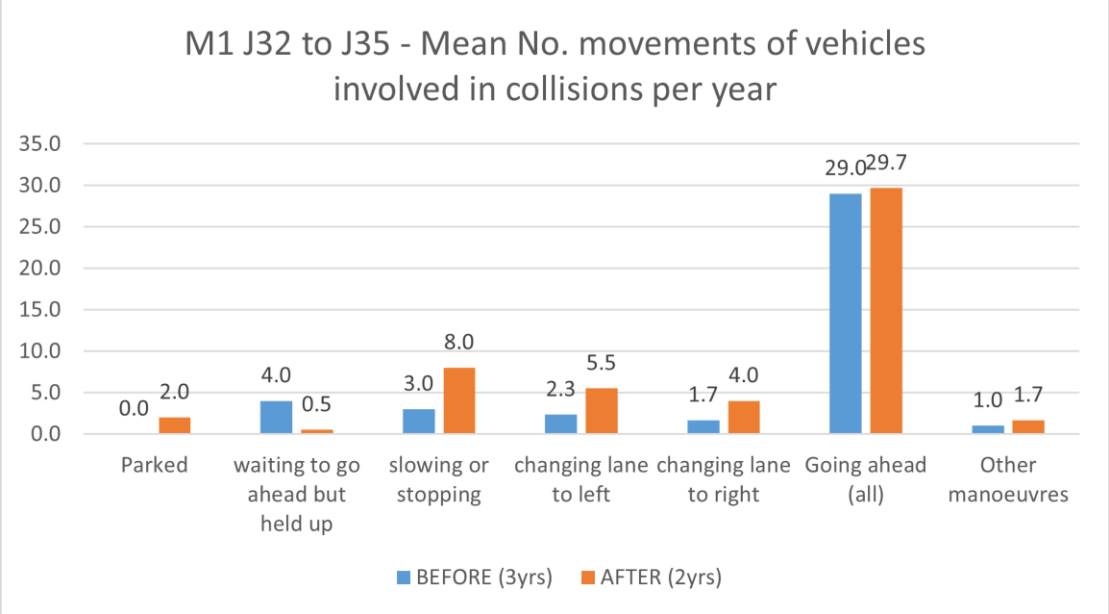


Figure 4.15 J32 to 35 Movements of vehicles involved in collisions for the before and after data periods

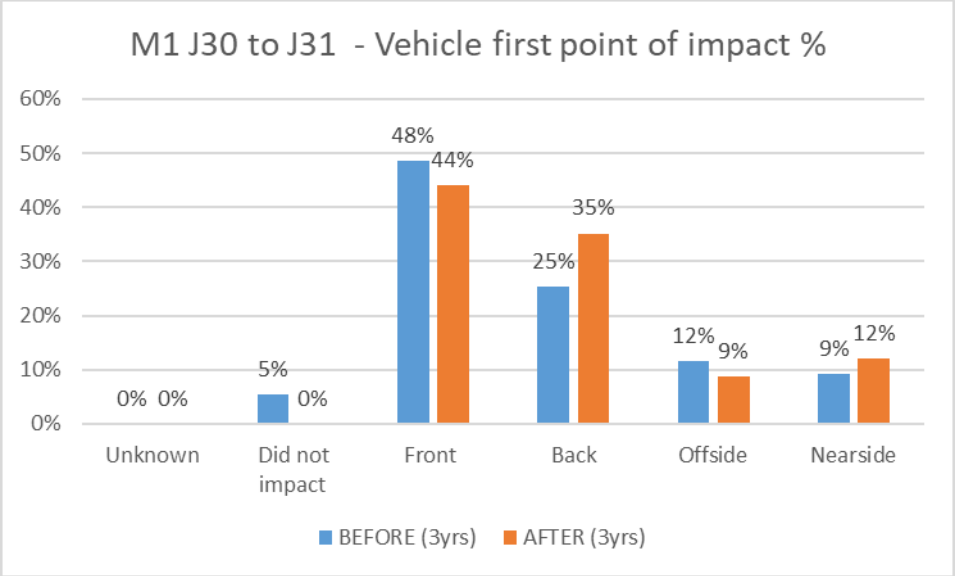


Figure 4.16 J30 to 31 Vehicle first point of impact for the before and after data periods

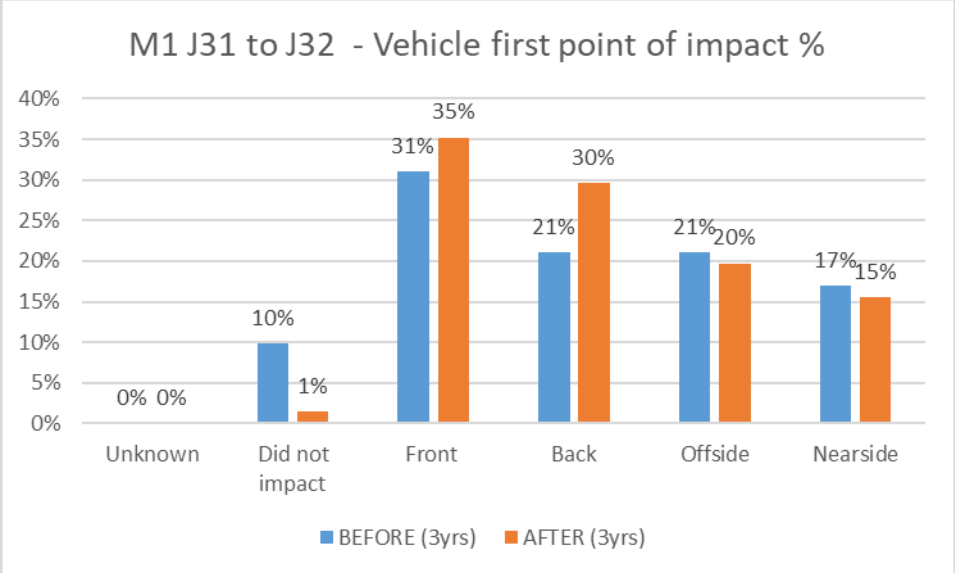


Figure 4.17 J31 to 32 Vehicle first point of impact for the before and after data periods

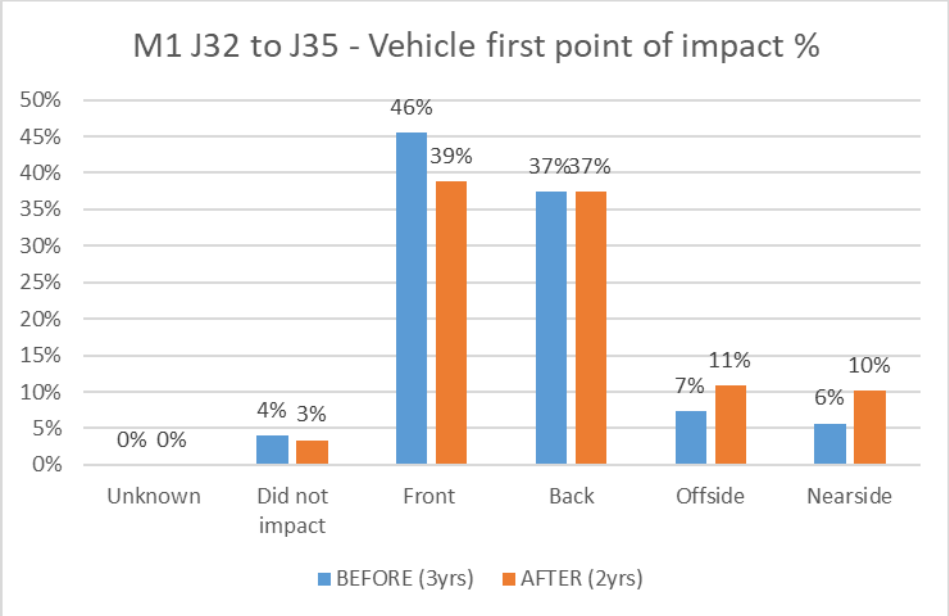


Figure 4.18 J32 to 35 Vehicle first point of impact for the before and after data periods

Key findings

The collision data analysis has highlighted the following issues which will be considered in the detailed investigation stage:

- Collisions involving goods vehicles.
- The number and location of wet collisions.
- Occurrence of multi-vehicle collisions.
- The occurrence of lane changing collisions.

4.3 Incident data review

Highways England control centre incident data from the last three years of smart motorway operation has been reviewed, with a focus on incidents most likely to affect live lanes (and which may otherwise or previously have involved use of the hard shoulder). The data has been filtered to identify incidents recorded as occurring between Junctions 31 and 32 controlled motorway (CM) separately to the remainder of the M1 all lane running (ALR) sections under investigation. See section 3 and section 4.2.1 for a more detailed description of the features of each section.

Across three years' incident logs there was an average of 3,344 unique recorded incidents per year on the M1 Junction 30 to Junction 35.

To provide further insight Table 4.7, Figure 4.19 and Figure 4.20 shows an analysis of the nature of the incidents in 2019 (the latest full year of available data), based on the categorisation[7] given to the incident by the operator.

Table 4.7 Incidents by type and operating regime (2019)

	J31-32 (CM)	J30-31 & J32-35 (ALR)	Total
Abandoned vehicle	6	19	25
Breakdown	344	2080	2424
Obstruction	75	376	451
Other	26	408	434
Pedestrian on network	11	90	101
Traffic Collision	31	145	176
Total	493	3118	3611

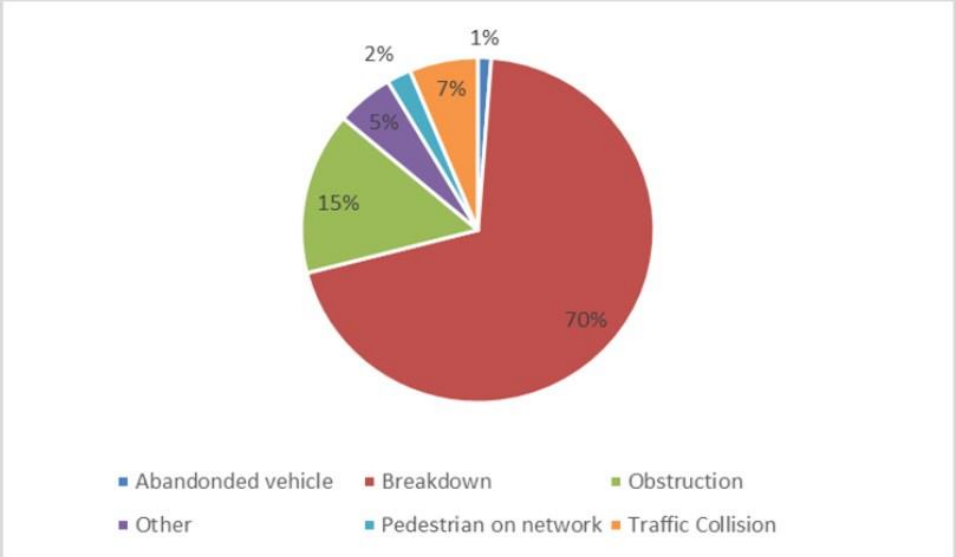


Figure 4.19 Proportion of incidents by type – J31-32 CM (2019)

[7] final closure code

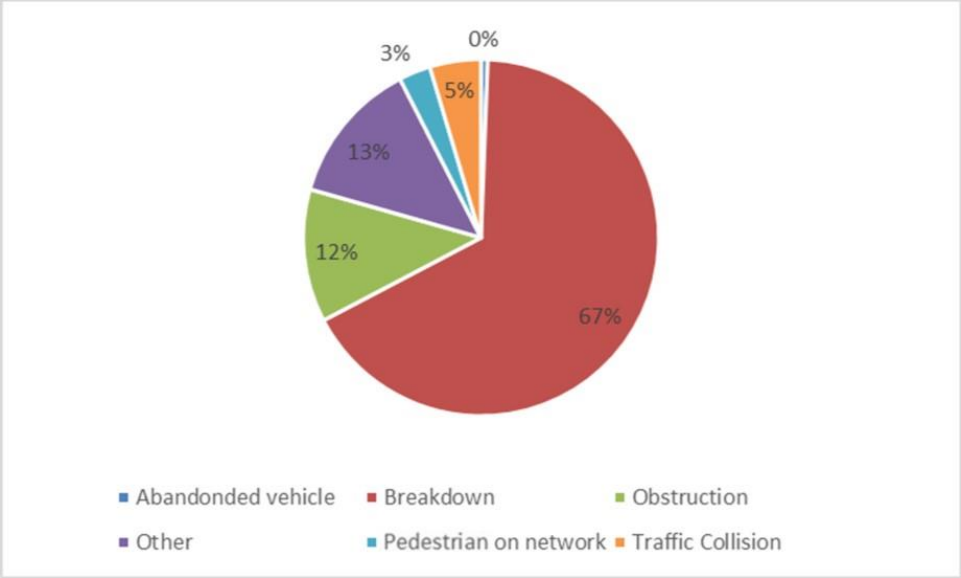


Figure 4.20 Proportion of incidents by type – J30-31 & 32-35 ALR (2019)

Figure 4.19 shows that breakdowns make up 70% of incidents on the controlled motorway link with Figure 4.20 showing 67% of incidents on the all lane running section are classified as breakdowns.

Looking at the all lane running sections in isolation in 2019 there were 40 breakdowns a week or nearly six a day. This compares to less than 1 per day on the controlled motorway section - however a breakdown on a hard shoulder is less likely to become a reportable incident than one in a live lane.

There were 176 incidents recorded as collisions in 2019 (9%) which is greater than the 134 reported officially in STATS 19. It is important to note that this will include *all* collisions of which the operations team are made aware, which will include damage-only collisions not captured elsewhere.

There were also 101 incidents related to the presence of a pedestrian, making up 3% of all incidents on the all lane running sections and 2% on the controlled motorway section. This could be a direct consequence of broken-down motorists walking to emergency areas or it could reflect the semi-urban nature of the section with local residents accessing the motorway, contravening the Motorways Traffic (England and Wales) Regulations, the Road Traffic Regulation Act and the Highway Code. This will be investigated further in section 5.

The number of breakdowns logged as live lane and as non-live lane across all three years are shown in Figure 4.21 & 4.22[8]. In 2017 and 2018 on the all lane running sections there were between 1.3 and 1.4 non-live lane breakdown incidents for every live lane incident. On the controlled motorway section there are far fewer live lane stops, again indicating that road users make use of the hard shoulder in around 86-89% of reported breakdown incidents. It should be noted that non-live lane incidents may go unrecorded.

[8] The way Incident data was reported changed part way through 2019, which included the way location information was categorised. For the purposes of this analysis and to ensure comparison of equivalent data, 2019 post-change data has been separated out into the Breakdown Undisclosed field and not compared to the location data from 2017 and 2018 and the early part of 2019.

