Post Opening Project Evaluation

M25 Junctions 23-27 Smart Motorway All Lane Running – One Year After

July 2017

Notice

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Foreword

Highways England's motorways are some of the safest in the world. Our road network carries a third of road traffic and we have seen demand grow by a quarter since 2000 with continued growth forecast.

One reason for the introduction is smart motorways is because there are more vehicles on the road. By making use of the full width of the road, smart motorways add that extra capacity to carry more vehicles and ease congestion.

They have evolved from **Controlled Motorways** (with variable speed limits) to **Dynamic Hard Shoulder Running** (opening the hard shoulder as a running lane to traffic at busy periods) to **All Lane Running** (permanently removing the hard shoulder and converting it into a running lane).

Compared to a traditional motorway widening they deliver:

- Increased capacity at significantly less cost than traditional motorway widening.
- New technology and variable speed limits to improve traffic flow.
- Less congestion and more reliable journeys for customers.
- Environmental benefits of not taking an extra corridor of land to use as new road.
- A safety record that's at least as safe, if not safer than conventional motorways.

The M25 junctions 23-27 smart motorway scheme, located in the northern section of the M25 between the A1(M) and M11 motorways, was one of first all lane running sections of smart motorway on the network.

Before the scheme, this part of the network experienced high levels of congestion and was over capacity for a significant number of hours during the day. One of the main aims of this scheme was to **improve congestion** and journey times.

This report indicates how the scheme was performing within its first year of operation. This initial assessment forms part of a longer-term evaluation which reviews performance over five years. The one year after study is not intended to provide conclusive evidence about scheme benefits but gives an early indication about whether a scheme is heading in the right direction. This helps us identify areas where we can focus effort to optimise the benefits of the scheme.

The evaluation findings indicate that congestion has reduced in the peak periods, with journey time reliability improving between J23 to J25. The traffic analysis was based on data relating to junctions 23 to 25, as there were concerns around the robustness of the traffic data between junctions 25 and 27. This evaluation has not been able to assess all of the benefits relating to this scheme and any conclusions should be reviewed with caution. Further monitoring data is available for this scheme which includes more robust traffic flow analysis.

Personal injury collisions on the strategic road network are very rare and can be caused by many factors. Due to their unpredictable nature, we monitor trends over many years before we can be confident that a real change has occurred as result of the scheme. Within the first year, it has not been possible to conclude the safety impacts of the scheme, but the findings from the three-year monitoring study demonstrate that the safety objectives of the scheme have been achieved.

We're working to continually improve our smart motorways so that they work better for customers. Our Traffic Officers work around the clock to operate our smart motorways, keeping customers safe from the control room and attending incidents the road. We've committed to additional signs and more visible markings for emergency areas and our latest set of standards will ensure that there's a safe place to stop in an emergency every mile on our upcoming schemes. All of this helps to provide one of the most modern and safe road environments in the world.

January 2020

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Executive summary

Scheme Description

The M25 Junctions 23 to 27 scheme is a Highways England major scheme to improve 16 miles of the M25 by providing additional capacity between J23 and J27 in Essex/Hertfordshire into a smart motorway. It was completed in two stages, J23 to J25 opening in April 2014 and J25 to J27 opening in November 2014.

The key smart motorway features in the scheme were the following in both directions:

• Conversion of the hard shoulder for use as a permanent traffic lane.

• Introduction of enhanced on-road technology to manage traffic flow, including variable mandatory speed limits.

Scheme Objectives

Objective (stated in Client Scheme Requirements)	Objective Achieved?
Reduce congestion and to develop solutions that provide additional capacity, increase journey time reliability and ensure the safe and economic operation of the motorway.	✓
Improve journey time reliability by improving and better managing traffic flow conditions.	✓ but more data is required to be conclusive
Achieve a safety objective under which the "after" accident numbers (per annum) are no greater than those in the "before" and the severity ratio is not increased.	✓ Collision numbers cannot be compared, but collision rates have decreased
Make best use of existing infrastructure providing additional capacity within the existing highway boundary, other than in exceptional circumstances.	✓
Minimise detrimental environmental effects of the smart motorway scheme by mitigation measures, taking account of costs, availability of funding and statutory obligations.	✓
Improve the currency and quality of information provided to drivers about the state of traffic flow on the motorway.	✓
Support the current role of the M25 as a major national and inter-urban regional transport artery.	✓

Key findings

- Congestion has reduced in the peak periods.
- Journey time reliability has improved along the scheme section.
- Initial results suggest safety has improved.
- Environmental impacts are broadly in line with expectation.

Summary of Scheme Impacts

Traffic

Traffic Volumes

- On average, two-way weekday traffic flows on the scheme is around 141,300 vehicles per day (vpd), an overall increase of 6% from before the scheme was built, in line with background growth.
- Most directional flows in scheme sections have seen similar levels of growth. Only the J24 to J25 clockwise link appears to have seen lower growth. This result is unexpected with no clear explanation.

Journey Times

- Anticlockwise journey times have improved by 9% overall, even after traffic volumes have increased. The weekday AM peak journey time has seen the greatest improvement with a 19% reduction in journey time. Journey time improvements in the clockwise direction are in the range of 4-7%.
- In the clockwise direction prior to the scheme, the speeds were generally low near J23 in the PM peak and this has improved after scheme opening. The speed remains the same between before and after for the remaining clockwise sections in the PM peak.
- In the anticlockwise direction, speeds have improved considerably in the AM peak especially between sections J27 to J25. In the PM peak, anticlockwise speeds remain unchanged between J27 and J25 but have improved between J25 and J23. Weekend and Inter-peak periods have seen only marginal improvements in speeds as this section was not congested before the scheme was built.

Operation of the Smart Motorway

- The AM peak in the anticlockwise direction sees the highest level of use of the variable mandatory speed limits (VMSL) on weekdays of up to 76% of the period.
- In the clockwise direction, the highest levels of use are seen in the PM period on weekdays (around 40% of the period).
- These highest levels of use correspond with the times that the scheme is busiest; anticlockwise in the AM peak and clockwise in the PM peak. They also correspond to the times when journey times were least reliable, and now most improved with the scheme.

Reliability

- Reliability has improved in all time periods with the largest changes seen in the time periods which were the most unreliable pre scheme (weekday PM peak clockwise and weekday AM peak anticlockwise). In the clockwise direction, whilst improved post opening, the PM peak remains the most unreliable period.
- Anticlockwise weekday AM peaks shows the largest improvement, but remains the most unreliable period post opening.
- In both directions, the less congested time periods show little change in reliability with the scheme.

Accuracy of Forecasts

- Traffic flows in 2012, just before the start of construction, were lower than forecast by an average of 17% for the M25 within the scheme. The modelling of the traffic growth from the base year of 2004 to 2012 did not account for the impact of the recession on traffic flows during this period. These differences before the start of construction explains most of the gap between the forecast and the observed post opening flows.
- The post-opening average daily traffic flows along the route are lower than forecast by between 20% and 24%.
- Post-opening traffic flows were forecast to increase on the directly affected sections of the M25 by an average 15%, higher than the rates forecast on the adjacent sections; what has been observed is that traffic growth has been slightly lower, on average 8%, and lower growth than that seen on the adjacent M25 sections.
- Journey time savings were forecast for all peaks across all sections of the scheme. Over the whole of the scheme, total journey time savings have been observed for all peaks.
- In the clockwise direction, the observed savings were comparable to the predicted savings between J23 to J26, but no savings were observed between J26 and J27 in any of the peaks.
- In the anticlockwise direction, the observed journey time savings exceed those predicted in the AM peak, but are lower than those predicted in the Inter-peak and PM peak.

Safety

Collisions

- Collision analysis is normally undertaken with a minimum of three full years' of data, so the emerging trends identified in a one year POPE, should be treated with some caution.
- Collision numbers reduced on the M25 within the scheme. However, due to staged opening, total values cannot be accurately compared between before and after. The collision rates provide a better method of comparison.
- The collision rate on the M25 within the scheme has decreased to 0.064 PICs/mvkm (Personal Injury Collisions per million vehicle kilometres), a fall of 13.4% when compared to the before scheme opening counterfactual rate.
- In the wider area, there are reductions in annual average collision numbers between the before and after periods, and a 5% decrease when post opening data is compared with expected number of collisions had the scheme not been built.
- Collision severity as a proportion of all collisions has decreased over the wider modelled area and the M25 mainline scheme section.
- Statistical tests show that the collision rate changes and the wider area collision number changes are not statistically significant at this one year after stage.
- The Fatal and Weighted Index (FWI) per hundred million vehicle miles has increased. The increase of FWI rate is impacted by two fatalities occurring in the after period which are not directly attributable to SM-ALR operation. The after period (one year for J23 to J25 and six months for J25 to J27) is a relatively short period; a larger data set is required before the FWI findings will become statistically significant.

Forecast vs. Outturn Collision Rate Savings

- Across the modelled area, the observed saving in terms of collisions is greater than that forecast.
- For the scheme section an increase in collisions was forecast, but an actual saving has been observed.

Environment

- Traffic forecast data indicates that the observed post-opening AADT traffic flows are lower than expected by between 20% and 24% between J23- J25 indicating that the impact on the noise climate is likely to be better than expected between J23-25, but as expected between J24-25 anti-clockwise. Noise impacts for J22-23 and J27-28 are also considered to be as expected. No post opening traffic flows are available for J25-27 and as such the impact on this section has not been assessed.
- The percentage differences between forecast and observed traffic flows are considered significant, and impacts on local air quality are likely to be better than expected between J23-25, and as expected between J22-23 and J27-28. No post opening traffic flows are available for J25-27 and as such the impact on this section has not been assessed.
- As expected, there has been a net increase in carbon emission from M25 traffic. However due to lower than expected traffic in the opening year, a lower increase than expected has occurred.
- As expected there has been a slight adverse effect on landscape. Although there are local variations in the effects expected, there is no reason to assume that the design changes made after the original appraisal have materially changed the expected landscape or visual amenity effects of the scheme overall.
- As expected, townscape features have not been affected by the scheme.
- It is considered that the reduction in highway infrastructure between the original assessment and the final design has not significantly altered the predicted overall slight adverse impact of the scheme on the landscape setting of the designated heritage assets. The screening and integration functions of the planting proposals with respect to heritage assets are likely to be more apparent, and should be reconsidered, at the FYA stage.
- No archaeological information relating to the additional landscape bunds at Holly Hill Farm and Skinners Farm has been made available for the purposes of this evaluation. More information should be available in popular and academic archaeological reports relating to the scheme which should have been published by the Five Years After (FYA) stage.
- Changes in vegetation clearance and proposed planting brought about by the final design are considered unlikely to have materially changed the original appraisal of the scheme on habitat. In the absence of post-

opening information, it is not possible to fully evaluate the effects of the scheme on species or habitat at this stage of the POPE process; however, these aspects should be considered further at FYA when the quarterly aftercare inspections and reports are likely to be available.

- There is no evidence to suggest that the facilities are unable to function in any way other than as expected, but further detail, such as as-built drainage drawings, would be required to confirm at the FYA stage.
- As expected, as there has been no reduction or increase in the degree of severance of the Public Right of Way (PRoW) network and no direct changes to the existing Non-Motorised User (NMU) facilities or routes.

Summary of Scheme Economic Performance

All monetary values in £ million 2002 market prices, discounted		Forecast	Outturn re-forecast
Present Value Benefits	Journey Times	628.6	523.9
	Vehicle Operating Costs (VOC)	-186.9	-129.2
	Construction period & Future maintenance periods	-193.3	-193.3
	Safety	45.3	*
	Carbon	-159.2	-96.9
	Noise	-1.3	-1.3
	Air Quality	0.0	0.0
	Indirect Tax	172.9	119.6
	Total	306.1	222.6
Present Value Costs (including operational costs)		145.0	123.8
Benefit Cost Ratio (BCR)		2.1	1.8

*Safety benefits not included as not statistically significant at this stage

Benefits

- Benefits from journey time savings were forecast to be large and provide the majority of the monetised benefits. Outturn journey time benefits are around 16% lower, but this is based on analysis of only part of the scheme section. As such it is too early to be confident in the trends observed over only one year to be indicative of long term trends.
- The lower journey time benefits result from the lower than forecast vehicle hours saved which is mainly due to lower traffic flows than predicted which are also around 16-20% lower. The lower than forecast flows do help offset the reduction in total benefits, with lower disbenefits from Vehicle Operating Costs and changes in carbon.
- The monetary benefits of the savings in the number of injury collisions is higher than forecast. However, this has not been included in the total benefits at this stage as the result is not statistically significant.
- Disbenefits from the delay during construction period and maintenance of the technology in future years were forecast to be high at £193.3million; however, this has not been recalculated and is assumed to be the same as forecast.
- The monetisation of the Carbon impact of the scheme was forecast to be a large disbenefit (-£159.2million) due to the increase in emissions, but the outturn evaluation is less negative at -£96.9million, due to the lower traffic volumes.
- Vehicle Operating Costs (VOC) which were forecast to be a disbenefit for road users and Indirect tax revenue impact which was expected to be a benefit for the Government have both been evaluated to be lower than forecast, again due to the lower than forecast traffic volumes.
- Other monetised benefits are roughly as expected.
- Reliability monetary benefits from the reduction in incident related delay were high in the appraisal. Based on the information currently available to POPE, journey time variability has improved, and a rerun of the model suggests the outturn reliability benefits could be higher than forecast.

Cost

- The investment cost of building the scheme was £121 million (non-discounted in 2002 prices), which was 24% lower than forecast.

- Long term costs of operating the smart motorway are assumed to be as forecast at £22.8million.
- The present value costs in discounted 2002 prices are 123.8million (£101million investment cost and £22.8 operating costs)

Benefit Cost Ratio

- The outturn BCR of 1.8 is slightly lower than the forecast BCR of 2.1. The outturn BCR of 1.8 is categorised as medium Value for Money. Despite the lower than forecast costs, there are lower outturn benefits which are mainly due to lower than forecast flows. Statistically insignificant safety benefits have not been included in the outturn BCR which also contributes to the reduction to BCR.
- Forecast and outturn reliability benefits have not been included in the overall benefits for the purpose of calculating BCR, in line with webTAG guidance.

1. Introduction

1.1. M25 J23-27 Smart Motorway is a Highways England major scheme which was completed in two stages, J23 to J25 opening in April 2014 and J25 to J27 opening in November 2014.

1.2. This report presents a One Year After (OYA) opening evaluation of the whole scheme between J23 and J27 and has been prepared as part of the Highways England Post Opening Project Evaluation (POPE) programme. The purpose of this report is to present the initial impacts of the scheme in the one year after opening.

1.3. This POPE study compliments the 12 month Smart Motorway Monitoring Evaluation Report published in February 2016. Traffic flow and safety analysis from that study has been used in this POPE report, but this report does not cover the in-depth operational analysis of the smart motorway. POPE reporting covers a wider scope of evaluation against the forecasts including economic and environmental impacts.

Scheme Context

1.4. The Smart Motorway All Lane Running (SM-ALR) scheme, M25 J23 to J27, is part of the key strategic orbital route around London which forms the hub of the English motorway network; it is also a commuter route for local traffic. It is within the counties of Hertfordshire, Essex and the Greater London Authority and located in the northern segment of the M25. J23 is the intersection with the A1(M) and J27 the intersection with the M11. The SM-ALR scheme encompasses two tunnels, Holmesdale located between J25 and J26 and Bell Common located between J26 and J27.

1.5. As part of the strategic national corridor and one of Europe's busiest motorways, vehicle demand on the M25 is high, placing pressure of the network and leading to congestion and unpredictable journey times especially during peak hours.

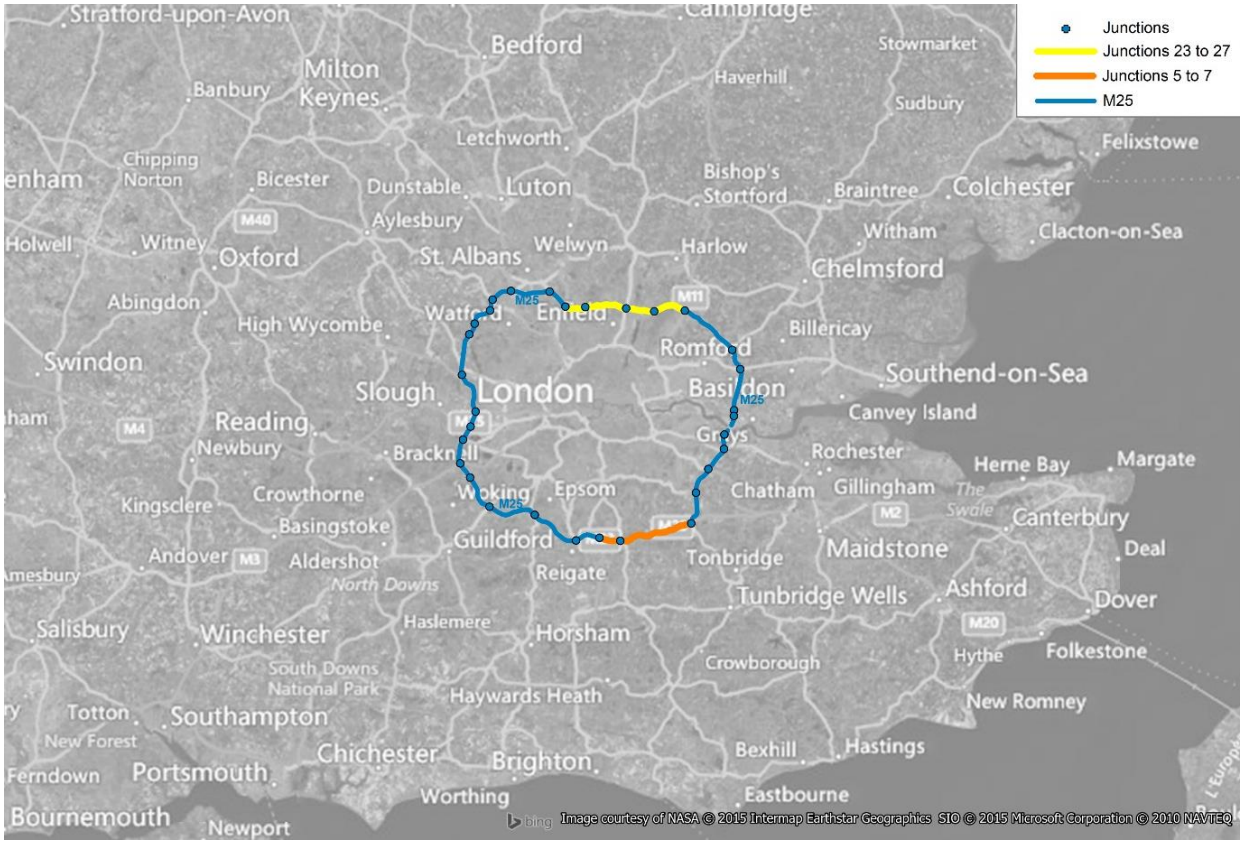
1.6. The strategic case for providing additional capacity on the M25 was examined in the early part of the last decade. This was to widen the remaining 3 lane sections to 4 lanes and was split into 5 sections for construction purposes. Three of these sections were built as widening schemes and opened between 2008 and 2012. In more recent years, however, proposals to widen the physical extents of motorways have been curtailed, with Smart Motorway schemes becoming the preferred option for increasing route capacity. The sections between J5-7 and J23-27 were together known as the Later Upgraded Sections (LUS). In January 2009, the Department for Transport (DfT) announced that the LUS sections would be taken forward as Dynamic Hard Shoulder Running (DHSR) schemes in place of widening to four lanes.

1.7. DHSR, also referred to as Managed Motorway HSR and now as Smart Motorway, makes use of the existing hard shoulder to provide the additional lane capacity during times of heavy congestion or during incident management. This is achieved by providing gantry mounted signals and variable message signs from a Controlled Motorway system to provide dynamic control of the use of the hard shoulder as a running lane together with emergency refuge areas (ERAs) for stopped vehicles. As a result of development of the scheme plans and developments in managed motorway guidelines, the proposed scheme changed to make this section 4 lanes through the permanent conversion of the hard shoulder to a running lane under the Controlled Motorway system. This is now termed an All Lane Running (ALR) scheme.

Location

1.8. The section of the M25 between J23-27 lies to the north of London. ***Figure 1-1*** shows the location of this scheme and the other M25 LUS within the regional context.

Figure 1-1 Locations of the Later Upgraded Sections of M25



Scheme Description

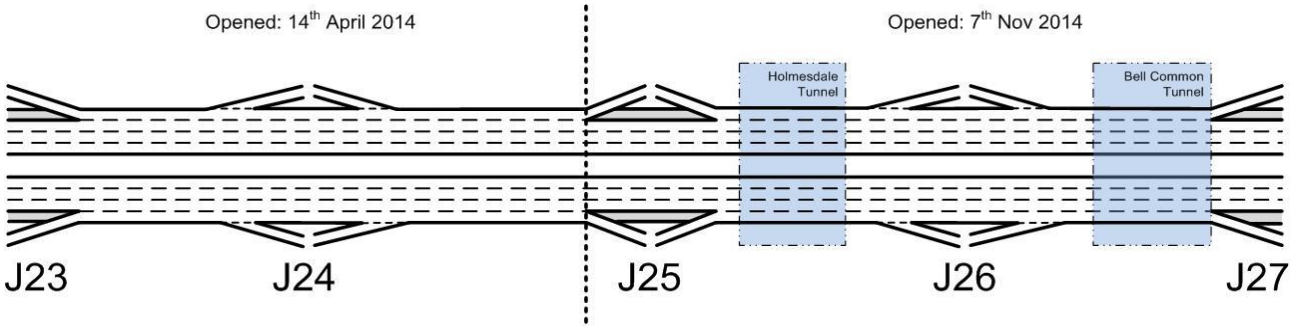
1.9. SM-ALR is a controlled four lane carriageway with no hard shoulder. This is supported by technology in the form of Motorway Incident Detection and Automatic Signalling (MIDAS) traffic detection and traffic control. The signs and signals can be controlled by operators and by automatic algorithms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

1.10. It should be noted that the M25 J23 to J27 SM-ALR scheme was opened in two stages, J23 to J25 opening in April 2014 and J25 to J27 opening in November 2014.

1.11. The scheme improved 16 miles (26km) of the M25 and involved:

- Conversion of the hard shoulder for use as a permanent traffic lane.
- Introduction of enhanced on-road technology to manage traffic flow.

Figure 1-2 Schematic of the Key Features of Scheme



Scheme Objectives

Transport Problems

1.12. The transport problems which necessitated the scheme, outlined in the Client Scheme Requirements were:

- Traffic flows along the section of the M25 between J23-J27 varied between 58,000 and 70,000 vehicles per day on average during 2010 in each direction depending upon location. The percentage of heavy vehicles that were over 5m in length often exceeded 20% which reflected use by a large proportion of heavy goods vehicles.
- On each carriageway, hourly traffic flows exceeded the flow instability point of 85% of the nominal 6000 vehicles per hour capacity on an average of more than 2.8 hours during a day during 2010. Traffic flows were above 50% capacity for between 13 and 14 hours each day.
- The collision rate between 2008 and 2010 was 0.066 Personal injury collisions per million vehicle kilometres and the resultant casualty rate was 0.101 per million vehicle kilometres.

Defined Objectives

1.13. The objectives of the scheme, summarised from the Client Scheme Requirements were:

- To reduce congestion and to develop solutions that provide additional capacity, increase journey time reliability and ensure the safe and economic operation of the motorway
- To improve journey time reliability by improving and better managing traffic flow conditions.
- To achieve a safety objective under which the "after" collision numbers (per annum) are no greater than those in the "before" and the severity ratio is not increased.
- To make best use of existing infrastructure providing additional capacity within the existing highway boundary, other than in exceptional circumstances.

- Minimise detrimental environmental effects of the SM scheme by mitigation measures, taking account of costs, availability of funding and statutory obligations.
- Improve the currency and quality of information provided to drivers about the state of traffic flow on the motorway
- To support and enhance the current role of M25 as a major national and inter-urban regional transport artery.
- To maximise the return on public investment.

History

1.14. A brief history of the key events in the development of the scheme is provided in ***Table 1-1***.

Table 1-1 Timeline of M25 J23-27 improvement

Date	Summary
2002/3	London Orbital Multi-Modal Study (ORBIT MMS), looked at operational issues on the M25. As a result, the strategy set by the Secretary of State was: - Widening of M25 would be pursued - Measures to include improvement of the management of traffic flow, in order to lock in the benefits of widening further investigation be carried out on how measures such as ramp metering and other technologies could be used to reduce congestion
2004	Schemes to widen **M25 J5-7 (Section 2)** and **J23-27 (Section 5)** included in Targeted Programme of Improvements programme TPI.
2009	Schemes for **Sections 2 and 5** known as the **M25 Later Upgraded Sections (M25 LUS)** to be taken forward as Dynamic Hard Shoulder Running schemes (DHSR) as assessment had shown that this would provide additional road capacity and be more economically viable than widening.
	M25 J23-27 (Section 5)
2010	M25 J23 to 27 Managed Motorway scheme was one of the schemes identified in the Spending Review 2010.

2011	New guidance on Smart Motorways stated that for schemes under development, DHSR was to be replaced by Managed Motorway All Lanes Running (MM-ALR), therefore this option was assessed in the appraisal of the J23-27 scheme.
February 2013	Start of works for M25 J23-27 SM ALR
April 2014	Completion of J23-25 SM ALR
November 2014	Completion of J25-27 SM ALR

1.15. The other LUS scheme, M25 J5-7 (Section 2) SM was also constructed and opened in April 2014.

1.16. The evaluation in this report takes into account this timeline to ensure that the analysis compares the changes between before and after the Smart Motorway was built, excluding the impact of its construction period.

Overview of POPE

1.17. Highways England are responsible for improving the strategic highway network (motorways and trunk roads) through the Major Schemes programme. At each key decision stage through the planning process, schemes are subject to a rigorous appraisal process to provide a justification for the scheme's continued development.

1.18. When submitting a proposal for a major transport scheme, the DfT specifies that an Appraisal Summary Table (AST) is produced which records the degree to which the Government objectives for Transport grouped under the categories, Economy, Environmental, Social and Public Accounts.

1.19. The contents of the AST allow judgements to be made about the overall value for money of the scheme. The AST for this scheme is presented in Appendix A of this report.

1.20. POPE studies are carried out for all Major Schemes to evaluate the strengths and weaknesses in the techniques used for appraising schemes. This is so that improvements can be made in the future. For POPE, this is achieved by comparing information collected before and after the opening of the scheme, against predictions made during the planning process. The outturn impacts of a scheme are summarised in an Evaluation Summary Table (EST) which summarises the extent to which the objectives of a scheme have been achieved. The EST for this scheme can be found in Appendix A of this report.

Contents of this Report

1.21. Following this introduction, the report is divided into six further chapters as follows:

- Chapter 2 – Traffic Impact Evaluation
- Chapter 3 – Safety Evaluation
- Chapter 4 – Economic Evaluation
- Chapter 5 – Environmental Evaluation
- Chapter 6 – Accessibility and Integration Evaluation
- Chapter 7 – Conclusions
- Appendix A – Appraisal Summary Table (AST) and Evaluation Summary Table (EST)
- Appendix B – Environment
- Appendix C – Tables and Figures in this Report
- Appendix D – Glossary

2. Traffic Impact Evaluation

Introduction

2.1. In order to evaluate the traffic flow, journey time and reliability impacts of the scheme, the following section reports on:

- Sources
- Summary of the traffic modelling approach and forecast assumptions
- Background traffic changes
- Observed traffic volume changes
- Traffic Flow forecasting accuracy
- Journey time changes on the M25
- Journey time changes forecasting accuracy
- Operation of the Smart Motorway
- Reliability impacts

Sources

2.2. The analysis of traffic in this section of the report is based on data collected from the following sources.

- Operation of the Smart Motorway
  - Highways England's HALOGEN (Highways England Logging Environment) data[1]. This is a record of the signs displayed on the overhead gantries for the smart motorway. The data can be used to determine the different speed limits in place as part of the variable speed limit (queue protection) used in Smart Motorways.
- Traffic volumes and classifications
  - Highways England's TRADS (Traffic Flow Data System) database for motorway locations and adjacent A roads
  - Radar data for the M25 J23-27 sourced from MIDAS
  - DfT data on national and regional traffic levels
  - Count data commissioned on adjacent roads
- Traffic speeds and journey times
  - Highways England's MIDAS data[2]
  - Journey time data was obtained from sat-nav[3] data from vehicles using the M25 along the full length of the scheme in the year before start of construction and year following completion.

2.3. Documents which have been sourced for the background to the traffic modelling and forecast traffic impacts are:

- M25 DBFO LUS Traffic Forecasting Report – Section 5 (July 2012), (TFR)

2.4. The report has been prepared to be read in conjunction with the SM-ALR M25 J23-27 Twelve Month Evaluation Report (January 2016). This report noted that this scheme is one of the first to use radar detectors as opposed to the inductive loops that have traditionally been used. The radar technology has been found to provide less accurate results than might be expected, with inconsistencies between the traffic counts of adjacent detector locations. The inconsistencies in

[1] Halogen data is available from Highways England and can be downloaded for the message screens displayed on overhead gantries forming part of a smart motorway scheme. The data can be used to determine when, and for how long, the hard shoulder was open for traffic and the different speed limits in place as part of the variable speed limit (queue protection) used in Smart Motorways.
[2] MIDAS data available from Highways England provides lane by lane traffic flows and speeds. MIDAS technology forms part of the Smart motorway operation, but records of lane by lane speeds and flows, together with the settings from the overhead gantries from Halogen data (i.e. whether the hard shoulder is open and what speed the Variable Mandatory Speed Limit is operating at) can provide additional insight into the operation of the Smart Motorway. As this data forms part of the Smart Motorway, it is not possible to perform a pre and post analysis.
[3] Drivers who use satellite navigation devices have the option to voluntarily allow anonymous data about their journeys to be collected and used to provide a range of services, including the analysis of historic journey times along specific routes.

detector outputs between J25 and J27 were so great that no analysis has been performed for this section.

Scheme Modelling and Forecast Assumptions

2.5. The scheme modelling was based on the M25 Assignment Model in SATURN.

2.6. Full variable demand modelling (VDM) approach was used in developing the future year matrices in the highway model of this scheme.

2.7. Modelling for this scheme was done at the same time as for the other LUS scheme (J5-7) known as section 2, and scenarios included all combinations for with and without each LUS scheme. Do Minimum (DM) modelling presented here included all other expected schemes on the network including local authority schemes as of early 2011. The Do Something (DS) model included the same schemes as the DM except the smart motorway on J5-7 and J23-27.

2.8. Traffic modelling had a base year of 2004, and three forecast years: 2015 (opening year), 2030 (design year) and 2040 (horizon year).

2.9. The time periods modelled were AM peak hour (08:00-09:00), average inter peak hour (10:00-16:00) and PM peak hour (17:00-18:00).

2.10. It was developed using NTEM (National Trip End Model) 6.2 central dataset (July 2011 definitive version) for car and public transport demands. The economic parameters were derived from WebTAG 3.5.6 released in April 2011. Growth for goods vehicles (LGV and HGV) was derived from NTM (RTF09).

2.11. Additional sensitivity tests were undertaken as detailed in the TFR using RTF2011 which had just become the current guidance at the time the traffic forecasts were being finalised. The conclusions from the sensitivity tests were that there was a marginal increase in LGV and HGVs and 0.2% more traffic in the opening year but it was not expected to have any significant effect on the economic appraisal.

2.12. The modelled area in SATURN included the entire area within the M25 and an area bounded approximately by Luton, Reading, Guildford, Crawley, Maidstone, Chelmsford and Stansted, covering all motorways, A and B roads, as well as important unclassified roads. This is a large area which is beneficial for ensuring that re-assignment can be fully considered, but may also lead to unlikely impacts well away from the scheme itself.