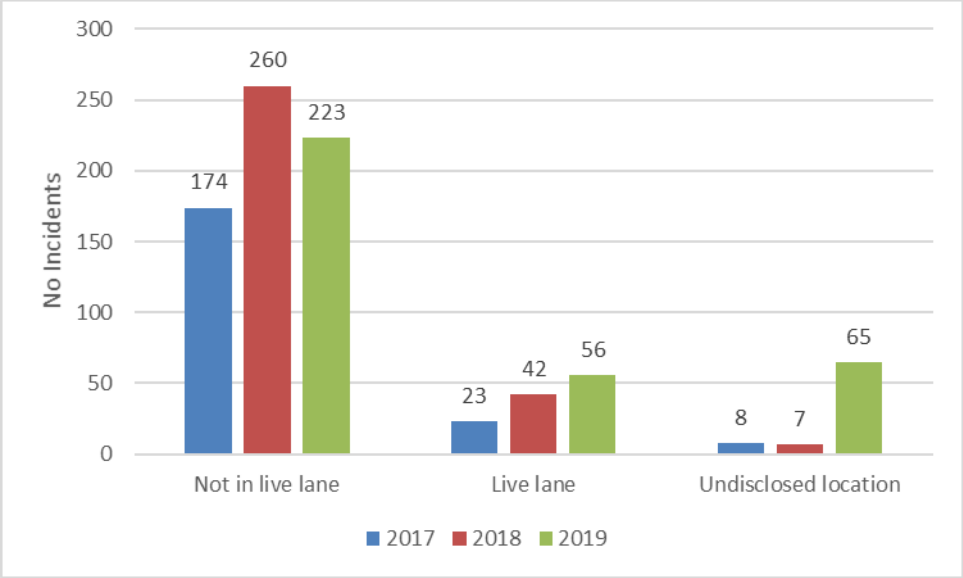


Figure 4.21 Number of breakdown incidents by type and year; J31-32 CM (2017-2019)

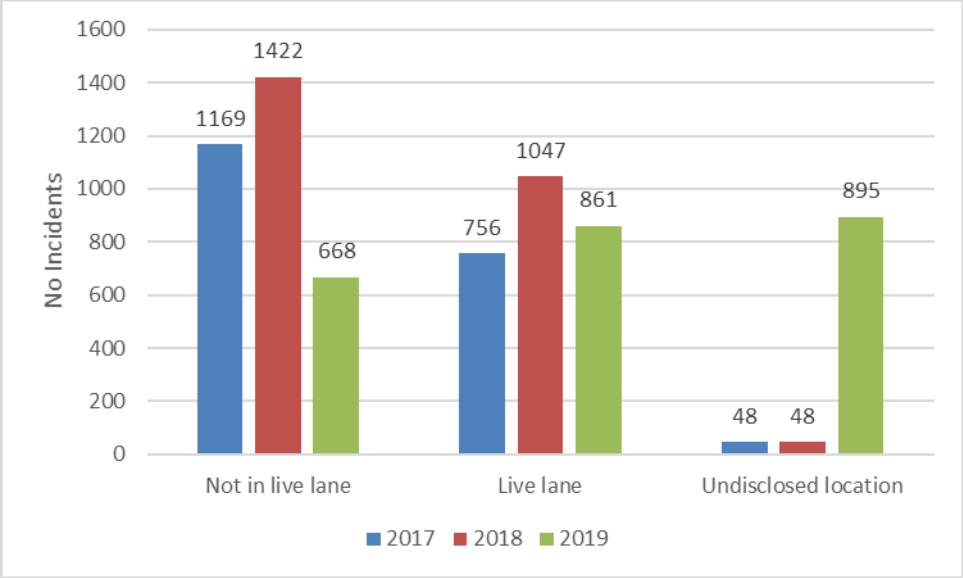


Figure 4.22 Number of breakdown incidents by type and year; J30-31 & 32-35 ALR (2017-2019)

These reported breakdowns have been further analysed by day of the week and time of day; the results are shown in Figures 4.23 - 4.25. The day of week analysis shows that the proportion of breakdowns that occur on Saturday and Sunday is marginally less than the Monday-Friday average. The hour of day analysis on the all lane running sections shows that the number of breakdowns seems to peak later in the afternoon and early evening. The busiest three hours for breakdowns are 15:00 to 18:00, however there is a less noticeable pattern in the morning peak between 7:00 to 8:00.

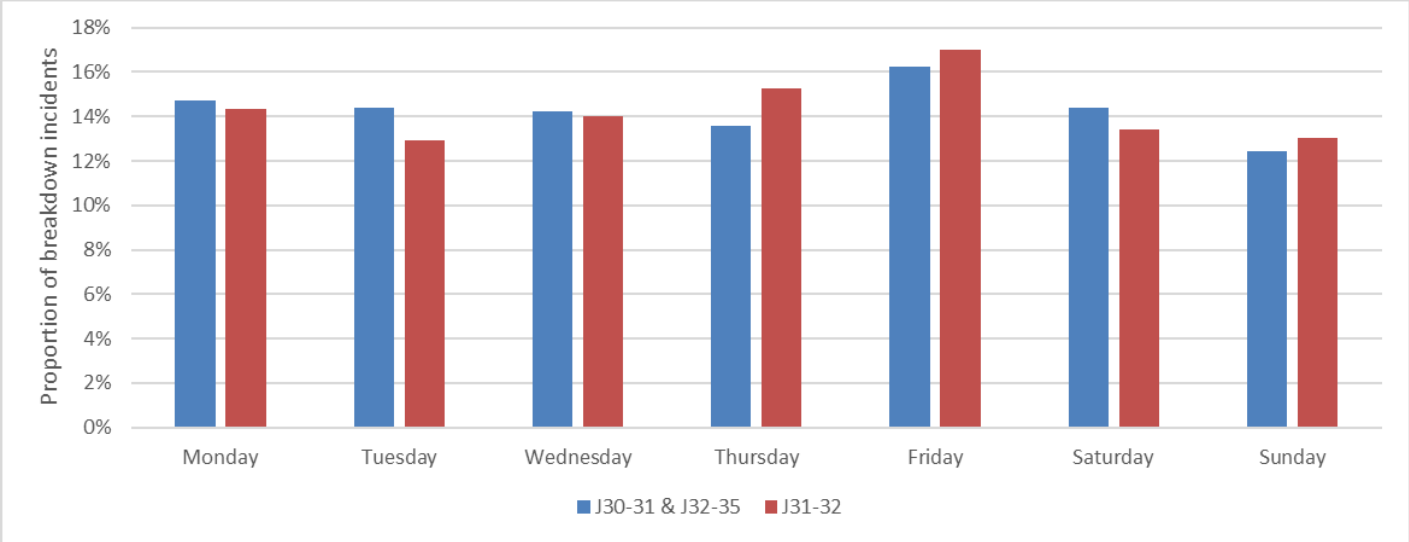


Figure 4.23 Proportion of breakdown incidents by day of the week (2017-2019)

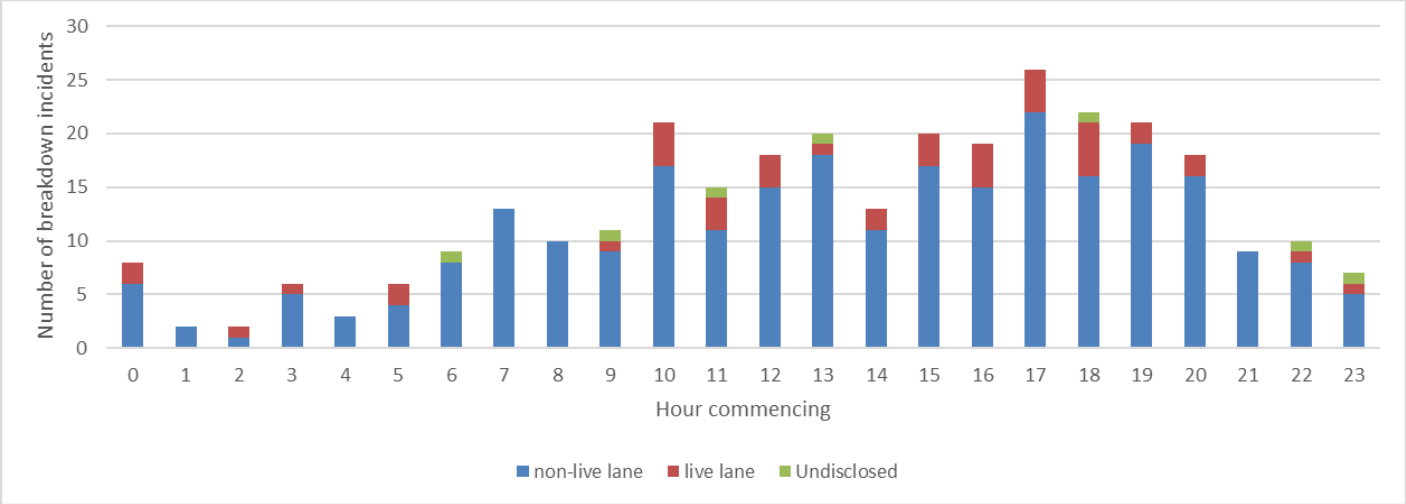


Figure 4.24 Number of breakdown incidents by hour of day on J31-32 CM (2017-2019)

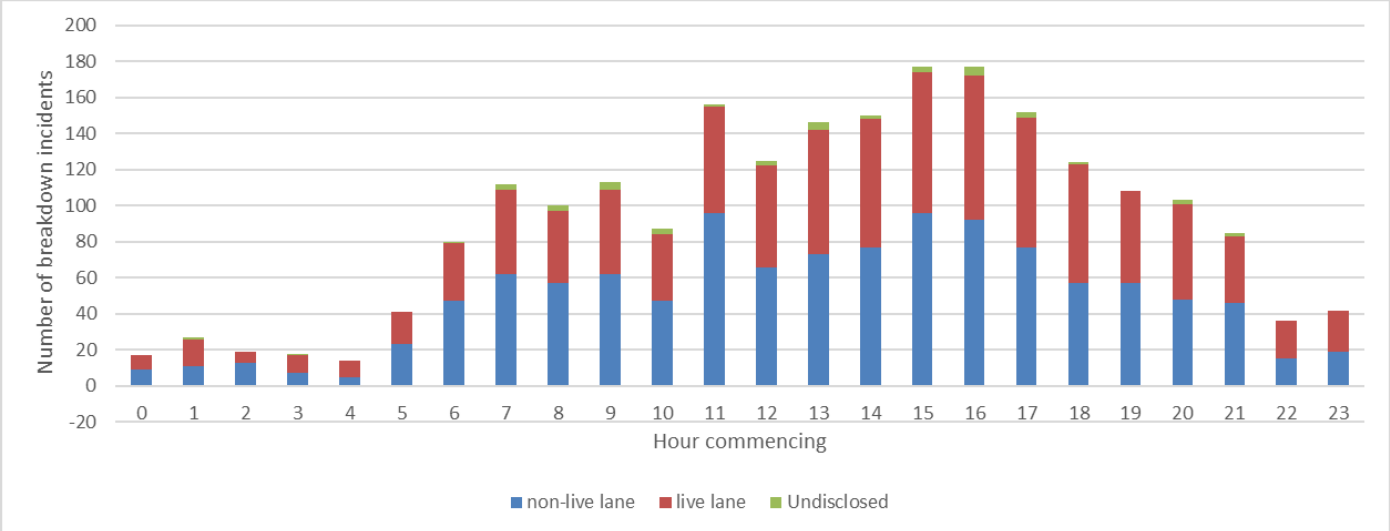


Figure 4.25 Number of breakdown incidents by hour of day on J30-31 & J32-35 ALR (2017-2019)

Using the most recent incident data with the greatest amount of breakdown location information (2018) it

is possible to calculate a live lane breakdown rate for the section. With 1,047 live lane breakdowns and, and excluding J31-32, the section length is 25.2 miles and the breakdown rate is 0.11 per mile per day. The SM-ALR overarching safety report[9] reported that the predicted live lane breakdown rate on a standard all lane running scheme was 0.35 live lane breakdowns per day per mile. However, evidence collected from nine operational schemes and included in the overarching safety report showed the actual average rate of live lane breakdowns is 0.18 per day. The worst performing scheme had a rate of 0.29 per day. Whilst this section with a calculated rate of 0.11 includes the Tinsley viaduct, which has a hardshoulder, the analysis suggests the level of live lane breakdowns is not high and is broadly as anticipated.

Appendix B shows the linear location of all breakdowns recorded in 2018.

Key findings

The incident data analysis has highlighted the following issues which will be considered in the detailed investigation stage:

- The location and number of pedestrian related incidents and collisions.

4.4 Design strategy record and departures from standard review

The design strategy records from the M1 Junction 28-31 and Junction 32-35a schemes have been reviewed to identify potential operational or safety related relaxations relating to design. No design strategy record was available for the Junction 31 to 32 scheme. The key features that merit further review as part of the next stage of safety analysis are included in Table 4.8 below. Some of these are also the subject of departures from standard. A more comprehensive list, including many that are likely to have a negligible impact but are included for completeness, is provided in Appendix C and D.

Table 4.8 Key Elements from design strategy records

Ref	Element	Location	Potential relevance to this work	Relevance to this investigation
J28-31 DSR 4.3	Junction design	J31 NB diverge	Type A (Taper diverge) instead of Type C (Lane drop)	Check diverge performance.
J28-31 DSR 4.3	Junction design	J30 SB diverge	Type A (Taper diverge) instead of Type C (Lane drop)	Check diverge performance.
J32-35a DSR 5.3	Junction design	J35 NB diverge	Taper diverge instead of lane drop – constrained by Smithywood footbridge and through junction running	Check diverge performance.
J32-35a DSR 7.1	Emergency area spacing	J35-34 SB	Emergency area spacing 2.5km (at maximum for contemporary standard, but above maximum for current smart motorways standards)	Consider live lane breakdowns in incident data review and investigate collisions.

The departures from standards checklists from the M1 J28-31 and J32-35a schemes have been reviewed to identify potential operational or safety related departures relating to design. These are included in Table 4.9 below.

[9] https://www.gov.uk/government/publications/smart-motorway-all-lane-running-overarching-safety-report-2019

Table 4.9 Key departures from standard

DAS ID	Element	Location	Departure summary	Relevance to this investigation
68787	Drainage	Throughout	Flow width for drainage entering lane 1	Check collisions on wet road surfaces
Unknown	Signing	J32 to 31	Details not within DfS tracker, but non-compliant series of advanced direction signs on Junction 31 Southbound approach	Check for collisions / incidents on the J31-32 link.
67379	Non-Motorised User (NMU) provision	J32-35 NB & SB	Exemption from NMU audits as no alternative NMU routes are provided by the scheme.	Check incident and collision data for pedestrian related issues.
68399	Junction design	J35 NB	Provision of a Type A (taper diverge) layout in place of the required Type D (ghost island lane drop).	Check diverge performance.

Key findings

Some design compromises are noted, in particular those relating to diverges where anticipated traffic would ordinarily justify lane drop layouts. In particular this investigation should consider:

- Live lane breakdown and related collisions.
- Wet road surface collisions.
- Incidents and collisions on the J31-32 link.
- Pedestrian issues.

These areas are considered within section 5.

4.4.1 Operations feedback

Operations staff with responsibility for the M1 J30-35 spoke to this project team via Microsoft Teams on 17th August 2020. Key points are noted below:

Signal availability / reliability was the first area of feedback raised, in particular MS4 message signs – at the time of the conversation, in region message sign availability was approximately 85%. Traffic Officers report near misses when lack of signal availability affects what can be displayed in response to an incident, and this information is fed to the technology maintainer bi-weekly. However, Operations were not aware of lack of technology availability of itself specifically causing or exacerbating any incidents. The use of average measures can sometimes mask specific or localised availability issues. Note that the technology availability point was made region-wide, affecting M1 J30 to J35, but not exclusively so.

Further to the discussion with Operations, signal availability data for August 2020 was provided for the M1 specifically between Junctions 31 to 32, where there is a hard shoulder, and between Junctions 32 and 35:

- Junction 31 to 32 Message sign availability <75%
- Junction 32 to 35 Message sign availability <80%
- Junction 31 to 32 Signal availability <85%
- Junction 32 to 35 Signal availability >95%

Logistics of Traffic Officer response was noted as a challenge for M1 J30 to 35, being served by the Sprotbrough Outstation, which is situated on the A1, some 13 miles from the scheme (via the A1 and M18).

No concerns were raised by Operations around breakdowns or emergency areas. Short term unlawful use occurs but was rarely reported (due to short durations) and Operations considered that this very rarely led to incidents.

4.5 Data review outputs

Given the findings from the data review, the following specific factors will be considered further in the safety analysis section, drawing on all collision data in the after period:

- Live Lane collisions
- Wet Collisions Junction 32 to 35
- Collisions involving goods vehicles Junction 32 to 35.
- Collisions Junction 32 to 35
- The occurrence of lane changing collisions.
- The location and number of pedestrian related incidents and collisions.

These are illustrated in Figure 4.26.

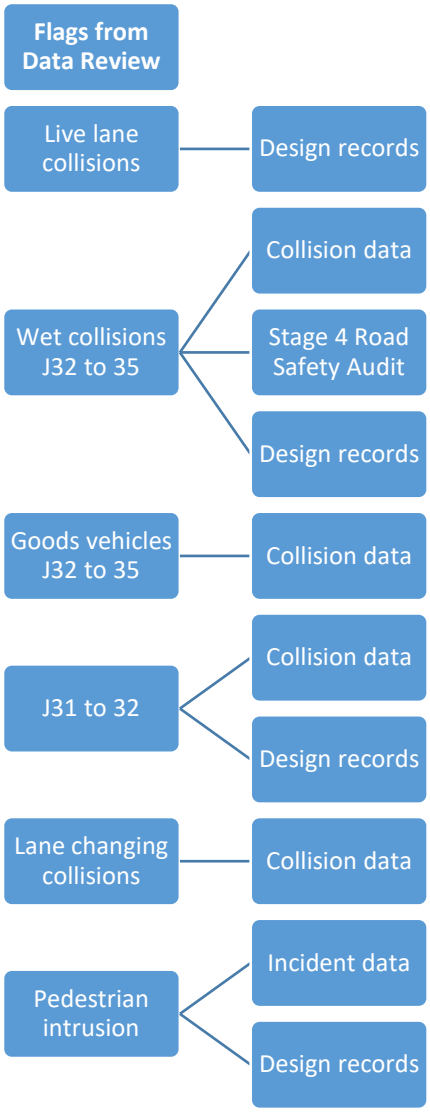


Figure 4.26 Specific factors identified from data review, to be considered for further safety analysis

5. Focussed Investigation

This section investigates in detail the key factors or areas identified in the preceding chapter, plus any additional factors or areas which come to light. It commences with a review of all collisions of fatal and serious severity, and all collisions associated with live lane stops. The objective of this section is to identify and verify treatable safety issues, or to clarify where certain factors or areas cannot be linked to a safety issue.

5.1 Fatal and serious collisions

5.1.1 Fatal collisions

Five fatal collisions are known to have occurred on the M1 between Junctions 30 and 35 between the smart motorway schemes becoming operational and the end of 2019; two of the collisions are not currently contained within the STATS 19 data and the data has been gathered from other sources. Table 5.1 details the collisions.

Table 5.1 Details of fatal collisions

Ref.	Location	Date Time	Conditions	Detail	Casualties	Comment
17191985	Northbound J34	16/06/2017 1359	Dry/light	**Pedestrian** runs onto the main carriageway and is hit by goods vehicle.	Male 31 - Fatal	Record notes that the fatality had mental health issues
18330350	J30 to 31 northbound after Woodall motorway service area	09/09/2018 2141	Dry/dark	V1(car) mechanical problem and **stopped in lane 1**. The vehicle was hit by three following vehicles.	Female 62 - fatal Male 30 - Slight Male 52 - slight	
19846089	J34 and 35 northbound	07/06/2019 0808	Dry/light	Two vehicles had **stopped in lane 1** following a 'minor bump' and then been hit by a goods vehicle.	Male 44 - fatal Male 22 - fatal	Goods vehicle driver pleaded guilty to two charges of death by careless driving.
22032019	J30 to 31 northbound between J30 and Woodall motorway service area	22/03/2019 1250	Unknown /light	Van **stopped in lane 1** (possible puncture). Hit by car and then a coach.	Male 83 – fatal	Collision not recorded in STATS 19, a further male occupant of one of the vehicles died in hospital two months after the collision
10042019	Southbound between J35 and 34	10/04/2019 0710	Unknown /light	Van **collided with the central reservation** and overturned.	Male 61 - fatal	Collision not recorded in STATS 19

Factors for further consideration

Collison reference 17191985

It is not clear from the details available for the pedestrian fatality the reason why the pedestrian entered the live carriageway. No other collisions resulting in pedestrian injuries were recorded in the vicinity of Junction 34 suggesting there is not an ongoing problem at this location but pedestrian collisions for the whole section are considered further in section 5.9

Collison references 18330350, 19846089 and 22032019

These collisions involved live lane stops which are considered further in section 5.2.

Collison reference 10042019

There is limited information available for this collision and it is unclear what caused the loss of control. There is no pattern or cluster of loss of control collisions in this location and therefore no potential intervention has been identified.

Collision data post-2019

A further fatal collision was recorded on 02/05/2020 on the Junction 31 to 32 link. This involved a car colliding with an HGV then subsequently being struck by a van and a further HGV. Whilst limited details are available for this collision, this link appears to have a high number of collisions which is already flagged for further consideration (refer to section 5.6).

5.1.2 Serious collisions

As identified in section 4.2.2 both the Junction 30 to 31 and Junction 32 to 35 sections have shown an increase in the number of collisions resulting in serious injury. Across the entire Junction 30 to Junction 35 length in the after period, a total of twenty-two collisions have resulted in serious injuries, with ten occurring at Junction 30 to 31, two occurring at Junction 31 to 32 and ten occurring at Junction 32 to 35.

Tables 5.2 and 5.3 summarise the number of serious injury collisions by link and give an indication of where serious collisions are occurring, the final year data was not a full year as noted in section 4 above. The Junction 30 to 31 link contains a regional boundary at Woodall motorway service area so data is split at this point.

Table 5.2 Junction 30 to 32 serious injury collisions by link (4 years)

Link	Serious	Serious injury collisions per year	Link length (km)	Serious collisions per km per year
Junction 30-Woodall motorway service area ALR	0	0	3.4	0
Woodall motorway service area to Junction 31* ALR	10	2.5	5.3	0.47
Junction 31 to 32 CM	1	0.33	2.4	0.13
Junction 32 CM (M18 Interchange)	1	0.33	1.7	0.17

*Includes ALR section through Junction 31

Table 5.3 Junction 32 to 35 serious injury collisions by link (3 years)

Link	Serious	Serious injury collisions per year	Link length (km)	Serious collisions per km per year
Junction 32 to 33 ALR	5	1.66	4	0.42
Junction 33 to 34 ALR	3	1	3.8	0.26
Junction 34 (Tinsley Viaduct)	0	0	1.9	0.00
Junction 34 to 35 ALR	2	0.66	4.2	0.16

Considering tables 5.2 and 5.3 along with the fatal collision in table 5.1, the killed and serious collisions are concentrated in three areas: Woodall motorway service area to Junction 31, Junction 32 to 33, and Junction 34 to 35.

Woodall motorway service area to Junction 31

Of the ten serious collisions, five occurred on the northbound carriageway over a 2.9km section, four of which potentially involved live lane stop. This was the section where fatal collision reference 18330350 occurred, which also involved a live lane stop. This cluster is reviewed in detail in section 5.3. Three collisions occurred at the northern extent of Junction 31 and are considered below. Two collisions occurred on the southbound carriageway with no apparent cluster or pattern present.

Junction 32 to 33

Four of the five collisions occurred on the northbound approach to Junction 33, three of which during wet conditions. Reviewing collisions of all severities in this location shows seven of the thirteen occurred on a wet road surface. This cluster is reviewed in detail in section 5.5.

Junction 34 to 35

Two serious injury collisions occurred between Junction 34 and 35, and as identified in Table 5.1 three fatal collisions. Within these five collisions there are no apparent patterns or clusters with each collision being of a different type: One pedestrian collision; one involving a live lane stop; one loss of control for unknown reason; one loss of control due to a caravan and one lane change collision.

Junction 31 to 32

Table 5.2 identifies one serious injury collision occurring on this link; however, three of the serious injury collisions on Junction 30 to 31, and the serious injury collision through Junction 32 happened close to the boundaries used in the analysis, so have been reviewed together. Whilst four of the five collisions occurred on the southbound carriageway there is no clear pattern within collisions: two were related to lane changes, one loss of control and one rear shunt. As noted in section 4 this link is considered further below.

Dark and wet collisions

Table 5.4 shows the location of serious collisions in the dark and wet. The majority of serious collisions on the Junction 30 to 31 link occurred north of Woodall services, including the dark collisions. Three out of five collisions on the Junction 32 to 33 section occurred on a wet road surface which may indicate an issue with wet collisions in this location. Both of these areas are reviewed further in sections 5.3 and 5.4 below.

Table 5.4 Dark and wet serious collisions by link

Link	Dark	Wet
Junction 30-31	7	2
Junction 31 to 32	1	0
Junction 32 (M18 Interchange)	1	0
Junction 32 to 33	2	3
Junction 33 to 34	1	0
Junction 34 (Tinsley Viaduct)	0	0
Junction 34 to 35	0	0

Rear shunts

Eight of the 27 serious and fatal collisions resulted from rear shunts, no specific pattern or cluster was

identified within these with the exception of two occurring on the northbound approach to Junction 33, which is considered in section 5.4.

Lane change collisions

Of the four collisions involving lane changing two occurred at southbound Junction 32 to 31, which is considered in section 5.6. The other two appear isolated.

Loss of control collisions

Five collisions involved vehicles losing control; there appears to be no further pattern or clusters within these.

Live lane stops

Seven collisions potentially involved live lane stoppages, four of which occurred north of Woodall motorway service area, the others were not clustered however it is noted that two of them occurred on left hand curves where forward visibility could be reduced. Live lane stoppages are considered within section 5.2.

Key findings

The review of fatal and serious collisions has identified the following locations for further consideration:

- Woodall motorway service area to Junction 31 northbound (section 5.3).
- Collisions Junction 32 to 33, including shunt collisions on the northbound approach to Junction 33 (section 5.5).
- Collisions Junction 31 to 32 (lane changes – section 5.6).

5.2 Live lane stop -related collisions

5.2.1 Places of relative safety

Places of relative safety between Junctions 30 to 35 comprise of:

- emergency areas (EAs) on the links between Junction 30 to 31 and Junction 32 to 35,
- hard shoulders between Junction 31 to 32, and
- hard shoulders through Junctions 32, Junction 33 and Junction 34.

Figure 5.1 summarises the provision of places of relative safety, measurement is approximate and from decision points. Requirements at the time of this scheme's design and construction (IAN 161/13) set a maximum spacing between emergency areas[10] and / or decision points of 2.5km. The strategy and spacing for this scheme complies with those requirements.

Northbound		Southbound	
Through Junction 35		Through Junction 35	
1.4km		1.4km	
Emergency Area		Emergency Area	
2.2km		2.4km	
Through Junction 34 – hard shoulder		Through Junction 34 – hard shoulder	
1.7km		1.4km	
Emergency Area		Emergency Area	
1.7km		2.1km	
Through Junction 33 – hard shoulder		Through Junction 33 – hard shoulder	
1.8km		2.0km	
Emergency Area		Emergency Area	
1.3km	↑	1.7km	↓
Junction 31 to 32 hard shoulder and through Junction 32		Through Junction 32 and Junction 31 to 32 hard shoulder	
1.4km		0.5km	
Junction 31 Diverge hard shoulder		Junction 31 Diverge hard shoulder	
1.6km		2.4km	
Emergency Area		Emergency Area	
1.6km		1.8km	
Emergency Area		Emergency Area	
2.0km		1.3km	
Woodall MSA		Woodall MSA	
1.3km		1.8km	
Emergency Area		Emergency Area	
2.3km		1.4km	
Junction 30 Diverge hard shoulder		Junction 30 Diverge hard shoulder	

Figure 5.1 Place of relative safety provision

Emergency areas have been retrofitted with orange surfacing and the latest sequence of approach signing. It is understood that this work was completed in early 2020, post-dating the collision and incident data available for this report.

[10] At the time of scheme design and construction these were referred to as emergency refuge areas – ERAs; i.e. an emergency refuge area (ERAs) as defined in the Motorways Traffic (England and Wales) Regulations 1982.

Junction 30 to 31

Six injury collisions relating to live lane stops have been recorded on the M1 Junction 30 to 31 between opening in 2016 to 2019. A plot illustrating the locations of live lane stop collisions is included in Appendix E.

Of these injury collisions:

- Two were classified as fatal and four serious.
- Five of the collisions were recorded on the northbound carriageway and one on the southbound carriageway.
- Of the six collisions, three stated vehicle breakdown or burst tyre as the reason for stopping.
- Three of the collisions were recorded in darkness (50%) and none on a wet road surface.

This section of the M1 is operating as all lane running. Four of the collisions specifically state the collision occurred in lane 1. Table 5.5 details the live lane stop collisions by direction and post opening year.

Table 5.5 Details of live lane stop collisions by year and direction of travel Junctions 30 to 31

Year	Northbound		Southbound		Total
	Frequency	Summary (time)	Frequency	Summary (time)	
2016	1 serious	Collision involving other vehicles changing lane to avoid a stopped vehicle (20:16)	0		1
2017	0		1 serious	Car broken down/puncture in lane 1 (04:50 - dark)	1
2018	1 fatal 2 serious	Vehicle broken down (21:41 – dark) Vehicle broken down in lane 1 – puncture (02:05 – dark) Vehicle stopped in lane 1 (18:20)	0		3
2019	1 fatal	Van stopped in lane 1 (12:55 but not confirmed)	0		1
Total	5		1		6

Junction 31 to 32

This section has a permanent hard shoulder, no live lane stop related collisions were recorded.

Junction 32 to 35

Nine injury collisions relating to live lane stops have been recorded on the M1 Junction 32 to Junction 35 between opening in 2017 to 2019. A plot illustrating the locations of live lane stop collisions is included in Appendix E.

Of these injury collisions:

- One was classified as fatal and eight as slight.
- Four of the collisions were recorded on the northbound carriageway and five on the southbound carriageway.

- Of the nine collisions three stated vehicle breakdown or burst tyre as the reason for stopping.
- Three of the collisions involved an abandoned vehicle, either because the occupants had left it or absconded.
- One of the collisions was alcohol related.
- Five of the collisions were recorded in darkness (56%) and four on a wet road surface.

This section of the M1 is operating as all lane running, with permanent hard shoulder through the junctions. Seven of the collisions specifically state the collision occurred in lane 1. Table 5.6 details the live lane stop collisions by direction and post opening year.