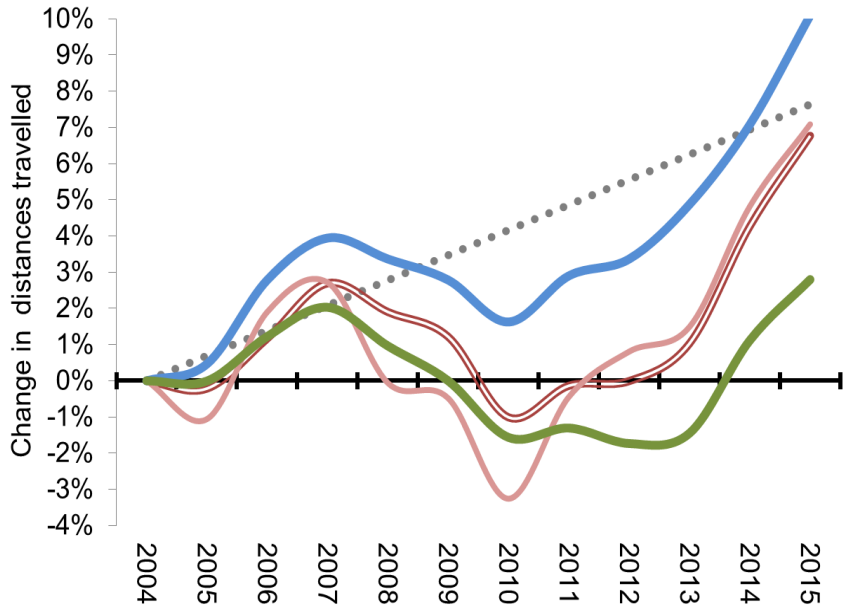
Background Changes National, Regional Traffic Trends

2.13. Historically in POPE scheme evaluations, the ‘before’ counts have been factored to take account of background traffic growth so that they are directly comparable with the ‘after’ counts. This usually involves the use of National Road Traffic Forecasts (NRTF), with local adjustments made using National Transport Model (NTEM) Local Growth Factors.

2.14. However, in light of the recent economic climate, which has seen widespread reductions in motor vehicle travel in the UK as a whole since 2008, it is no longer deemed appropriate to use this method of factoring ‘before’ counts to reflect background changes in traffic. Rather, recent POPE studies have taken a more considered approach in order to assess changes in the vicinity of the scheme, within the context of national, regional and locally observed background changes in traffic.

2.15. The best measure of the wider trends in overall traffic levels both regionally and nationally is shown in DfT annual statistics for total distance travelled (million vehicle kilometres). ***Figure 2-1*** shows the changes by year in the period from 2004 (base year in forecasting), 2011 (pre-construction) and 2015 (the latest available) for the region in which it lies, and motorways managed by Highways England, and for England as a whole. Also shown here is the growth rate from NTEM 6.2 as used in the traffic forecasts.

Figure 2-1 National and Regional Trends[4]



From 2011-2015	2011	2012	2013	2014	2015
Motorways	0%	0%	2%	4%	7%
England	0%	0%	0%	2%	4%
East of England	0%	0%	1%	4%	7%
Hertfordshire	0%	1%	2%	5%	8%
NTEM 6.2	0%	1%	2%	3%	5%

2.16. The key points regarding the wider trends in recent years are:

- From 2011 (when the traffic forecast modelling was undertaken) up to 2014, motorways nationally have shown growth of traffic in line with NTEM forecast over the period.
- Overall traffic levels in England have been lower than the forecast and this is largely due to traffic trends during 2011/12 which are associated with the economic downturn.

2.17. The observed traffic flows presented in the traffic analysis in this chapter are as recorded in the before construction and post opening periods and have not been adjusted for the background trend of net growth of traffic seen regionally on all roads and nationally on motorways in the years between 2012 and 2015. However, actual traffic growth over this period is around 5%, so this should be considered when interpreting these results.

Traffic Volumes before and after scheme construction

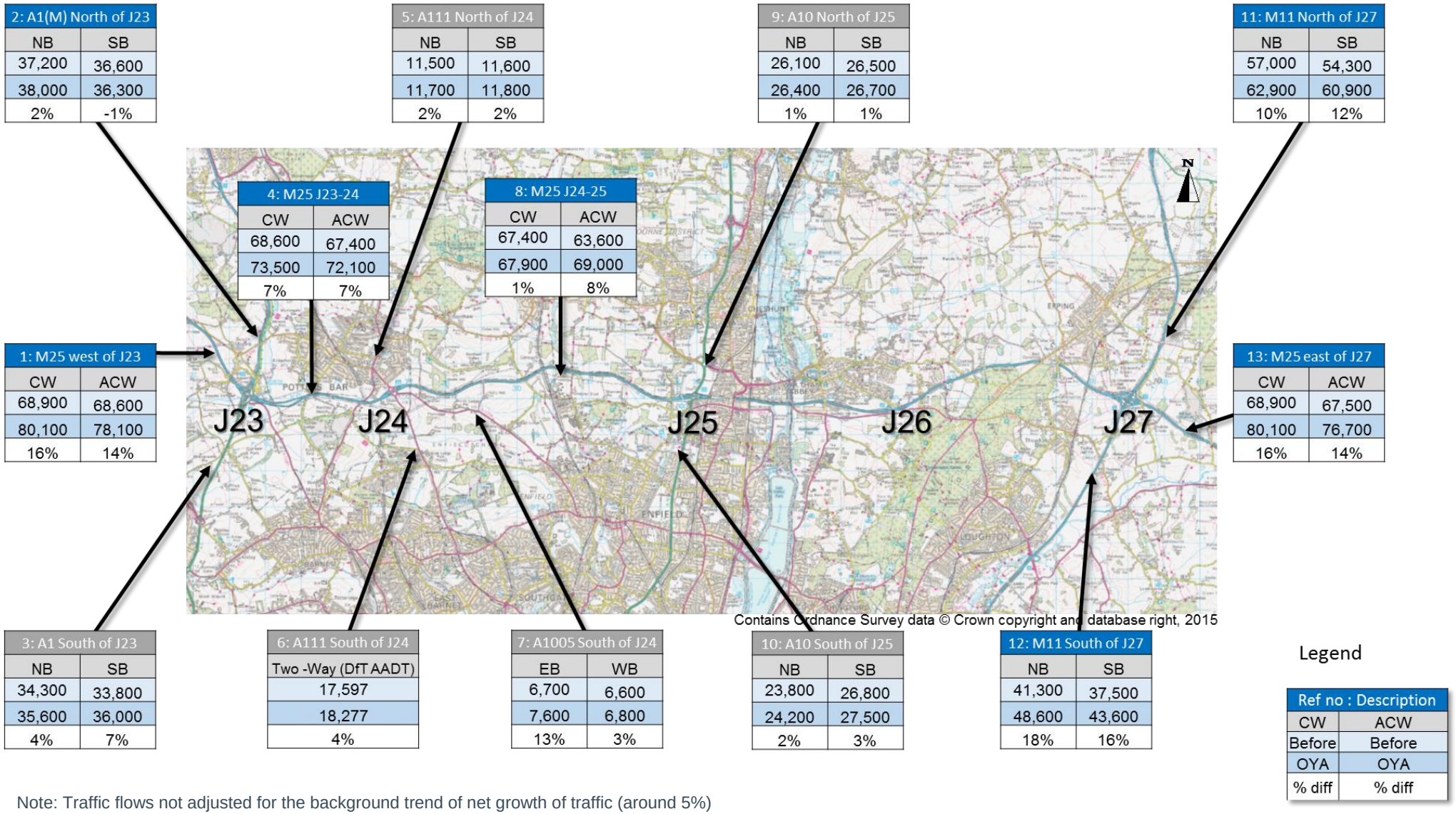
2.18. Weekdays traffic flows have been analysed for the M25 through the scheme and for the other motorways and 'A' roads at M25 J23, J24, J25 and J27. The results for the Average Weekday Traffic (AWT) flows on the links are presented in ***Figure 2-2***.

2.19. The key points shown for the weekday traffic flows on the M25 and adjacent roads are:

- The SM-ALR sections have experienced average weekday traffic growth of on average 6% between the before and after periods (in line with expected background growth), with most directions in sections seeing growth of between 7 and 8%. Only the J24 to J25 clockwise link appears to have seen lower growth, however this result is unexpected and could be the result of drivers being slow to return after the period of roadworks for construction of the scheme, or an anomaly with the traffic data.
- Flows on the M25 upstream and downstream of the scheme have seen higher increases than the background trends, as have flows on the M11 which connects onto the eastern end of the scheme.
- Generally flows on the local adjacent roads to the south of the scheme have seen larger increases than those to the north.

[4] Graph based on data in DfT tables TRA8904 and TRA4112

Figure 2-2 Average Weekday Traffic (AWT) flows on M25 and other adjacent links before (2012) and after (2015)



Note: Traffic flows not adjusted for the background trend of net growth of traffic (around 5%)

HGV traffic flows

2.20. Analysis of HGV levels is through vehicle classification by length, in which a HGV is classed as a vehicle over 6.6m in length. Due to technical limitations of the traffic counting at sites through the scheme, the scheme section HGV classification is not sufficiently accurate and cannot be analysed on this occasion.

Traffic Flow forecasting accuracy

2.21. Justification of the scheme was based on detailed forecasting of the traffic impacts. We will now compare the observed traffic impacts with those forecast. As noted earlier (page 14), the final detailed traffic flow forecasts were modelled for the central growth option only using TEMPRO and NTEM 6.2 and for opening year of 2015.

2.22. As the modelled opening year was 2015 for the Do Minimum (DM) and Do Something (DS) scenarios, for comparisons with observed traffic data from before start of construction in 2012, we have created proxy forecasts for 2012 DM data to compare against observed pre-scheme data. The adjustment was made using factors from TEMPRO 6.2 for the East of England region.

2.23. ***Table 2-1*** shows the accuracy of the modelling before and after construction for the M25 within the scheme (emphasised in pale green) and adjacent sections. Forecast flows are Annual Average Daily Traffic (AADT) and observed flows are Average Daily Traffic (ADT) for a neutral month (October).

Table 2-1 Daily Traffic flow on M25: Forecast and Observed

Map ref	Location	Dir	Without Scheme 2012			With Scheme 2015			Increase with scheme*	
			Forecast DM	Observed	% diff	Forecast DS	Observed	% diff	F'cast	Obsv'd
1	M25 J22-23	CW	78,300	67,800	-13%	85,200	76,800	-10%	9%	13%
		ACW	72,000	66,100	-8%	78,000	75,300	-3%	8%	14%
4	M25 J23-24	CW	79,600	64,400	-19%	91,600	70,000	-24%	15%	9%
		ACW	77,000	63,400	-18%	87,400	69,000	-21%	14%	9%
8	M25 J24-25	CW	72,900	62,700	-14%	84,600	64,600	-24%	16%	3%
		ACW	71,600	59,500	-17%	82,400	66,100	-20%	15%	11%
13	M25 J27-28	CW	70,700	65,400	-7%	75,000	75,900	1%	6%	16%
		ACW	70,700	64,200	-9%	75,000	73,300	-2%	6%	14%

* Difference between 2012 DM and 2015 DS including net impact of scheme and wider trend of traffic growth

2.24. The key points regarding the accuracy of the forecasts for the scheme and adjacent M25 sections as shown in ***Table 2-1*** are:

- Traffic flows in 2012, before the start of construction were also lower than forecast (DM scenario) by an average of 17% within the scheme. This discrepancy before construction explains most of the gap between the forecast and the observed post opening flows. The inaccuracy of the DM forecasts suggests that the modelling of the traffic growth from the base year of 2004 to 2012 did not account for the impact of the recession on traffic flows during this period.
- With the scheme in place, post opening traffic flows are also lower than forecast (the DS scenario) by between 20% and 24% within the scheme length, averaging 22% lower.
- Traffic was forecast to increase on the sections of the M25 within this scheme by on average 15%, which were higher rates than forecast on the adjacent sections; what has been observed is that growth is slightly lower, on average 8%, and lower growth than that seen on the adjacent sections.

2.25. The impact of the recession on traffic flows compared with predicted growth from the base year of 2004 to 2012 is highlighted in Figure 2-1 which shows the difference between 2012 predicted growth and the lower actual growth.

2.26. ***Table 2-2*** shows the accuracy of the traffic flow forecasts for adjacent sections of motorway and 'A' roads.

Table 2-2 Daily Traffic flow on adjacent roads: Forecast and Observed

Map ref	Location	Dir	Without Scheme 2012			With Scheme 2015			Increase with scheme*	
			Forecast DM	Observed	% diff	Forecast DS	Observed	% diff	F'cast	Obsv'd
2	A1(M) North of J23	NB	44,900	34,400	-23%	46,400	34,700	-25%	3%	1%
		SB	38,700	34,100	-12%	40,800	34,400	-16%	5%	1%
3	A1 South of J23	NB	39,200	31,600	-19%	40,400	33,100	-18%	3%	5%
		SB	36,000	31,200	-13%	37,600	34,100	-9%	4%	9%
5	A111 North of J24	NB	11,900	11,200	-6%	12,900	11,300	-12%	8%	1%
		SB	12,200	11,300	-7%	12,400	11,500	-7%	2%	2%
7	A1005 South of J24	NB	9,000	6,300	-30%	9,200	7,100	-23%	2%	13%
		SB	7,500	6,100	-19%	7,800	6,300	-19%	4%	3%
10	A10 South of J25	NB	29,200	23,200	-21%	30,500	23,600	-23%	4%	2%
		SB	28,900	26,100	-10%	30,600	26,900	-12%	6%	3%
11	M11 North of J27	NB	60,200	54,700	-9%	62,200	60,500	-3%	3%	11%
		SB	55,900	52,900	-5%	57,700	59,200	3%	3%	12%
12	M11 South of J27	NB	40,600	39,300	-3%	42,400	46,400	9%	4%	18%
		SB	35,300	36,300	3%	36,600	42,600	16%	4%	17%

* Difference between 2012 DM and 2015 DS including net impact of scheme and wider trend

2.27. The key points regarding the accuracy of the forecasts for the adjacent motorways and 'A' roads are:

- Traffic flows on the A1(M) and A1 are lower than expected but this is similar for both the pre-construction and one year after opening flows.
- The observed traffic flows on the M11 are generally higher than forecast with the scheme in 2015, and the observed increases are much higher than the predicted forecast increases. These M11 increases are however comparable to patterns observed in the adjacent section of the M25 between J27-28 to the east of the scheme.

Journey Time Analysis

2.28. This section considers the impact on journey times following the scheme's implementation. Pre-scheme journey times along the M25 are compared with post-opening journey times for both directions as recorded by sat-nav devices in vehicles using the route.

2.29. The journey time analysis is split into three components:

- Analysis of pre and post-scheme journey time differences along the scheme.
- A comparison of forecast and outturn journey times along the scheme.
- A comparison of journey time reliability pre-scheme and post-opening.

Observed Journey Times before and after

2.30. Data was obtained for the pre and post-construction periods in the AM, Inter-peak (IP) and PM peak periods as follows:

- Before: Nov 2012 – April 2013
- After: Nov 2014 – April 2015

2.31. The time periods examined (which are those used in the 12 month evaluation report) are as follows:

- Monday – Thursday:
  - AM: 05:30 – 10:30
  - IP: 10:30 – 15:00
  - PM: 15:00 – 20:00
- Friday:
  - AM: 05:00 – 09:00
  - IP: 09:00 – 13:00
  - PM: 13:00 – 20:00
- Saturday and Sunday:
  - Peak: 08:00 – 20:00

2.32. ***Figure 2-3*** and ***Figure 2-4*** show the mean of the times observed between the junctions in the above time periods and each direction through the scheme.

2.33. Note that the journey times here are measured between the mid-points of the junctions on the mainline carriageway.

Figure 2-3 M25 J23 – 27 Clockwise Journey Time Comparison

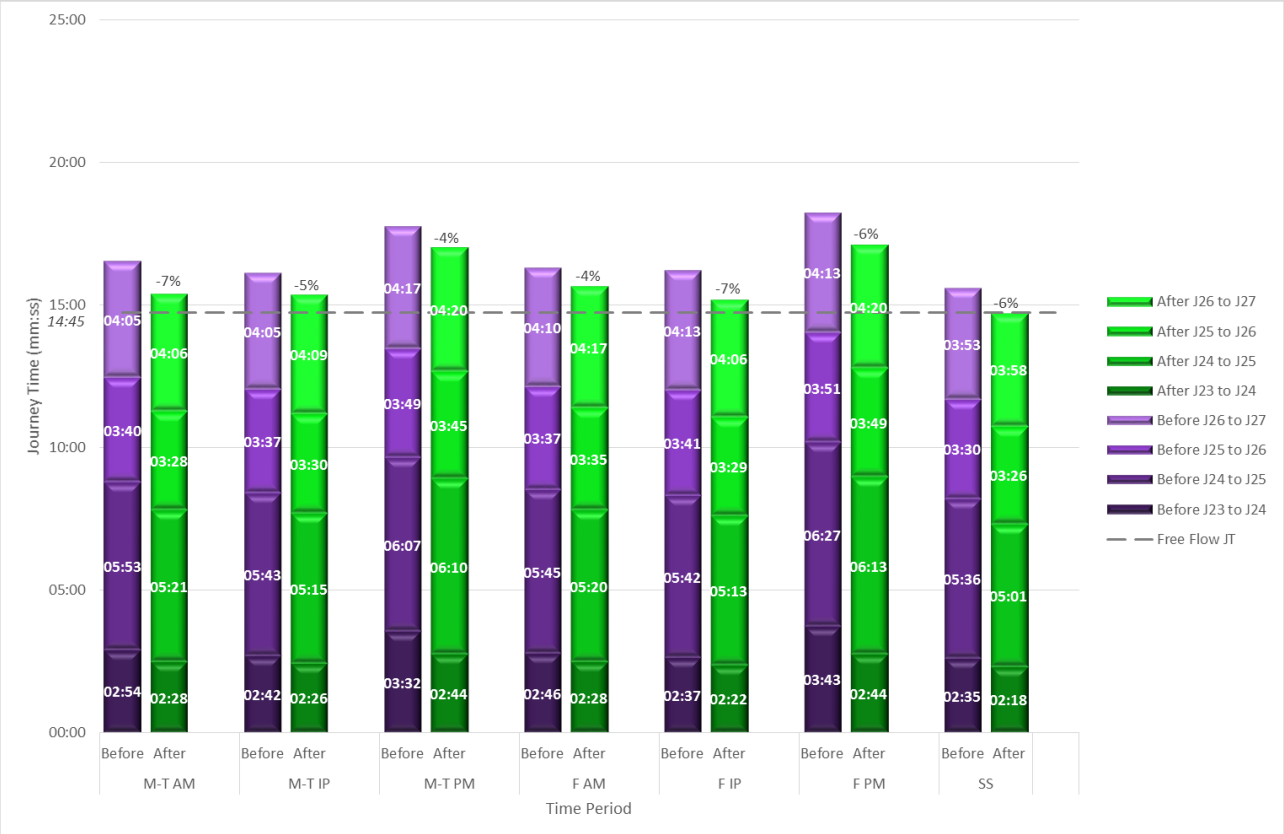
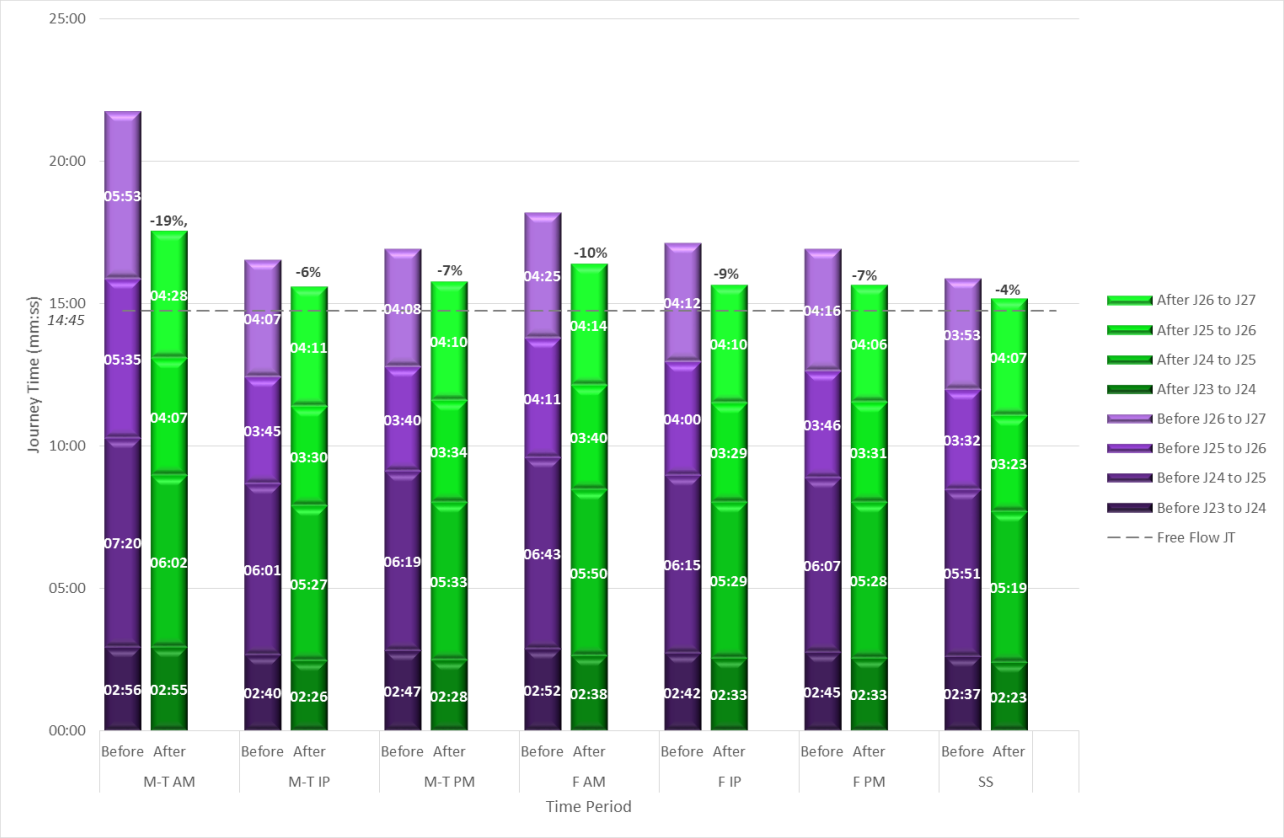


Figure 2-4 M25 J23 – 27 Anticlockwise Journey Time Comparison



2.34. These results presented in ***Figure 2-3*** and ***Figure 2-4*** demonstrate positive findings, with all time periods experiencing time savings in all time periods and both directions. Anticlockwise journey times have improved by 9% overall. The weekday AM peak journey time has seen the highest improvement with a 19% reduction in journey time, equating to a reduction of over 4 minutes on average. Journey time improvements in the clockwise direction is in the range of 4-7%.

Speed by Distance Analysis

2.35. The average journey time impacts show journey time savings in all time periods, particularly in the most heavily delayed periods in the before but much smaller impacts in all other time periods. To understand where the journey times have improved, analysis of average speed along the scheme has been carried out.

2.36. ***Table 2-3, Table 2-4*** and ***Table 2-5*** on the following pages show the average speed every 100m along the scheme by time period. Junction numbers are shown so it can be seen where performance improvements have been made and whether they relate to on- or off slip locations. When the after line is above the before line, journey time improvements are being shown.

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Table 2-3 Speed over Distance before and after M25 J23-27: Monday-Thursday

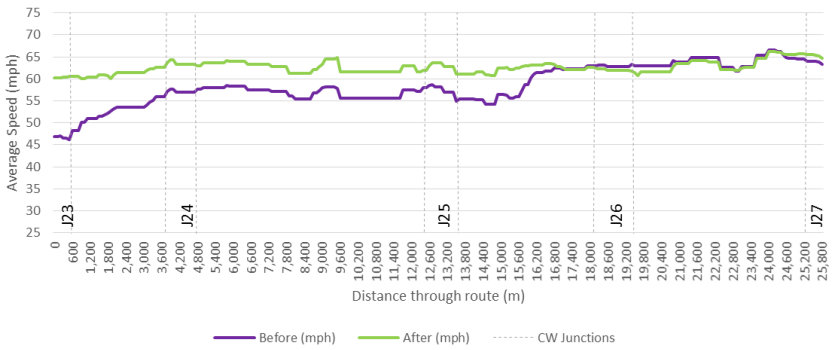
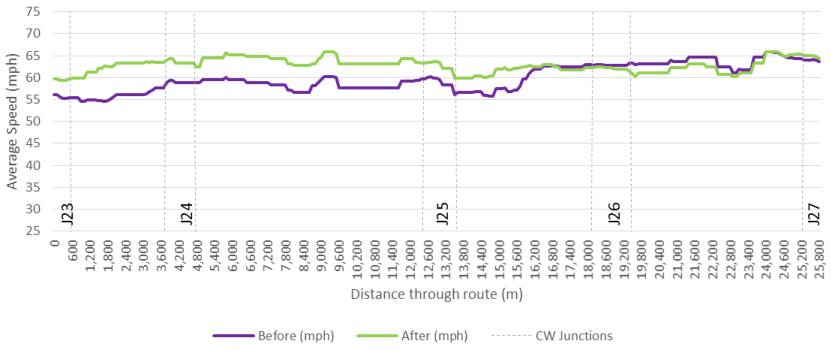
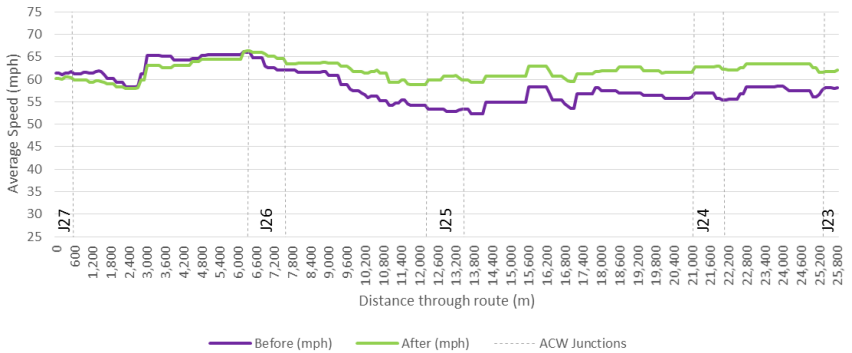
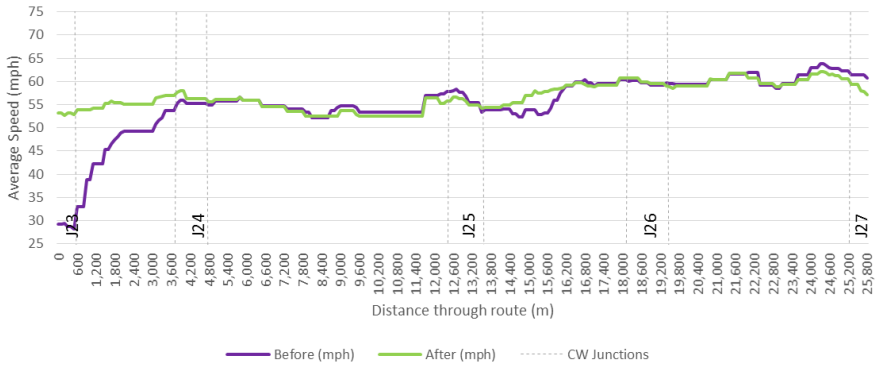
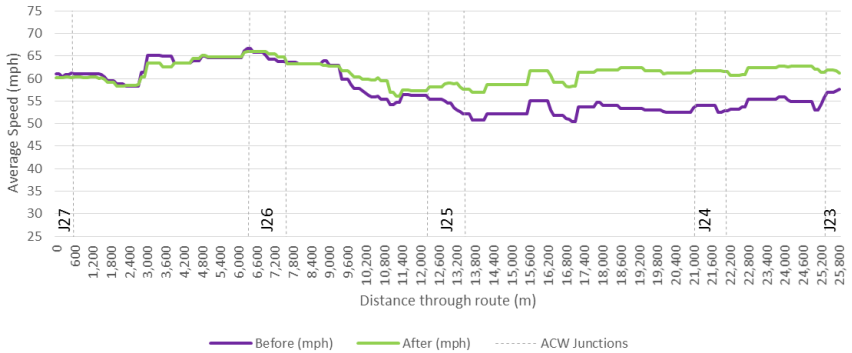
	Clockwise	Anticlockwise
AM		
IP		
PM		

Table 2-4 Speed over Distance before and after M25 J23-27: Fridays

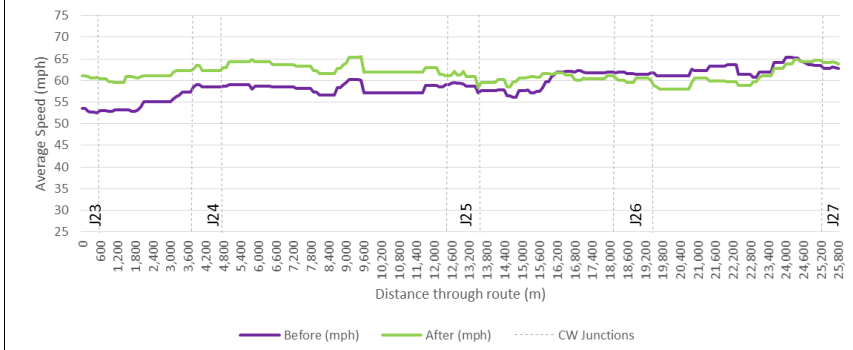
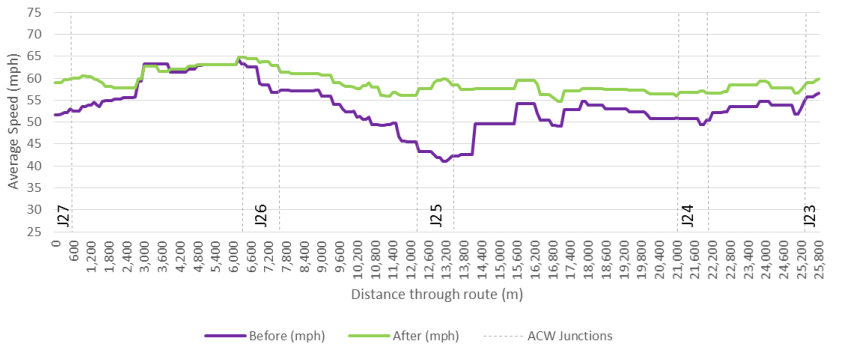
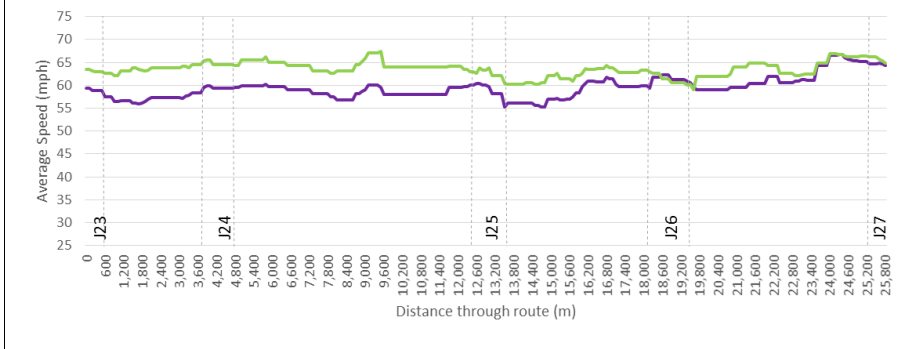
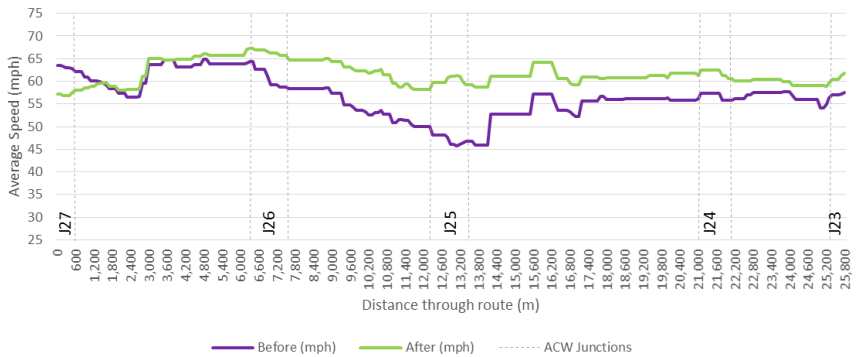
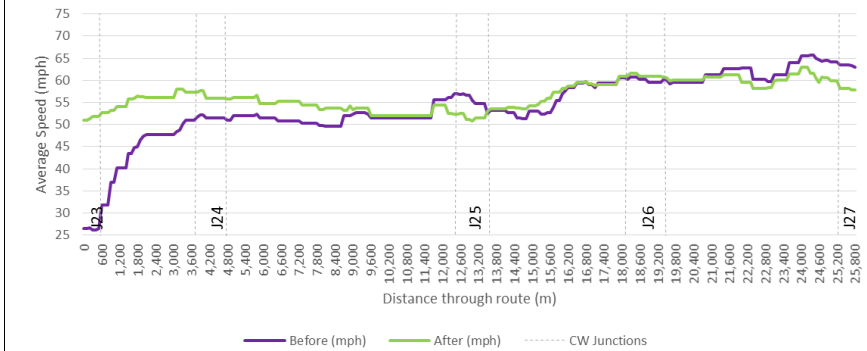
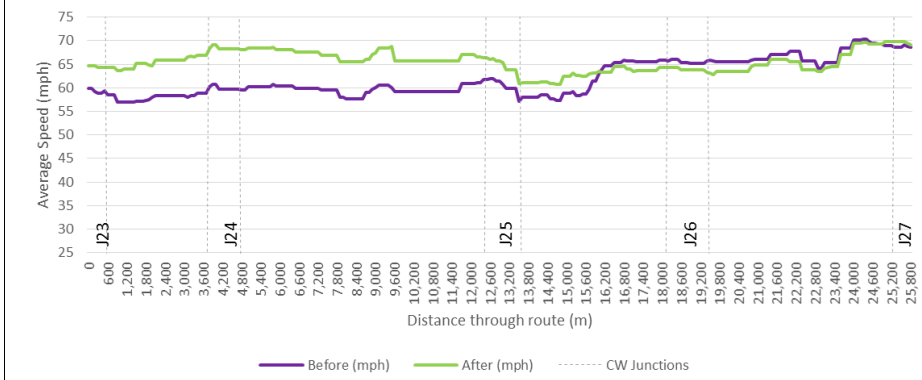
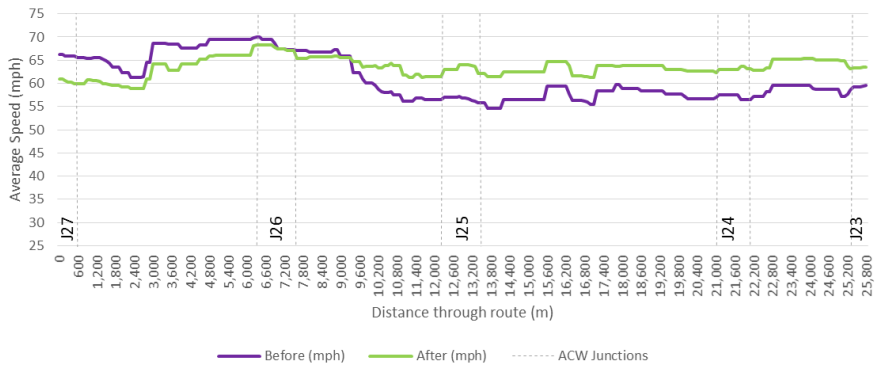
	Clockwise	Anticlockwise
AM		
IP		
PM		

Table 2-5 Speed over Distance before and after M25 J23-27: Saturday and Sunday

	Clockwise	Anticlockwise
		

2.37. The key findings shown by the weekday speeds over distance plots in ***Table 2-3*** and ***Table 2-4*** **clockwise** are:

- Before, the speeds are generally low near J23 in the PM peak and this has improved after scheme opening. The speed remains the same between before and after for the remaining sections in the PM peak.
- Speed has improved in the Inter-peak between J23 and J25 and remains same for the remaining sections.
- Marginal improvements are seen in the weekend period.