Table 5.6 Details of live lane stop collisions by year and direction of travel Junctions 32 to 35

Year	Northbound		Southbound		Total
	Frequency	Summary (time)	Frequency	Summary (time)	
2017	1 slight	Vehicle broken down in lane 1 – puncture (18:12 – dark/wet)	1 slight	Vehicle abandoned in lane 1 after hitting barrier (04:35 – dark/wet)	2
2018	1 slight	Vehicle abandoned (02:13 – dark/wet)	3 slights	Vehicle broken down in lane 1 – puncture (18:30 – dark) Vehicle stopped on the diverge at Junction 33 (00:45 – dark(lit), alcohol related) Vehicle abandoned in lane 1 (08:28 – wet)	4
2019	1 fatal 1 slight	Vehicle stopped in lane 1 (08:08) Vehicle broken down in lane 1 (11:15)	1 slight	Collision involving other vehicles to avoid a stopped vehicle (13:05)	3
Total	4		5		9

The key points for live lane stop collisions:

- There are more killed and seriously injured live lane stop collisions (average per year) between Junctions 30 and 31 than on the longer section between Junction 32 and 35.
- No live lane collisions were reported between Junction 31 and 32, which has a hard shoulder.
- The proportion of collisions recorded on a wet road surface between Junctions 32 and 35 is 44%, and is 0% between Junctions 30 and 32.
- On both sections the proportion recorded in darkness is 50% or higher.
- Eleven of the injury collisions state that the stopped vehicle was in lane 1.

5.2.2 Discussion

Six live lane stop collisions were recorded between Junctions 30 and 31 with three located in close proximity to the emergency area south of Junction 31 and two close to Woodall motorway service area. Only one occurred during a weekday peak.

Of the nine live lane stop collisions recorded between Junctions 32 to 35 six were recorded between Junctions 33 and 34, two northbound and four southbound. Three were on a wet road surface and three in the dark.

Live lane collisions can occur quickly from the point at which the vehicle stops before Highways England can be made aware and set signals. The programme wide introduction of stopped vehicle detection (SVD) may reduce the risk for some of these collisions.

Incident data for all sections being considered records 1,089 live lane breakdown events in 2018. During the same period, seven injury collisions relating to live lane stops due to a breakdown have occurred.

Key findings

The requirement at the time of the design was for places of relative safety to be designed at 2.5km spacing; all spacings are below this.

The severity of the live lane stop collisions on the all lane running section between Junctions 30 and 31 are all fatal or serious. Two thirds of the live lane stop collisions on the all lane running section between Junctions 32 and 35 were recorded between Junctions 33 and 34. No live lane collisions occurred between Junction 31 and 32 where a permanent hard shoulder is present.

The majority of the live lanes stoppages are distributed though the scheme; introduction of stopped vehicle detection system may reduce the risk associated with stopped vehicles on this section of the network by rapidly alerting operators and allowing signals to be set and assistance dispatched.

5.3 Woodall motorway service area to Junction 31 northbound

As noted within the review of killed and seriously injured collisions there appears to be a cluster of collisions on the northbound all lane running section to the north of Woodall motorway service area, involving five serious collisions and one fatal collision and including four live lane stops. Figure 5.2 illustrates the view north of the services on the northbound carriageway. From the incident data there does not appear to be an increased number of live lane stoppages in this location, and whilst it is located following Woodall motorway service area there does not seem to be a reduction in live lane collisions. Signing is in place for the service area and it operates 24 hours; it could reasonably be expected that the local motorway service area would reduce the number of live lane stoppages by providing an obvious set of facilities for road users in difficulty (if they are able to limp).

The collisions occurred outside peak period when queue protection is less likely to be automatically implemented due to low traffic volumes, and from the incident data it appears the live lane stoppage was not notified or identified prior to each collision occurring.

It is unclear as to why live lane stoppages are resulting in a cluster of serious collisions in this location. Two of the collisions occurred on a sweeping left hand bend with the other two occurring downstream of this, forward visibility to vehicles may therefore be an issue. This was noted as an issue with the Stage 4 road safety audit.

Figure 5.2 Northbound visibility North of Woodall motorway service area (dashcam video, July 2020)

Key findings

Whilst there is a no clear reason for the localised number of serious live lane collisions in this location there is a long left hand curve which may affect forward visibility. Whilst no geometrical departure from standard has been identified forward visibility could further be improved, therefore it is recommended that the impact vegetation is having on forward visibility is checked and where required cut back to provide a minimum 295m of visibility. Given the number of serious live lane collisions in this location, the provision of an additional emergency area should also be considered.

5.4 Collisions on wet road surfaces Junction 32 to 35

The collision data review identified that since that the introduction of the smart motorway all lane running scheme the number of collisions occurring on a wet road surface had increased from 9 per year to 10 per year, with the proportion of wet collisions being 38%, above the national average for all motorways of 25%. Prior to the introduction of the smart motorway the proportion of collisions occurring on a wet road surface was 29%, with the increase in this proportion largely attributed to a reduction in the number of collisions on a dry road surface.

Between 29th April 2017 and 31st December 2019 twenty-four collisions occurred on wet road surfaces between Junction 32 and 35, including three serious collisions. Ten of these occurred Junction 32 to 33 including the three serious collisions, five between Junction 33 to 34, and nine between Junction 34 to 35. These equate to 42%, 28% and 36% of the collisions on each of the links respectively.

Whilst both the Junction 32 to 33 link and Junction 34 to 35 link have a high ratio of collisions on wet road surfaces there appears to be no pattern or cluster. On the Junction 32 to 33 link there is a cluster of collisions on wet road surfaces on the northbound approach to Junction 33, which is considered further below.

Key findings

The proportion of collisions occurring on a wet road surface on each of the links between Junction 32 and 35 is above the national average for all motorways of 25%. The is no pattern within the collisions north of Junction 33, however there is a cluster of collisions on the northbound approach to Junction 33, which is considered further below.

5.5 Collisions occurring Junction 32 to 33 Northbound

Of the ten collisions on a wet road surface which occurred on the Junction 32 to 33 link, four slight and three serious collisions occurred on the northbound carriageway either at Junction 33 or on the approach to it from the A616 overbridge northwards. Six of these were shunts, with the one collision being a loss of control under braking. A further collision on a wet road surface occurred on the Northbound on the approach to the 2/3 mile advanced direction sign and two occurred on the Southbound carriageway.

The overall number of wet surface collisions on the Junction 32 to 33 link has remained broadly unchanged since the before period, however the number of northbound collisions occurring on a wet road surface has increased from one in three years to seven in three years.

On the approach to Junction 33 there were a further five shunt collisions on a dry road surface with a further four on the approach to the 2/3-mile advanced direction sign. A total of 18 collisions occurred on this northbound link; Figure 5.3 shows the collision types.

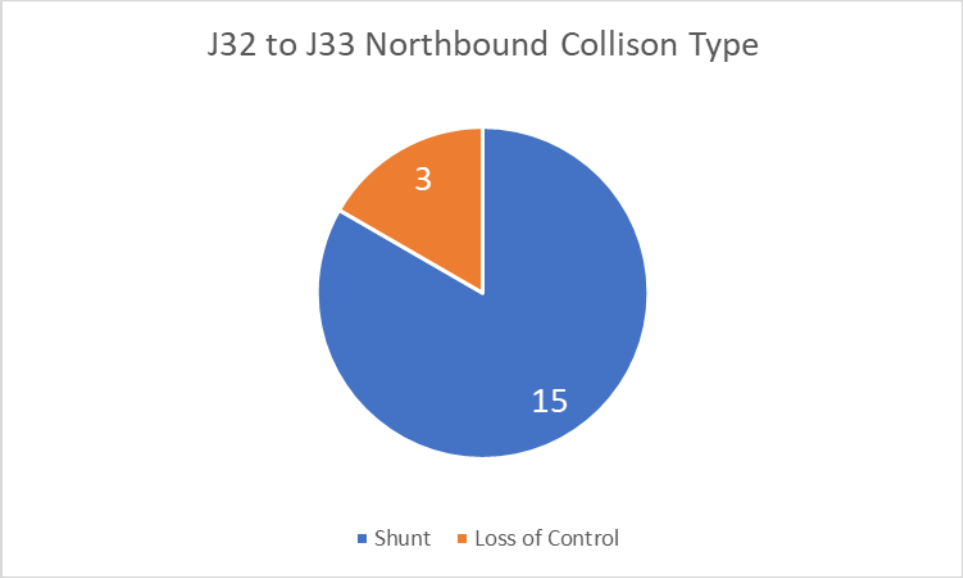


Figure 5.3 Junction 32 to 33 northbound collision type

Figure 5.4 shows the collisions times for the link, with half the collisions on the link occurring between 6:00 and 10:00. This would suggest congestion during this period.

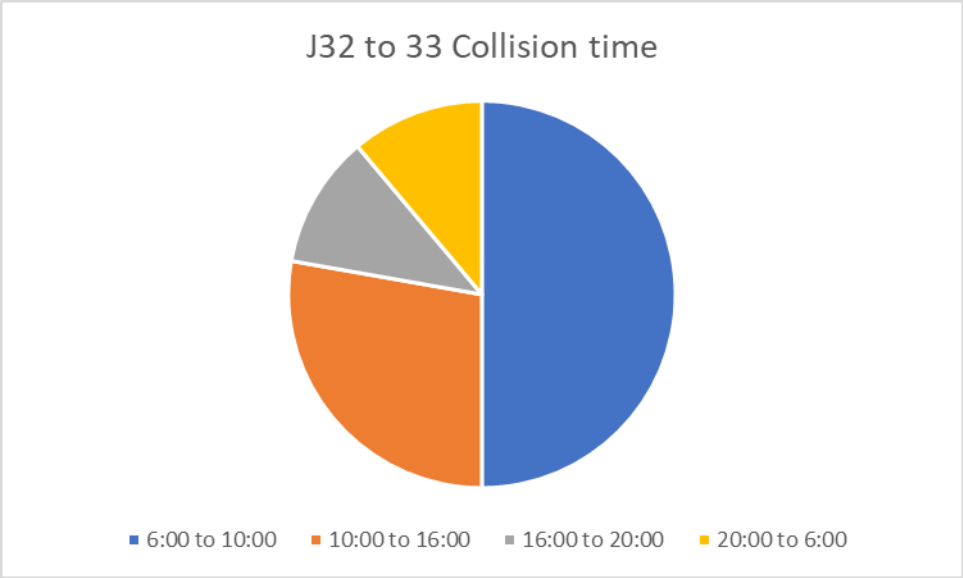


Figure 5.4 Junction 32 to 33 wet surface conditions northbound collision times

Key findings

Of the 63 collisions between Junction 32 to 35, eighteen occurred between Junction 32 and 33 northbound; this represents 4.5 collisions per km in comparison to 2 collisions per km for the other areas. Eight out of the 18 collisions on this link occurred on a wet road surface; these were concentrated on the approach to Junction 33. This suggests that there could be an issue with wet skid resistance of the road surface or poor drainage, it is however noted that no flooding events have been reported within the incident data.

The majority of collisions occurred on the approach to Junction 33 with a total of fifteen shunt collisions being recorded. This and the collision description highlight a potential issue with congestion / queuing on the exit to Junction 33, with queues backing up onto the mainline particularly during the morning peak.

The following potential interventions may alleviate any congestion and improvements to the road surface or drainage may reduce the likelihood that congestion leads to shunt collisions:

a) The Junction 33 traffic signal timings should be reviewed to examine whether any slip road queues could be reduced;

b) The motorway signalling should be reviewed to ensure it is providing suitable queue protection, including for queues on the exit slip;

c) The skid resistance of the carriageway should be investigated;

d) The presence of any flooding hotspots should be reviewed. The drainage is provided by combined kerb drainage, if flooding at low points occurs additional outlets could be provided.

e) If the above actions do not address the issue, reconfiguration of the junction should be considered to increase queuing capacity and potentially reduce queuing on the mainline. The replacement of the diverge type D option 1 with a diverge type D option 2 may provide this additional queuing capacity but the disbenefits relating to lane discipline would need to be considered and evaluated.

5.6 Collisions Junction 31 to 32

Junction 31 to 32 is a four-lane section of carriageway with a permanent hard shoulder. The data review identified that a higher proportion of collisions involving lane changes were occurring on the Junction 31 to 32 link including two serious collisions. The link has a short weaving length between the junctions with 1.2km Northbound and 1.4km Southbound. The smart motorway scheme removed the northbound lane gain and southbound lane drop from Junction 31. The hard shoulder was converted into a running lane through Junction 31, and through the merge and diverge. The advance direction signing on both carriageways provides shorter advanced warning of the Junction 32 strategic diverge to the M18 than would normally be provided, with a primary ½ mile and a secondary ¼ mile sign (a supplementary sign is also provided upstream but this is text rather than ADS style).

The collisions on the Junction 31 to 32 link have been reviewed. Note that the extent of this section differs to that considered in section 4 of the report which also included through Junction 32. Twenty-four collisions were reported in the before period and twenty-eight in the after period, this is represented by a slight increase in the number of collisions per year from 8 to 8.3 (for the first 3 full years after opening), with the severity increasing since the introduction of smart motorway. Figure 5.5 provides a summary of the collision types for the before and after periods for each of the carriageways. This shows that for both the northbound and southbound the number of collisions has increased marginally, with the northbound increase being driven by an increase in shunt collisions and southbound being driven by lane change collisions.

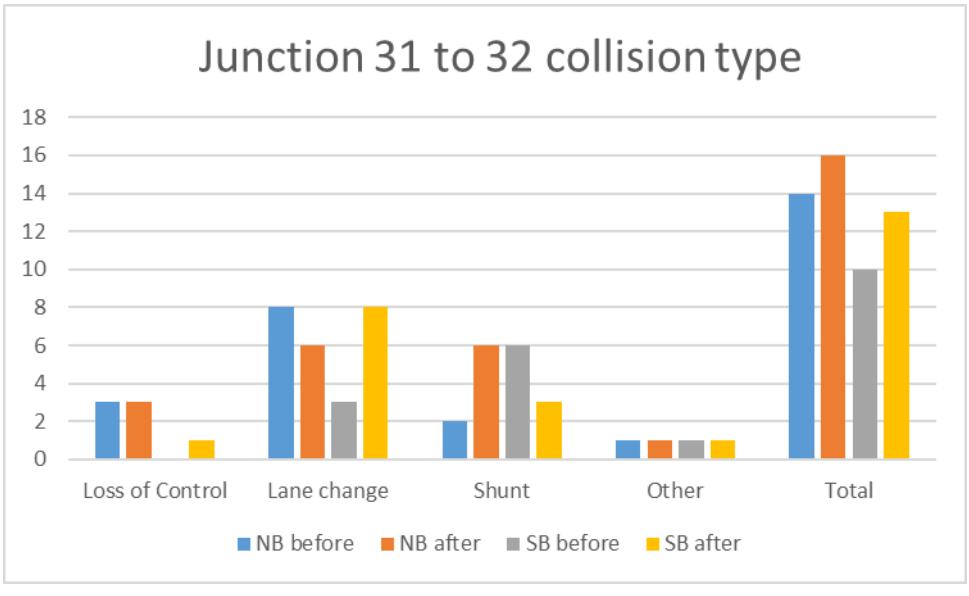


Figure 5.5 Junction 31 to 32 collision types

The increase in shunt collisions on the northbound carriageway would suggest an increase in congestion, but given the increased capacity and signalling this is unlikely to be the case. Four of these collisions occurred in 2016 with only two occurring in the subsequent years. In 2016 the Junction 32 to 35a smart motorway was in construction and the traffic management may have been increasing congestion on the approach through this link; the completion of those works and the resultant increased capacity downstream may have addressed the number of shunts.

The Junction 28 to 31 smart motorway scheme removed the southbound lane drop at Junction 31 to provide four lanes through the junction and revised the signing on the approach to the junction to reflect the diverge layout, the link has a weaving length of approximately 1.4km. There has been an increase in collisions involving lane changing in the after period. There is no apparent pattern between the collisions, being spread along the link and associated with various manoeuvres, however the increase in collisions would suggest a potential increase in the number of lane changes occurring which improved signing may address.

A review of the drive through video as shown in figure 5.6, has identified that the exit signs on the southbound carriageway are positioned above lane 1 and partially above lane 2 rather than being offset to the left and the hazard road markings are provided up to the secondary advance direction sign, both of these may lead road users to misunderstand the layout for a lane drop ahead and result in unnecessary lane changes.

Figure 5.6 ½ mile advanced direction sign for Junction 31 over lane 1 / 2; hazard lines between lane 1 / 2 (dashcam video, July 2020)

As identified in section 4, 39% of the collisions for Junction 31 to 32 occurred on a wet road, which is above the national average for all motorways of 25%[11]. Whilst the number and proportion of collisions occurring on a wet road surface has reduced between Junction 31 and 32, since the implementation of the smart motorway the proportion of wet collisions here is higher than the national average. In additional to this three collisions report aqua-planning or standing water. This could indicate that the section has poor drainage.

[11]Reported road accidents, Great Britain,2018, England, Motorways

Key findings

The number of collisions per year have only marginally increased between Junction 31 and 32, but a change in the pattern of collisions has occurred. For the northbound carriageway this appears to relate to shunt collisions when the M1 Junction 32 to 35a works were ongoing. For the southbound there is an increase in collisions involving lane changes; the following potential interventions may reduce the risk of lane change collisions:

1. Improve lane discipline through considering lane destination markings and a supplementary advance direction sign on the southbound approach to Junction 31.
2. Review the provision of hazard road markings on the approach to Junction 31 Southbound.

To confirm whether there is a drainage issue the following intervention should be considered:

3. A review of existing drainage provision including any identified flooding hot spots and site surveys during varying weather conditions to identify potential problems. If problems are identified develop appropriate drainage and/or surfacing schemes to address.

5.7 Goods vehicle collisions between Junctions 32 to 35.

The data collation and review exercise shows that the average number of collisions involving goods vehicles has increased from 8.3 to 12.3 per year between Junction 32 to 35. Further analysis of the after collisions involving goods vehicles has been undertaken.

In total there were 29 collisions in the after period split evenly between the northbound and southbound carriageway and a relatively even spread through the extent of the scheme. Eleven collisions were recorded between Junction 32 to 33, seven between Junction 33 to 34 and eleven between Junction 34 to 35 with no apparent cluster. The type of vehicles and year of occurrence are shown in Table 5.7. Two of the collisions were fatal and 4 were serious. Table 5.7 illustrates that there was a marked increase in collisions in 2018, with 16 compared to 2 in the previous year. On the SRN in 2018, LGVs made up 19% of all motorway collisions and HGVs accounted for 20%. Based on the data in Table 5.7 for 2018 LGVs account for 31% and HGVs account for 25% of collisions on this section.

Table 5.7 Type of goods vehicles involved in collisions between Junction 32-35 by year

	2017	2018	2019	Total
LGV	0	8	5	13
HGV	2	7	4	13
Unknown	0	1	2	3
Total	2	16	11	29

The primary contributory factor for goods vehicle collisions is recorded in Table 5.8. The majority are common to the top 10 contributory factors for LGVs and HGVs in the Highways England 2018 Casualty report. The only exceptions are ‘aggressive driving’, ‘dazzling sun’ and ‘impaired by alcohol’ but these have a relatively low incidence on the M1. In terms of manoeuvres the majority of the collisions (69%) are classed as ‘going ahead other’ with 14% related to ‘slowing and stopping’ and ‘changing lane to the left’. A review of the time of occurrence shows that many of the collisions occur in the morning peak hours with a further increase in the late afternoon (see Figure 5.8). Analysis based on lighting condition and weather show no notable findings.

Although an overall increase in goods vehicle collisions has been identified in this section, no clear treatable issue is apparent. A location plan of all goods vehicle collisions can be found in Appendix G.

Table 5.8 Primary contributory factor for goods vehicle collisions between Junction 32 to 35

Primary contributory factor	Number of collisions
Failed to judge other person's path or speed	6
Careless, reckless or in a hurry	5
Failed to look properly	5
None	4
Aggressive driving	2
Dangerous actions in carriageway	1
Dazzling sun	1
Fatigue	1
Following too close	1
Impaired by alcohol	1
Loss of control	1
Sudden braking	1

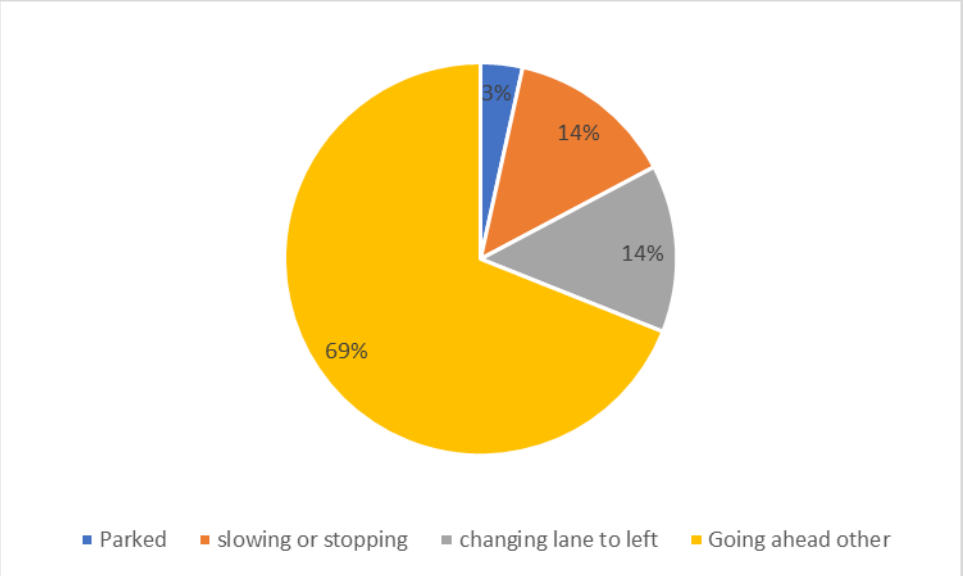


Figure 5.7 Manoeuvres for goods vehicle collisions between Junctions 32 to 35

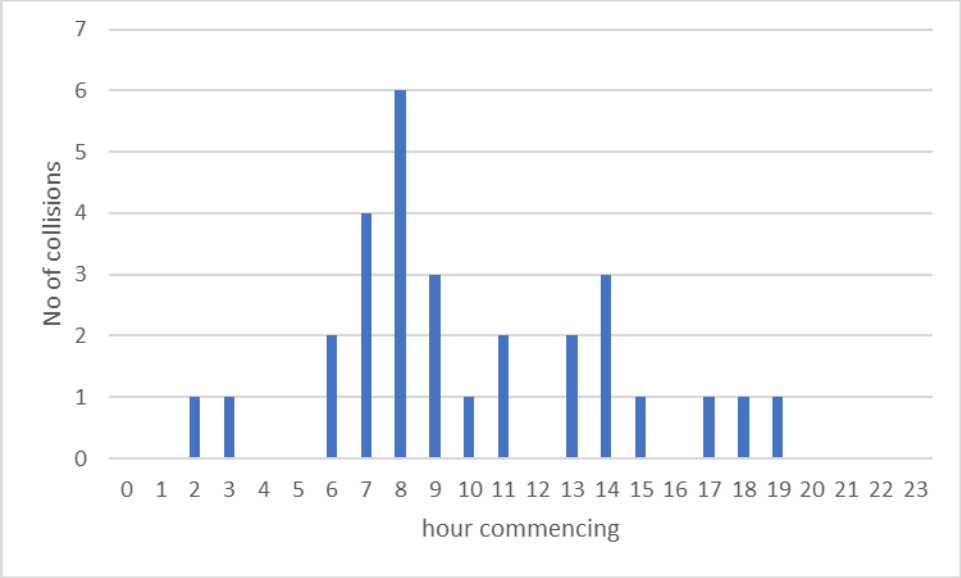


Figure 5.8 Time of occurrence for goods vehicle collisions between Junctions 32 to 35

5.8 Lane changing collisions

The data collation and review exercise suggested that the number of lane changing collisions had increased in the after period, and further analysis of the after-collision data has been undertaken. A location plan of all lane changing collisions can be found in Appendix F. In total there were 38 collisions in the after period with 18 on the Junction 30 to 32 section and 20 on the Junction 32 to 35 section, see Table 5.9. The majority of the lane change collisions between Junction 30 to 32 occurred on the Junction 31 to 32 link and have been considered above in section 5.6. Collisions are fairly evenly split between the northbound and southbound on both sections; see Table 5.10.

Table 5.9 Collision severity for vehicles involved in lane changing

	Junction 30 to 32 (4 years)	Junction 32 to 35 (3 years)
Fatal	0	0
Serious	5	1
Slight	18	20
Total	23	21

Table 5.10 Recorded carriageway for vehicles involved in lane changing collisions

Direction	Junction 30 to 32 (4 years)	Junction 32 to 36 (3 years)
Northbound	13	12
Southbound	10	9
Total	23	21

Further analysis of the contributory factors for lane changing collisions across the whole section is reported in Table 5.11. This shows that driver behavioural factors are the most frequently occurring entries. An increase in lane changing collisions could be due to the additional capacity of the all lane running section reducing congestion and possibly resulting in increased speed differential between lanes.

Table 5.11 Primary contributory factor for vehicles involved in lane changing collisions between Junctions 30 to 35

Primary contributory factor	Number of collisions
Careless, reckless or in a hurry	12
Failed to judge other person's path or speed	5
Failed to look properly	5
None	4
Poor turn or manoeuvre	4
Vehicle blind spot	3
Following too close	2
Loss of control	2
Slippery road (due to weather)	1
Aggressive driving	1
Stationary or parked vehicle	1
Illness, disability, metal or physical	1
Impaired by alcohol	1

Figure 5.9 shows the split of collisions by the hour in which they occur. Lane changing collision occurrence appears to align with peak periods on the M1, i.e. there are more collisions at peak times. There are slightly more collisions in the evening peak, which is similar to the findings for HGV collisions.

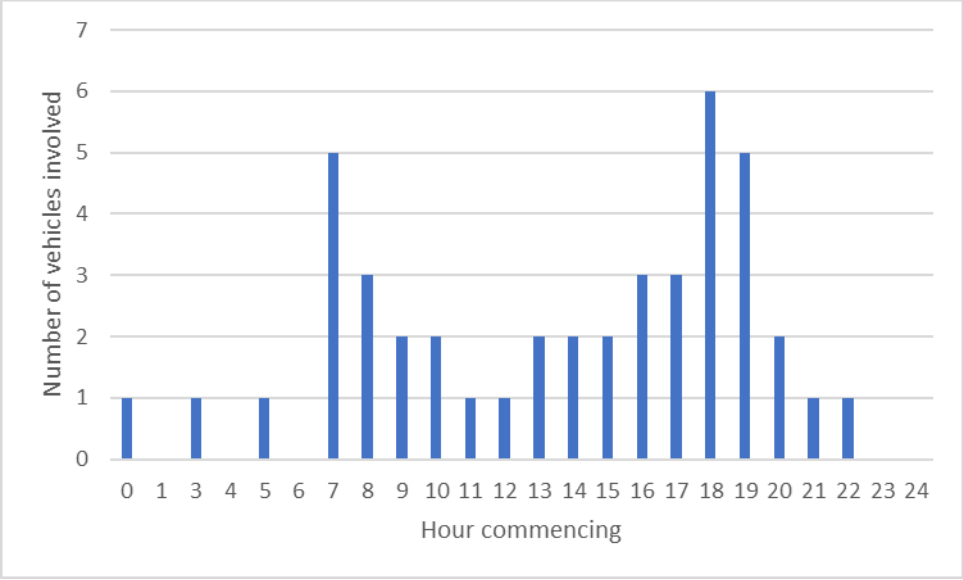


Figure 5.9 Time of occurrence of lane changing collisions between Junctions 32 to 35

Key findings

The lane change collisions are relatively evenly spread through the section under review with the exception of the Junction 31 to 32. This section is reviewed in detail in section 5.6.

5.9 Pedestrian incidents and collisions

Analysis of the fatal collision on this section identified a pedestrian using the northbound entry slip road at Junction 34 in daylight, crossing the carriageway and being struck. A pedestrian footway is provided on the west side of Junction 34 and then drops down to Blackburn Road via a ramp. It may not be clear to users that the footway provision ends at the ramp and pedestrians could continue northwards towards

the entry slip road. This has prompted analysis of data to establish other trends around pedestrians on the network.

Two injury collisions with pedestrian involvement have been identified over the after periods, both originating off-network:

- The aforementioned fatality from a potentially socially vulnerable pedestrian who had gained access to the carriageway from a slip road at Junction 34. The view of the entry slip road at Junction 34 is shown in Figure 5.10 with the ramped footway in the foreground and a maintenance path continuing towards the slip road.
- A serious collision involving a pedestrian on the northbound entry to Junction 31 being struck by a vehicle. The view of the northbound entry slip road at Junction 31 is shown in Figure 5.11 with the footway and uncontrolled crossing in the foreground.

Figure 5.10 Streetview image of junction 34 northbound entry slip

Figure 5.11 Streetview image of Junction 31 northbound entry slip

Incident data for the study extents referenced as 'pedestrian on the network' has been reviewed and identified that an average of 104 incidents involving pedestrians are recorded every year. This identified that:

- between Junctions 31 and 32 a cluster of incidents appear to be associated with where a number of public rights of way run immediately adjacent to the motorway and converge at an accommodation bridge in order to cross the motorway. Figure 5.12 illustrates the incidents and their locality with respect to public rights of way. The detour is approximately 750m and may result in pedestrians attempting to cross the carriageway rather than follow the footpath. This situation with accommodation bridges occurs at other locations along this section of the motorway but potential pedestrian clusters are not apparent elsewhere.

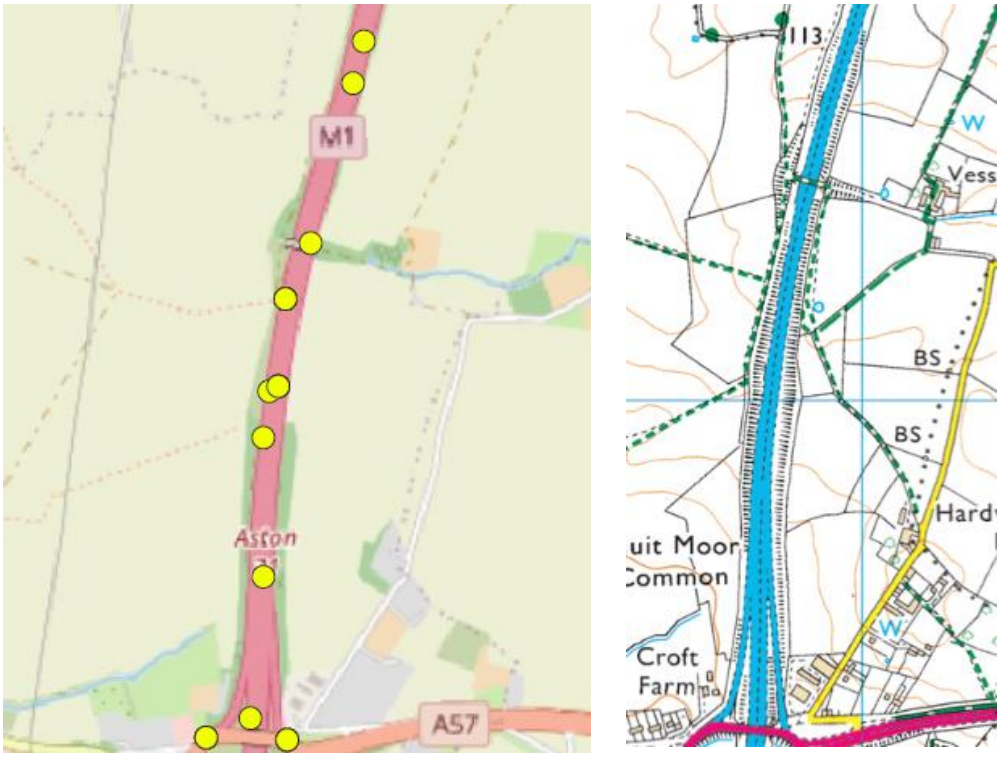


Figure 5.12 Pedestrian on network plot north of Junction 31 and corresponding public rights of way network

- incidents are shown in the vicinity of emergency areas, Woodall motorway service area and at junctions where pedestrian facilities are present.