2.38. The key findings for the speeds **anticlockwise** are:

- Speed have improved considerably in the AM peak especially between sections J27 to 25.
- In the PM peak, speed remains same between J27 and J25 and has improved between J25 and J23.
- Weekend and Inter-peak period has seen marginal improvement in speed since this section was not congested in the pre-scheme.

2.39. The results show that reliability is improved in all time slices and in both directions, as demonstrated by the consistency of the DS speeds, i.e. mainly horizontal on the preceding graphs with fewer deviations in both direction and all time periods.

Journey Time forecasting accuracy

2.40. The TFR included details of the forecast speeds on sections of the M25 within the scheme by time period for the modelled years and DM and DS scenarios. The time periods were weekdays as follows:

- AM: 08:00-09:00
- IP: 10:00-16:00
- PM: 17:00-18:00

2.41. It is noted that the forecasts do not directly align with weekday time periods of the observed data (as set out in paragraph 2.31), which has much wider peak periods and treated Fridays separately. Thus direct comparison of forecast and observed data for journeys and speeds can only be approximate. Comparison here has been done by calculating forecast journey times from the forecast speeds then working out the net difference as shown in ***Table 2-6***.

Table 2-6 Journey Time Forecasting accuracy: net saving (seconds)

Net change (seconds) Green is saving, red is worsening		AM		IP		PM	
		Forecast AM peak 08-09:00	Observed	Forecast Inter-peak 10-16:00	Observed	Forecast PM peak 17-18:00	Observed
CW	M25 J23-J24	19	19	16	14	15	27
	M25 J24-J25	26	27	26	26	24	0
	M25 J25-J26	12	9	15	7	17	4
	M25 J26-J27	18	-3	21	-2	24	-3
ACW	M25 J23-J24	9	2	10	11	10	0
	M25 J24-J25	25	42	21	29	23	9
	M25 J25-J26	13	49	13	14	12	0
	M25 J26-J27	26	47	27	-3	26	20
Total	CW	75	52	78	45	80	28
	ACW	72	140	71	51	72	28

2.42. The key points on journey time forecasting accuracy shown in ***Table 2-6*** are:

- Journey time savings were forecast for all peaks across all sections of the scheme. Observations show savings for the total journey time over the full length of the scheme for all peaks although the differences for individual sections are not all positive.
- In the clockwise direction, the observed savings were comparable to the predicted savings between J23 to J26, but have not been achieved across the whole of the scheme, with no savings observed between J26 and J27 in any of the peaks, which may be a result of downstream congestion.
- In the anticlockwise direction, the observed savings exceed those predicted in the AM peak, but are lower than those predicted in the Inter-peak and PM peak.
- The forecast was derived from modelling which was based on predictions of much higher volumes of traffic than those observed. However, these lower volumes apply to the before and after scenarios, so limited conclusions can be confidently inferred in relation to observed savings compared to forecast savings.

Operation of the Smart Motorway

2.43. We now present a summary of how the smart motorway is operating based on data as recorded in HALOGEN data (Highways England's LOGging ENvironment).

HALOGEN Operation Data Analysis

2.44. This is a record of the smart motorway settings as installed by this scheme, and therefore there is no equivalent pre-scheme data shown here. Analysis of HALOGEN data has been used to determine how much, on average, different speed limits were in place during the peak periods.

2.45. The time periods used in this analysis are 07:00-10:00, 10:00-16:00 and 16:00-19:00 for the AM, Inter-peak and PM peaks respectively.

- Monday – Thursday:
  - AM: 06:00– 10:00
  - IP: 10:00 – 15:00
  - PM: 15:00 – 20:00
- Friday:
  - AM: 06:00 – 09:00
  - IP: 09:00 – 13:00
  - PM: 13:00 – 20:00
- Saturday and Sunday:
  - Peak: 08:00 – 20:00

2.46. The smart motorway includes capability to use variable mandatory speed limits (VMSL) along the full length of J23-27. This means that when it is deemed necessary to reduce the speed limit below the national speed limit (70mph), the VMSL is activated and the gantries on the relevant part of the motorway show the speed limit setting. When 70mph applies the gantries do not show the speed limit.

2.47. HALOGEN data has been analysed for several points though the scheme as the speed limits setting by the variable mandatory speed limits (VMSL) can vary along a section of carriageway. ***Figure 2-5*** and ***Figure 2-6*** show this for all sections in the scheme.

Figure 2-5 VMSL active setting by time period (Monday – Thursday)

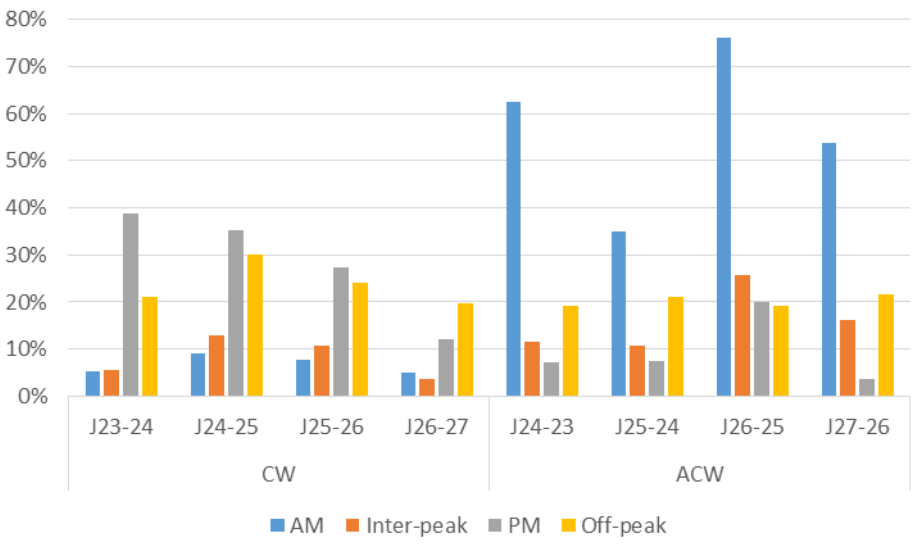
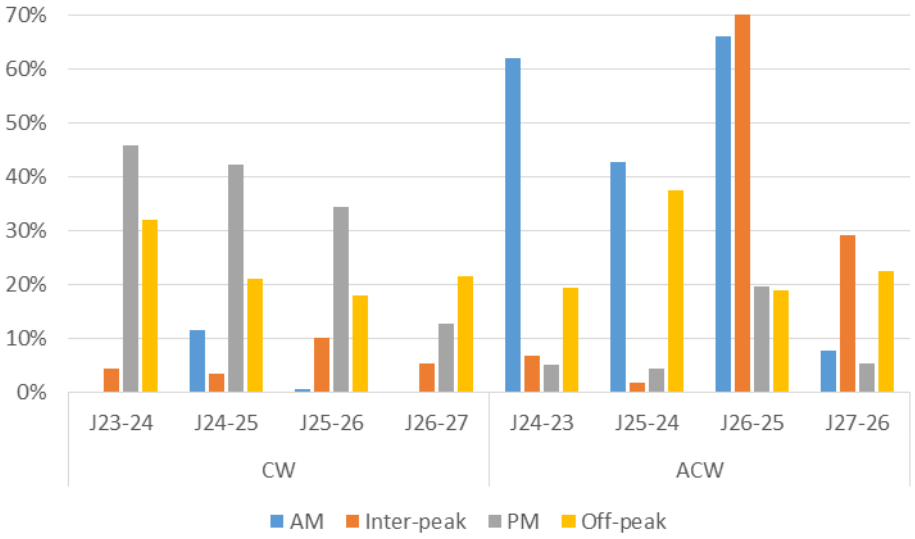


Figure 2-6 VMSL active setting by time period (Friday)

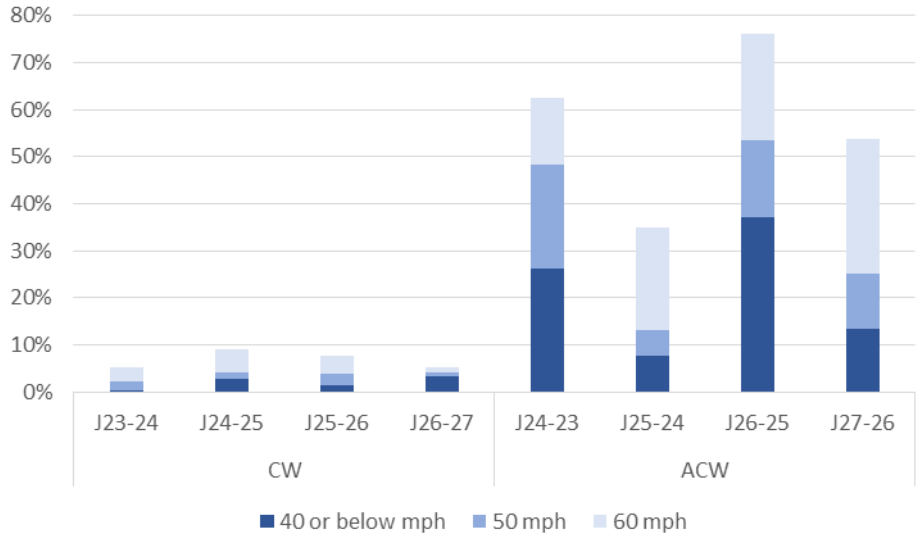


2.48. The key points shown by these plots of the average proportions of the time periods that the VMSL is active are:

- AM anticlockwise sees the highest level of use of the VMSL on Monday-Thursdays, ranging between 35% and 76%.
- In the clockwise direction, the highest levels of use is seen in the PM period on Monday – Thursdays and Fridays (around 40% of the period).
- Clockwise Inter-peak and PM peaks see VMSL use around 10% or less of the time on Monday-Thursdays, with anticlockwise Inter-peak and PM peaks seeing VMSL use around 10% or less of the time on most sections.
- Fridays show similar trends in use of VMSL compared to other weekdays.
- J26-25 shows the highest levels of use of VSML on average across all periods for all weekdays.
- It should be noted that the off-peak use of the VMSL represents its use for overnight roadworks.

2.49. Further analysis of the VMSL setting in the most used period, the AM peak are shown by speed in ***Figure 2-7***. As 30mph or below is only rarely used, it is included within the 40mph band.

Figure 2-7 VMSL Speed settings as proportion of AM peak (Monday – Thursday)



2.50. This shows the following key points regarding speed limit settings in the AM peak:

- Speed limits regularly set by VMSL in the AM peak anticlockwise within the scheme are split between the 40, 50 and 60mph settings.
- 40mph setting is most commonly used on the relatively short section between J26 and J25 where there is potential for lane changing and consequent peak period congestion.

2.51. The proportions of the time periods when any VMSL is active are summarised in ***Table 2-7.***

Table 2-7 Summary of VMSL use proportions by time period

% of time period that VMSL is set		Monday-Thursday				Friday				weekend peaks
		AM	Inter-peak	PM	Off-peak	AM	Inter-peak	PM	Off-peak	
CW	J23-24	5%	6%	39%	21%	0%	4%	46%	32%	8%
	J24-25	9%	13%	35%	30%	11%	3%	42%	21%	6%
	J25-26	8%	11%	27%	24%	1%	10%	34%	18%	11%
	J26-27	5%	4%	12%	20%	0%	5%	13%	22%	4%
ACW	J24-23	62%	12%	7%	19%	62%	7%	5%	19%	3%
	J25-24	35%	11%	8%	21%	43%	2%	4%	38%	6%
	J26-25	76%	26%	20%	19%	66%	70%	20%	19%	11%
	J27-26	54%	16%	4%	22%	8%	29%	5%	22%	4%

2.52. This shows that :

- The AM peak in the anticlockwise direction sees the highest level of use of the variable mandatory speed limits (VMSL) on weekdays of up to 76% of the period.
- In the clockwise direction, the highest levels of use are seen in the PM period on weekdays (around 40% of the period).

Flows and Speeds by Lane

2.53. In addition to the traffic flow and journey time analysis presented earlier in this chapter, additional analysis has been completed using MIDAS data focusing on the main peak period flows, namely AM peak in the anticlockwise direction and the PM peak in the clockwise direction. Unlike the sat-nav data, MIDAS data includes a breakdown by lane.

2.54. The graphs presented in the remainder of this section show the lane-by-lane traffic flows and speeds on the All Lane Running section between J23 and J25. Data for J25 – 27 is not shown due to the issues with the accuracy of the radar data.

2.55. The analysis here is for an average Monday to Thursday in March 2015. This is the same month that has been used for post-opening traffic flow. In each figure, the different coloured lines represent the different lanes as shown in the key. The distance on the x-axis is the distance in metres from within J25 in the anticlockwise direction and within J23 in the clockwise direction. All analysis has been completed on the mainline MIDAS sites on each carriageway.

2.56. Time periods are the same as the journey time data as detailed on page 18.

2.57. ***Table 2-8*** shows the flows and speeds in the AM peak on the busiest direction (anticlockwise), and ***Table 2-9*** shows the clockwise flow and speeds in the PM peak period.

Table 2-8 Flows and Speeds by Lane on J23 – 25: Mon – Thurs AM peak (05:30- 10:30) Anticlockwise

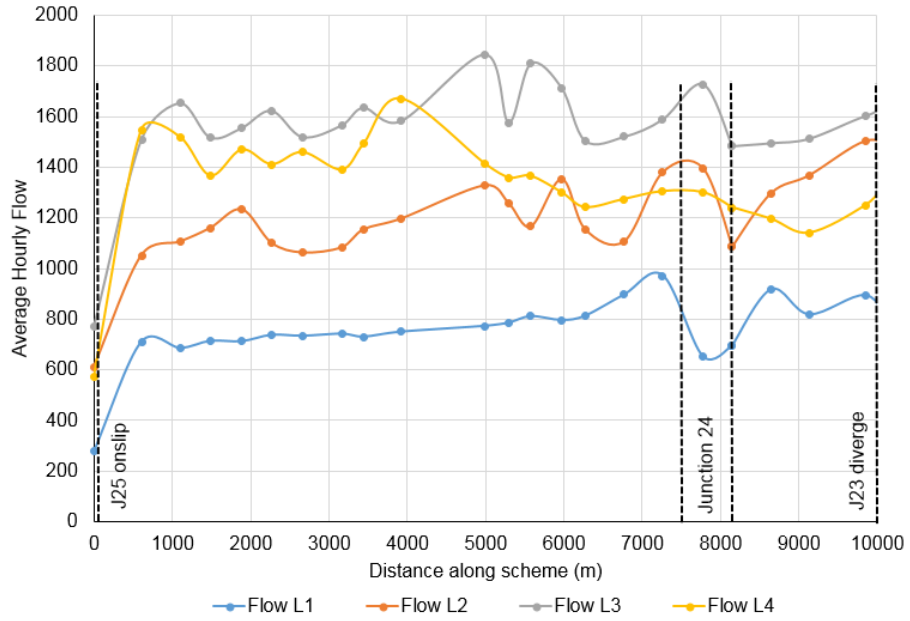
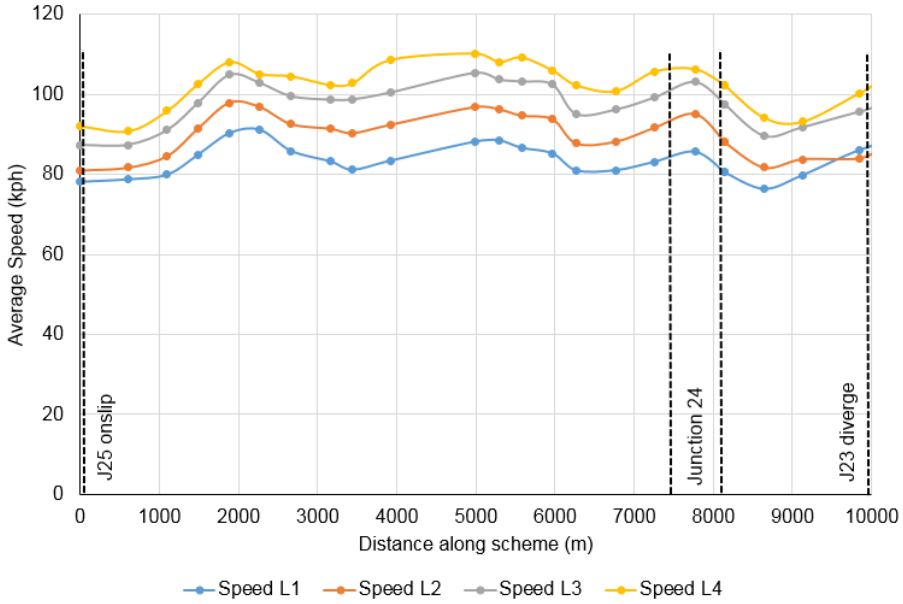
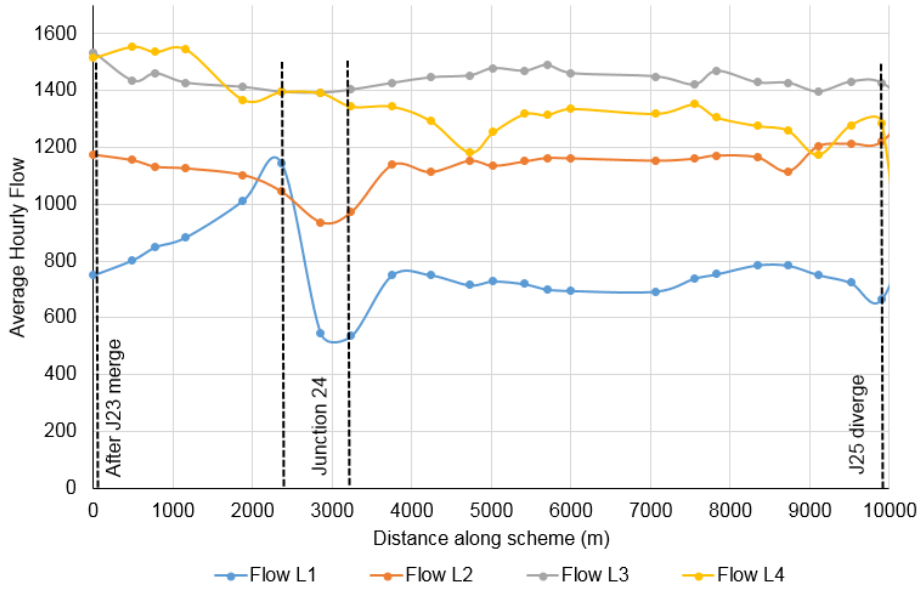
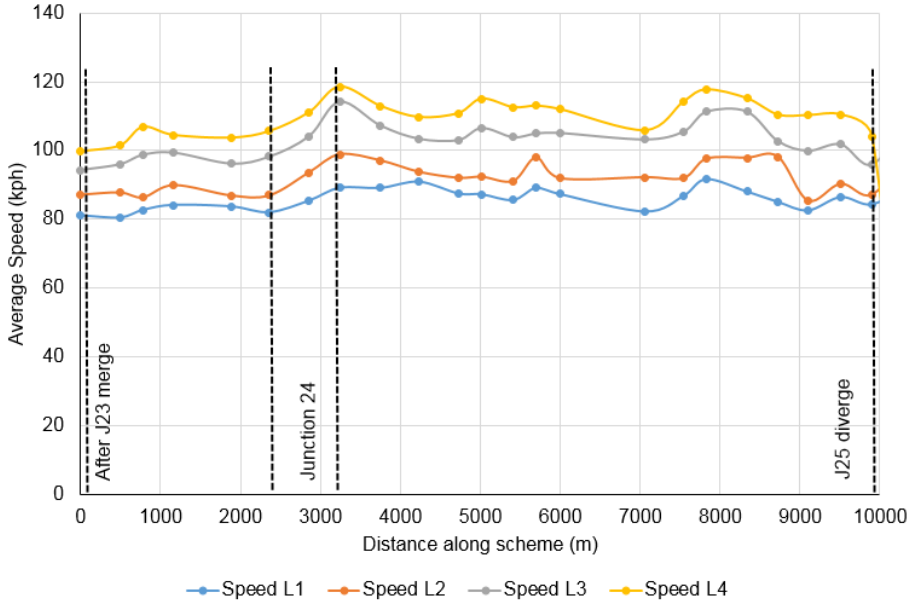
	Flows by Lane	Speeds by Lane
AM peak		
Comment	• Comparing the flows by lane shows that Lanes 1 to 3 show higher levels of use, and flow in lane 4 is similar to lane 2. This usage pattern shows that the scheme has successfully increased the used capacity on this section. • Lane 1 was formerly the hard shoulder and has the lowest level of use. However, as these flows are measured in vehicles they do not take into account the larger size of HGVs. As the majority of HGVs will be in this lane for much of the time, this lower level of use is a reasonable result across a 4-lane motorway.	• In this time period, speeds across all lanes are on average 93kph (58mph). Between J24 and J23 speeds are on average 89kph (55mph). This is a result of the setting of the speed limit to 60 or below for a relatively high proportion of the time, as shown in ***Figure 2-5***. • Lane 1 has the lowest flow and the lowest speed, again this is likely to be reflecting the higher proportion of HGVs in this lane.

Table 2-9 Flows and Speeds by Lane on J23 – 25: Mon – Thurs PM peak (15:00 – 20:00) Clockwise

	Flows by Lane	Speeds by Lane
PM peak		
Comment	• There are similar levels of lane 1 flows to those in the AM peak in the opposite direction as shown in ***Table 2-8*** . • Between J23-J24, the flows in lane 1 and lane 4 are higher than those between J24-J25. This increased capacity reflects the improved speeds and journey times observed in this section when compared to before the scheme opened.	• Average speeds in the PM peak are higher in all lanes than in the AM period (98kph or 61mph). This reflects the reduced frequency of VMSL activated in this time period, compared to the AM peak anticlockwise. • There is a slightly larger spread of average speeds by lane, with an average difference of 24kph (14 mph) between lanes 1 and 4.

Reliability

2.58. The reliability sub-objective of this scheme was appraised using the HSR INCA (Incident Cost Benefit Appraisal) which forecast a benefit over 60 years of £40.352m (2010 prices). This included high benefits for day-to-day travel time variability (TTV) but a small disbenefit for delay reliability (due to collisions and incidents) arising from the impact of the loss of the hard shoulder.

2.59. It is not possible to evaluate reliability using data on observed incidents before and after the scheme was built because the nature of the Smart Motorway means that recording of incidents has much improved. Clearly a basic assessment of the data would show more incidents being recorded through the Smart Motorway technology than that recorded by more manual means before opening.

2.60. The alternative approach to the evaluation of reliability impact is to study the impact that the scheme has had on the variability of journey times.

2.61. Variability is the extent to which journey times vary from the expected average journey time on a particular day of the week at the time of day in question. The distribution of journey times is considered to be a good indication of how much journey times vary.

2.62. The sat-nav data which was used to determine the average journey time along the route also provides the distribution of journey times by percentile ranges. ***Figure 2-11*** and ***Figure 2-12*** present the variability in journey times for the different peak periods. The analysis presented is for the route as a whole (J23 –27). The nature of traffic flows and congestion issues vary by peak and direction depending on the section of the scheme so, in turn, the variability is greater for individual sections of the scheme.

2.63. Four metrics of the distribution of journey times through the scheme have been used:

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

2.64. These four metrics are shown below in ***Figure 2-8*** and ***Figure 2-9*** as box-and-whiskers diagrams for each time period, before and after. The 75th percentile and 95th percentile journey times are annotated on the plots.

Figure 2-8 Clockwise Journey Time Reliability Analysis

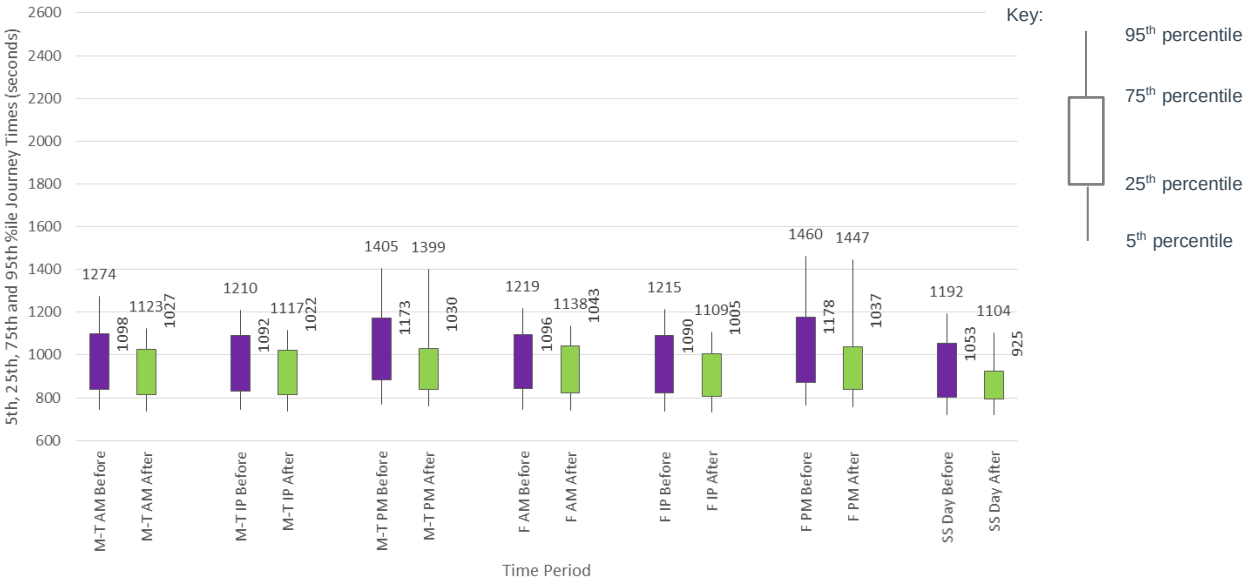
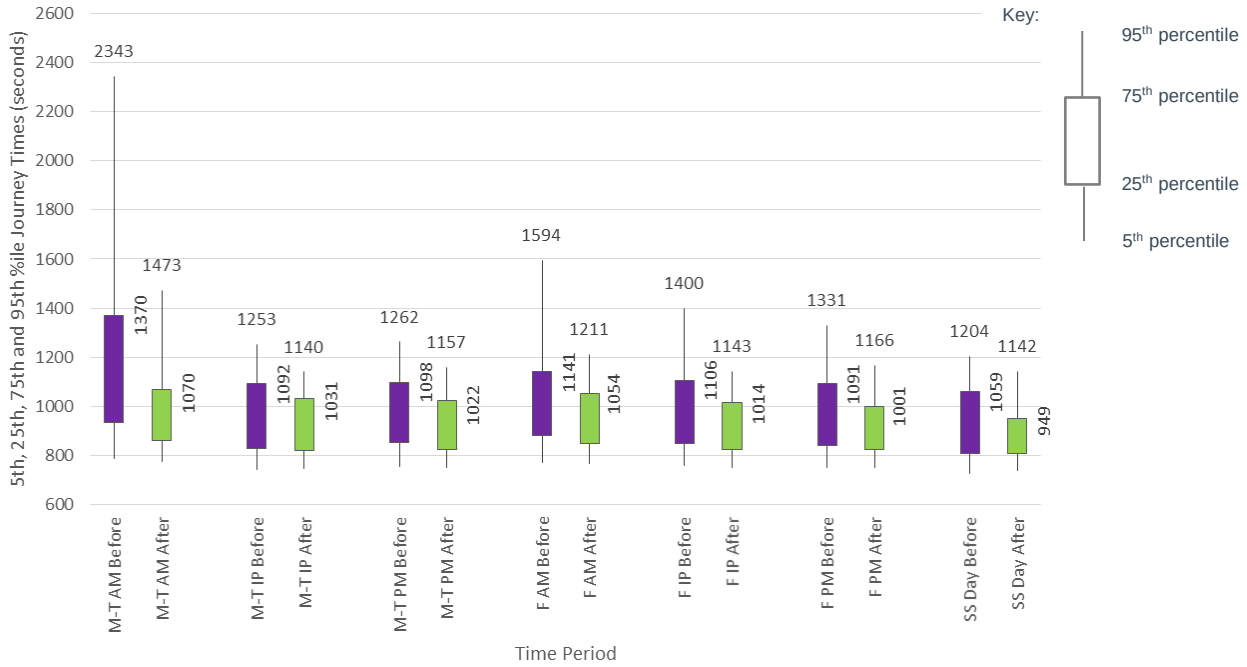


Figure 2-9 Anticlockwise Journey Time Reliability Analysis



2.65. The results show that reliability is improved in some time periods but remains similar in others.

2.66. Observations on clockwise journey time reliability shown in ***Figure 2-8*** include:

- The most unreliable journey times are in the Monday – Thursday and Friday PM peaks. These have improved post scheme opening.
- The less congested time periods have similar results before and after.