Key findings

The two recorded injury collisions involving pedestrians have occurred at locations where there are pedestrian facilities in close proximity to motorway junctions.

There has been a consistent number of pedestrian related incidents recorded between 2017 and 2019. Pedestrian on network incident plots are included in Appendix H showing that whilst these occur throughout the scheme there are clusters at each junction.

To identify detailed intervention measures it is recommended to review the pedestrian provision, fencing and other deterrents. The large scheme process set out in GG 142 *Walking cycling and horse-riding assessment and review* would be a suitable structure for this exercise.

6. Potential Interventions

The preceding sections have identified the following key findings, which are considered for specific potential interventions. The potential interventions answer the question posed for the scheme of, “what more could be done to improve safety?”. They must be viewed in context of the national programme of improvements to smart motorways, which for this scheme is planned to result in the introduction of Stopped Vehicle Detection technology.

Table 6.1 Smart Motorway Incident and Infrastructure Investigation potential intervention

Key finding – Data analysis	Existing, programmed or national campaign control measures	Prospective specific intervention measures	Potential intervention
There is a cluster of shunt collisions on the northbound approach to Junction 33, including 50% occurring on wet road surface. This may be as a result of queuing on exit slip and possibly low wet skid resistance or surface water. Note: Skidding resistance has not been reviewed as part of this investigation.	None – locally specific issue	The extent of queuing on the slip road and mainline should be confirmed and if required, improvements to traffic capacity at the exit could be made. If necessary improve the carriageway skid resistance and/or drainage. There may be a potential to improve queue protection signalling.	A) Investigate a package of measures to reduce queuing and, if required, improve drainage and/or carriageway skid resistance, with the following suggestions for consideration: • The Junction 33 traffic signal timings should be reviewed to examine whether any slip road queues could be reduced; • The motorway signalling should be reviewed to ensure it is providing suitable queue protection, including for queues on the exit slip; • The skid resistance of the carriageway should be investigated; • The presence of any flooding hotspots should be reviewed. The drainage is provided by combined kerb drainage, if flooding at low points occurs additional outlets should be investigated. • If the above actions do not address the issue, reconfiguration of the junction should be considered to increase queuing capacity. The replacement of the diverge type D option 1 with a diverge type D option 2 may provide this additional queuing capacity but the disbenefits relating to lane discipline would need to be considered and evaluated.
Increased number of collisions involving lane changes between Junction 32 and 31.	None – locally specific issue	Improve comprehension of layout and enhance lane discipline	B) Investigate a package of measures to improve clarity of and driver perception of the link layout, with the following suggestions for consideration:

Key finding – Data analysis	Existing, programmed or national campaign control measures	Prospective specific intervention measures	Potential intervention
		between Junction 32 and 31 on the Southbound carriageway.	• Improve lane discipline through the provision of lane destination markings. • Consider a supplementary advance direction sign on the southbound approach to Junction 31. • Review the provision of hazard road markings on the approach to Junction 31 southbound.
Whilst the number and proportion of collisions occurring on a wet road surface has reduced between Junction 31 and 32 since the implementation of the smart motorway the proportion of wet collisions here is higher than the national average. Three collisions report aqua-planning or standing water.	None – locally specific issue	Improve carriageway drainage through this link.	C) Undertake a review of existing drainage provision including any identified flooding hot spots. Site surveys should be undertaken during varying weather conditions to identify potential problems. If problems are identified develop appropriate drainage and/or surfacing schemes to address.
A cluster of serious collisions involving live lane stoppages has been identified northbound north of Woodall motorway service area.	Stopped vehicle detection implementation	Improve forward visibility in lane 1 on left hand curve.	D) Consider providing additional emergency areas to reduce places of relative safety spacing. Consider vegetation removal in close proximity to the carriageway where it could improve sightlines including to stationary vehicles.
Pedestrian collisions and existence of potential risk factors	Motorways Traffic (England and Wales) Regulations prohibit pedestrians, although those who are vulnerable, in distress or with judgement impaired by drugs or alcohol are unlikely to be deterred by this.	Local desire lines, security and prevention measures should be reviewed.	E) Review the pedestrian provision, fencing, signing and other deterrents. The large scheme process set out in GG 142 *Walking cycling and horse-riding assessment and review* would be a suitable structure for this exercise. Consider the suicide prevention tool kit.
Key finding – Operations feedback	**Existing, programmed or national campaign control measures**	**Prospective specific intervention measures**	**Potential intervention**
Technology reliability has the potential to limit the setting of signals and is frequently reported	Technology maintenance is regionally managed with performance levels established. Feedback to this investigation from	The specific local availability / reliability of technology on this scheme should be reviewed.	F) Review wider data set and root cause behind reported message sign and signal availability in Junction 31 to 32 and Junction 32 to 35 sections.

Key finding – Data analysis	Existing, programmed or national campaign control measures	Prospective specific intervention measures	Potential intervention
as 'near miss' by Operations (region-wide issue). Message Sign availability J31-32: <70% June 2020, <75% Aug 2020 J32-35: <75% June 2020, <80% Aug 2020 Signal availability J31-32: <85% June 2020, <85% Aug 2020	Operations is that technology availability / reliability is not as expected.		

7. Conclusion

The safety of the smart motorway section of the M1 between Junction 30 and Junction 35 has been investigated. This section has a number of operational regimes with Junction 30 to 31 being all lane running including through the junctions, Junction 31 to 32 having four lanes and a permanent hard shoulder and Junction 32 to 35 being all lane running. Junction 32, 33 and 34 have three lanes and a hard shoulder.

Overall the average numbers of collisions per year have decreased in the after period for all sections, due to a fall in the number of slight injury collisions. The number of serious injury collisions per year have increased across both all lane running sections, and fatal injury collisions have increased from one in three years to three in three years for the Junction 32 to Junction 35 section. Accordingly, the ratio of fatal and serious injury collisions has increased in the after period for both schemes.

On the all lane running sections occurrences of breakdowns in live lanes are reported on average at a similar rate to those evaluated in the Smart Motorway All Lane Running Overarching Safety Report. In 2018, 1,047 live lane breakdown incidents were reported on the all lane running sections and three injury collisions associated with live lane stops were recorded. Over the full after period, collision records indicate fifteen collisions relating to live lane stops, including three fatal collisions.

Collision cluster locations were identified between Woodall motorway service area and Junction 31, between Junction 31 and Junction 32, and on the northbound approach to Junction 33. Specific factors relating to goods vehicle collisions and lane change collisions were investigated but no clear treatable problems identified.

Pedestrian collisions and incidents have been reviewed and the range of crossing and potential access points (i.e. via slip roads close to urban areas) is a risk factor. Measures to prevent pedestrian incursion at slip roads are recommended.

This part of the motorway network is likely to benefit when stopped vehicle detection is introduced by 2021. In addition to that programme- level intervention, six key recommendations are made:

A. A package of measures to address congestion and associated risk factors at Junction 33 northbound.

B. Improve lane discipline through the provision of lane destination markings and a supplementary advance direction sign on the southbound approach to Junction 31.

C. Review the existing drainage provision including any identified flooding hot spots between Junctions 31 and 32.

D. Consider the provision of additional emergency areas to reduce places of relative safety spacing and vegetation removal in close vicinity to the carriageway, between Woodall motorway service area and Junction 31 northbound.

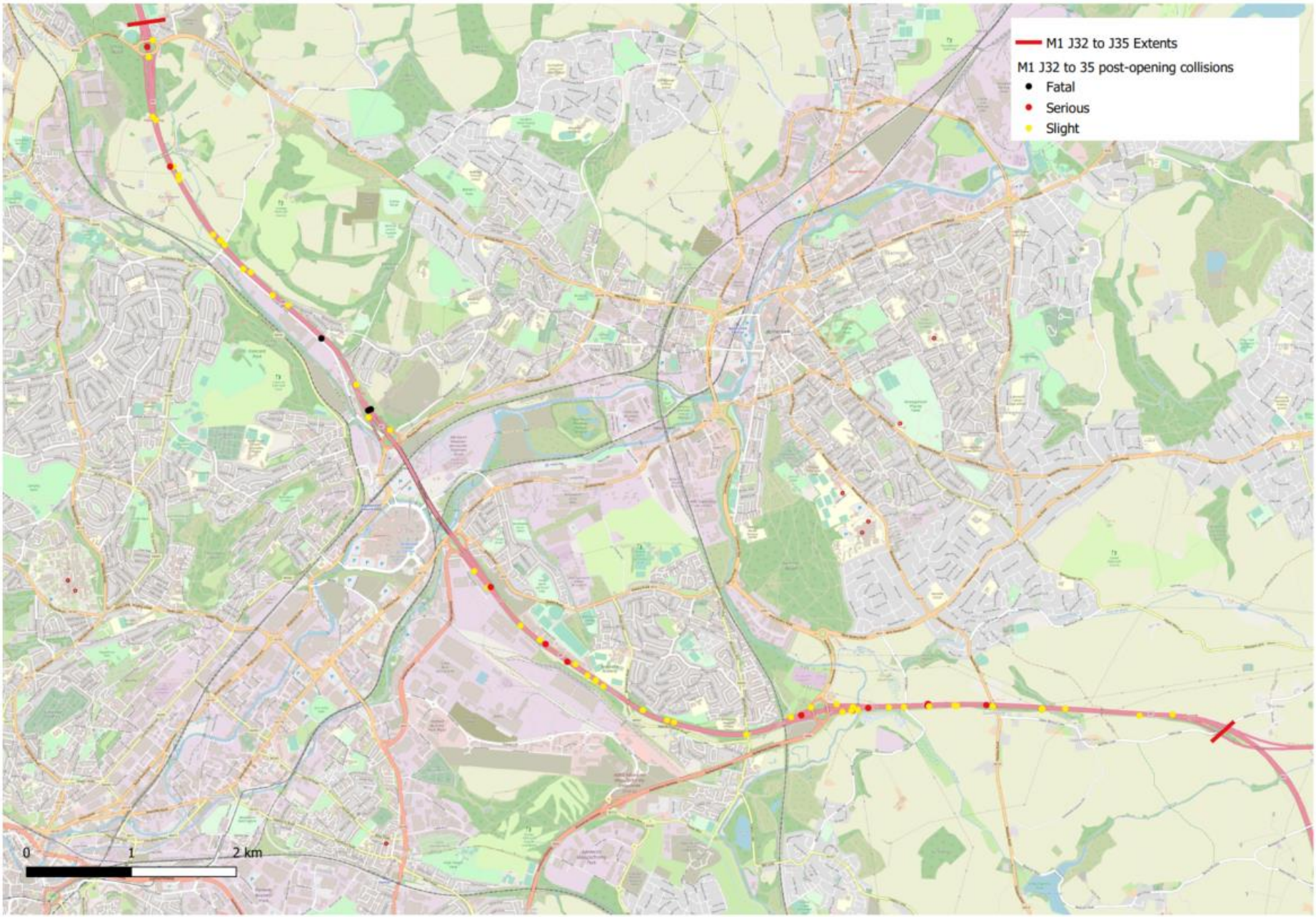
E. Review pedestrian routes, including signing, and network fencing integrity to provide better facilities and prevent or deter future pedestrian incursion. Consider applying the Suicide Prevention Toolkit.

F. Review wider data set and root causes behind message sign and signal availability in Junction 31 to 32 and Junction 32 to 35 sections.