2.67. Observations on anticlockwise journey time reliability shown in ***Figure 2-9*** include:

- The most unreliable journey times are in the weekday (Monday – Thursday, and Friday) AM peaks.
- The benefits in journey time reliability are gained in the two most unreliable time periods.
- The less congested time periods have similar results before and after.

2.68. Reliability is monetised in the Economy chapter later in this report.

Planning Time Index

2.69. The Planning Time Index (PTI) is a relatively new metric by which reliability is measured. As set out in Highways England's Operation Metrics Manual, this measure is designed to indicate how much additional time road users need to allow to ensure they arrive on time. It highlights roads where very slow journeys are encountered. This measure is the ratio of the 95th percentile journey time to the free-flow journey time, where free-flow time is the maximum of the journey time and 15th percentile journey time (i.e. that when taken at the 85th percentile speed) and the journey time taken at the 70mph motorway speed limit.

2.70. Table 2-10 below shows the PTI for the before and after periods journeys through the full length of the scheme based on the sat-nav journey time data, weighted by flows in the individual time periods.

Table 2-10 Flow-weighted PTI

	Before	After
Clockwise journeys J23-27	1.55	1.47
Anticlockwise journeys J27-23	1.80	1.48

2.71. The PTI figures show that the reliability has improved in the post opening period in both directions, with the greatest improvement for anticlockwise journeys.

Traffic Impacts – Key Points

Flows

- On average, two-way weekday traffic flows on the scheme is around 141,300 vehicles per day (vpd), an increase of 6% from before the scheme was built, in line with background growth.
- Most directional flows in scheme sections have seen growth of between 7 and 8%. Only the J24 to J25 clockwise link appears to have seen lower growth, however this result is unexpected and could be the result of drivers being slow to return after the road works for construction of the scheme, or an anomaly with the traffic data.

Journey Times

- Anticlockwise journey times have improved by 9% overall, even after traffic volumes have increased. The weekday AM peak journey time has seen the greatest improvement with a 19% reduction in journey time. Journey time improvements in the clockwise direction are in the range of 4-7%.
- In the clockwise direction prior to the scheme, the speeds were generally low near J23 in the PM peak and this has improved after scheme opening. The speed remains the same between before and after for the remaining sections in the PM peak.
- In the anticlockwise direction, speeds have improved considerably in the AM peak especially between sections J27 to J25. In the PM peak, speeds remain unchanged between J27 and J25 but have improved between J25 and J23. Weekend and Inter-peak periods have seen only marginal improvements in speeds as this section was not congested before the scheme was built.

Forecast vs. Outturn Flows and journey time impacts

- Traffic flows in 2012, just before the start of construction, were also lower than forecast by an average of 17% for the M25 within the scheme. These discrepancies before construction began explains most of the gap between the forecast and the observed post opening flows. The inaccuracy of the pre scheme forecasts suggests that the modelling of the traffic growth from the base year of 2004 to 2012 did not account for the impact of the recession on traffic flows during this period.
- With the scheme in place, average daily traffic flows along the route are lower than forecast by between 20% and 24%.
- With the scheme in place, traffic flows were forecast to increase on the directly affected sections of the M25 by an average 15%, higher than the rates forecast on the adjacent sections; what has been observed is that traffic growth has been slightly lower, on average 8%, and lower growth than that seen on the adjacent M25 sections.
- Journey time savings were forecast for all peaks across all sections of the scheme. Over the whole of the scheme, total journey time savings have been observed for all peaks.
- In the clockwise direction, the observed savings were comparable to the predicted savings between J23 to J26, but have not been achieved across the whole of the scheme, with no savings observed between J26 and J27 in any of the peaks.
- In the anticlockwise direction, the observed journey time savings exceed those predicted in the AM peak, but are lower than those predicted in the Inter-peak and PM peak.

Operation of Smart Motorway

- The AM peak in the anticlockwise direction sees the highest level of use of the variable mandatory speed limits (VMSL) on weekdays of up to 76% of the period.
- In the clockwise direction, the highest levels of use are seen in the PM period on weekdays (around 40% of the period).

Reliability

- The benefits in journey time reliability are gained in the two most unreliable time periods. In the clockwise direction, the most unreliable journey times are in the weekday PM peaks while the reverse direction experiences the most unreliability in the AM peak.
- In both directions, the less congested time periods show little change with the scheme.

3. Safety Evaluation

Introduction

3.1. This section of the report considers the impact of the scheme in terms of the level of success in addressing the objective of reducing collisions.

3.2. The Client Scheme Requirements (CSR) document notes that one of the scheme objectives was:

> *To achieve a safety objective under which the "after" accident numbers (per annum) are no greater than those in the "before" and the severity ratio is not increased.*

3.3. In order to assess the impact of the scheme on collisions, personal injury collisions (PICs) occurring in the pre-construction period, and the available post opening period have been analysed. Evaluation of the schemes impact on personal security has been undertaken through the use of observations made during a site visit.

3.4. This section of the study concerns collision numbers; the economic impact of the change in collisions is evaluated later in the Economy section of this report.

Sources

3.5. The sources used in this section are:

- AST
- Economic Appraisal Report (EAR)
- Recorded Collision data for the DfT and the DBFO operator
- Monitoring Evaluation Report (2015)
- COBA (COst Benefit Analysis) model

3.6. The extent of the network for COBA collision analysis was defined as part of the work undertaken in 2009 during PCF Stage 2. The area covered in the original appraisal is that part of the model network expected to be most affected by the scheme, in terms of AADT flow. This was determined by comparing differences between the flows in the DM and DS scenarios, with links included in the COBA network where the forecast AADT flows vary by more than ±5% and ±50pcu.

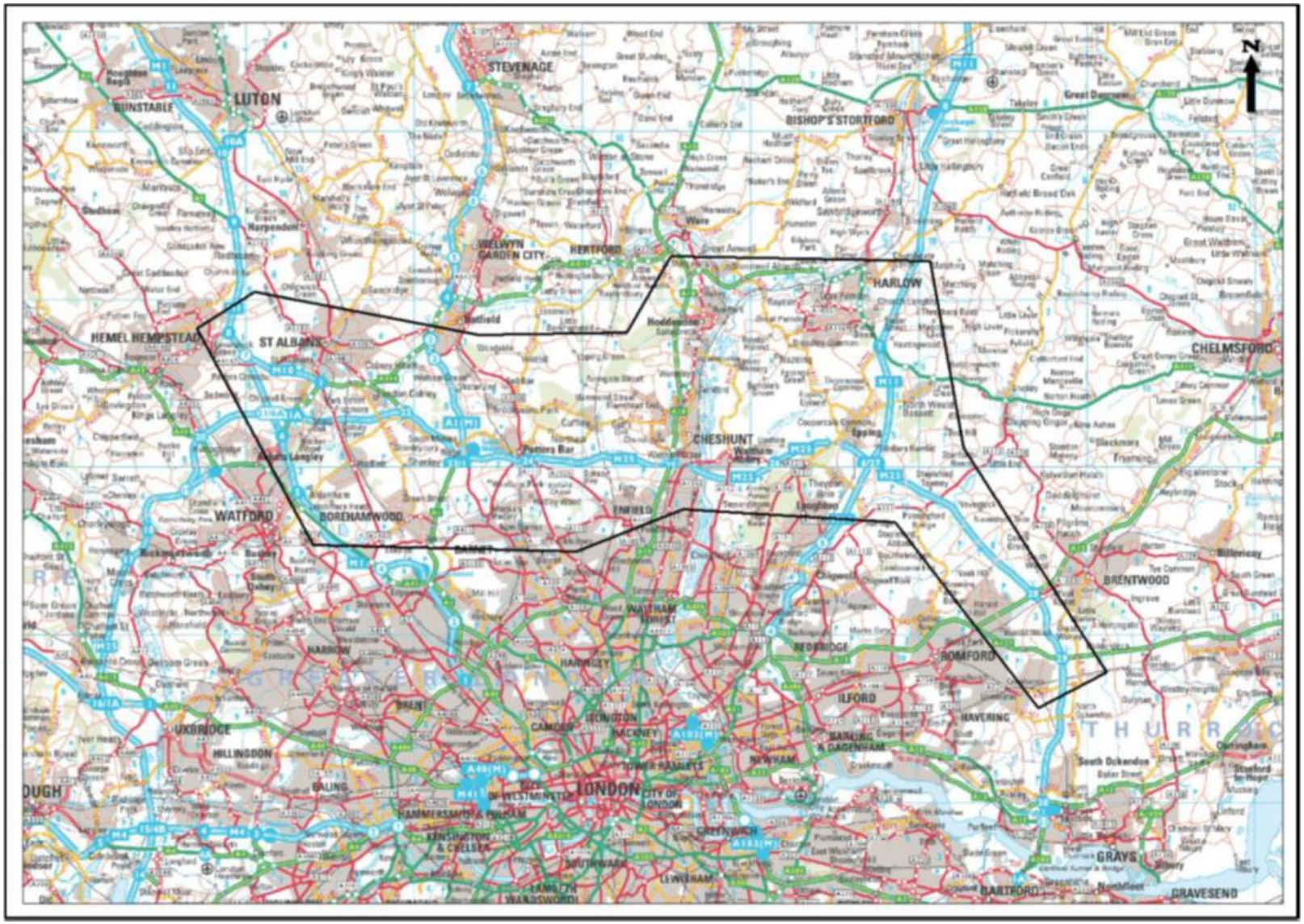
Forecast sources

3.7. Over the whole modelled area (includes the M25 between Junctions 21 and 29, A1(M), A10, M11 and some links on the local road network), the 60-year impact was forecast to be a reduction of 934 collisions (1.00%), despite the higher level of traffic expected with the scheme.

3.8. The EAR stated that *"On the mainline scheme links themselves, the analysis shows an increase of 160 accidents as a result of the scheme, over the 60-year appraisal period. This masks a net reduction in accidents on the scheme links between junctions 23 and 26. On junction 26-27 the additional traffic increases the forecast number of accidents and there is no assumed reduction in accident rate to counter this. A 'Hazard Log' approach to operational management will be implemented, and mitigation measures put in place to ensure that the absolute number of accidents on scheme links will not increase. Overall therefore, the accident benefits calculated are a conservative estimate of the expected benefits"*.

3.9. To ensure like for like comparison between the predicted and observed collision changes, the overall geographical area of analysis used for this study is the same area, as shown in ***Figure 3-1*** and same scope of just the motorways and 'A' roads.

Figure 3-1 Area of Roads modelled for Collision Impact Appraisal



Observed data sources

3.10. Collisions by their nature include a random element and are somewhat unpredictable events. To ensure that the scheme is the main change in the immediate area and the observed changes are likely to be linked to the scheme, the following approach has been taken.

3.11. Collision data has been obtained from the DfT database for the area shown in ***Figure 3-1*** covering the following time periods:

- Pre Scheme:1 February 2008 – 31 January 2013 (five years)
- Post Construction: 1 December 2014 – 30 September 2015 (10 months)

3.12. The collision data is based on the records of Personal Injury Collisions (PICs) that are recorded in the STATS19 database as collected by police when attending collisions. Collisions that do not result in injury are not included in this dataset, and are therefore not included in this evaluation.

3.13. Collision analysis is normally undertaken with a minimum of three full years' of data, so the emerging trends identified in a one year POPE, should be treated with some caution.

3.14. Additionally, more detailed data has been obtained from the DBFO operator for the motorway within the scheme itself. This data has also been used in the monitoring studies, thus for consistency this scheme data reported here covers the same time periods:

- Pre Scheme:1 Feb 2010 – 31 January 2013 (three years)
- Post Construction for J23 to J25: 1 May 2014 – 30 April 2015 (12 months)
- Post Construction for J25 to J27: 1 November 2014 – 30 April 2015 (6 months)

Analysis of Collision Numbers

3.15. This section analyses the observed changes in PICs following the implementation of the scheme. This section includes an investigation into the changes in the number of collisions and associated casualties as well as whether there has been any change in the relative severity of recorded collisions.

Background Collision Reduction

3.16. It is widely recognised that, over a decade, there has been a year on year reduction in the number of personal injury collisions on the roads, even against a trend of increasing traffic volumes over much of that period. The reasons for the reduction are considered to be wide ranging and include improved safety measures in vehicles and reduced numbers of younger drivers. This background trend needs to be considered when looking at the changes in collision numbers in the scheme area in the before and after periods. If the scheme had not been built, collision numbers in the area are still likely to have been influenced by wider trends and reduced.

3.17. The best way to take this into account is to assume that, if the scheme had not been built, the number of collisions on the roads in the modelled area here would have dropped at the same rate as they did nationally during the same time period. This gives what is known as a counterfactual 'without scheme' scenario on a like for like basis with the observed post opening data which is the 'with scheme' scenario.

3.18. The difference between the numbers of collisions in these two scenarios can then be attributed to the scheme rather than the wider national trends. This result will inform the calculation of monetised safety benefits achieved by the scheme as discussed in the economy chapter of this report.

Evaluation of Collision Numbers and Severity in the Scheme Modelled Area

3.19. The evaluation of the before and after collision numbers by year for the scheme modelled area (as shown in ***Figure 3-1***) and the counterfactual number of collisions which could have been expected in the opening year had the scheme not been built, is shown in ***Figure 3-2*** and ***Table 3-1***. The severity of a collision is defined by the most serious injury incurred. Note that the after period data covers only 11 months, so the graph additionally shows the total extrapolated to 12 months.

Figure 3-2 Number of Collisions on Year by Year Basis for Scheme Modelled Area

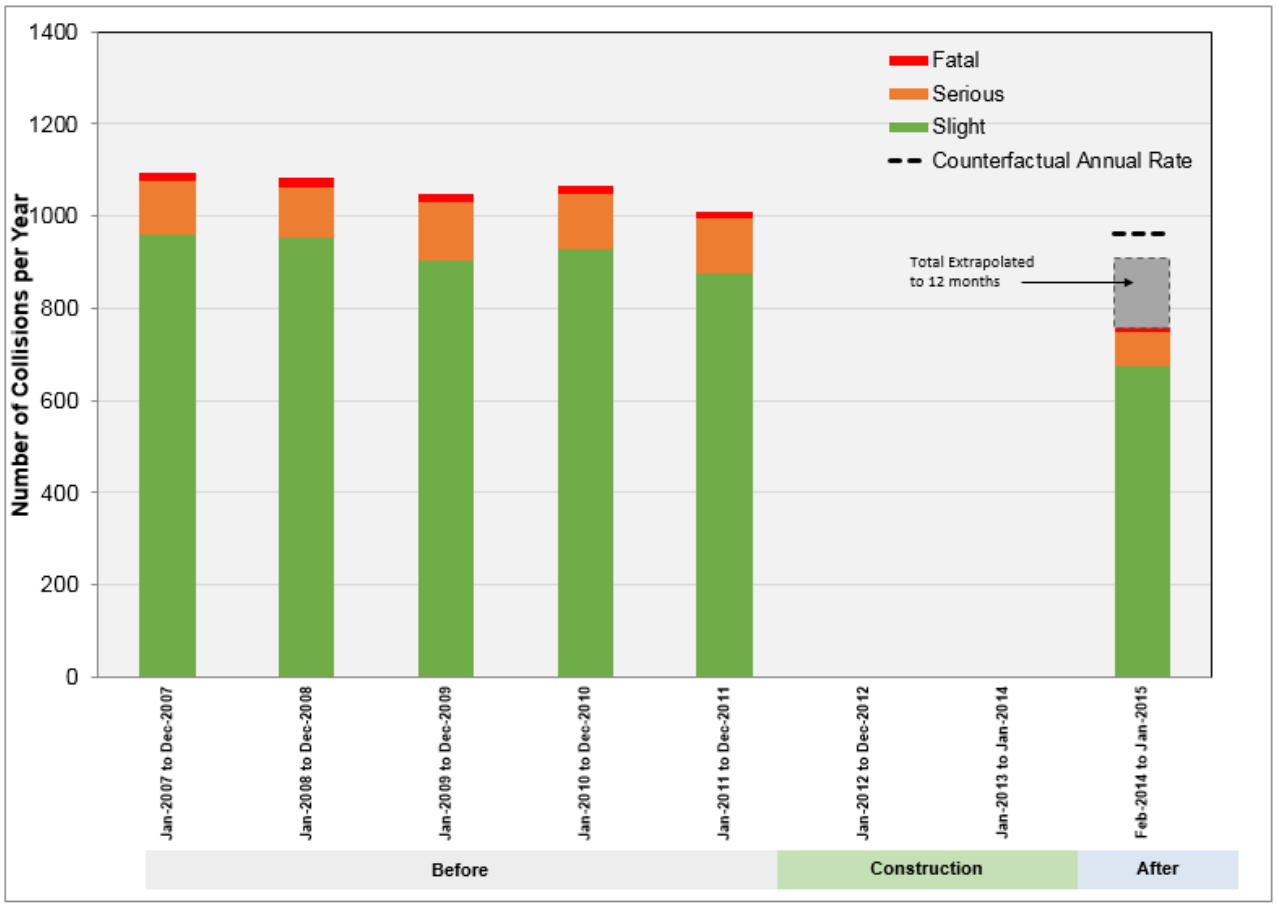


Table 3-1 Annual Average Number of Collisions by severity in Modelled Area

	Five years Before	10 months after (annualised)	Difference	% Difference
Fatal	16.4	9.6	-6.8	-41%
Serious	119.0	91.5	-27.5	-23%
Slight	923.6	810.3	-113.3	-12%
Total	1059	911.4	-147.6	-14%
Total Adjusted counterfactual*	961		-49.6	-5%

*Adjusted figure is the counterfactual annual average i.e. the estimated annual average if collisions risk due to the road layout was the same as observed before construction, reduced by the background trend observed nationally.

3.20. Collison data shown here for the modelled area shows that at this stage there are reductions in annual average collision numbers in this area between the before and after periods, and a 5% decrease in total collisions when the post opening data is compared with expected number of collisions had the scheme not been built (the counterfactual scenario).

3.21. A statistical test[5] on the change in collisions numbers shows that this 5% saving is not a statistically significant difference.

[5] Chi-square test with a 95% confidence interval.

Evaluation of Collision Numbers and Severity on M25 J23 -27 through the scheme

3.22. This sub-section examines the numbers of collisions and rate occurring on the section of the M25 improved by the scheme. This has been previously evaluated as part of monitoring work for the smart motorway, so data presented here is taken from this work and uses a 3-year period prior to start of construction and a full year after opening of section 5a (J23-25) and 6 months after opening of section 5b (J25-27).

Table 3-2 Annual Average Number of Collisions by severity for M25 J23-27

	Three years Before	Six Months / One Year After**	Difference	% Difference
Fatal	1.3	2	0.7	54%
Serious	9.0	3	-6.0	-67%
Slight	86.7	55	-31.7	-37%
Total	97.0	60	-34	-36%
Total Adjusted counterfactual*	94.1			

*Adjusted figure is the counterfactual annual average i.e. the estimated annual average if collisions risk due to the road layout was the same as observed before construction, reduced by the background trend observed nationally.
**Due to staged opening this uses 12 months' data for J23 to J25 and 6 for J25 to J27, total values cannot be accurately compared between before and after.

3.23. This shows that collision numbers fell by 34 (36%) on J23 to 27 of the M25 within the scheme. However, due to staged opening, this uses 12 months' data for J23 to J25 and 6 months for J25 to J27, so total values cannot be accurately compared between before and after. The collision rates shown in **Table 3-3** provide a better method of comparison.

Evaluation of Collision Rates on M25 through the scheme

3.24. The number of collisions along a length of road in conjunction with its AADT can be used to calculate a collision rate (calculated as the number of collisions per million vehicle kilometres travelled). By looking at the rate it is possible to identify the safety impact on the roads of interest whilst ignoring the impact of the change in traffic volumes.

3.25. These collision rates can also be compared against the expected rates used in the forecasts is shown in the EAR and COBA model. The forecast collision impact in the COBA model includes a predicted collision reduction over time. The POPE evaluation counterfactual rate as shown below is based on the observed national reduction in collisions on motorways from DfT national data between the before and after time periods.

Table 3-3 Collision rates on M25 J23 – 27

	Three years before		Observed after*	Difference
	Observed	Counterfactual		
Personal Injury Collision per million vehicle kilometres (PIC/mvkm)	0.080	0.074	0.064	-13.4%

*Due to staged opening this uses 12 months data for J23 to J25 and 6 for J25 to J27

3.26. The results show that the collision rate has decreased to 0.064 PICs/mvkm, a fall of 13.4% when compared to the counterfactual rate. This collision saving is not statistically significant at this stage when only one year's post opening data is available for parts of the scheme, and six months for other parts.

Collison Severity

3.27. ***Table 3-4*** shows the comparison of results for the Severity Index which is calculated based on fatal and serious collisions as a proportion of all collisions. The results indicate a decrease in the Severity Index in the modelled area and the M25 mainline scheme section; however, this is based

on a small sample size and is not statistically significant, so no conclusions should be drawn at this stage.

Table 3-4 Severity Index of Collisions

Scope	Before	After
Modelled area	13%	11%
M25 mainline (scheme section only)	11.9%	9.1%

Forecast vs. Outturn Collision Numbers and Rates

3.28. Forecasting of the safety impact of this scheme was undertaken using the COBA modelling software. This gave forecasts of the changes to collision numbers which is examined here and the associated monetary benefit which is evaluated in the next section of this report.

3.29. The extent of the network of roads included in the COBA modelling was defined as the part of the SATURN network most affected by the scheme in terms of traffic flows.

Forecast vs. Outturn Collision Rates

3.30. Forecast and observed changes in collision rates are shown in ***Table 3-5***.

Table 3-5 Collision Rates on M25 J23-27: Forecast and observed (PIC/mvkm)

Section	Forecast			Observed		
	Do Minimum	Do Something (with scheme)	% diff	Before (with counterfactual adjustment)	After	Diff
J23-24	0.189	0.164	13%	0.074	0.064	-13.4%
J24-25	0.189	0.164	13%			
J25-26	0.189	0.164	13%			
J26-27	0.189	0.189	0%			

3.31. The key points on collision rates shown here are:

- The observed decrease in the collision rate of 13.4% (including adjustment for counterfactual) is comparable to those forecast on much of the scheme.
- It is noted in the EAR that no reduction in rate is proposed in the J26-27 section as collision rate benefits would only be attributable to those sections that do not currently have MIDAS loops at a sufficient density coupled with the required VMS signs and communication system.

Forecast vs. Outturn Collision Numbers

3.32. ***Table 3-6*** shows the forecast saving in terms of collision numbers has been extracted from the COBA model, and the numbers are compared with the observed data on savings from ***Table 3-1*** and ***Table 3-2***.

Table 3-6 Collision numbers: Forecast and Observed

Scope	Forecast		Observed	
	Saving	%	Saving	%
Modelled area	14.2	1%	49.6	5%
M25 J23 – 27	-2.8*	Not Known*	34**	36%**

*Neither the COBA outputs nor the EAR provide direct results for the scheme section.

**The observed savings for the section uses 12 months data for J23 to J25 and 6 for J25 to J27. As such the total values cannot be accurately used in comparisons.

3.33. The key points on number of collisions saving forecast are:

- Across the modelled area, the observed saving in terms of collisions is greater than that forecast.
- Neither the COBA outputs nor the EAR provide detailed results for the scheme section. The text in the EAR notes 'On the mainline scheme links themselves, the analysis shows an increase of 160 collisions because of the scheme, over the 60-year appraisal period'. Using the COBA outputs for the 60-year period over the whole area to proportion this increase gives a 2015 saving of -2.8. This cannot be expressed as a percentage as the 2015 Do Minimum value for the scheme section is not known.
- The observed savings for the section uses 12 months data for J23 to J25 and 6 for J25 to J27. As such the total values cannot be accurately used in comparisons.
- A negative saving (i.e. more collisions) for the scheme section was forecast, but a real collision saving has been observed.

Fatal Weighted Injuries (FWI)

3.34. Fatal and weighted injury (FWI) casualties and the rate of FWI casualties per billion vehicle miles per annum are metrics used in the objectives of the smart motorway as set out in the Interim Advice Note IAN 161[6]. ***Table 3-7*** shows the number of casualties and the FWI for the before and after periods. This is calculated based on the numbers of fatal, serious and slight casualties as weighted proportions, to adjust for the severity. Note that no adjustment has been made here for the background reduction in casualties as in the approach for the collision counterfactual assessment above.

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

3.36. The FWI per billion vehicle kilometres (FWI / bvkm) or hundred million vehicle miles (FWI / hmvm) allows a comparison between road sections with different flows and lengths.

Table 3-7 Casualties and FWI

		Before		After	Difference
		36 months	Annual average	12 months*	
Severity	Fatal	4	1.3	2	
	Serious	36	12.0	4	
	Slight	401	133.7	90	
	Total	441	147.0	96	
FWI		11.6	3.9	3.3	-15%
Distance Travelled	bvkm	3.6	1.2	0.9	
	hmvm	22.6	7.5	5.8	
FWI / bvkm		3.2		3.5	+11%
FWI / hmvm		0.5		0.6	

*Due to staged opening this uses 12 months data for J23 to J25 and 6 months for J25 to J27.

- The increase of FWI rate is impacted by two fatalities occurring in the after period which are not directly attributable to SM-ALR operation; a suspected suicide and a stowaway incident.
- In addition, the after period (one year for J23 to J25 and six months for J25 to J27) is a relatively short period; a larger data set is required before the findings will become statistically significant and confidence can be placed in them. The desirable minimum period for the analysis of collision data is three years.

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

Security

Forecast

3.37. The AST stated that this sub-objective was not appraised.

Evaluation

3.38. Smart Motorway schemes can be beneficial to security because they include permanent surveillance of the motorway with CCTV. However, this was already installed on this section of the M25. Therefore, the OYA assessment of the security impact is neutral.

Safety Impact – Key Points

Collisions

- Collision analysis is normally undertaken with a minimum of three full years' of data, so the emerging trends identified in a one year POPE, should be treated with some caution.
- Collision numbers fell on the M25 within the scheme. However, due to staged opening, total values cannot be accurately compared between before and after. The collision rates provide a better method of comparison.
- The collision rate on the M25 within the scheme has decreased to 0.064 PICs/mvkm, a fall of 13.4% when compared to the before scheme opening counterfactual rate.
- In the wider area, there are reductions in annual average collision numbers between the before and after periods, and a 5% decrease when post opening data is compared with expected number of collisions had the scheme not been built (the counterfactual scenario).
- Collision severity as a proportion of all collisions has decreased over the wider modelled area and the M25 mainline scheme section.
- Statistical tests show that the collision rate changes and the wider area collision number changes are not statistically significant at this one year after stage.

Casualties

- The Fatal and Weighted Index (FWI) per hundred million vehicle miles has increased. The increase of FWI rate is impacted by two fatalities occurring in the after period which are not directly attributable to SM-ALR operation.
- The after period (one year for J23 to J25 and six months for J25 to J27) is a relatively short period; a larger data set is required before FWI findings will become statistically significant.

Forecast vs. Outturn Collision Rate Savings

- Across the modelled area, the observed saving in terms of collisions is greater than that forecast.
- The scheme appraisal forecast an increase in collisions for the scheme section post opening, but an actual saving has been observed.

Security

- The impact is neutral.

4. Economic Evaluation

Introduction

4.1. This section presents an evaluation of how the scheme is performing against the DfT's economy objective, which is defined in WebTAG as:

To support sustainable economic activity and achieve good value for money

4.2. The sub-objectives for economy are as follows:

- To achieve good value for money in relation to impacts on public accounts.
- Improve transport economic efficiency for business users and transport providers.
- Improve transport economic efficiency for consumer users.
- Improve reliability.
- Provide beneficial wider economic impacts.

4.3. When a scheme is appraised, an economic assessment is used to determine the scheme's value for money. This assessment is based on an estimation of costs and benefits from different sources:

- Transport Economic Efficiency (TEE) benefits (savings related to travel times, vehicle operating costs and user charges).
- Collision costs (savings related to numbers and severity level of collisions).
- Costs to users due to delays during construction and future maintenance periods.

4.4. This section provides a comparison between the outturn costs and benefits and the forecast economic impact, as well as evaluating reliability and the scheme's wider economic impacts.

Sources

4.5. The economic forecasts presented in this section are based upon:

- Benefits as presented in the M25 DBFO LUS Economic Appraisal Report S5, August 2012 (EAR).
- Forecast costs of the scheme as in the October 2012 LUS estimates;
- AST (July 2012).
- Economic model outputs from:
  - Transport Users Benefit Appraisal (TUBA): Transport Economic Efficiency, Indirect Tax Impact.
  - Incident Cost-benefit Analysis (INCA): Journey Time reliability (including incident related delay).
  - Cost Benefit Analysis (COBA): Safety impact.

4.6. The outturn results are based on the following sources:

- Costs from the Regional Finance Manager in April 2016.
- Benefits are based on the observed changes to the traffic and numbers of collisions as detailed in the preceding traffic and safety sections of this report monetised to create re-forecasts of the long term impacts.
- WebTAG guidance: Carbon impact, Fuel consumption.
- PAR 6.3 guidance[7].

4.7. The appraisal report provides forecasts of the benefits for a 60-year appraisal period. All costs presented in the EAR and this chapter are in 2002 prices discounted to 2002 unless otherwise stated. This is in line with the price base as used in the EAR.

[7] Project Appraisal Report (PAR) is Highways England's standard approach to appraisal typically used for smaller schemes based on webTAG guidance on economic assessment. It provides a basis for POPE evaluations where is not appropriate to re-run full models.

Present Value Benefits

4.8. The appraisal considered the economic benefits of this scheme expressed in terms of present value (present value benefits – PVB) for the aspects set out in ***Table 4-1***. This table also sets out the approach taken in this post opening evaluation to the reforecasting of the benefits based on the observed data at this stage, and those which have not been evaluated and have been assumed as forecast. A 'yes' indicates that the element of benefits is considered as part of this evaluation. A 'no' indicates that the forecast impact from the appraisal will be used in place of a full evaluation at this stage.

Table 4-1 Economic Benefits of Scheme (2002 prices and values)

Benefits in £m 2002 market prices, discounted	Forecast £m (EAR)	Evaluate ?	Evaluation Approach
Journey Time (TEE business and consumer users)	628.649	Yes	Outturn journey time impacts in opening year can be calculated from observed data and forecasts.
Vehicle Operating Costs (VOC)	-186.933	Yes	Net change in fuel consumption monetised to calculate a proxy outturn reforecast value of VOC.
Construction period & Future maintenance periods: Journey time and VOC impacts	-193.382	No	Not known at this stage and not within the remit of POPE to evaluate.
Safety Benefits	45.350	Yes	Based on reduction in collision numbers, if this is statistically significant
Carbon Benefits	-159.204	Yes	Ratio between forecast and outturn opening year carbon impact used to calculate 60 year reforecast
Noise Benefits	-1.259	No	Small proportion of the overall scheme impacts.
Air Quality	0.000	No	Small proportion of the overall scheme impacts.
Indirect tax impact as a benefit	172.927	Yes	Calculate outturn change in fuel consumption and use ratio against forecast change to reforecast 60 year benefit
Total PVB	306.148		
Reliability	40.352	Yes	Re-run INCA model with observed opening year traffic flow data
Total including Reliability	346.500		

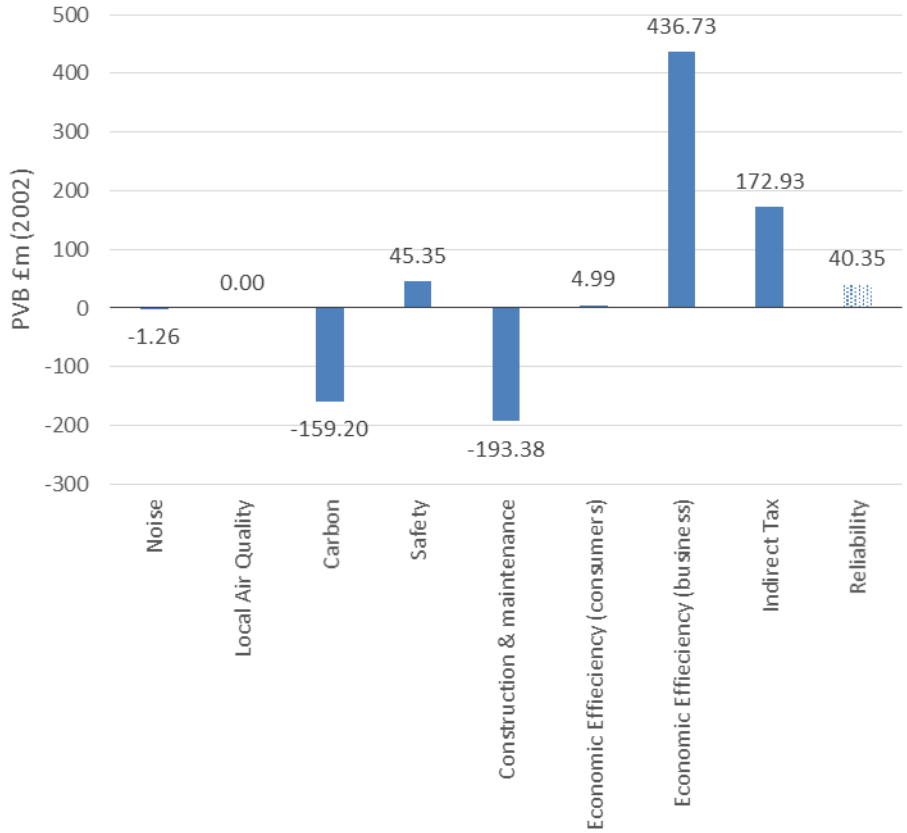
4.9. It is noted that although the reliability benefit was forecast in the EAR, it was not included in the overall benefits as set out in the Analysis of Monetised Costs and Benefits (AMCB) table in the EAR. This is because the webTAG guidance states that the monetised reliability benefits should not be included in the overall AMCB.

4.10. Economic modelling was primarily for a core scenario, with low and high growth extrapolated in line with webTAG guidance on Forecasting and Sensitivity (TAG Unit 3.15.3). The forecasts presented above are all from the core scenario, as are the results shown in the rest of this section.

How are the forecast benefits made up?

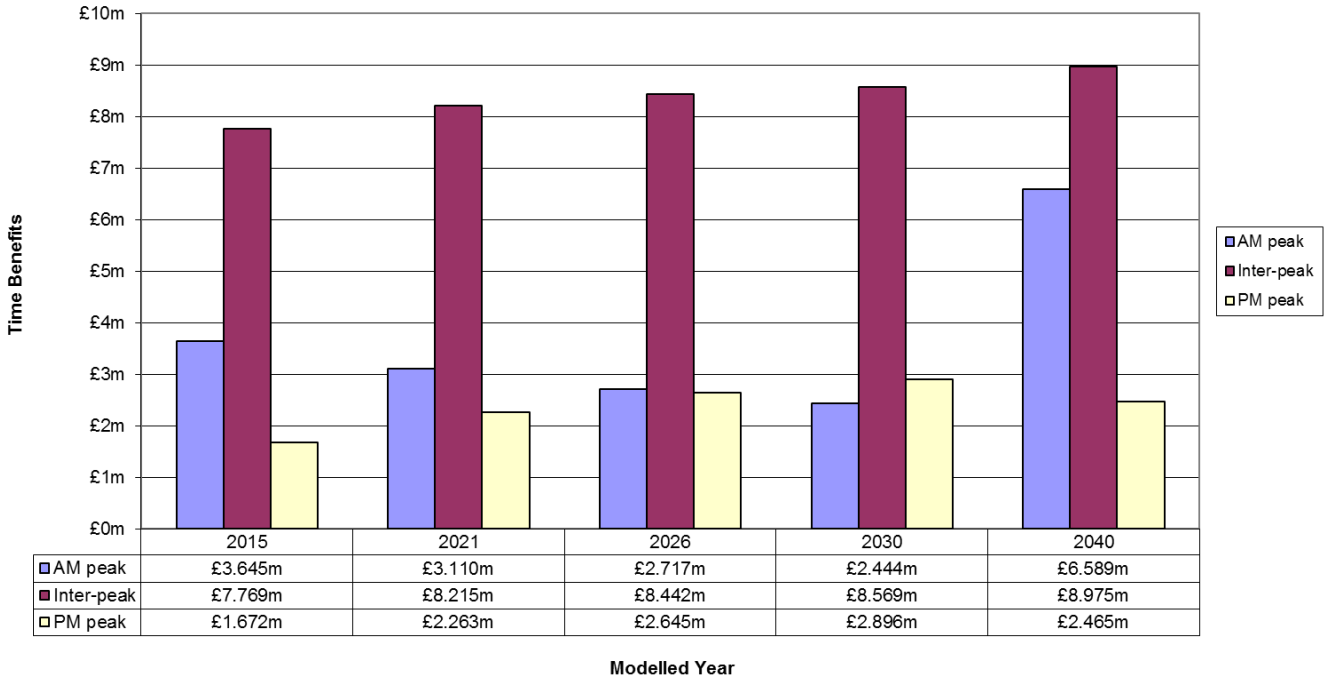
4.11. Benefits as listed in ***Table 4-1*** are shown graphically in ***Figure 4-1*** emphasizing the relative importance of the component parts.

Figure 4-1 Forecast 60 year Benefits by type



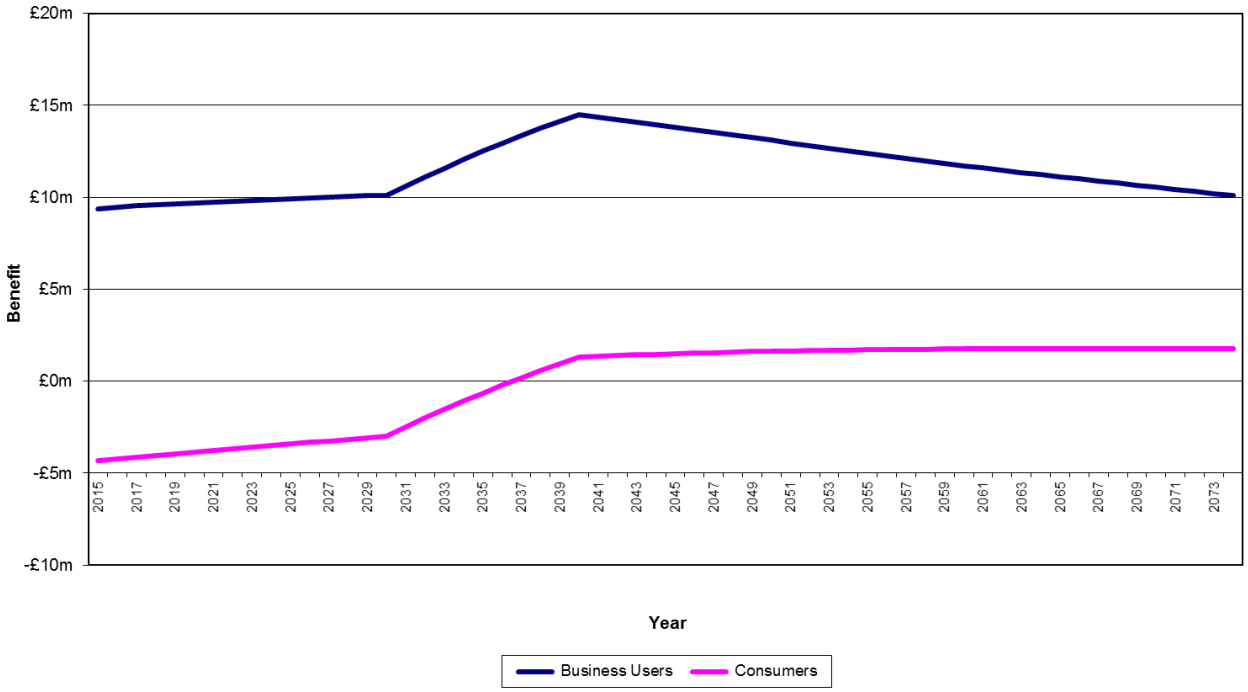
4.12. Supplementary analysis of the TUBA forecasts detailed how the journey time benefits were split between time periods over five modelled years. These graphs are shown in ***Figure 4-2*** and ***Figure 4-3***.

Figure 4-2 Forecast Journey Time Benefits spread by time period and modelled years (£m)



	2015	2021	2026	2030	2040
AM peak	£3.645m	£3.110m	£2.717m	£2.444m	£6.589m
Inter-peak	£7.769m	£8.215m	£8.442m	£8.569m	£8.975m
PM peak	£1.672m	£2.263m	£2.645m	£2.896m	£2.465m

Figure 4-3 Forecast Annual Benefits spread over 60 years (£m)



4.13. The graphs of the spread of the benefits and analysis of the TUBA model output shows:

- The EAR stated that the benefits were expected to increase to 2030, the design year. Beyond 2030 the benefits increase significantly until 2040 due to increased congestion on the road in the DM scenario and hence more congestion relief in the DS scenario. Then business user benefits drop steadily over time due to no additional effects on congestion (2040 is the last modelled year in the analysis) and to the effect of discounting.
- Further analysis of the TUBA model shows that the inter-peak period was expected to provide the majority of the benefits, both in the opening year and in the long term. As business users gain the most from inter-peak travel time benefits and have higher personal values of time, this explains why they have the higher benefits.

Transport Economic Efficiency (TEE) benefits

4.14. TUBA was used to appraise the TEE benefits of the scheme compared to just having the existing situation.

4.15. The time periods used in the modelling were weekdays as follows:

- AM: 4 hours
- Inter-peak: 6 hours
- PM: 3 hours
- Weekend AM peak: 5 hours
- Weekend PM peak: 9 hours

4.16. TUBA analysis did not cover off-peak periods as the scheme was not expected to generate benefits in this period as there were only low congestion levels.

4.17. TEE benefits assessed in TUBA include journey time benefits and vehicle operating costs (VOC), in addition to indirect tax revenue impact.

Evaluation of Journey Time Benefits

4.18. The standard POPE methodology for evaluating the economic value of benefits arising from journey time benefits is based upon comparing the observed vehicle hour savings in the opening year against a forecast of the savings. It is then assumed that the ratio between these at OYA is

indicative of the long term trend, hence the 60-year outturn monetised benefits can be derived from the forecast 60 year benefits.

4.19. Due to the absence of reliable traffic flow information for the section of the scheme between J25-J27, the observed vehicle hour savings have been compared against the opening year forecast vehicle hour savings for the section of scheme between J23-J25.

4.20. Calculating the vehicle hour benefits in the first year attributable to the scheme is not a straightforward calculation. Several logical assumptions were therefore required and these are summarised below:

- The traffic already using the routes included in the assessment (in the before period) receives the full journey time benefit observed at this one year after stage;
- Any additional traffic receives half of the journey time benefits. This concept is known as the 'rule-of-a-half' and is the standard approach for dealing with extra traffic; and
- Off-peak periods are omitted as no forecasts were provided for these time periods and it is assumed that the motorway has spare capacity in these periods, even without the improvement.

4.21. The journey time benefits are shown in ***Table 4–2***.

Table 4-2 Journey Time Benefits

	Vehicle Hours
Re-Forecast Opening year observed vehicle hours saved on M25 J23-25	479,867
Observed Opening year observed vehicle hours saved on M25 J23-25	399,913
Ratio	83.3%

Forecast 60 year (Whole Area)	Outturn 60 year (Whole Area)
£628.6m	£523.9m

4.22. It can be seen from this assessment of the 60 year benefits, that the journey time benefits are lower at £523.9m. This is based on the assumptions outlined above, and based on analysis of only part of the scheme section. As such it is too early to be confident in the trends observed over only one year to be indicative of long term trends.

Vehicle Operating Costs (VOC)

4.23. WebTAG guidance states that the use of the road system by private cars and lorries gives rise to operating costs for the user. These are fuel and non-fuel costs, where fuel is the majority net impact of conventional highways schemes.

4.24. In the case of this scheme, the forecast VOC impact in the EAR was from the TUBA model. This forecast that VOC impact of the scheme would be a net disbenefit. This disbenefit would be mainly for consumer users, and this was largely due to the expected diversion of some consumer traffic from local roads onto the M25, which would have more capacity due to the ALR provided by the scheme. This would result in drivers travelling further to reach their destinations, but doing so in less time. As a result of the rerouting they were forecast to use more fuel (and non-fuel resources), thus increasing their operating costs. Business users see less impact as business traffic generally uses strategic roads and hence was forecast to only have a small disbenefit VOC, due to the increase in speeds slightly increasing the fuel costs.

4.25. As with journey time benefits, the TUBA model cannot be rerun to evaluate the impact. The alternative approach adopted here is based on comparing estimated changes in fuel consumptions between observed and forecast scenarios at OYA. This approach consists of the following steps:

- Estimating changes in fuel consumption one year after opening on the M25 between J23-J25 using observed data for flows and speeds by time period and based on VOC guidance on calculations given in webTAG.
- Estimating changes in fuel consumption one year after opening on the M25 between J23-J25 using forecast data for flows and speeds by time period and based on VOC guidance on calculations given in webTAG.
- Using the ratio between these at OYA to proportion the forecast 60 year VOC, the 60-year outturn monetised benefits can be derived.

4.26. This evaluation approach is based on the assumptions:

- Changes to fuel consumption are much of the VOC impact.
- The changes on J23-25 where flow data is available are proportional to the changes on J25-27.
- Changes on the key links J23 – 27 are indicative of the changes overall.
- The ratio between the changes in fuel consumption at OYA is indicative of the long term trend, hence the 60-year outturn monetised benefits can be derived from the forecast 60 year benefits.

4.27. The evaluation of the outturn impact based on the observations in the opening year is shown in **Table 4-3** compared with the forecast from the EAR.

Table 4-3 Vehicle Operating Costs (VOC)

		Net Change (£m)
Observed total net change in fuel costs in open year		5.563
Forecast total net change in fuel costs in open year		8.045
Ratio		69.2%
	Forecast (whole area)	**Outturn reforecast (whole area)**
60-year impact £m	-186.9	-129.2

4.28. This shows that the outturn assessment shows lower VOC disbenefit than was forecast. This is in part due to the lower than forecast observed flows. This result however, needs to be taken with caution, as EAR stated that the magnitude of the disbenefit forecast was largely due to consumer users travelling longer distances to use the improved capacity M25. It was not possible to evaluate the VOC disbenefit for this traffic from observed data as no detailed forecast of the impact on local roads was included in the TFR and the impacts over a wide network of roads is likely to be proportionately minor compared with other traffic changes between the before and after periods occurring in this wide area over the same period.

Monetised Safety benefits

4.29. As set out in the EAR and in the preceding safety section of this report, the safety benefits were forecast using the COBA modelling software. This also forecast the monetised value of the safety impact at £45.3m over 60 years.

4.30. As shown in **Table 3-6** in the safety section of this report; neither the COBA outputs nor the EAR provide direct results for the scheme section. The text in the EAR notes ‘On the mainline scheme links themselves, the analysis shows an increase of 160 collisions as a result of the scheme, over the 60-year appraisal period.’ An equivalent 2015 forecast increase of 2.8 (i.e. negative saving) has been estimated using the COBA outputs for the 60-year period over the whole area to proportion this increase.

4.31. Due to the staged opening of the scheme, the observed savings for the scheme section uses 12 months data for J23 to J25 but only 6 months for J25 to J27. This data has been used in the monitoring studies, thus for consistency the safety data covers the same time periods. As such the total values for annual savings cannot be accurately used in comparisons.

4.32. The POPE methodology for evaluating the safety benefit is based on the difference between the forecast and observed number of collisions, the PAR method for monetising injury collisions, and the schemes forecast 60-year monetary savings. How these combine to produce an outturn monetary benefit is set out in **Table 4-4**.

Table 4-4 Monetisation of Outturn Safety Impact

Forecast		Outturn	
COBA forecast opening year collision saving on key links J23 – 27	-2.8	Observed annual average saving in first year on key links J23 – 27	34*
		Net difference from forecast	36.8
		PAR based monetisation of net difference in first year	£3.435m
Forecast Monetary benefit for whole area (60 years)	£45.3m	60-year monetisation of net difference in collision numbers on the M25 J23 - 27 key links	£174.1m
		Total safety PVB whole area (60 years)	£219.4m

*Due to staged opening this is calculated from 12 months data for J23 to J25 and 6 for J25 to J27, as such annual values cannot be accurately compared between before and after.

4.33. This evaluation of the re-forecast 60 years safety impact shows the benefits to be £219.4m, which is above that forecast. However this figure outturn result should be taken with extreme caution due to the limitations of the data, and the collision savings at this stage not being statistically significant. Hence the outturn saving is not included in the total benefits of the scheme in accordance with the POPE methodology. It will be re-evaluated as part of the five year after evaluation.

Indirect Tax Revenue

4.34. Indirect tax revenue impact in the context of scheme appraisal means the changes to the revenue raised by central Government. For highway schemes, this primarily means the revenue from fuel duty for all users and, for consumers, from VAT which will both change if the scheme impacts the amount of fuel used by road users. Fuel usage changes are from the following:

- Changes in speeds which mean that vehicles are travelling at a greater or worse fuel efficiency;
- Changes to the amount of traffic; and
- Change to the journey lengths.

4.35. When this scheme was appraised, the impact of the scheme on net indirect tax revenue raised by central Government over the 60-year appraisal period was included as part of the benefits, rather than as part of the costs as had previously been the approach.

4.36. As the forecast indirect tax revenue for Government as a benefit is of similar magnitude, although in reverse, to the Vehicle Operating Costs (VOC) paid by users, the approach to evaluate the outturn impact is the use the ratio between the forecast and outturn VOC benefits to calculate the outturn reforecast of the 60 years Indirect Tax impact, as shown in **Table 4-5**.

Table 4-5 Indirect Tax Impact of scheme as a benefit (60 years, £million, 2002 prices and values)

	Forecast (whole area)	Outturn reforecast (whole area)
60-year impact	£172.9m	£119.6m

4.37. This shows that the indirect tax was forecast to be a large benefit of the scheme and that the outturn results is lower than forecast, again due to lower traffic volumes than forecast, and less change in volumes after opening compared to forecasts.

Greenhouse Gas (Carbon) Benefits

4.38. The monetised Carbon impact of the scheme was undertaken in accordance with TAG Unit 3.3.5 with the value of carbon from Department for Energy and Climate Change (DECC) 'Valuation of Energy Usage and Greenhouse Gas Emissions for Appraisal and Evaluation' published in June 2010. This was used as more appropriate than the TUBA model output.

4.39. The forecast carbon modelling was based on an area called the Traffic Model Reliability Area and extended around the north of the M25 from J15 (M4) at Colnbrook in the west to south of J2 at Dartford in the east, including sections of all radial routes, M40, A41, M1, A414, A1081, A1(M), A10, M11, A12, A127 and A13.

4.40. The forecast was a large disbenefit of -£159.2m which is the mid-point between the low and high estimates of the impact in the core scenario.

4.41. WebTAG states that for highway schemes, greenhouse gas emissions are assumed to be proportionate to the number of litres of fuel burnt. The evaluation of the fuel consumption undertaken in the VOC analysis showed that the total petrol and diesel consumption between J23 and 25 had increased by 11%, but outturn VOCs were lower than forecast VOCs, mostly due to lower than forecast flows.

4.42. Therefore, the POPE outturn evaluation is based on calculating the opening year net carbon emissions, then using the ratio method to calculate the monetised impact. The evaluation of the carbon emissions is detailed later in this report (page 66).

4.43. ***Table 4-6*** summarises the evaluation of the monetary impact.

Table 4-6 Carbon Benefit (£m)

Carbon	**Forecast (core traffic growth)**			**Outturn**
Net change in carbon tonnes within scheme links in 2015	15% increase			9% increase
Monetised impact	**lower estimate**	**upper estimate**	**mid-point**	
60 years' net change £m	-£75.3m	-£243.1m	-£159.2m	-£96.9m

4.44. The result of the evaluation of the carbon impact is a net increase in carbon emissions, but this is lower than forecast hence the level of the disbenefits of proportionately lower at -£96.9m over 60 years.

Other benefits: Noise, Air Quality, Impact of Construction period and future maintenance

4.45. Noise and Air Quality impacts of this scheme a very small proportion of the monetised benefits of this scheme respectively. Although the traffic flows have been lower than predicted (as shown in ***Table 2-2***), as the importance of the monetary impact is so low, the monetised impacts have assumed to be as forecast for both.

4.46. During the construction period, there was forecast to be disbenefits, largely due to delays caused to M25 journey times. The impact of future maintenance was also considered and the total net impact was -£193.3m. The EAR states that this includes the replacement of the steel safety barrier in the central reserve with a rigid concrete barrier (RCB) with no further requirement for maintenance or replacement within the 60-year appraisal period.

4.47. It is not part of the POPE process to evaluate the impacts during the construction period and at this point, it can be assumed that the future maintenance of the scheme will be as expected, therefore the OYA assessment of the impact of the construction period and future maintenance is as forecast at -£193.3m.

Reliability Impact

4.48. The scheme appraisal estimated the reliability benefits for the scheme. The monetised reliability benefit was not included in the overall monetised benefits in the EAR. The reliability sub-objective includes the impact of the scheme on incidents and day-to-day journey time variability.

4.49. Benefits of delays and travel time variability costs relating to incidents were examined using INCA. The appraisal used INCA (INcident Cost Benefit Assessment) version 4.1 for estimating the benefits of reduced delay, and travel time variability (TTV) caused by unforeseen incidents that reduce capacity, such as collisions, breakdowns, debris on the carriageway and major disruptions such as fire, load shedding or spillage. The combined impact on delay and variability are known as reliability. The forecast INCA benefit was not however included in the overall benefits for the purpose of calculating the BCR. This is in line with the webTAG guidance which states that the monetised reliability benefits should not be included in the overall Analysis of Monetised Costs and Benefits (AMCB).

4.50. INCA modelling was based on two modelled years (2015 and 2030) from which the INCA software extrapolates the 60 year benefits. ***Table 4-7*** shows the forecasts as stated in the EAR and from a rerun of the INCA model obtained for this study. The POPE outturn evaluation is based on calculating the opening year reliability using forecast and observed traffic flow data, then using the ratio method to calculate the monetised impact.

Table 4-7 Reliability Benefits from INCA (£m)

	Forecast (£m)	Outturn reforecast (£m)
Total Travel Time Variability Benefits Net Change over 60 years (Re-run for J23-25)	242.431	237.088
Total Delay Benefits Net Change over 60 years (Re-run for J23-25)	-236.526	-225.915
Total Reliability Benefits Net Change over 60 years (Re-run for J23-25)	**5.905**	**11.173**
Ratio		189.2%
60-year net impact £m (Whole Scheme)	**40.35**	**76.35**

4.51. The re-forecast reliability impact is 89% higher. Reliability is a combination of delay benefits (or in this case disbenefits) and variability benefits. The lower than forecast flows result in lower delay disbenefits. They also result in slightly lower variability benefits. The combination of these two changes result in greater total reliability benefits.

4.52. As most of the years in the re-forecast are still based on the original model from 2030 onwards there is still considerable uncertainty in terms of whether the scheme is likely to achieve the forecast monetary benefit for reliability.

4.53. It is further noted that the INCA assessment is based on the observed data on incidents on the motorway. Although this data does exist for the M25 before and after the scheme was built, the data cannot be compared on a like-for-like basis, as once a smart motorway is fully operational, the additional technology means that far more incidents are automatically being detected and hence recorded, than was the case with all manual recording before the scheme was in place.

Summary of Total Present Value Benefits

4.54. The total benefits as forecast and the outturn reforecast of the 60 year benefits are shown in ***Table 4-8***.

Table 4-8 Present Value Benefits summary (£m)

Costs in £m 2002 market prices, discounted	Forecast	Outturn
Journey Time	628.6	523.9
Vehicle Operating Costs (VOC)	-186.9	-129.2
Construction period & Future maintenance periods: Journey time and VOC impacts	-193.3	-193.3
Safety Benefits	45.3	*
Carbon Benefits	-159.2	-96.9
Noise Benefits	-1.3	-1.3
Air Quality	0.0	0.0
Indirect tax impact as a benefit	172.9	119.6
Total	306.1	222.6

*Safety benefits not included as not statistically significant at this stage

4.55. This summary of the total benefits shows that due to the lower journey time benefits, the outturn total benefits are lower than forecast. The lower journey time benefits result from the lower than forecast vehicle hours saved which is mainly due to lower traffic flows than predicted. The omission of safety benefits due to the lack of statistical significance at this stage also contributes to the lower outturn total. The lower than forecast flows do help offset the reduction in outturn total by contributing to lower than forecast Vehicle Operating Cost disbenefits and reduced carbon disbenefits.

Scheme costs

4.56. Costs of the scheme are also considered for the full appraisal period of 60 years such that they can be compared with the benefits over the same period. Investment costs are considered in terms of a common price base of 2002 for comparison with forecast. For comparison with the benefits, overall costs are expressed in terms of present value, termed Present Value Cost (PVC).

Present Value Costs (PVC)

4.57. Cost benefit analysis of a major scheme requires all the costs to be considered for the whole of the appraisal period and they need to be expressed on a like-for-like basis with the benefits. This basis is termed Present Value. Present Value is the value today of an amount of money in the future. In cost-benefit analysis, values in differing years are converted to a standard base year by the process of discounting giving a present value.

4.58. Following current Treasury Green Book guidance, calculation of the present value entails the conversion to market prices, then discounting by year. This uses a rate of 3.5% for the first 30 years and 3% thereafter. Note that the base year used here is 2002, as used in the scheme forecasts.

4.59. Appraisal of this scheme included the following types of cost:

- Investment costs: before and during construction; and
- Operational costs of the smart motorway during the 60 years after opening.

4.60. Note that when this scheme was appraised, the impact on Indirect Tax revenues during the 60 years after opening was included as part of the benefits in accord with then current guidance, rather than as part of the costs. It has likewise been treated as a benefit in this report.

Investment Cost

4.61. The investment cost is the cost to Highways England of the following:

- Costs of construction;
- Land and property costs;
- Preparation and supervision costs; and
- Allowance for risk and optimism bias.

4.62. For the purpose of this evaluation, we have determined the forecast scheme cost based on data presented in the M25 Later Upgraded Sections (estimate of 11/10/12) which was an update on the figures presented in the EAR. This gave a total cost for Highways England Major Projects of £194.6m.

4.63. No Do Minimum costs were detailed in the EAR. It stated that cost of upgrading the steel safety barrier to rigid concrete barrier (RCB) as a necessary part of the conversion of J23-27 to ALR was excluded from the forecast cost of the Do Something scheme as it was also a necessary cost for the Do Minimum scenario. The cost of the RCB was not given.

4.64. For comparison with the outturn costs on an equivalent basis, the investment part of the PVC was calculated assuming the same spend profile by year as the forecast spend by milestone, and adjusted to 2002 prices (without discounting), as presented in ***Table 4–8***.

4.65. The outturn investment costs as of April 2016 for building this scheme have been obtained from the Regional Finance Manager at Highways England covering the period 2008 – 2015. For the purpose of comparison between forecast and actual, and with other major schemes, prices have been converted to 2002 prices. This figure can then be compared with the forecast cost on a comparable basis. These figures are shown below in ***Table 4-9***.

Table 4-9 Investment Cost of Scheme (£million, 2002 prices, not discounted)

Forecast	Outturn	Difference
149.7	121.2	24%

4.66. This shows that the outturn cost was 24% lower than forecast. It is understood that this saving was achieved through value engineering.

Operational Costs

4.67. Operational costs of the scheme were assessed in the EAR in line with guidance in IAN 164/12. It covers expenditure relating to the following aspects of the smart motorway:

- Day-to-day running and operation of the smart motorway;
- Enforcement costs including police; and
- Capital costs of renewal. This is the costs over 60 years of the maintenance and renewal of the technology and associated infrastructure. Note that this is distinct from Vehicle Operating Costs (VOC) which is the impact on the costs to road users, and is considered as part of the benefits assessment above.

4.68. No outturn reassessment of the operating costs has been made as at this stage; the assumptions made in the appraisal are still considered to hold true.[8]

Summary of Present Value Cost (PVC)

4.69. ***Table 4-10*** shows the total of the costs expressed in terms of present value.

[8] It is understood the costs so far have been higher than expected, but no figure was available for the additional costs in the long term.

Table 4-10 Present Value Costs Summary (£m)

Costs in £m 2002 market prices, discounted	Forecast	Outturn
Investment cost	122.3	101.0
Operational costs	22.8	22.8
Total PVC	145.0	123.8

4.70. It should be noted that there are no Do Minimum costs included in this summary. The EAR stated that the capital cost of regular maintenance (other than for the smart motorway) would be similar in Do Minimum and Do Something scenarios. Capital cost of the smart motorway technology renewal is covered within the operating costs[9].

4.71. With these costs expressed in Present Value on the same basis as the benefits (PVB), we can now assess the benefit cost ratio.

Benefit Cost Ratio

4.72. The benefit-cost ratio (BCR) is an indicator used in the cost-benefit analysis of a road scheme that attempts to summarize the overall value for money of a project or proposal. The BCR is the ratio of the benefits of a scheme or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms. All benefits and costs are expressed in present values as detailed in the above sub-sections.

4.73. ***Table 4-11*** shows the calculation of the BCR using the costs and benefits presented earlier in ***Table 4-10*** and ***Table 4-8***.

Table 4-11 Benefit Cost Ratio (£m)

Monetary values in £m 2002 market prices, discounted	Forecast	Outturn
Present Value Benefits (PVB)	306.1	222.6
Present Value Costs (PVC)	145.0	123.8
Benefit Cost Ratio (BCR)	2.1	1.8

4.74. The key points regarding the BCR assessments are:

- The original forecast was 2.1 meaning than over £2 of benefits were expected for every £1 spent.
- The outturn evaluation BCR is lower at 1.8 which is categorised as medium Value for Money (VfM). Despite the lower costs, there are lower outturn benefits which are mainly due to lower than forecast flows. Statistically insignificant safety benefits have not been included in the Outturn BCR which also contributes to the reduction to BCR.
- Uncertainty over predicting the long term trend of journey time saving based on only the first year for a scheme of this type means that the outturn BCR has the potential for a wide range of outcomes.

4.75. Reliability benefits (as shown in ***Table 4-7***) are not included in this BCR assessment, in line with the original appraisal. If they are included, then the forecast BCR rises to 2.4. For the outturn, if we include the rerun reliability benefit (***Table 4-6***) and on the grounds that journey time reliability has been observed to improve (as shown in the traffic chapter in ***Figure 2-8*** and ***Figure 2-9***), then the outturn BCR at OYA is also 2.4.

4.76. It should be noted that the BCR ignores non-monetised impacts. In the former NATA assessment and its replacement, the Transport Business Case, the impacts on wider objectives must be considered but are not monetised.

[9] In line with guidance in Interim Advice Note 164/12 – The economic assessment of Managed Motorways – All lanes running

4.77. The evaluation of the environmental and social objectives is covered in the following sections.

Regeneration, Wider Economic Benefits

4.78. The AST stated that as the scheme was not in a regeneration area, Regeneration Impacts were not assessed. Likewise, no Wider Economic impacts were assessed.

4.79. The EAR noted that at the scheme's PCF stages 2 and 3, it was deemed that a Regeneration Impacts Report would not be required for this scheme.