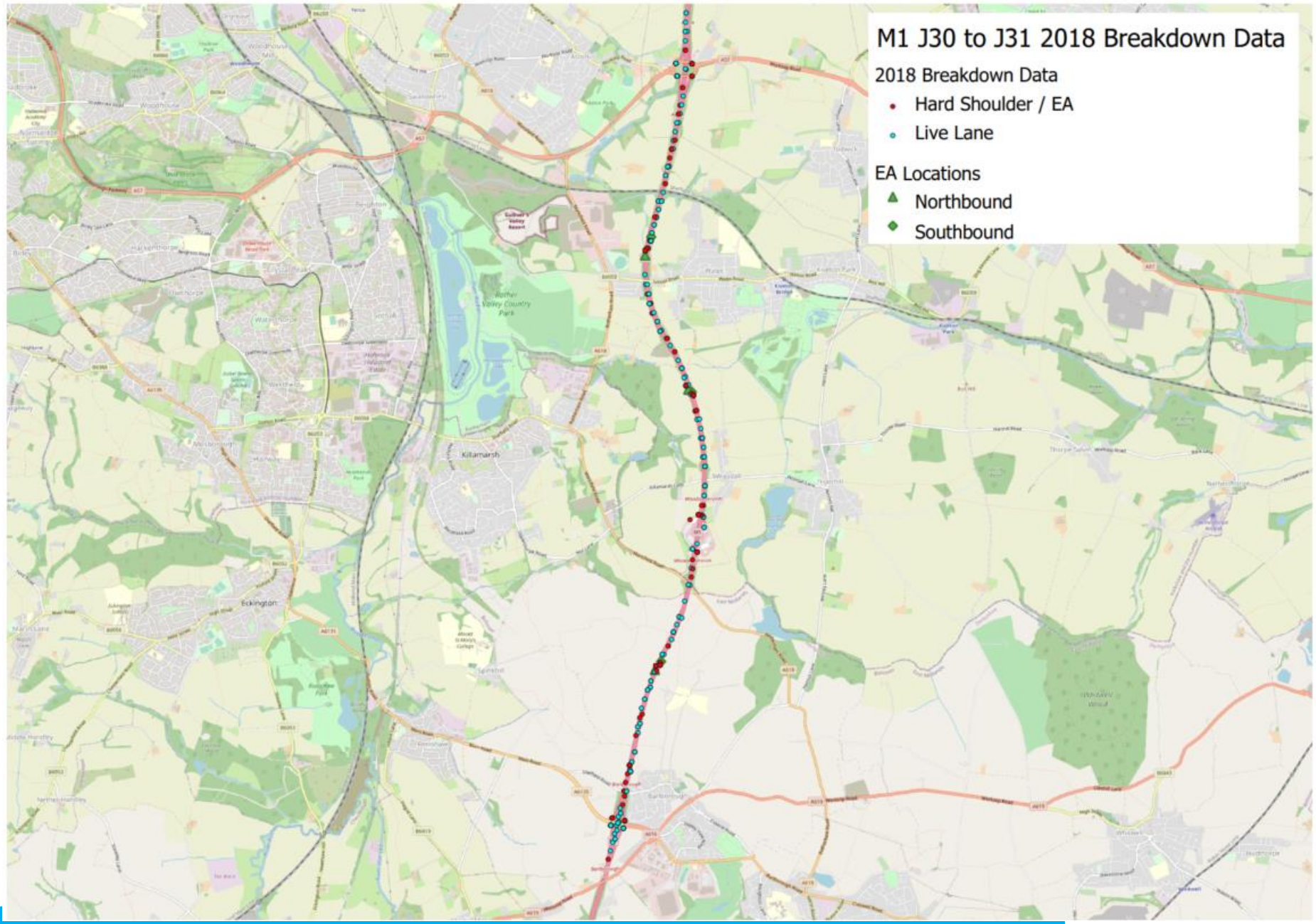
Appendices

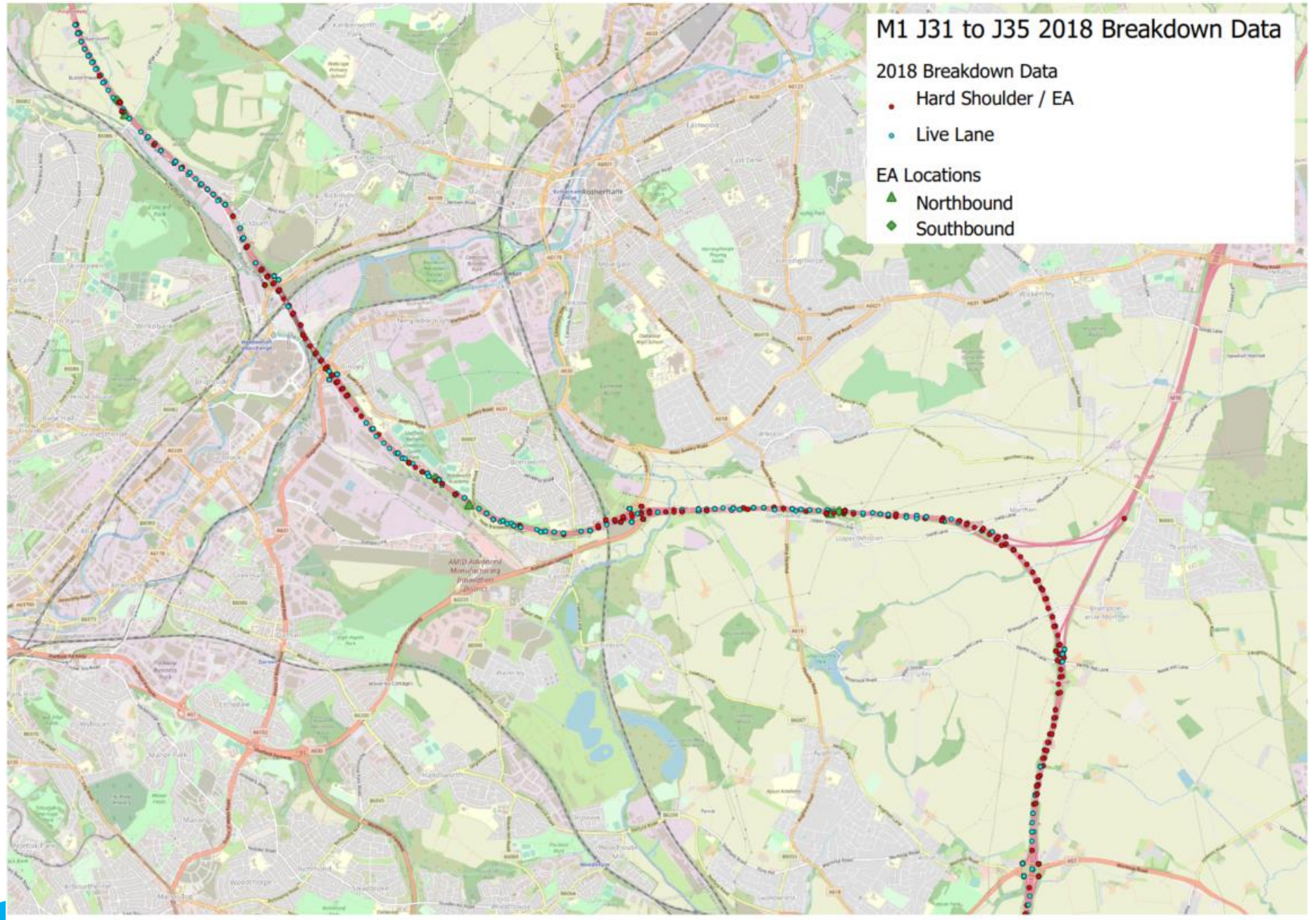
Appendix A. All Collisions (after)


M1 J31 to 32 extents
M1 J30 to 31 All Lane Running extents
M1 J30 to J32 Post-opening collisions
Fatal
Serious
Slight
0
1
2 km


M1 J32 to J35 Extents
M1 J32 to 35 post-opening collisions
Fatal
Serious
Slight
0
1
2 km

Appendix B. Breakdown incidents (2018)


M1 J30 to J31 2018 Breakdown Data
2018 Breakdown Data
Hard Shoulder / EA
Live Lane
EA Locations
Northbound
Southbound
Killamarsh
Eckington


M1 J31 to J35 2018 Breakdown Data
2018 Breakdown Data
Hard Shoulder / EA
Live Lane
EA Locations
Northbound
Southbound

Appendix C. Design strategy record

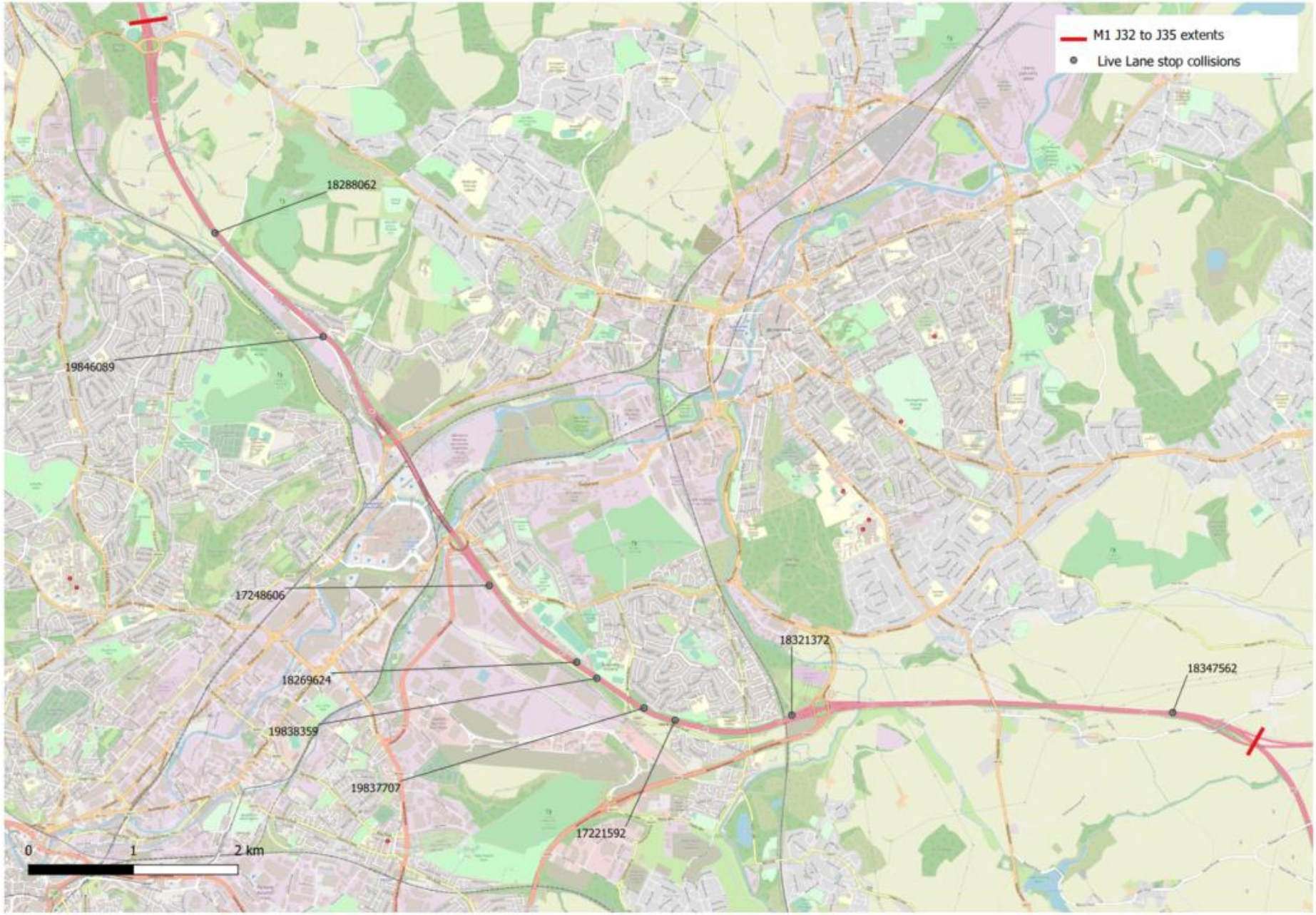
Ref	Element	Location	Potential relevance to this work	Relevance to this investigation
J28-31 DSR 4.3	Junction design	J30 NB merge	Type D (2-lane urban merge) instead of Type E (lane gain)	Awareness only.
J28-31 DSR 4.3	Junction design	J31 NB diverge	Type A (Taper diverge) instead of Type C (Lane drop)	Awareness only.
J28-31 DSR 4.3	Junction design	J31 SB diverge	Type B2 (Parallel diverge) instead of Type D (Ghost Island)	Awareness only.
J28-31 DSR 4.3	Junction design	J31 SB merge	Type D (2-lane urban merge) instead of Type E (Lane gain)	Awareness only.
J28-31 DSR 4.3	Junction design	J30 SB diverge	Type A (Taper diverge) instead of Type C (Lane drop)	Awareness only.
J28-31 DSR 4.3	Junction design	J30 SB merge	Type D (2-lane urban merge) instead of Type E (Lane gain)	Awareness only.
J32-35a DSR 5.3	Junction design	J34 NB merge	Type E (Lane Gain) instead of Type F (Lane Gain with Ghost Island)	Awareness only.
J32-35a DSR 5.3	Junction design	J35 NB diverge	Taper diverge instead of lane drop – constrained by Smithywood footbridge and Through Junction Running	Awareness only.
J32-35a DSR 5.3	Junction design	J35 SB merge	Type D (2-lane urban merge) instead of Type E (lane gain)	Awareness only.
J32-35a DSR 5.3	Junction design	J34 SB diverge	Type C (Lane drop taper) instead of Type D (ghost island diverge)	Awareness only.
J32-35a DSR 7.1	emergency area spacing	J35-34 SB	Emergency area spacing 2.5km	Consider live lane breakdowns in incident data review and investigate collisions.
J32-35a DSR 7.5	emergency area gradient	J33-32 SB	Emergency area 7-B1 has uphill gradient of 2.5%	Awareness only.

Appendix D. Departures from standard checklist

DAS ID	Element	Location	Departure summary	Relevance to this investigation
68787	Drainage	Throughout	Flow width for drainage entering lane 1	Check collisions on wet road surfaces
Unknown	Signing	J32 to 31	Details not within DfS tracker, but non-compliant series of advanced direction signs on Junction 31 Southbound approach	Check for collisions / incidents on the J31-32 link.
67737	Signals	Gantry G4-03 Southbound (J30 SB diverge)	Final sign gantry located further upstream of Exit Datum Point than tolerance allows.	Awareness only.
Unknown	Signals	Gantry G4-04b to G4-06 Northbound (approach to Woodall)	Signal not visible for 50% of the spacing, and for less than 350m. Gantries through Woodall MSA to be formulated after design has been reviewed	Awareness only.
67733	Signals	Gantry G4-06 to G4-08 Northbound (through Woodall)	Signal Spacing greater than 1500m, not visible for more than 600m and for more than 50% of the spacing	Awareness only.
67739	Signals	Gantry G4-12a to G4-15 Northbound	Signals not visible for more than 600m.	Awareness only.
67379	NMU provision	J32-35 NB & SB	No NMU's routes are within the scheme extents	Check incident and collision data for pedestrian related issues.
68398	Junction design	J34 southbound diverge	Substandard taper length.	Awareness only.
68399	Junction design	J35 NB	Provision of a Type A (taper diverge) layout in place of the required Type D (ghost island lane drop).	Awareness only.
74713	Signs	J34 to J35 SB	Southbound final sign is located in excess of 50m from the exit datum point	Awareness only.
74707	Signs	J33 NB	Non-standard position of the 2/3 mile advance direction sign (G7-09) on the approach to J33 northbound.	Awareness only.
74708	Signs	J32 SB	Non-standard position of the 1 mile advance direction sign (G7-10) on the approach to J32 southbound.	Awareness only.
74701	Signs	J33 SB	Final sign is located in excess of 50m from the exit datum point	Awareness only.
74709	Signals	J32 to 35	Signals not visible from 500m from upstream gantry and in excess of 600m.	Awareness only.
75086	Signals	J32 to 35	No separate VMS on gateway gantry G10-03	Awareness only.
74741	Signals	J32 to 35	No separate VMS with lane signals on G7-14	Awareness only.
74714	Signals	J32 to 35	No separate VMS with lane signals on G10-03	Awareness only.
68176	Queue detection	Tinsley Viaduct	Non-Implementation of MIDAS on Tinsley Viaduct	Awareness only.