4.80. At OYA, there has been no change to regeneration area designation. No evaluation of Regeneration or Wider Economic Benefits has been undertaken.

Economic Impacts – Key Points

Benefits

- Benefits from journey time savings were forecast to be large and provide the majority of the monetised benefits. Outturn journey time benefits are lower, but this is based on analysis of only part of the scheme section. As such it is too early to be confident in the trends observed over only one year to be indicative of long term trends.
- The lower journey time benefits result from the lower than forecast vehicle hours saved which is mainly due to lower traffic flows than predicted. The lower than forecast flows do help offset the reduction in total benefits, with lower disbenefits from Vehicle Operating Cost and carbon.
- The monetary benefits of the savings in the number of injury collisions is higher than forecast. However, this has not been included in the total benefits at this stage as the result is not statistically significant.
- Disbenefits from the delay during construction period and maintenance of the technology in future years were forecast to be high at £193.3million; however this has not been recalculated.
- The monetisation of the Carbon impact of the scheme was forecast to be a large disbenefit (-£159.2million) due to the increase in emissions, but the outturn evaluation is less negative at -£96.9million.
- Vehicle Operating Costs (VOC) which were forecast to be a disbenefit for road users and Indirect tax revenue impact which was expected to be a benefit for the Government have both been evaluated to be lower than forecast.
- Other monetised benefits are roughly as expected.
- Reliability benefits from the reduction in incident related delay were large in the appraisal. Based on the information currently available to POPE, journey time variability has improved, and a rerun of the model suggests the outturn reliability benefits could be higher than forecast.

Cost

- The investment cost of building the scheme was £121 million (non-discounted in 2002 prices), which was 24% lower than forecast.
- Long term costs of operating the smart motorway are assumed to be as forecast at £22.8million.
- The Present value costs in discounted 2002 prices are 123.8million (£101million investment cost and £22.8 operating costs)

Benefit Cost Ratio

- The outturn BCR of 1.8 is slightly lower than the forecast BCR of 2.1. The outturn BCR of 1.8 is categorised as medium Value for Money. Despite the lower than forecast costs, there are lower outturn benefits which are mainly due to lower than forecast flows. Statistically insignificant safety benefits have not been included in the Outturn BCR which also contributes to the reduction to BCR.
- Forecast and outturn reliability benefits have not been included in the overall benefits for the purpose of calculating BRC, in line with webTAG guidance.

5. Environmental Evaluation

Introduction

Background

5.1. The strategic case for providing additional capacity on the M25 was examined in 2002 by the ORBIT Multi-Modal Study (MMS). The aim of the ORBIT MMS was to develop a long-term multi-modal strategy for the sustainable management of the M25 orbital motorway and more generally, for the transport corridor around London.

5.2. On 9th July 2003, the Secretary of State for Transport responded to the ORBIT MMS by accepting its recommendation to widen the M25 to four lanes in each direction in a number of places, including Section 5 (J23-27).

5.3. Following on from this, in March 2008, the Advanced Motorway Signalling and Traffic Management Feasibility Study identified M25 Section 5 as one of the preferred candidates for Dynamic Hard Shoulder Running (DHSR), which could provide a large proportion of the benefits of widening at a significantly lower cost.

5.4. In December 2011, it was announced that Managed Motorways - All Lanes Running (MM-ALR) would replace DHSR and reduce the number of signs, gantries, and Emergency Refuge Areas (ERAs) required.

Scheme Overview

5.5. The M25 Section 5 MM-ALR runs for 26 km, and is situated entirely within the limits of the Strategic Road Network (SRN) estate. The Scheme makes use of the existing hard-shoulder to provide the additional lane capacity between J23-27, and is managed by a system of gantry mounted electronic signs and signals. ERAs are provided approximately every 2.5km where topography and road layout permit.

5.6. Outside of that required for the effective operation of MM-ALR, the Scheme proposals only included the minimum of improvements to the road superstructure (i.e. surfacing, vehicle restraint systems, environmental mitigation, and drainage improvements) that would be required to achieve safe and legal operation of the MM-ALR.

5.7. MM ALR operates between J23-27, with through junction running at J24 and J26 (i.e. using the hard shoulder through each junction).

5.8. At J25, the previously existing 3 lanes, and 4 lanes through Holmesdale Tunnel, were to be maintained. The Bell Common Tunnel (previously running with 3 normal lanes and widened hard shoulders and central reserve margins) was to be upgraded to provide 4 lanes, with a hard shoulder for approximately 500m either side of the tunnel to conform to European codes. Past this area and up to J27 MM ALR was to apply.

5.9. It was proposed that a mixture of cantilever and portal gantries were to support the signs and signals required for MM ALR. In order to accommodate the gantry legs and associated signal equipment cabinets, the motorway earthworks were to be widened using driven steel sheet piling. At the junctions, there are several merges and diverges that were also to be widened using steel sheet piles, with any existing drainage and lighting being replaced after completion of the widening works.

5.10. The ERA drainage system was to discharge to the existing networks at a slow rate so as not to overload the drainage system and therefore no alteration to the drainage system was required. All the outfalls to streams and rivers were to remain as existing.

5.11. In addition to the implementation of the MM-ALR requirements, the central reserve was to be hardened (where it was not previously) and a concrete barrier constructed. Although this would require the removal and replacement of the existing surface water drainage collection system in the central reserve, the drainage networks in the central reserve would essentially remain unchanged.

5.12. No new lighting was proposed for the main line, and existing lighting was to be retained unaltered unless replacement was required in areas of widening works.

5.13. The construction phase of the Scheme was from February 2013 to November 2014.

5.14. Prior to the Scheme, there was approximately 60% to 70% of low noise surfacing on the existing carriageways. No new low noise surfacing was proposed, but it was anticipated to take place when the maintaining authority programmed resurfacing works. However, web based material from Highways England states that the second and third lanes of the M25 were resurfaced with a quieter running surface, both clockwise and anti-clockwise between J23-24 and J25-27, from December 2014 to June 2015.

5.15. The Scheme is within 2 km of two internationally important designated sites, including the Lee Valley Special Protection Area (SPA) and Ramsar Site, and Epping Forest Special Area of Conservation (SAC).

Assessment

5.16. An environmental assessment for the Scheme was undertaken and reported in an Environmental Assessment Report (EAR), which notes that the environmental objectives of the Scheme were:

- To minimise the detrimental environmental effects of the Scheme and offset by mitigation measures where technically feasible and economic to do so, taking account of costs, availability of funding, and statutory obligations.

5.17. For each of the environmental sub-objectives considered by the EAR, the evaluation in this chapter assesses the environmental impacts predicted in the Scheme's Appraisal Summary Table (AST) and EAR against those observed one year after opening.

5.18. In the context of the AST and EAR forecasts and using evidence collected one year after (OYA) opening, this chapter presents:

- A record of any significant changes to the Scheme that have taken place since the EAR.
- An evaluation of the effectiveness of the mitigation measures implemented as part of the Scheme.
- A summary of key impacts against all of the ten environmental WebTAG sub-objectives.

Data Collection

5.19. The following documents/ data have been used in the compilation of this environmental chapter of the OYA report:

- Appraisal Summary Table Report (November 2012).
- Stage 3 Preliminary Design, Environmental Assessment Report (November 2012).
- Alternative Design Proposal - Landscape Bund at Holly Hill Farm, Enfield (August 2013).
- Construction Environmental Management Plan – Section 5 (September 2013).
- Scheme Visual Impact Assessment Review (October 2013).
- Environmental Masterplan drawings, issued For Construction (October 2013).
- Alternative Design Proposal – Skinners Farm Landscape Bund (November 2013).
- Advance Environmental Design drawings (partial, 19/37 drawings) marked up As Built (February 2014).
- Draft Handover Environmental Management Plan, without appendices, (November 2014).
- Final Use Assessment – Noise Insulation Regulations Assessment (December 2014).
- M25 J23-27 Twelve Month Evaluation Report (January 2016).
- Web based Scheme information.
- Scheme Newsletters/ publicity material.

5.20. A list of the background information specifically requested and received to help with the compilation of this report is included in Appendix B.

Alternative Design Proposals and Design Development Changes

5.21. During design development, Alternative Design Proposals (ADP's) were assessed for approval. Several alternative proposals relating to both infrastructure and earthworks were made due to changes throughout the design process, originating either from design development or from addressing on-site constraints found during construction. The ADP's for earthworks utilised private land outside the highway boundary.

5.22. ADP's which were built (and detailed further in the relevant sub-objective sections, below) included:

- Changes to locations and types of highway infrastructure (gantries); and
- Construction of two additional landscape bunds, one at Holly Hill Farm, Enfield, and the other at Skinners Farm, Theydon Mount.

Site Visit

5.23. As part of the OYA evaluation, a site visit was undertaken in mid-May 2016. The visit included the taking of photographs to provide a photographic record of the Scheme. Where appropriate, these photographs have been included within the text of this document; no photographs were contained in the EAR, so no comparison photographs were able to be taken.

Consultation

5.24. Statutory environmental organisations, stakeholders, District/ Borough/ County councils, and relevant organisations that were consulted prior to the final publication of the EAR were contacted as part of the OYA evaluation regarding their views on the impacts they perceive the Scheme has had on the environment are shown in Table 5-1 below.

Table 5-1 Summary of Environmental Consultation Responses

Organisation	Field of Interest	Comments at OYA
Natural England	Biodiversity & Landscape	Did not respond to the invitation to provide feedback.
Historic England	Heritage	Did not respond to the invitation to provide feedback.
Environment Agency	Water	Responded that they had no comments to make.
Hertsmere Borough Council	General	Did not respond to the invitation to provide feedback.
Hertfordshire County Council	General	Did not respond to the invitation to provide feedback.
Welwyn Hatfield Borough Council	General	Responded that they were unaware of adverse impacts on the visual openness of Green Belt, or adverse impacts on historical, archaeological, or ecological assets and resources. Had no comment to make regarding water, air quality, or noise. Noted that lighting and signage should be kept to the minimum given the Scheme's Green Belt context.
London Borough of Enfield	General	Did not respond to the invitation to provide feedback.
Epping Forest District Council	General	Did not respond to the invitation to provide feedback.

Organisation	Field of Interest	Comments at OYA
Borough of Broxbourne	General	Did not respond to the invitation to provide feedback.
CPRE[10]	General	Did not respond to the invitation to provide feedback.
Epping Town Council	General	Did not respond to the invitation to provide feedback.
Waltham Abbey Town Council	General	Did not respond to the invitation to provide feedback.

Animal Mortality

5.25. The M25 Network Managing Agent (NMA) was also consulted with regard to animal mortality figures, which have been made available for the eight year period between 2009 and 2016 inclusive; these figures are discussed in the Biodiversity section of this chapter.

Awards

5.26. The Skanska Balfour Beatty Joint Venture (SBBJV), involved in upgrading the M25 motorway between J23-25 and J5-7, received three CEEQUAL (Civil Engineering Environmental Quality Assessment and Award Scheme) awards in May 2015; please refer to Appendix B, Information Requested for Environmental Evaluation, for further details.

Traffic Forecast Evaluation

5.27. Three of the environmental sub-objectives (noise, local air quality, and greenhouse gases) are directly related to traffic flows. No new noise or air quality surveys are undertaken for POPE and an assumption is made that the level of traffic and the level of traffic noise and local air quality are related.

5.28. Table 5-2, below, shows the accuracy of the traffic modelling before and after construction for the M25 within the Scheme between J23-25. No data has been provided for J25 - J27, due to significant inconsistencies in detector outputs (as noted by the M25 J23-27 Twelve Month Evaluation Report - TMER).

5.29. The traffic forecasts presented in the traffic chapter of this report correspond to this data, and the Environmental evaluations are consistent with this. It should be noted that rounded values (to the nearest 100) are presented.

Table 5-2 Traffic flow (AADT) on M25: Forecast and Observed

Location	Dir	Without scheme 2012			With Scheme 2015			Increase with scheme*	
		DM F'cast	Obsv'd	% diff	DS F'cast	Obsv'd	% diff	F'cast	Obsv'd
M25 J22-23	CW	78,300	67,800	-13%	85,200	76,800	-10%	9%	13%
	ACW	72,000	66,100	-8%	78,000	75,300	-3%	8%	14%
M25 J23-24	CW	79,600	64,400	-19%	91,600	70,000	-24%	15%	9%
	ACW	77,000	63,400	-18%	87,400	69,000	-21%	14%	9%
M25 J24-25	CW	72,900	62,700	-14%	84,600	64,600	-24%	16%	3%
	ACW	71,600	59,500	-17%	82,400	66,100	-20%	15%	11%
M25 J27-28	CW	70,700	65,400	-7%	75,000	75,900	1%	6%	16%
	ACW	70,700	64,200	-9%	75,000	73,300	-2%	6%	14%

[10] CPRE: Campaign for the Protection of Rural England

* Difference between the 2012 Do Minimum (DM) and 2015 Do Something (DS) scenarios, including the net impact of the scheme and wider trends regarding traffic growth.

5.30. In order to provide a context for the following review and evaluation of environmental topics, the key points regarding the accuracy of the traffic forecasts for the Scheme and the adjacent sections of the M25 are summarised as follows:

- Observed post-opening traffic flows are lower than expected (between 20% and 24% between J23 - J25), the average being 22% lower.
- Traffic flows in 2012, before the start of construction, were also lower than expected (between 14% and 19% between J23 - J25), the average being 17% lower. This may partially explain why the observed post-opening flows are lower than forecast. The inaccuracy of the DM forecasts reflect that the modelling of the traffic growth from the base years of 2004 and 2012 did not include the impact of the recession.
- Traffic was forecast to increase between J23-25 by between 14% and 16%, which were higher than the rates forecast for the adjacent sections; what has been observed is that growth is slightly lower than predicted (on average by 8%), and is lower than the growth observed on adjacent sections.

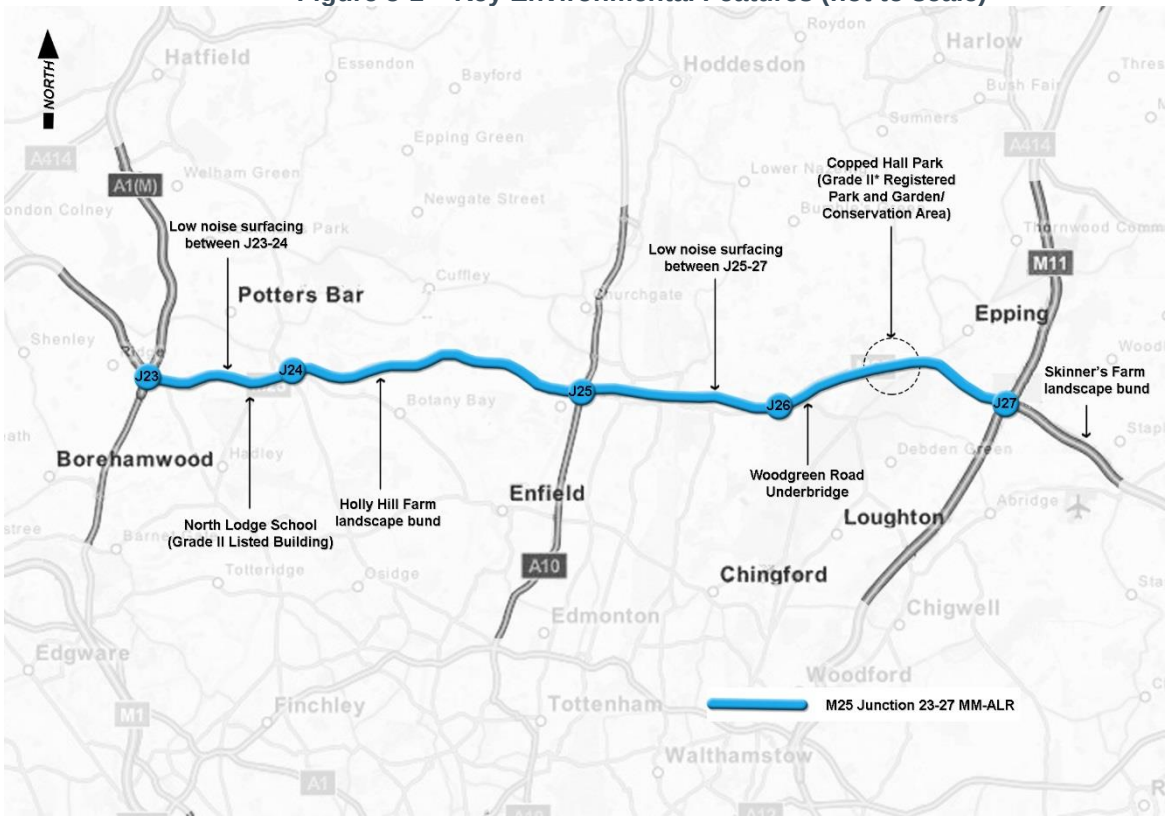
5.31. Analysis of HGV levels is through vehicle classification by length, in which an HGV is classed as a vehicle over 6.6m in length. No comparisons between HGV/ speed data have been made due to technical limitations of the traffic counting at sites throughout the scheme.

One Year After Environmental Assessment

5.32. Included in this section is a brief summary of statements from the AST and EAR evaluations which have been included to provide the context for the OYA evaluation.

5.33. The key environmental features that are discussed in this chapter are shown in Figure 5-1, below.

Figure 5-1 Key Environmental Features (not to scale)



Noise

Forecast

Appraisal Summary Table

5.34. The AST stated that 9,829 dwellings and 56 other noise sensitive receptors were considered in the detailed study area, and that:

- On opening: 258 dwellings and 4 other noise sensitive receptors were predicted to experience a minor increase in noise, and 12 dwellings predicted to experience a minor decrease in noise; all other changes were predicted to be negligible or no change.
- Over the design period: no significant increases in noise were predicted, primarily due to low noise resurfacing works. 1 dwelling was predicted to experience a minor decrease in noise, with all other changes being negligible or no change.
- Those living within income quintile[11] 2 (the second most deprived) would have a higher share of the net losers than the corresponding share in the total population of the assessment area, and would thus have a large impact. However income quintile 1 (the most deprived) would receive a large beneficial impact, as there would be more properties experiencing a decrease, rather than an increase, in noise. The other income quintiles were predicted to receive moderate adverse impacts.

5.35. Overall, the AST concluded that there would be 30 more people annoyed by the Scheme than would be without the Scheme; no overall qualitative assessment (i.e. the degree of adverse or beneficial impacts) of the effect of the Scheme on the noise climate was given.

Environmental Assessment Report

5.36. The EAR contained calculations for the detailed study area which predicted that approximately 3% of receptors would experience a minor change in noise, but that the majority of receptors would experience negligible or no change. By the design year, no receptors were expected to experience a perceptible increase in noise.

5.37. A number of increases were predicted on routes within the wider area, although these increases were predicted to occur both with and without the scheme, and therefore were not considered to be direct impacts of the scheme.

5.38. The EAR considered that construction works could give rise to short term significant adverse impacts, particularly from works near residential properties, or from works taking place at night. However, it was expected that these impacts would be limited by the use of Best Practicable Means.

5.39. Overall, the EAR considered that there would be a **slight adverse** effect in terms of noise on scheme opening, but this was expected to be reduced to **neutral** after 15 years.

Consultation

5.40. Welwyn Hatfield Borough Council responded that they had no comments to make.

Evaluation

5.41. Highways England web-based material has confirmed that post-opening, the second and third lanes of the M25 have been resurfaced with a quieter running surface than existed prior to the resurfacing works, both clockwise and anti-clockwise between J23 - 24, and between J25 -27.

5.42. The Final Use Noise Insulation Regulations Assessment (FUNIRA) calculated the prevailing and relevant road traffic noise levels at a sufficient number of representative receptors12, and concluded that the façades of The Gables and Preston Grange (properties on the A1000 Barnet

[11] Quintile: The portion of a frequency distribution containing one fifth of the total sample (statistics).

[12] Using the methodology detailed in the DoT technical memorandum Calculation of Road Traffic Noise (CRTN). CRTN is the methodology used to determine entitlement under the Noise Insulation Regulations 1975 (as amended 1988) (NIR) and is the accepted method for the prediction of traffic noise in the UK.

Road) and the caravans within Brooke's Place (also off Barnet Road), were shown to qualify for noise insulation, and that the increase in noise was primarily due to traffic changes on the M25 which was shown to rise from an 18 hour AAWT13 flow of approximately 78,000 in 2015 to a flow of approximately 100,000 in 2030. The FUNIRA noted that if the scheme had not been built, the increase in noise due to the change in traffic flow on the M25, between 2015 and 2030, would have been 0.5dB, compared with the 1.1dB increase with the scheme in place.

5.43. Although the FUNIRA demonstrated that the change in road noise for the properties eligible for noise insulation was 0.6dB louder that it would have been without the scheme, it should be noted that a change in road traffic noise of 1dB in the short term (e.g. when a Scheme is opened) is the smallest change that is considered perceptible by DMRB HD213/1114, and that in the long term, a 3dB change is considered perceptible.

5.44. The M25 J23-27 TMER commissioned by Highways England to evaluate the Scheme, stated that the measured noise levels taken during the After (construction) period were no greater than the baseline measurements, other than at one location (Guys Lodge Farm) where the summer measurements exceeded the predicted levels by just over 1dB. The TMER considered that the results therefore provided a positive indication that noise levels had not increased as a result of the scheme.

5.45. An assumption is made by POPE methodology that noise levels will be as expected if observed traffic flows are within 25% more or 20% less than predicted; as can be seen by the comparison of both the predicted and observed AADT flows in Table 5-2, above, with the exception of anti-clockwise between J24-25 where the figure is 20% lower (and therefore considered to be as expected), the available data indicates that the observed AADT Traffic Flows are between 21% and 24% lower than forecast at all other locations between J23-25 and as such, exceeding the 20% tolerance prescribed by POPE, are considered better than expected.

5.46. Although POPE methodology would normally take HGV/ speed data into account when evaluating the noise climate, no comparisons between HGV/ speed data have been made due to technical limitations of the traffic counting at sites through the scheme.

5.47. Based on the available information, it is therefore concluded that the effects of the Scheme on the noise climate are likely to be generally **better than expected** between J23-25, but as expected between J24-25 anti-clockwise.

Table 5-3 Evaluation Summary: Noise

Sub-Objective	AST	OYA
Noise	Population annoyed without Scheme: 3,160. Population annoyed with Scheme: 3,190. Net change: 30 more people annoyed.	Generally better than expected between J23-25, but as expected between J24-25 anti-clockwise.

Air Quality

Forecast

Appraisal Summary Table

5.48. The AST stated that with the Scheme, there would be an overall slight improvement in Nitrogen dioxide (NO_2) and Particulate Matter (PM_{10}) concentrations, and that:

- In terms of local air quality, there were 16 Air Quality Management Areas (AQMAs) for annual average NO2, and 6 AQMAs for 24 hour PM10 within 200m of the affected road network.

[13] AAWT: Average of 24 hour flows, seven days a week, for all days within the year.

[14] DMRB: Design Manual for Roads and Bridges, a series of 15 volumes that provide standards, advice notes and other documents relating to the design, assessment, and operation of trunk roads, including motorways, in the United Kingdom. HD213/11 sets out example classifications of the magnitude of operational noise impacts for changes in noise experienced within both the short term and the long term.

- Exceedances in 6 AQMAs of annual average NO2 concentrations 20m from the road in the opening year (2015) were predicted, with expected changes in NO2 concentrations being between -0.4 µg/ m3 to +1.9 µg/ m3.
- Changes in annual mean PM10 concentrations in PM10 AQMAs were expected to be between -0.1 µg/ m3 to +0.4 µg/ m3 at 20m from the road, although it was noted that PM10 AQMAs were for 24 hours.
- Those living within income quintiles 1, 3, and 4 were expected to receive net dis-benefits ranging from slight to large adverse, and those living within income quintiles 2 and 5 (the latter being the least deprived) were expected to receive net benefits. The overall proportion of properties experiencing a deterioration/ an improvement was stated as being very similar.

5.49. No overall qualitative assessment of the effect of the Scheme on air quality was given, although the impact of the Scheme was quantified as follows:

- In terms of changes in NO2 concentrations: 2,321 properties would experience improvement, 2,345 would experience deterioration, and 639 would experience no change.
- In terms of changes in PM10 concentrations: 2,079 properties would experience improvement, 2,055 would experience deterioration, and 1,171 would experience no change.

Environmental Assessment Report

5.50. The EAR stated that an air quality assessment of the Scheme had been undertaken in accordance with the DMRB HA207/07[15], and that the assessment included consideration of:

- Local air quality impacts at representative receptors, in terms of human health and designated sites with ecologically sensitive features, as a consequence of the Scheme in 2015 (the first full year after Scheme opening).
- Regional air quality impacts, in terms of changes in emissions as a consequence of the Scheme in 2015 and 2030 (the design year).
- Construction dust impacts, in terms of relevant sensitive receptors within 200m of the Scheme.

5.51. The EAR noted that an assessment in accordance with WebTAG had also been undertaken and although reported separately, the key findings were summarised within the EAR.

5.52. Using the (former) Highways Agency (HA) draft evaluating significance approach and in the context of the European Union criteria for evaluating significance, the overall conclusions of the EAR on the M25 Section 5 scheme were as follows:

- Local air quality (annual average NO2): there would be no overall significant effects for human health impacts.
- Annual average NOx16 on designated ecological sites: there would be no overall significant effects.

5.53. The assessment of the changes in total Nitrogen (N) deposition as a result of the scheme indicated that deposition rates were higher than the Critical Loads17 for the sensitive features at Epping Forest and Water End Swallow Holes, and this was mostly attributed to the high background N deposition rates. Deposition rates were below the Critical Load at Curtismill Green. The predicted maximum increase in the road increment contribution to the total N deposition rates was 0.4 kg N/ ha/ year compared to the Do Minimum (DM) scenario, which is a change of 1%.

5.54. The regional assessment indicated that there would be increases in emissions with the scheme of between 10-12% in 2015 and between 14 -18% in 2030, compared with the DM scenario. There was predicted to be a reduction in all emissions in 2015 and 2030, with the exception of carbon presented as carbon dioxide equivalent, when compared with the base scenario.

[15] HA207/07 deals with Air Quality Assessment.

[16] NOx is a generic term for the mono-nitrogen oxides NO and NO_2.

[17] A quantitative estimate of an exposure to one or more pollutants, below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge.

5.55. In terms of construction, with mitigation measures in place, implemented on the construction site and not at individual receptors, the risk during construction was stated as low, and construction was therefore considered be unlikely to cause a statutory nuisance.

5.56. The EAR concluded that there would be no significant effects on air quality.

Consultation

5.57. Welwyn Hatfield Borough Council responded that they had no comments to make.

5.58. The TMER stated that although NO2 concentrations exceeded the NO2 annual mean criterion in both the Before and After (construction) periods, they appeared to be lower following the opening of the scheme, which was considered to be a positive finding. However, TMER noted that it was not possible to directly attribute the reduction in measured concentrations to the scheme itself, as there are many other factors which can cause variation in air quality monitoring data, including changes in fleet composition and contribution from secondary NO2 sources (i.e. NO2 not directly emitted from vehicle exhausts). No conclusions were able to be drawn from the results of the NOx analysis.

5.59. An assumption is made by POPE methodology that local air quality will be as expected if observed traffic flows are within 10% more or 10% less than predicted; as can be seen by the comparison of both the predicted and observed AADT flows in Table 5-2, above, the data indicates that the observed post-opening traffic flows are lower than expected by between 20% and 24% between J23-25.

5.60. Where the tolerances assumed by POPE are exceeded and in terms of the shortfall between the absolute number of vehicles and the predicted figures, traffic flows are less than predicted by between 16,300 and 21,600 AADT and being greater than 1,000 AADT, the percentage differences between the predicted and observed flows are considered likely to be significant.

5.61. Although POPE methodology would normally take HGV/ speed data into account when evaluating air quality, no comparisons between HGV/ speed data have been made due to technical limitations of the traffic counting at sites through the scheme.

Based on the information presented in this evaluation, it is therefore concluded that the effects of the Scheme in terms of local air quality are likely to be **better than expected** between J23-25.

Table 5-4 Evaluation Summary: Air Quality

Sub-Objective	AST	OYA
Air Quality	NO_2 Overall Assessment Score: -21. Properties with improvement 2,321, deterioration 2,345, no change 639. PM_{10} Overall Assessment Score: -5. Properties with improvement 2,079, deterioration 2,055, no change 1,171.	Better than expected between J23-25.

Greenhouse Gases

5.62. For transport, Carbon Dioxide (CO2) is considered the most important greenhouse gas therefore it has been used as the key indicator for the purposes of assessing the impacts of a road scheme on climate change. Changes in CO2 levels are considered in terms of equivalent tonnes of Carbon released as a result of the scheme under evaluation.

5.63. The AST forecast that carbon emissions would increase with the scheme due to the increase in vehicle kilometres travelled. This was assessed for the opening year and for 60years using a non-TUBA method. The 2015 emissions were forecast to be a net increase of 0.07 MtCO2e (Million metric tons of carbon dioxide equivalent), which is 19,091 tonnes of carbon.

5.64. In the ES, the Regional Air Quality Impacts, which include carbon emissions, were assessed based on total emissions from roads included in the regional air quality ARN (based on selection of roads where significant change was forecast). These were the M25 mainline from J16 (M40) to J31 (A13 at Grays) inclusive, the A1081 and A414 between M25 J22 and M1 J7, A1 from Apex Corner south of the M25 to A1(M) J3 north of the M25, A10 immediately north and south of the M25 J25, and M11 J5 (Chigwell) south of the M25 to J8 (Bishops Stortford) north of the M25. The forecast impact on these links was a net increase of 38,700 tonnes (12%). This is higher than the forecast in the AST, reflecting the large area modelled.

5.65. The POPE approach to the evaluation has been to measure the net carbon impact in the opening year for the sections of the M25 within the scheme for which traffic flow data is available. For the purpose of meaningful comparisons, a forecast has been created for the same links (J23-25) based on published traffic flow and speed forecasts. Carbon calculations have been undertaken using the DMRB regional air quality spreadsheet.

Table 5-5 Forecast and Outturn opening year carbon impact (tonnes carbon)

	Forecast	Outturn
Do Minimum/ Without scheme	37,057	30,435
Do Something / with scheme	42,535	33,175
Net impact	5,478 (+15%)	2,740 (+9%)

5.66. This evaluation shows a lower carbon increase than forecast on the M25 through the section of scheme for which flow data is available, which is largely due to lower than forecast traffic flows.

Landscape

Forecast

Appraisal Summary Table

5.67. The AST stated that gantries and signage would increase the perception of urbanisation in the countryside, leading to a very minor loss of landscape features within the highway boundary, predominantly resulting in neutral to slight adverse effects on landscape and visual receptors.

5.68. Overall, the landscape impact of the Scheme was predicted by the AST to be **slight adverse**.

Environmental Assessment Report

5.69. The EAR assessed the landscape and visual effects of the Scheme at Year 1 and Year 15; no effects on landscape character were considered to be any worse than Slight Adverse, and no Large Adverse visual effects were identified:

- Landscape: The EAR considered that the increase in gantries and signage would slightly increase the perception of urbanisation in the countryside and result in a very minor loss to landscape features within the highway boundary; overall the landscape effect of the Scheme was predicted to be **slight adverse**.
- Visual Amenity: The majority of the effects of the Scheme were considered by the EAR to be Neutral or Slight Adverse due to the location of all proposed work being within the existing M25 highway boundary which, with existing lighting and signage, was predicted to have an adverse visual effect. Overall, the EAR considered that the Scheme would have a slight adverse effect on visual amenity, predominantly due to the minor increase in visual intrusion resulting from the proposed gantries. Overall, the EAR concluded that the visual effect of the Scheme would be **slight adverse**.

5.70. Overall therefore, the EAR concluded that the Scheme would have a slight adverse effect on landscape and visual amenity.

Scheme Visual Impact Assessment Review

5.71. As a result of design development, some of the infrastructure (i.e. gantries) implemented to support the scheme were located differently than had been proposed by the EAR, and different infrastructure was proposed and some infrastructure was deleted. The intention was to make the

scheme work more efficiently and to minimise cost, whilst maintaining or reducing predicted adverse environmental effects.

5.72. The Scheme Visual Impact Assessment Review (SVIAR) report was prepared to compare the scheme prepared for the EAR with the detailed design proposals, and to identify if there were any significant changes in relation to the visual impact of the schemes.

5.73. Table 5-6, below, summarise the changes in the quantity of infrastructure that was altered between the Preliminary (EAR) and Detailed Design stages.

Table 5-6 Gantry Quantities at Preliminary/ EAR and Detailed Design

Gantry Type	A Carriageway		B Carriageway		Total	
Design Stage	**EAR**	**Detailed**	**EAR**	**Detailed**	**EAR**	**Detailed**
Existing Superspan Gantries	1	2	1	2	1*	2*
Existing Singlespan Gantries	9	9	10	10	19	19
Existing Cantilever MS3's	2	2	3	3	5	5
Existing Superspan Gantries retained	1	2	1	2	1*	2*
New Single Span Portal Gantries	3	4	2	2	5	6
New Cantilever MS4's	13	15	13	17	26	32
New Superspan Gantries	25	11	25	11	25*	11*
Existing portal Gantries retained	4	3	5	2	9	5
New ADS Cantilevers	5	6	4	5	9	11
Existing Cantilever MS3's retained	1	1	1	1	2	2
New Cantilever MS3's	1	1	2	2	3	3
TOTAL	53	**43**	**53**	**42**	**80**	**72**

* Superspan gantries are only counted once

5.74. The tables show that there has been a reduction of 10% in the infrastructure needed between the Preliminary Design scheme assessed in the EAR and the Detailed Design. Overall, the number of individual elements has been reduced between EAR stage and detailed design stage from 80 to 72, with the number of Superspan gantries (the most visually intrusive) being reduced from 25 to 11.

5.75. In several areas, the SVIAR noted that the relocation of gantries reduced the visual impact for some receptors, but noted that there was one area, Barnet Road Underbridge to Junction 24, where the adverse visual impact of the Detailed Design would be slightly greater than the preliminary design; the superspan gantry at chainage 40,710 proposed by the EAR was moved further east to chainage 40,900, where it was considered to be less screened by the existing vegetation and more visible from Barnet Road Caravan Site and properties off Byers Close and Dove Lane at Potters Bar.

5.76. Although no overall score was provided by the SVIAR as a result of the reduction in the number of gantries throughout the Scheme, the SVIAR did conclude that the Detailed Design was better than the Preliminary/ EAR Design in terms of its effect on the landscape and most visual receptors.

Alternative Design Proposals

5.77. In order to accommodate surplus materials generated by the scheme, two landscape bunds that were not envisaged at the time of the EAR were proposed:

- Holly Hill Farm landscape bund: On the anticlockwise side of the M25 between North Lodge Farm Bridge and Holly Hill Farm Bridge between chainages 43,200 and 44,250.
- Skinners Farm landscape bund: Adjacent to the clockwise side of the M25 near Theydon Mount, Essex and east of junction 27. The bund would be located within a field to the west of Mount Road and to the north of the M25.

5.78. The ADP report for the Holly Hill Farm landscape bund stated that:

- Landscape Impact: Vegetation loss would be limited to semi-intact hedgerow field boundaries adjacent to drainage ditches to allow access and construction. No further offsite vegetation clearance was anticipated.
- Visual Impact: The design of the proposed landscape bund was such that the finished ground levels would be approximately 4-5m above existing at its highest point. This would help to screen views of the M25 motorway from receptors, particularly from those to the south of the ADP, and would provide a slight beneficial effect for receptors with open or filtered views.
- Mitigation: The design of the bund would be naturalistic, with new contours blending into the existing topography to maintain the open nature of the site and the landscape character of the wider area. Reinstatement of the hedgerows following construction would reinforce the existing boundary hedgerows, and maintain the existing landscape character of the site.
- Conclusion: It was considered that the overall landscape and visual impacts would be slight beneficial and in terms of the overall AST score for the scheme, the ADP would have a neutral effect.

5.79. The ADP report for the Skinners Farm landscape bund stated that:

- Landscape Impact: Vegetation loss would be limited to scattered scrub with some (dead) mature trees already having cleared prior to any work taking place. Every effort would be made to retain existing vegetation to the eastern boundary, in particular the mature oaks trees located in the south east corner of the site. No further offsite vegetation clearance was anticipated.
- Visual Impact: The design of the proposed landscape bund was such that the finished ground levels would be approximately 10m above existing at its highest point. This would help to screen views of the M25 motorway from receptors, particularly from Hill Hall to the north of the ADP, and would provide a neutral beneficial effect for receptors with open or filtered views.
- Mitigation: The design of the bund would be naturalistic, with new contours blending into the existing topography to maintain the open nature of the site and the landscape character of the wider area. An opportunity exists to reinforce and extend the existing plantation woodland to the south east corner of the proposed site, along the southern boundary of the site to connect with existing woodland vegetation to the south west. This proposed new planting would, in time, help to screen any views of the M25.
- Conclusion: It was considered that the overall landscape and visual impacts would be neutral to none and in terms of the overall AST score for the scheme, the ADP would have a neutral effect.

Consultation

5.80. Welwyn Hatfield Borough Council responded that they were unaware of any adverse impact of the Scheme on the visual openness of the Green Belt, but noted that due to the Green Belt status of the land the M25 runs through, signage and lighting should be kept to a minimum.

Evaluation

Effects of Design Changes

5.81. No information regarding changes to the lighting of the Scheme has been made available to POPE for the purposes of this study.

5.82. With regard to the comments received from Welwyn Hatfield Borough Council concerning signage, there has been a reduction in the number of gantries implemented as part of the Detailed Design compared to the EAR proposals. In the context of this review, the impact on residential properties is most significant, and the following points summarise the key changes in visual impact for residential visual receptors at locations along the route as stated by the SVIAR:

- Baker Street Underbridge to Barnet Road Underbridge: In the Preliminary Design there was an MS3 and an MS4 at chainages 39,460 and 39,610 respectively. These contributed to a reported slight adverse effect on two properties (Elm Farm and Elm Cottage, Bentley Heath Lane) to the south. Both signs were deleted in the Detailed Design, reducing the visual impact in this section.

- Barnet Road Underbridge to Junction 24: In this section the Preliminary Design had a superspan gantry at chainage 40,710. Adjacent to this was a mobile home site to the north and the effect of the gantry was recorded as moderate adverse with some screening provided by mature roadside vegetation. Properties off Byers Close and Dove Lane (Potters Bar) to the east were also noted as being affected by the gantry and a final Advance Direction Sign (ADS) cantilever at chainage 41,000. In the Detailed Design the gantry was moved further east to chainage 40,900 where it was less screened by the existing vegetation and more visible from the houses and caravan site. However, the ADS was removed with beneficial effects.
- Cattlegate Road Underbridge to Crews Hill Railway Underbridge: The Preliminary Design had a link Variable Message Sign (VMS) at chainage 45,760 where the M25 is on embankment with screening vegetation. The effect reported in the EAR on Owls Hall Farm to the south was slight adverse. Properties on Cattlegate Road (Woodhurst Farm, Woodhurst Cottages, Ridge House Farm, and Cattlegate Farm including static homes) to the north was recorded as moderate adverse but this impact included the effect of other signs to the west on some of the properties. The Detailed Design did not include the link VMS resulting in improvements to the visual impact on these properties.
- Cattlegate Farm Underbridge to Burnt Farm Ride Underbridge: In this section a superspan gantry was proposed in the Preliminary Design at chainage 46,700, with 2 link VMS's at chainages 46,100 and 46,580. These would have an effect on views and the impact was recorded as slight adverse on a group of properties (The Paddocks, Glasshouse, and Oakhill Farm, including properties on Crews Hill, Glasgow Stud, and a Nursery/ Garden Centre) to the south, with vegetation on the M25 embankment filtering views. In the Detailed Design the superspan gantry was deleted and the positions of the link VMS's altered to chainages 46,200 and 46,400. Because of the local screening vegetation, this did not lead to a significant reduction in visual impact.
- Holmesdale Tunnel (eastern approach): In both the Preliminary Detailed Designs, the existing gantry at chainage 51,610 was to be modified and re-used, but in the Public Information Exhibition it was shown to be removed. The proposed superspan gantry at chainage 51,850 in the Preliminary Design was reduced to a single span on the clockwise carriageway in the Detailed Design. The visual impact reported in the EAR on properties in Arlington Rd adjacent to the tunnel portal was slight adverse, reflecting the presence of existing M25 infrastructure and the urban setting. The reduction in infrastructure in the Detailed Design led to a reduction in visual impact.
- Bell Common Tunnel (western approach): Two properties on the High Road in Epping at the western portal of the Bell Common Tunnel were affected by partially screened views of the Gantry at chainage 59,880 in the Preliminary Design. The visual impact on the properties was assessed as slight adverse. In the Detailed Design, this gantry was deleted leading to an improvement in views from this property. The Gantry at chainage 59,505 was moved eastwards to chainage 59,620, but this had little effect on views from properties as it is screened by onsite and off-site vegetation.

5.83. These changes to infrastructure have been reviewed by a combination of desk studies and a site visit, and it is considered by POPE that there is no reason to consider the SVIAR assessment of the changes to be anything other than valid. In general, any reduction in highway infrastructure is considered to be beneficial as it has the potential to reduce the landscape and visual effects of a scheme and while the relocation of gantries slightly reduces the effect on some receptors and slightly increases it on others, there is one area where the Detailed Design changes have had an overall worsening effect on receptors (Barnet Road Underbridge to Junction 24); as such, the effects of the scheme are considered to be as expected overall.

5.84. While the Detailed Design may therefore be considered to be generally better than the Preliminary EAR Design in terms of the effects of highway infrastructure on the landscape and for the majority of visual receptors, it is considered that the frequency, scale, and appearance of the 52 new gantries along the M25 has resulted in the increased visual intrusion and increased perception of urbanisation of the countryside as predicted by the EAR. As such, the reduction in infrastructure from the Preliminary EAR Design is considered unlikely to have significantly altered the predicted slight adverse impact of the Scheme overall.

5.85. POPE is unaware of any design changes to the form of the gantries outlined by the Preliminary EAR design.

5.86. Regarding the Holly Hill Farm landscape bund, the site visit observed that the bund's height, form, and contours, the associated mitigation (hedgerow) planting, and the context in which the bund is located (illustrated by Figure 5-2, below), were as prescribed by the ADP report; it is therefore considered that the landscape and visual effects of the bund are likely to be as predicted by the ADP report and less, i.e. better, than expected in the EAR at this location due to the increased visual screening of the M25 afforded by the bund to visual receptors, and the reinforcement of the existing boundary hedgerows (as also observed during the site visit); due to the localised effects of the bund, this study is also in agreement with the ADP report in that the overall AST score for the scheme has likely not been altered by the implementation of this landscape bund.

Figure 5-2 The naturalistic design of the landscape bund near Holly Hill Farm (centre left), and the reinstated hedgerow along the highway boundary (centre right).

5.87. The additional landscape bund at Skinners Farm was not able to be accessed during the site visit; although verification is required, based on views from Skinners Farm Overbridge (refer to the comparison photographs in Figure 5-3, below) it is considered that any localised effects arising from the implementation of the Skinners Farm landscape bund are unlikely to have altered the AST score for the Scheme overall, as it would appear that the bund is well screened by the surrounding topography and vegetation and as such is not readily visible from within the M25 corridor or from its surrounding context. It should be noted however, that the mitigation measures suggested by the ADP, specifically reinforcement (planting) to extend the existing plantation woodland to the south east corner of the site along the southern boundary of the site to connect with existing woodland vegetation to the south west of the site, does appear to have been undertaken (refer to Figure 5-3).

Figure 5-3 Pre-construction view towards the southern boundary of the landscape bund at Skinner's Farm from Skinner's Farm overbridge in August 2012 (top, Google Maps imagery) and from broadly the same location at OYA in July 2016 (bottom). Post construction reinforcement planting can be seen connecting the blocks of vegetation on the embankment on the far side of the carriageway in the lower image (centre left).

Implementation of Planting Proposals

5.88. The intention of the planting was to minimise the visual impact of the infrastructure associated with the scheme and replace vegetation lost during the construction. The nature of the scheme meant that the planting was in discrete packages associated with specific items of highway infrastructure such as gantries, signs, or ERAs.

5.89. Although in draft status at the time of the OYA evaluation, it was stated in the Handover Environmental Management Plan (HEMP) that planting mixes were based on indigenous species which were surveyed as part of the Existing Vegetation Design with the intention of integrating the new scheme into the existing landscape design and maintaining the (unstated) environmental design aims of the original M25 planting.

5.90. The draft HEMP confirmed that percentages of trees and shrubs comprising each planting mix were based on the required Environmental Element i.e.:

- Woodland: 40% trees, 60% shrubs
- Woodland Edge: 20% trees, 80% shrubs
- Scattered Trees: 100% trees
- Linear Belts of Trees: 35% trees, 65% shrubs
- Shrubs with Intermittent Trees: 20% trees, 80% shrubs

5.91. Plant spacing was stated in the draft HEMP as generally at 2m centres giving a planting density of 0.25 plants/ m^2, and plants within planting plots were stated as comprising transplants (typically sized 40-60cm or 60-80cm) and feathered trees (typically sized 175-200cm). A single seed mix was specified for all areas of disturbed ground, including amenity grass within planting plots, and this was stated as a tussock mix that was specified for ecological value and sown at a rate of 4g/ m^2.

5.92. Where planting plots were able to be accessed, the OYA site visit observed that the tree and shrub planting/ grassland plots comprising the landscape mitigation measures generally appeared to have been implemented in line with the EAR; plant stock sizes appear to be broadly as indicated by the draft HEMP, with plant species appearing to be broadly as specified and set out in line with expectations; plant shelters generally remain in place throughout planted areas.

5.93. In terms of the planting that was proposed by the Preliminary EAR design and that which was implemented as part of the Detailed Design, the Advance Ecological Design (AED) drawings (marked up As Builts) showed that there has been a reduction in the areas planted at a number of the planting plots to the west of junction 25. However, it is considered that while there will be some slight variation in the effects expected at a local level, it is thought that the changes to the planting proposals as a result of Detailed Design have not materially altered the overall landscape and visual effects of the Scheme from the slight adverse impact that was predicted by the AST and EAR, as there has been the expected increase in perception of urbanisation of the countryside and visual intrusion resulting from the gantries.

Establishment and Condition of Planting Proposals

5.94. The contract Aftercare Period for the scheme was originally 5 years but the draft HEMP stated that this had been reduced to 1 year following discussions with the NMA. Aftercare Operations stated in the draft HEMP are presented in Table 5-7, below, with those relevant to the OYA stage highlighted in grey.

Table 5-7 Aftercare Operations as stated in the draft HEMP

Operation	Times per year	Timing
Weed control (planting stations)	4	March, May, July, September
Plant replacement	1	November
Cutting of vegetation	2	May, September
Spot weed control	3	Each month
Removal of tree stakes	1	Feb in Year 5
Removal of shelters/guards	1	Feb in Year 5
Aftercare Inspection Reports	4	March, June, October, December

5.95. The draft HEMP further stated that at the time of writing (November 2014), no significant issues had been identified and no other problems were anticipated to arise during (the remainder) of the Aftercare Period; it has therefore been assumed by POPE that the responsibility for undertaking Aftercare Operations for the remainder of the Aftercare Period has passed from the Contractor to the NMA.

5.96. No records of maintenance operations or specific issues arising were documented in the draft HEMP, and the quarterly Aftercare Inspection Reports were not available to POPE for the purposes of this evaluation.

5.97. Although many plots were unable to be accessed fully during the site visit, it was observed that the establishment and the condition of the plant stock was generally as would be expected at OYA; the condition of the plant stock and the level of vegetation within the plots are illustrated by Figure 5-4, below, and are representative of the conditions observed by the site visit throughout the planting plots.

5.98. Although the level of weeds/vegetative growth suggests that weed control operations may not have been undertaken in March as proscribed by the draft HEMP, the height of the vegetation indicates that maintenance operations were undertaken during the previous growing season.

5.99. However, it should be noted that the OYA site visit also observed that one of the plots had been recently maintained (Figure 5-4, also below) and given the timing of both the site visit (mid-May) and the Aftercare maintenance items as outlined in the draft HEMP, it is considered that although unconfirmed, maintenance operations (in terms of vegetation cutting at least) are likely to be a work in progress at the time of writing.

Figure 5-4 Typical vegetation cover within the representative sample of planting plots that were accessed during the site visit (top left and right), and a recently maintained planting plot (below).

5.100. While the planting plot adjacent to the clockwise carriageway directly west of Woodgreen Road Underbridge (illustrated by Figure 5- and Figure 5-6, below) was similar to the majority of the other planting plots observed during the site visit in terms of weed control/ vegetation cutting maintenance operations, plant establishment at this location was noted to be less than would be expected at the OYA stage; areas of plant stock failure (approximately 15% over the plot as a whole) were noted to broadly correspond with areas of predominantly bare ground within the planting plot; construction debris, along with soil heaped up around the bases of retained trees, was also noted (see Figure 5-6, also below).

Figure 5-5 General view of the planting plot adjacent to the clockwise carriageway directly west of Woodgreen Road Underbridge (left), and a planting station on bare ground at the same location (right).

Figure 5-6 The planting plot adjacent to the clockwise carriageway directly west of Woodgreen Road Underbridge with construction debris and soil heaped up around the base of a retained tree (left), and evidence of minimal topsoil (right).

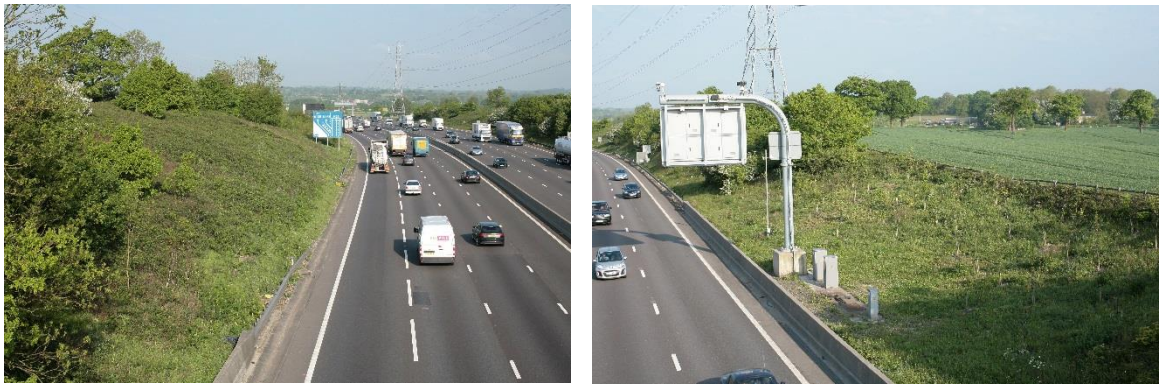
5.101. Although the exact cause of the plant stock failure and resulting gaps in the planting matrix are unclear, it can be seen from the (animal) excavated soil profile in Figure 5-6, above, that the topsoil depth in the areas of predominantly bare ground is minimal and unlikely to be able to support sustained plant growth. As such, it is considered that without remedial action being undertaken at this location, it is unlikely that the visual amenity function of this planting plot will be fully realised by design year.

5.102. The Environmental Masterplan (EM) drawings did not indicate areas that were to be seeded as grassland, but did indicate areas of Natural Regeneration of Habitat following Construction; although it has not been confirmed, it is considered likely that these areas equate to the areas of disturbed ground noted as being seeded by the draft HEMP following the cessation of construction activities.

5.103. Although POPE is unable to confirm whether seeding has been undertaken in the disturbed areas, the site visit was able to confirm that the areas consistent with the EM drawings are regenerating naturally as illustrated by Figure 5-7, below; although these areas were unable to be directly accessed during the site visit and as such the species composition of these areas is not able to be confirmed, it should be noted that the quarterly Aftercare Inspection Reports referred to by the draft HEMP should be available at the FYA stage, and these may inform the FYA evaluation as to whether the disturbed areas were seeded or not.

5.104. The site visit also observed that the maintenance of grassland swards on the verges near and around structures for visibility purposes has been undertaken (illustrated by Figure 5-7, below), and that maintenance appeared to be consistent with the Aftercare Operations as specified by the draft HEMP.

Figure 5-7 Areas of natural regeneration along the verge (left), and of recent grassland management around structures (right).



5.105. Although it is considered too early for any meaningful assessment of the environmental functions of the planting proposals to be made at this OYA stage, it is suggested that a more accurate assessment of the planting proposals should be possible at FYA.

Long term Landscape Management

5.106. It was stated in the draft HEMP that the longer term objectives of landscape management were to:

- Maintain dense screening where required.
- Maintain working access to plots and roadside equipment.
- Vary the age of planting individually or in blocks by thinning and coppicing.
- Encourage multi-stem re-growth from coppicing.
- Promote ecologically sound habitats/ habitat diversity.
- Maintain the safety of the travelling public.

5.107. The draft HEMP also outlined strategies for regular maintenance and stated that whilst in line with best practice, the developing landscape planting would require ongoing monitoring to review the interval, scope, and extent of management interventions to ensure that the landscape objectives would be met, and that any monitoring should include identification of problems that could potentially prevent the landscape objectives from being realised; no specific third party commitments to monitoring of the landscape scheme were noted.

5.108. In light of the draft HEMP's acknowledgement of the objectives of the detailed landscape design and the subsequent maintenance thereof, it is considered that the establishment and maintenance of the landscape proposals should be considered further at FYA when the final version of the HEMP is available.

Summary

5.109. Overall, the changes brought about by the final design, including changes to the proposed planting design and the type and location of highways infrastructure, are evident along the length of the scheme.

5.110. Although there has been a reduction in the quantity of infrastructure proposed by the Preliminary/ EAR design, it is considered that these design changes have not significantly altered the overall slight adverse impact of the Scheme on landscape and visual amenity as predicted by the AST/ EAR and as such, the impacts are considered likely to be as expected.

5.111. Although the landscape bund at Skinners Farm was not able to be accessed during the site visit, it is considered that the design changes regarding both this landscape bund and the bund at Holly Hill Farm have not materially changed the expected landscape or visual amenity effects of the scheme overall, despite there being local variations in the effects expected.

5.112. Similarly, landscape mitigation measures in the form planting proposals appear to have been broadly implemented as anticipated and any local variations in the effects expected are also considered unlikely to have materially changed the predicted landscape or visual amenity effects of the Scheme.

5.113. In terms of effective establishment and maintenance of the plant stock, while it is too early for any evaluation of the plant stock to be meaningful at OYA and a more meaningful assessment of the environmental functions of the planting proposals should be possible at the FYA stage, it is apparent that to ensure that the full potential of planting proposals is realised in the long term, continued Aftercare Operations (as detailed in the draft HEMP) are required throughout the Scheme extents, and that remedial operations at Woodgreen Lane Underbridge are required.

5.114. It is therefore considered that the landscape and visual amenity effects of the Scheme are generally as expected, although consideration could be given to undertaking remedial action at the planting plot adjacent to the clockwise carriageway directly west of Woodgreen Road Underbridge.

Table 5-8 Evaluation Summary: Landscape Evaluation Summary: Landscape

Sub-Objective	AST	OYA
Landscape	Slight Adverse	Generally as expected

Townscape

Forecast

Appraisal Summary Table

5.115. The AST stated that townscape areas within the study area (Potters Bar and Waltham Cross/ North Enfield) comprised residential estates, and commercial/ industrial properties with a medium to low sensitivity to change. The Scheme was considered by the AST to be generally compatible with existing townscape character, and the impact of the Scheme on townscape was considered to be **neutral** overall.

Environmental Assessment Report

5.116. No Townscape specific assessment was undertaken by the EAR.

Consultation

5.117. No responses to consultation requests were received for this sub-objective.

Evaluation

5.118. No changes from the AST regarding Townscape were identified during the site visit, and settlements remain well separated from the road by embankments and vegetation; it is therefore considered unlikely that any townscape feature would have been affected by the Scheme.

5.119. No further evaluation has been undertaken, as no changes from the AST regarding Townscape were identified during the site visits.

5.120. It is therefore concluded that the effects of the Scheme on Townscape are neutral, **as expected**.

Table 5-9 Evaluation Summary: Townscape

Sub-Objective	AST	OYA
Townscape	Neutral	As expected

Heritage and Historic Resources

Forecast

Appraisal Summary Table

5.121. The AST stated that slight adverse impacts to the historic settings of 1 Grade II* Registered Historic Park and Garden (Copped Hall) was expected, along with a slight adverse impact on the settings of 1 Grade II Listed Building and 1 Conservation Area within the study area; overall, the AST assessed the impact of the Scheme on the heritage resource as **slight adverse**.

Environmental Assessment Report

5.122. Guidance contained in Section 5 of the Interim Advice Note 111/09 for Managed Motorways Implementation Guidance - Hard Shoulder Running (Highways Agency, November 2009) states that as most Schemes are contained within the disturbed highway boundary, impacts on buried archaeology are considered to be unlikely. Any potential impacts are therefore likely to be limited to receptors off site such as the effects on the setting of heritage assets. The EAR assessment was therefore concerned with the potential visual and aural impacts of the proposed scheme on the setting of designated heritage assets only.

5.123. Overall, the EAR stated that the Scheme would not affect the vast majority of approximately 55 designated heritage assets within the study area, but noted that there would be slight adverse effects on the following:

- Copped Hall Park (Grade II* Registered Park and Garden)
- Copped Hall Park (Conservation Area)

- North Lodge School (Grade II Listed)

5.124. Taking into account mitigation measures designed to minimise any impact (summarised as minimising vegetation removal and providing additional (screen) planting at specific locations), the EAR considered that there would be no significant effects on any designated heritage asset as a result of the Scheme, and concluded that the impact of the Scheme would be **slight adverse**.

Alternative Design Proposals

5.125. The ADP report for the landscape bund at Skinners Farm stated that:

- Potential Impacts: The bund had the potential to alter the character of the (Hill Hall) Grade II Registered Park & Garden it was to be situated in, and to affect the immediate and long-view settings of the associated nationally important heritage assets nearby. However, it was considered that any adverse visual impacts would be minor or neutral, and that the ADP could have a beneficial screening effect on some assets. Earthworks for the construction of the bund were stated to have the potential to disturb or destroy any buried archaeological remains present, including any field divisions of antiquity marked by hedgerows.
- Recommendations: Further detailed assessment should be carried out to inform both the final design of the bund, and the mitigation strategy.

Consultation

5.126. Welwyn Hatfield Borough Council responded that they were unaware of any adverse impact on historical or archaeological assets/ resources.

Evaluation

5.127. As noted in the Landscape sub-objective, above, there has been a reduction in the quantity of infrastructure (i.e. gantries) proposed by the Preliminary EAR design and that which was implemented as part of the Detailed Design. None of the Heritage assets noted in the EAR as receiving slight adverse effects were considered by the SVIAR receive any worse effect at detailed design when compared to the preliminary/ EAR design, and so it is considered that these design changes have not significantly altered the impact of the proposals on the landscape setting of the these designated heritage assets as predicted by the AST/ EAR; as such, the impact of the Scheme on designated Heritage assets may be considered as expected.

5.128. Regarding mitigation planting, it is considered that although planting has been implemented broadly as expected, it is too early for any evaluation of the plant stock to be meaningful at OYA, and that the screening and integration functions of the planting proposals with respect to the landscape setting of heritage assets should be reconsidered at the FYA stage.

5.129. The detailed assessment of the proposed Skinner's Farm landscape bund, recommended by the ADP report to inform both the final design of the bund and the mitigation strategy, was not available for the purposes of this evaluation; further, and as noted in the Landscape sub-objective (above), the bund was unable to be accessed during the OYA site visit. Consequently, the potential impacts of the bund at Skinner's Farm on the heritage resource as outlined by the ADP report have not been able to be confirmed by POPE, and this aspect should be revisited at FYA.

5.130. Regarding the potential for the construction of Skinners Farm Bund to disturb or destroy any buried archaeological remains present, including any field divisions of antiquity marked by hedgerows, no further information other than that provided by the ADP has been made available for this study. However, it is assumed by POPE methodology that all popular and academic archaeological reports relating to the scheme should have been published/ submitted to journals and deposited (along with any archaeological finds) by the FYA stage; it is therefore suggested that this could be confirmed at that point in time.

5.131. Although Heritage was not considered in detail by the ADP for the landscape bund at Holly Hill Farm, the summary table did state that Strip Mapping and Sampling would be carried out during topsoil stripping; however, no mapping/ sampling results or further information regarding this aspect of the ADP has been received by POPE.

5.132. No further evaluation has been undertaken as there were no outstanding issues highlighted by the information received as part of this study, or raised during the site visit.

5.133. It is therefore considered that based on the information presented above, the effects of the Scheme on the heritage resource are likely to be **as expected**, although confirmation is required regarding the effects of the landscape bunds on the heritage resource at Skinner's Farm and Holly Hill Farm.

Table 5-10 Evaluation Summary: Heritage and Historic Resources

Sub-Objective	AST	OYA
Heritage and Historic Resources	Slight Adverse	Likely to be generally as expected

Biodiversity

Forecast

Appraisal Summary Table

5.134. The AST stated that although no long term impacts on the 5 statutory (including 2 internationally) designated sites present within the study area were expected, it was highlighted that there were risks of slight adverse impacts on 8 adjacent non-statutory sites.

5.135. Overall, the Scheme was considered to have a **slight adverse** impact on ecological resources, resulting from what was considered to be an insignificant reduction in the buffering of adjacent designated sites and loss and severance of habitat within the (former) Highways Agency soft estate that, although itself of lower value, contributes to the habitat of protected species.

Environmental Assessment Report

5.136. The EAR predicted that there would be no long term impacts on designated sites, although there would be a risk of a slight adverse effect during the construction phase on Epping Forest Special Area of Conservation (SAC)/ Site of Special Scientific Interest (SSSI); however, the impacts were not considered to be significant.

5.137. Any risk of potential impacts on designated watercourses and other watercourses were stated as being reduced by use of appropriate pollution prevention measures, which would be covered under the Construction Environmental Management Plan (CEMP).

5.138. During the construction phase, the EAR considered that there would be a neutral effect on habitats of negligible value within the soft estate and on their associated protected species. Mitigation of potential effects on protected species were stated as appropriate seasonal timing of works, translocation, and ecological watching briefs, with habitat enhancement and creation measures being undertaken where appropriate. Where required, the EAR stated that protected species licences would be obtained prior to works.

5.139. Construction phase impacts of the scheme were considered to be slight adverse on great crested newts, although the EAR stated that the impact on this species would be reduced by appropriate mitigation measures, including European Protected Species (EPS) licensing.

5.140. Overall the scheme was considered to have a **slight adverse** effect on ecological resources resulting from loss and severance of negligible value habitat within the soft estate, reduction of buffering of adjacent designated sites, and severance of habitat within the soft estate that, although itself considered to be of negligible value, contributed to the habitat of protected species; however, this was not considered significant.

5.141. The EAR also stated that a separate Assessment of Implications for European Sites (AIES) concluded that the scheme would likely not result in a risk of significant effects on any Natura 2000 sites, and therefore did not require Appropriate Assessment.

Alternative Design Proposals

5.142. The ADP for the landscape bund at Holly Hill Farm stated that:

- Designated Sites: There were no statutory designated sites within 2km of the ADP, but two County Wildlife Sites (Fir and Pond Wood Nature Reserve, and Cattle Gate Wood) were within 1km of the site.
- Great Crested Newts: It was recommended that the single pond with potential to support Great Crested Newts (GCN) located within the proposed footprint of the ADP should be surveyed to confirm presence of absence of GCNs, and to confirm whether a license would be required or if a Precautionary Method of Working (PMW) could be adopted. It was noted that any work in adjacent fields that was scheduled prior to the GCN surveys would require a buffer zone to ensure that the works did not encroach into terrestrial habitat that was suitable for GCNs, or affect the pond.
- Reptiles: Despite a number of locations along the verge adjacent to the site being identified as suitable habitat for reptiles, no reptiles were recorded during the surveys undertaken in 2010, it was recommended that a PMW be implemented.
- Nesting Birds: Vegetation clearance was to be planned outside the bird breeding season. If this was not possible, then a detailed inspection for breeding birds by an ecologist was to be carried out no more than 24 hours prior to any works being undertaken.
- Bats: It was recommended that the mature trees throughout the site offering moderate to high potential to support bat roosts be retained, and that should any of these trees require felling or lopping, an ecologist should further assess the bat potential of the trees.
- Conclusion: Any effects on protected species would be mitigated to ensure that the impact of the ADP was neutral, ensuring that there would be no change to the AST score.