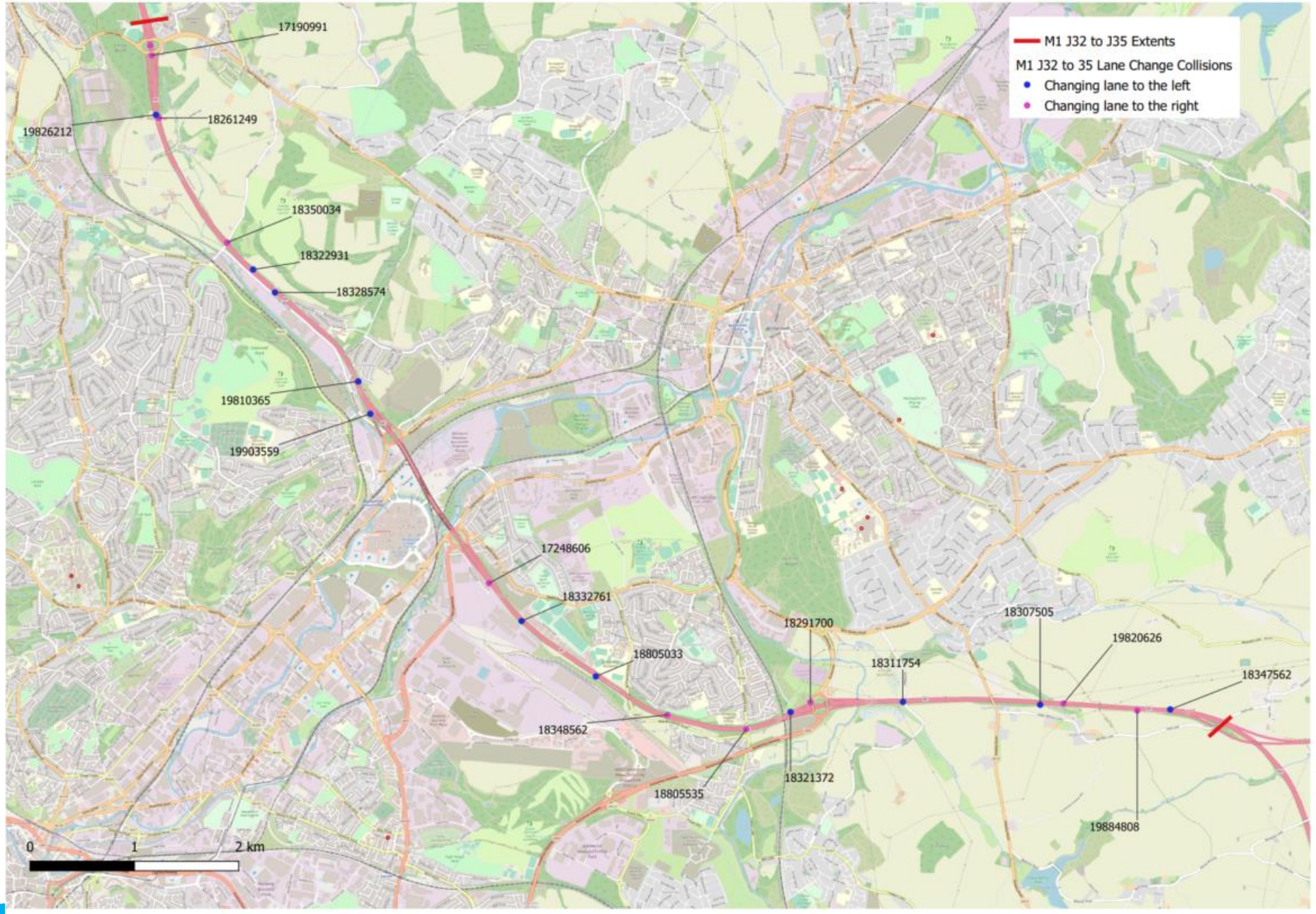
Appendix E. Live lane stop collisions (after)


M1 J31 to 32 extents
M1 J30 to 31 All Lane Running extents
Live lane stop collisions
17241347
16100178
18293232
18330350
18295361
0
1
2 km

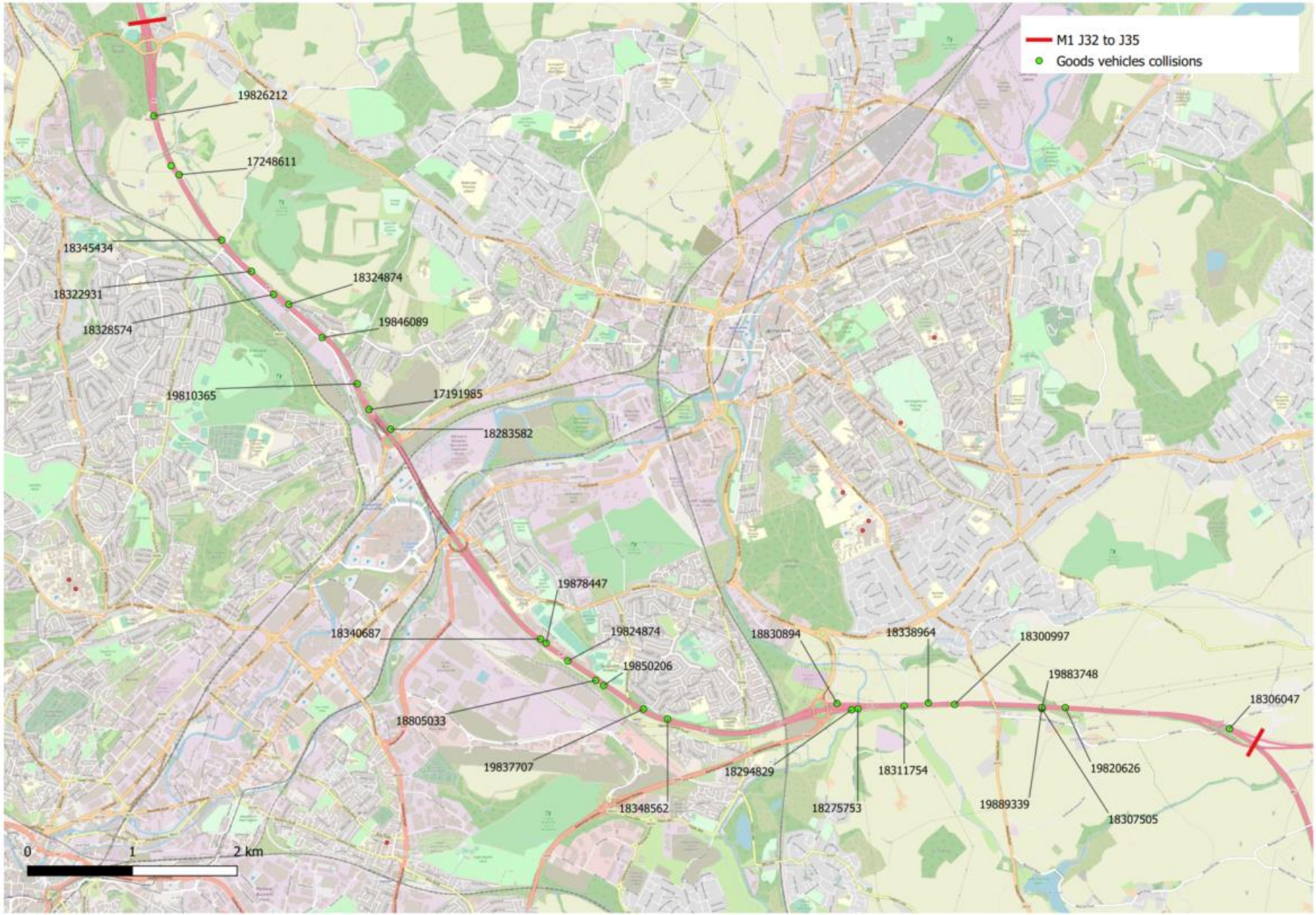

M1 J32 to J35 extents
Live Lane stop collisions
18288062
19846089
17248606
18269624
19838359
19837707
17221592
18321372
18347562
0
1
2 km

Appendix F. Lane change collisions (after)

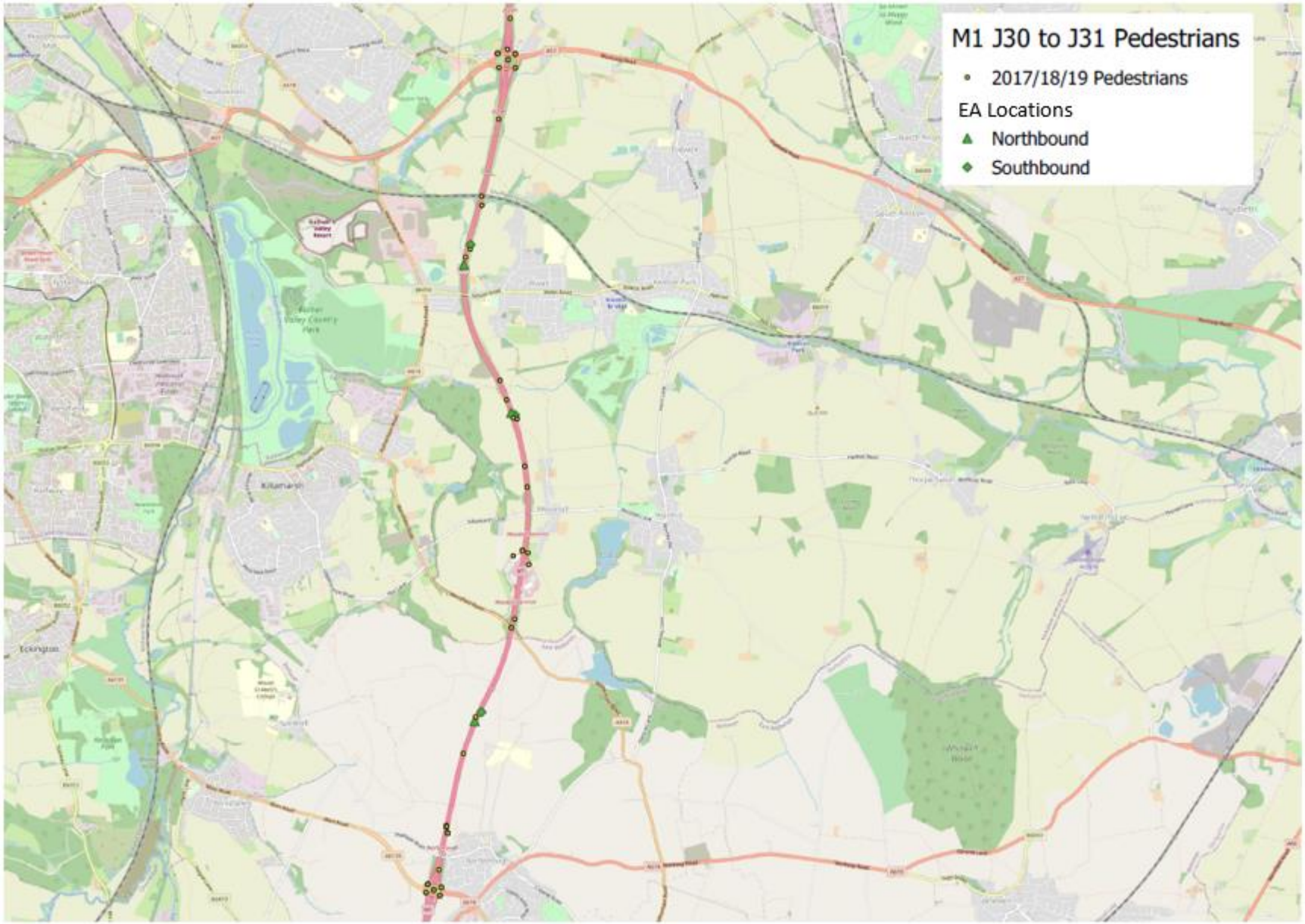

M1 J31 to 32 extents
M1 J30 to 31 All Lane Running extents
M1 J30 to J32 lane change collisions
changing lane to left
changing lane to right
18344344
17180319
17255501
19827648
19809041
16103385
16140337
1675080
16139393
18288540
17231967
18309202
16136299
18294860
16136193
17243641
16100178
1699009
17256876
18295361
17251544
17218549
0
1
2 km

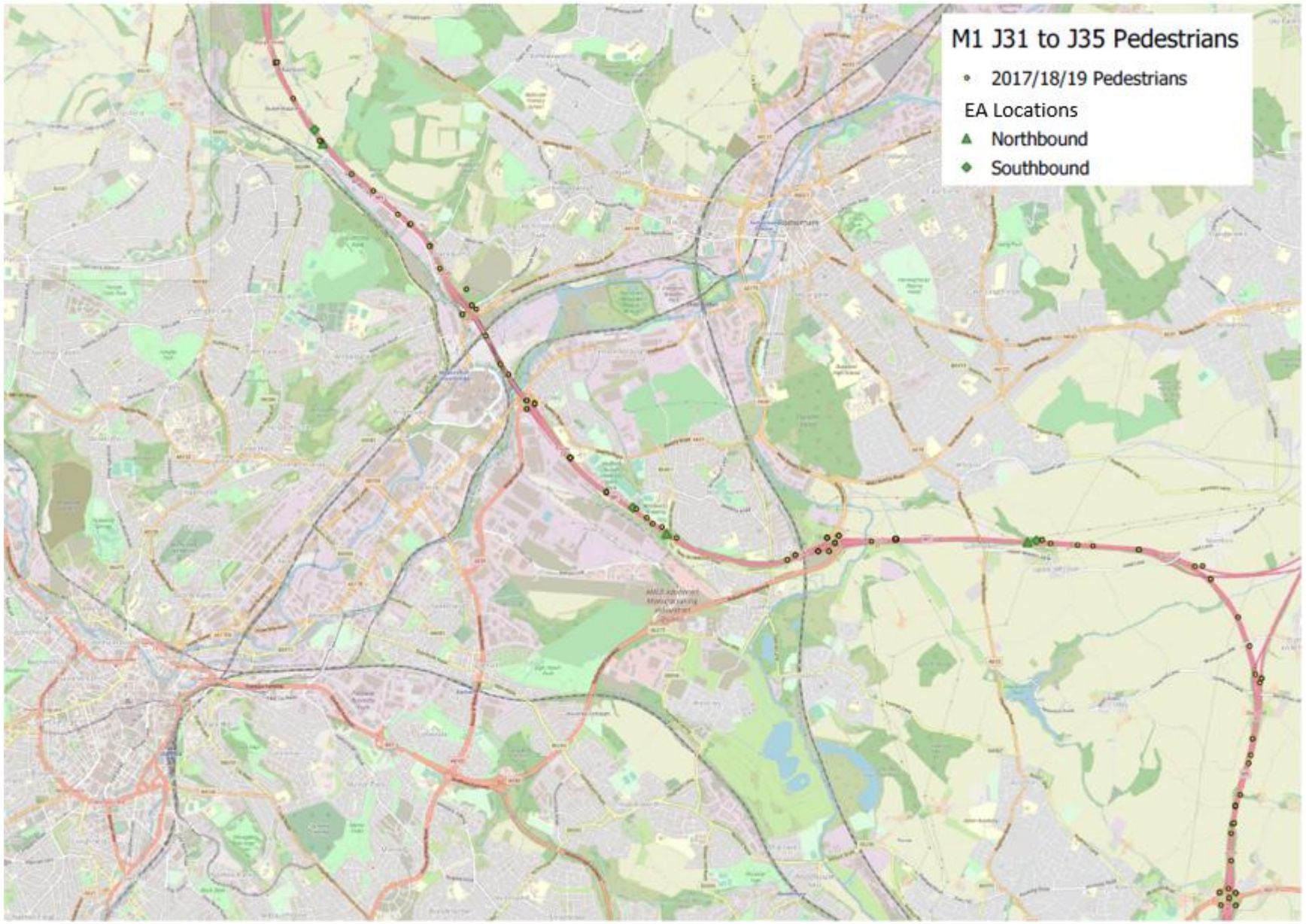

M1 J32 to J35 Extents
M1 J32 to 35 Lane Change Collisions
Changing lane to the left
Changing lane to the right
17190991
19826212
18261249
18350034
18322931
18328574
19810365
19903559
17248606
18332761
18805033
18348562
18805535
18291700
18311754
18321372
18307505
19820626
18347562
19884808
0
1
2 km

Appendix G. Goods vehicle collisions between J32-35 (after)


M1 J32 to J35
Goods vehicles collisions
19826212
17248611
18345434
18322931
18328574
18324874
19846089
19810365
17191985
18283582
19878447
18340687
19824874
19850206
18805033
19837707
18348562
18830894
18338964
18300997
19883748
18306047
19820626
18307505
19889339
18275753
18311754
18294829
0
1
2 km

Appendix H. Pedestrians on network recorded incidents (2017 to 2019)


M1 J30 to J31 Pedestrians
2017/18/19 Pedestrians
EA Locations
Northbound
Southbound


M1 J31 to J35 Pedestrians
2017/18/19 Pedestrians
EA Locations
Northbound
Southbound

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Updated May 2022 - version includes updated figure/table referencing and clarification over status of collision data used.