5.143. The ADP for the landscape bund at Skinners Farm stated that:

- Designated Sites: There were no statutory designated sites within 2km of the ADP, but three Local Wildlife Sites (Hill Hall Park, Bush Grove, and Hilly Spring) were within 1km of the site. No detrimental effects were anticipated.
- Great Crested Newts: It was agreed that a PMW could be adopted during the works.
- Reptiles: A survey for reptiles should be undertaken, and reasonable effort should be undertaken to translocate any reptiles at the site to a suitable receptor site.
- Nesting Birds: Vegetation clearance was to be planned outside the bird breeding season. If this was not possible, then a detailed inspection for breeding birds was to be carried out no more than 24 hours prior to any works being undertaken with nest birds left in situ with an exclusion zone around the nest to remain for their entire nesting period.
- Bats: It was recommended that the mature oak with moderate bat potential on the eastern boundary should be retained, and not felled, lopped, or damaged during the works. A design for directional temporary lighting to minimise disturbance to bats was agreed.
- Badgers: A further check for badgers at the large mammal burrows present on the site should carried out prior to the start of works, and if found to be occupying a sett, humane methods should to be employed to exclude any badgers from the setts under licence from Natural England.
- Invasive species: A further check for the presence of invasive species should be carried out during the appropriate season prior to the works commencing and if found to be present, methods should to be employed to eradicate the species from the site.
- Conclusion: Any effects on protected species would be mitigated to ensure that the impact of the ADP was neutral, ensuring that there would be no change to the AST score.

Draft Handover Environmental Management Plan

5.144. The draft HEMP confirmed that:

- The Advanced Ecological Design (AED) identified all the necessary mitigation works that were to be carried out prior to the start of construction in each part of the Scheme, and along with an outline methodology and timings of works, included a set of drawings indicating where mitigation should be employed.
- Due to the presence of GCN on parts of the road verge, it was necessary to apply to Natural England for a licence to undertake work in these areas. As part of that licence (EPSM2012-4671), it was necessary to ensure that mitigation measures to reinstate and enhance habitats were undertaken (such as creation of log piles and hibernacula), and that general monitoring of vegetation establishment should be undertaken in line with landscape requirements during the aftercare period.

- Construction was supported on site by a team of ecologists in liaison with the design team. Where necessary, amendments to the AED and licence were undertaken due to changes in design and construction proposals.

5.145. In terms of species aftercare, the draft HEMP stated that all future construction and maintenance work on the soft estate (i.e. habitat) should be carried out in such a way so as to avoid harm to protected species, and set out the potential impacts along with relevant mitigation techniques, particularly in relation to breeding birds, GCN, reptiles, Badgers, Bats, and other Wildlife, including Hazel Dormice. Although the latter species were not mentioned in the ADP's or recorded as being present in habitat within or adjacent to the highway boundary, the draft HEMP noted that there was the potential for small populations to be present and that the scrub and woodland habitat on the verge was suitable for this species, particularly where adjacent to woodland outside the highway boundary.

5.146. The draft HEMP also noted that should any maintenance or repair works with the potential to affect protected species that may be found on site be proposed in the future, the appropriate mitigation methodology would need to be put in place and the relevant licence applied for.

5.147. In terms of habitat aftercare, the draft HEMP stated that should any future construction and maintenance works be likely to affect any SSSI of Epping Forest SAC, approval should be obtained from Natural England prior to the commencement of any activity.

5.148. No specific monitoring (other than of the general establishment of planting during the aftercare period as required by the GCN licence) was proposed.

Consultation

5.149. Welwyn Hatfield Borough Council responded that they were unaware of any adverse impact on ecological assets/ resources.

Evaluation

Species

5.150. Although the draft HEMP made no mention of the mitigation outlined in the ADP's for the landscape bunds at Holly Hill Farm and Skinner's Farm, it did confirm that the AED (comprising 19/37 drawings marked up as "As-built" made available to POPE for the purposes of this study) had defined the approach to the ecological mitigation measures adopted during the construction phase, and outlined the Scheme's ecological mitigation principles which included:

- Avoidance of the most sensitive ecological features or reduction of adverse effects through design of the scheme and sensitive programming of works.
- Measures to minimise risks of harm to individual animals of legally protected species during site clearance and construction.
- Compensation measures to offset residual impacts remaining following the application of mitigation measures.
- Incorporation of enhancement measures.

5.151. The draft HEMP also confirmed that mitigation measures included obtaining protected species licences for GCNs. It is therefore considered that construction phase impacts of the Scheme on GCN are unlikely to have been significant, as the mitigation measures outlined in the EAR have been implemented.

5.152. In the absence of any further information, it remains to be confirmed whether the mitigation measures as stated by the ADP's for the landscape bunds at Holly Hill Farm and Skinner's Farm were implemented.

5.153. It should also be noted that the landscape bund at Holly Hill Farm was not shown on the AED drawings (marked up as "As-built"), and the AED drawing(s) covering the location of Skinner's Farm were not provided to POPE for the purposes of this study.

5.154. Animal mortality data received from the M25 NMA are shown in Table 5-11, below. It can be seen that the mortality rates of legally protected species are either isolated (badgers), or have remained

relatively consistent across the time period presented by the dataset (swans); this would suggest that during both construction and operation, the Scheme has had a **neutral impact** on the mortality rates of the legally protected species recorded.

Table 5-11 M25 (J23-27) Animal Mortality Data, 2009-2016

Animal	2009*	2010	2011	2012	2013	2014**	2015	2016*
Swans		4		2	2	2	1	
Badgers			1					
Dogs	3	1	2	1		2		
Cats			1	2		1		
Foxes		3	6	5	1			
Deer	3	12	4	9	6	1	3	1
Pheasants				2				
Birds unspecified			1					
Ponies				2				
Unspecified			1	1				
TOTALS	**6**	**20**	**16**	**24**	**9**	**6**	**4**	**1**

* Data in these years may be incomplete
** Scheme opening

5.155. An underlying trend of decreasing (total) animal mortalities since 2013 (i.e. from the construction phase onwards) can also be seen from the dataset; although it is possible that this trend is as of a direct consequence of the Scheme, no firm conclusions can be drawn in the absence of additional monitoring information at this stage. It is therefore suggested that this aspect should be reconsidered at FYA, when additional post-opening data may be available for evaluation.

5.156. POPE is unaware of any other information regarding species and as such, it remains to be confirmed whether the mitigation outlined in the ADP's for the landscape bunds at Holly Hill Farm and Skinner's Farm were implemented during construction. The operational impact of the Scheme on species, protected or otherwise, also cannot be confirmed at this stage.

Habitat

5.157. The draft HEMP stated that two stands of Japanese knotweed were located within the highway boundary between J23-27, confirmed that (unspecified) treatment had been undertaken during the construction period, and noted that the location of Japanese knotweed stands were shown on the EM drawings.

5.158. As noted in the landscape section, also above, the OYA site visit found that the planting proposals appear to have been implemented broadly as expected, although changes in vegetation clearance and proposed planting brought about by the Detailed Design are evident along the length of the Scheme; it is considered that any local variations in the effects expected are unlikely to have materially changed the predicted effects of the Scheme on habitat overall. However, it is also considered that it is too early for any meaningful assessment of the planting proposals in terms of habitat to be made at this OYA stage, but that a more accurate assessment should be possible at FYA.

5.159. The key of the EM drawings indicates that specific habitat enhancement measures were proposed along the Scheme extents, and these comprised a combination of dormice boxes, hibernacula, and log piles.

5.160. Although dormouse boxes and hibernacula were indicated on the AED drawings (marked up as As-Built), none were noted during the site visit; however, several log piles were observed, one of which is illustrated by Figure 5-8, below.

Figure 5-8 Habitat mitigation in the form of a log pile, one of several observed throughout the site visit.

5.161. The quarterly Aftercare Inspections and Reports as noted in the draft HEMP were unavailable for the purposes of this evaluation, and POPE is unaware of any other information regarding habitat. As such, it is considered that a full evaluation of the impact of the Scheme on habitat (including the monitoring results regarding the general establishment of planting during the aftercare period as required as part of the GCN licence) is not possible at this stage of the POPE process, but that this should be considered further at FYA when the quarterly Aftercare Inspection Reports are likely to be available.

Long term Ecological Management

5.162. The draft HEMP stated that all future maintenance work on the soft estate should be carried out in such a way so as to avoid harm to protected species, also noting that:

- Should any future maintenance or repair works that have potential to effect protected species that may be found on site be proposed, the appropriate mitigation methodology will need to be put in place and the relevant licence applied for; and
- A number of designated sites are present adjacent to the soft estate. If any works is likely to affect a SSSI or Epping Forest SAC, approval for the works should be obtained from Natural England in advance of any activity.

5.163. In light of the draft HEMP's acknowledgement of the above and the requirement of the GCN licence for the establishment monitoring of the planting proposals in general, it is considered that these aspects should be considered further at FYA when the results of any monitoring should be available for evaluation.

Summary

5.164. Construction phase impacts of the Scheme on species, protected or otherwise, are unlikely to have been significant as the mitigation measures outlined in the EAR appear to have been implemented as confirmed by the draft HEMP, and it is considered that any changes in vegetation clearance and proposed planting brought about by the Detailed Design are unlikely to have materially changed the predicted effects of the Scheme on Habitat.

5.165. In the absence of post-opening information, it is not considered possible to fully evaluate the effects of the Scheme on species or habitat at this stage of the POPE process, but that these aspects could be considered further at FYA when the quarterly Aftercare Inspection Reports are likely to be available.

5.166. It is therefore considered that the impact of the Scheme on biodiversity at OYA is likely to be **as expected**, i.e. slight adverse, at this stage, but more information is required to confirm this.

Table 5-12 Evaluation Summary: Biodiversity

Sub-Objective	AST	OYA
Biodiversity	Slight Adverse	Likely to be as expected

Road Drainage and the Water Environment

Forecast

Appraisal Summary Table

5.167. The AST stated that operational impacts of the Scheme on surface water had been scoped out (as potential impacts had been mitigated through design), as had operational impacts of the whole road on surface water (as they would be picked up by the Priority Outfalls Investigation assessing the impacts from all motorways and trunk roads).

5.168. The AST concluded that the Scheme would have a neutral impact on the water environment overall.

Environmental Assessment Report

5.169. The EAR stated that the operational impacts of the whole road on water environment attributes were scoped out of the assessment, as the overall assessment and water quality mitigation measures required for the section of road were to be considered as part of the Priority Outfalls Investigation18 assessing the impacts from all motorways and trunk roads. However, local operational impacts from the ERAs and slip road widening were considered as part of the scheme design, which included mitigation measures.

5.170. The EAR considered that the most significant construction effects impacts on surface water were likely to occur where construction was to take place in close proximity to waterbodies with good water quality:

- The ERA at chainage 45,200 (Turkey Brook) on the clockwise carriageway.
- The ERA at chainage 44,400 (Turkey Brook) on the anticlockwise carriageway.
- Slip road widening at chainage 37,550 – 38,600 (Mimshall Brook).
- Slip road widening at chainage 37,750 – 38,500 (Mimshall Brook) and at chainage 55,400 – 56,150 (Cobbin's Brook) on the anti-clockwise carriageway.

5.171. The EAR stated that the most significant impacts on groundwater were likely to occur where construction was to take place in close proximity to protected groundwater, specifically the ERA at chainage 53,400 on the clockwise carriageway.

5.172. The EAR also stated that where construction was to take place in Flood Zone 2, there was the potential for an increase in flood risk due to potential loss of storage; the location was given as the ERA at chainage 53,400 on the clockwise carriageway.

5.173. The EAR considered that potential construction impacts on surface and ground waters could be addressed by following relevant guidance regarding pollution prevention at all times at the locations given above during construction; specifically it was considered that action should be taken on:

- Bunding
- Routes of temporary traffic diversions
- Storage of hazardous wastes and materials
- Procedures for concreting
- Wash down areas and disposal of surface water run-off from excavations during construction

[18] Priority Outfalls Investigation: one of a series of ongoing research projects commissioned by the former Highways Agency to develop a better understanding of the risks that the highway drainage asset presents to the travelling public and to the environment, whose aim is to identify priority outfalls on the drainage network that are at risk of polluting the surface water courses that they flow into, so that mitigation measures can be designed and installed.

5.174. With the mitigation measures in place, the EAR considered that the overall construction effects of the Scheme on water and drainage should be **neutral**; operational effects were also considered to be **neutral**, as mitigation had been included in the design of the ERAs and widened slip-roads.

Alternative Design Proposals

5.175. The ADP to drain the landscape bund at Holly Hill Farm comprised a filter drain at the interface between the motorway verge and proposed bund.

5.176. The ADP for the landscape bund at Skinners Farm stated that the Scheme would not be affected, as the bund was outside the highway boundary – the existing filter drain within the highway boundary at the top of the Motorway cutting was stated as to remain unaffected

5.177. Both of the ADPs for the landscape bunds stated that there would be no change to the serviceable life of the Scheme by adopting the ADPs, and that there would be no adverse effects on long term drainage performance at either location.

5.178. However, both ADPs noted that regular (unspecified) maintenance would be required.

Consultation

5.179. Both the Environment Agency and Welwyn Hatfield Borough Council responded that they had no comments to make.

Evaluation

5.180. The Construction Environmental Management Plan (CEMP) described the site specific procedures for managing the environmental aspects of construction works to comply with the requirements of the Contract, legislation, and industry best practice, stating that where appropriate, account would be taken of the Environment Agency Pollution Prevention Guidelines (PPGs) to prevent pollution to groundwater and watercourses; specific pollution prevention measures included:

- Storage of fuel and oil in accordance with the Control of Pollution (Oil Storage) (England) Regulations 2001, with refuelling carried out in designated areas by trained personnel.
- Storage of chemicals and other potentially polluting substances (typically COSHH materials) in accordance with the manufacturer's instructions, with the minimum possible inventory of such chemicals stored on site at any one time.
- Minimising dust production by material recycling, with stockpiles and conveyors damped with water as necessary.
- Provision of readily available Emergency Spill Kits to allow prompt clearing of any spillage of fuel, oil or other chemical.
- Establishment of waste segregation areas on hard standing areas, with skips / containers of an appropriate construction to prevent the escape of any waste contained.
- Provision of a designated impermeable area for road sweeper wash out.
- Agreement of measures to control of runoff with the Environment Agency.

5.181. The CEMP also set out the actions that were to be taken in the event of an environmental incident or emergency, and provided a mechanism to record incidents so that trends could be identified and action implemented to prevent recurrence.

5.182. No information indicating whether any incidents that may have affected the drainage system during construction activities (or post-opening) have been received by POPE.

5.183. No as-built drainage drawings were available for this evaluation, and all drainage facilities noted during the OYA site visit appeared to be generally clear of vegetation/ litter/ detritus, with no evidence to suggest that any of the observed facilities were unable to function in any way other than as would be expected.

5.184. Based on the site visit, the information provided by the EAR and the CEMP, and the response received from the Environment Agency at consultation, it is concluded that although the overall, direct effect of the Scheme on water quality and drainage is likely to be **as expected**, further information is required to confirm; it is suggested that this aspect could be reconsidered at FYA.

Table 5-13 Evaluation Summary: Water Environment

Sub-Objective	AST	OYA
Water Environment	Neutral.	As expected

Physical Activity

Forecast

Appraisal Summary Table

5.185. The AST stated that the Scheme would have no effect on the activity duration of pedestrians, cyclists, or equestrians, as no direct changes to existing Non-Motorised User (NMU) facilities or routes were proposed; overall, the impact of the Scheme on NMUs was assessed as **neutral**.

Environmental Assessment Report

5.186. Physical Activity was not considered by the EAR as, following the DMRB guidance current at the time of assessment (August 2011), it was concluded that the Scheme (i.e. a managed motorway) was unlikely to have any significant impact on NMUs such as pedestrians, cyclists, and equestrians.

Consultation

5.187. No responses to consultation requests were received for this sub-objective.

Evaluation

5.188. The combination of desk studies and the site visit undertaken as part of POPE methodology has found no reason to suppose that there have been any significant changes to NMU facilities.

5.189. No NMU survey has been undertaken specifically for this study, and POPE is not aware of any NMU audits or Vulnerable User Studies undertaken for this Scheme.

5.190. The sections of the PRoW network viewed during the OYA site visit appeared to be capable of performing generally as expected; cyclist and pedestrian activity was observed, and evidence of equestrian use was also noted.

5.191. It is concluded that the effects of the Scheme on physical activity are likely to be as predicted, as there has been no reduction or increase in the degree of severance of the PRoW network; the overall effect of the Scheme on NMUs is therefore considered to be **as expected**.

Table 5-14 Evaluation Summary: Physical Activity

Sub-Objective	AST	OYA
Physical Activity	Neutral	As expected

Journey Quality

5.192. The journey quality sub-objective considers traveller care (facilities and information), traveller views, and traveller stress (frustration, fear of potential collisions, and route uncertainty).

Forecast

Appraisal Summary Table

5.193. The AST did not consider traveller care, but stated that a neutral effect on traveller views was expected as there would be no overall change to views from the road. An overall improvement to driver stress was predicted, as the Scheme would improve capacity and travel information, which was expected to alleviate route uncertainty and reduce driver stress levels. Overall, the impact of the Scheme on journey quality was assessed as **slight beneficial**.

Environmental Assessment Report

5.194. The effects of the Scheme on non-motorised users and communities were scoped out of the EAR, which focussed instead on the effects of the Scheme on vehicle travellers, including travellers' views, changes in amenity (traveller care), and driver stress which, in summary:

- Traveller Care: No additional facilities were proposed as part of the Scheme, and a good level of facilities for Traveller Care was stated as being already provided in close proximity to the scheme. Overall, traveller care facilities were to remain the same, i.e. **neutral**, with or without the Scheme, although it was considered that the improved signage could prompt drivers to utilise South Mimms Motorway Service Area (MSA) and in accessing local towns and villages such as Cheshunt, Potters Bar, and Enfield.
- Traveller Views: During construction, short term adverse effects on Traveller Views were expected by the EAR. During operation, the EAR recognised that there would be a number of additional gantry and cantilever signs which would be visible in views from the road, but it was expected that the existing open and intermittent views along the route would be retained; a slight deterioration in views from the road was expected, resulting in **slight adverse** effects on travellers views.
- Traveller Stress: The EAR stated that whilst the traffic data forecasts showed that traffic volumes (AADT) were expected to increase in 2030 when compared to existing conditions, traffic flows were predicted to be slightly higher on average in 2030 with the Scheme in place due to additional lane capacity and as such, driver stress levels were predicted to be lower than the Do Minimum scenario which would result in slight beneficial effects. In addition, the Scheme was expected to incorporate improved Advance Distance Signage (ADS) which together with gantry and cantilever message signs, would help alleviate route uncertainty and improve driver comfort. As a result, the overall impact of the scheme on driver stress was expected to be **slight beneficial**.

5.195. The overall EAR assessment of permanent effects on vehicle travellers in the long term, taking into account traveller views and stress as outlined above, was considered to be **neutral**.

Consultation

5.196. No responses to consultation requests were received for this sub-objective.

Evaluation

Traveller Care

5.197. No changes regarding traveller care were proposed as part of the final design, and none were identified during the OYA site visits; consequently, this aspect has not been evaluated further and the impact of the Scheme on traveller care is considered to be **as expected**.

Traveller Views

5.198. The reduction in highway *clutter* brought about by the decreased number of gantries (from 80 to 72) implemented as part of the Detailed Design was considered by the SVIAR to be better than predicted by the EAR, but it is considered by POPE that signing is a part of the expected traveller experience and as such, the effects of the gantry amendments on Traveller Views are not significant as although the frequency, scale, and appearance of the 52 new gantries along the M25 may have resulted in a slight deterioration in views from the road (i.e. a slight increase the perception of urbanisation), the existing open and intermittent views along the route have been generally retained.

5.199. As noted in the Landscape section, above, the landscape bund at Skinner's Farm is not able to be viewed from the carriageway. Along as the effects of the landscape bund at Holly Hill Farm are considered likely to be as predicted by the ADP report it is concluded that these bunds would not have increased perception of urbanisation of the countryside and as such, any localised effects are unlikely to have affected the overall AST score for the scheme overall in terms of traveller views.

5.200. As noted in the landscape sub-objective, above, the landscape mitigation measures in the form of planting proposals appear to have been broadly implemented as anticipated. It is considered that

any local variations in the effects expected are considered unlikely to have materially changed the predicted visual effects of the Scheme for vehicle travellers overall.

5.201. Route verges were observed to be generally tidy and litter free at the time of the site visit.

5.202. Based on the information presented in this evaluation, it is considered that Traveller Views are **as expected** at this stage, as while the existing open and intermittent views along the route have been generally retained, there is likely to have been a slight increase the perception of urbanisation in the countryside due to the additional infrastructure within the route corridor.

Traveller Stress

5.203. In terms of route certainty and fear of potential collisions, web based material from Highways England states that the removal of old lane markings following the widening works left scorch marks on the road that were very noticeable, and could lead to driver confusion (particularly when very sunny or when the road was wet) as they could be equally or even more visible than the newer lane markings; these adverse effects of the scorch marks are considered by POPE to be worse than expected on Scheme opening (November 2014).

5.204. However, this is balanced by the fact that from December 2014 to June 2015, the second and third lanes of the M25 were resurfaced, both clockwise and anti-clockwise between J23-24, and between J25-27 (the section between J24-25 was stated as not requiring resurfacing); the resurfacing works comprised the removal of 4 cm of the road surface, including the misleading scorch marks, and replacement with a newer, quieter running surface, complete with new lane markings.

5.205. It is therefore considered that the worse than expected post-construction adverse effects of the misleading scorch marks have now been rectified by the resurfacing works, and that this issue has been resolved.

5.206. The increased capacity of the M25 is considered to provide more opportunities for the safe overtaking of slower vehicles and a greater likelihood of free flowing traffic and although this has not been confirmed, it is probable that these factors will have a positive bearing on the degree of driver frustration, and therefore Traveller Stress, experienced.

5.207. At the time of the site visit, the route appeared to be well signed (as illustrated in Figure 5-9 below) with junctions (and routes) clearly indicated, and the junctions providing safe access and egress points to and from the M25.

Figure 5-9 Gantry at the entrance to Bell Common Tunnel, exhibiting clear, informative signage

5.208. Although the traffic chapters of this report should be referred to for a full discussion regarding journey times and safety, in summary:

- Journey Times: The performance of the scheme differs depending on the day, time period, and the direction being considered; anti-clockwise journey times have improved by 9% overall; the weekday AM peak journey time has seen the highest improvement with a 19% reduction in journey time; and journey time improvements in the clockwise direction is in the range of 4-7%. Overall, the scheme has reduced journey times and as such, it is considered

that the time savings (in AM peak periods especially) is likely to have had a beneficial impact on driver stress.

- Safety: Although post-opening collision rates have decreased by 13.4% when compared to the expected number of collisions had the scheme not been built, this decrease is not statistically significant at this stage; in the wider area, there are reductions in annual average collision numbers between the Before and After (construction) periods, with a 5% decrease in collisions when post-opening data is compared with expected number of collisions had the scheme not been built - again, this decrease is not statistically significant; and collision severity as a proportion of all collisions has decreased over the wider modelled area, and on the M25 mainline between J23 and J27.

Summary

5.209. Based on the information presented in this evaluation, it is considered that the effects of the Scheme on Journey Quality are likely to be **as expected** in terms of Traveller Care, Traveller Views, and Traveller Stress. Table 5-15 and Table 5-16 summarise the evaluation of the Scheme's impact on Traveller Factors and Journey Quality respectively.

Table 5-15 Evaluation Summary: Traveller Factors

Traveller Factor	AST	OYA
Care	Not considered	No change, as expected
Views	Neutral	As expected
Stress	Reduced	As expected

Table 5-16 Evaluation Summary: Journey Quality

Sub-Objective	AST	OYA
Journey Quality	Slight Beneficial	As expected

Environmental Impacts – Key Points

Noise and Local Air Quality

- Traffic forecast data indicates that the observed post-opening AADT traffic flows are lower than expected by between 20% and 24% between J23 and J25. Based on the information available:
  - The impact on the noise climate is considered likely to be better than expected between J23-25, but as expected between J24-25 anti-clockwise; and
  - The percentage differences between forecast and observed traffic flows are considered significant, and impacts on local air quality are likely to be better than expected between J23-25.

Greenhouse Gases

- The evaluation shows a lower carbon increase than forecast on the M25 through the section of scheme for which flow data is available, which is largely due to lower than forecast traffic flows.

Landscape

- Changes brought about by the final design, including changes to the proposed planting design, the additional landscape bund at Holly Hill Farm, and the type and location of highways infrastructure, are evident along the length of the Project;
- The potential landscape and visual effects of the additional bund at Skinners Farm cannot be confirmed at this stage as it was not possible to gain access during the site visit;
- Although there are local variations in the effects expected, there is no reason to assume that the design changes have materially changed the expected landscape or visual amenity effects of the Project overall; and
- While the landscape and visual amenity effects of the Scheme are likely to be generally as expected, consideration could be given to undertaking remedial action at the planting plot adjacent to the clockwise carriageway directly west of Woodgreen Road Underbridge, as plant establishment at this location was noted to be less than would be expected at the OYA stage.

Townscape

- As expected, townscape features have not been affected by the Scheme.

Heritage & Historic Resources

- It is considered that the reduction in highway infrastructure has not significantly altered the predicted overall slight adverse impact of the Scheme on the landscape setting of the designated heritage assets;
- No archaeological information relating to the additional landscape bunds at Holly Hill Farm and Skinners Farm has been made available for the purposes of this evaluation. However, it is assumed by POPE methodology that all popular and academic archaeological reports relating to the scheme should have been published/ submitted to journals and deposited (along with any archaeological finds) by the FYA stage; and
- The screening and integration functions of the planting proposals with respect to heritage assets are likely to be more apparent, and should be reconsidered, at the FYA stage.

Biodiversity

- Construction phase impacts of the Scheme on species, protected or otherwise, are unlikely to have been significant, as per the Environmental Assessment Report. Changes in vegetation clearance and proposed planting brought about by the Detailed Design are considered unlikely to have materially changed the predicted effects of the Scheme on Habitat.
- In the absence of post-opening information, it is not possible to fully evaluate the effects of the Scheme on species or habitat at this stage of the POPE process; however, these aspects should be considered further at FYA when the quarterly Aftercare Inspections and Reports are likely to be available.

Water Environment

- There is no evidence to suggest that the facilities are unable to function in any way other than as expected, but further detail, such as as-built drainage drawings, would be required to confirm at the FYA stage.

Physical Activity

- As expected, as there has been no reduction or increase in the degree of severance of the PRoW network and no direct changes to the existing NMU facilities or routes.

Journey Quality

- The effects of the Scheme on Journey Quality are likely to be as expected in terms of Traveller Care, Traveller Views, and Traveller Stress.

6. Social Impacts Evaluation

Introduction

6.1. WebTAG guidance current when the scheme was appraised described Social impacts as covering the human experience of the transport system and its impact on social factors, not considered as part of economic or environmental impacts. This covered the following impacts:

- Accidents
- Physical Activity
- Security
- Severance
- Journey Quality
- Option and Non-Use Values
- Accessibility
- Personal Affordability

6.2. Accidents (collisions) and security were considered in section 3 of this report, and Physical Fitness and Journey Ambience in the environment chapter, this section here covers the remaining social impacts.

Sources

6.3. Sources of the forecast social impacts of this scheme are:

- AST

Physical Activity

6.4. See environment section.

Journey Quality

6.5. See environment section.

Affordability

6.6. In the AST, it was stated that as the overall impact on affordability is adverse then all income quintiles receive a moderate adverse impact as a result of the scheme as they are in line with the overall population distribution +/- 5%. This is with the exception of those living in income quintile 1 areas which experience a slight adverse impact.

6.7. The outturn evaluation of vehicle operating costs impact showed it to be a disbenefit but this was less than expected (*Table 4-3*) so the affordability impact has been assessed as slight adverse.

Access to Services, Severance and Option Values

6.8. The AST stated that these sub-objectives were not relevant to this scheme thus they were not appraised. There has been no change to the scheme as built which would alter impacts on these, thus they have likewise not been evaluated in this OYA.

7. Conclusions

7.1. To conclude this report, this section summarises how the scheme is meeting its specified objectives.

7.2. ***Table 7.1*** presents an evaluation of the scheme's objectives using the evidence presented in this study.

Table 7-1 Summary of Success of Scheme Objectives at OYA

Objective	Has the objective been achieved?	
Reduce congestion and to develop solutions that provide additional capacity, increase journey time reliability and ensure the safe and economic operation of the motorway	Conversion of J23-27 to 4 lanes ALR has provided additional capacity	✓
Improve journey time reliability by improving and better managing traffic flow conditions	Journey time reliability improvements have been observed, mainly at the times when journey times were most unreliable in the before period, i.e. the clockwise PM peaks and the anticlockwise AM peaks. At less congested times the journey time reliability has not significantly changed	✓ but more data is required to be conclusive
Achieve a safety objective under which the "after" accident numbers (per annum) are no greater than those in the "before" and the severity ratio is not increased.	Due to the staged opening, data for changes in collision numbers cannot be accurately compared, so rates provide a more suitable basis for comparison. Initial results show reduction in collision rates on M25 within the scheme and across the wider area, and a decrease in severity. However, it is too soon at this stage to be confident of the trend in numbers and to assess the severity impact.	✓ Collision no's cannot be compared, but collision rates have decreased
Make best use of existing infrastructure providing additional capacity within the existing highway boundary, other than in exceptional circumstances	M25 provided with additional capacity within highway boundary	✓
Minimise detrimental environmental effects of the SM scheme by mitigation measures, taking account of costs, availability of funding and statutory obligations.	Landscape mitigation measures in the form of planting proposals appear to have been broadly implemented as anticipated and any local variations in the effects expected are considered unlikely to have materially changed the predicted environmental effects of the Scheme overall.	✓
Improve the currency and quality of information provided to drivers about the state of traffic flow on the motorway	Gantries provided by the scheme have improved driver information.	✓
Support the current role of the M25 as a major national and inter-urban regional transport artery.	M25 provided with additional capacity	✓

Appendix A. Appraisal Summary Table & Evaluation Summary Table

Appraisal Summary Table

7.3. The AST is a brief summary of the main economic, safety, environmental and social impacts of a highway scheme. Table 7-2 presents the AST for the M25 Junctions 23-27 Smart Motorway All Lane Running Scheme.

7.4. The AST presents a brief description of the scheme, a statement detailing the problems that the scheme planned to address, and makes an assessment of the scheme's predicted qualitative and quantitative impacts against the following objectives:

- **Economy** – Estimated impact of the scheme upon journey times, vehicle operating costs, journey time reliability, regeneration and wider impacts.
- **Environmental** – an estimate of the impact of the scheme on factors such as noise, air quality, greenhouse gases, landscape, townscape, heritage, biodiversity and water.
- **Social** – a review of scheme impact upon commuting and other users, physical activity, journey quality, collisions, security, access to services, affordability, severance and option values.
- **Public accounts** – estimated impact upon cost to broad transport budget and indirect tax revenues.

Evaluation Summary Table

7.5. The EST was devised for the POPE process to record a summary of the outturn impacts against the objectives, compared to the predictions in the AST.

7.6. Drawing on the results presented in this report, Table 7-3 presents the EST for the scheme. An assessment of each of the objectives at the OYA stage is given. Where possible, the format of the EST mirrors the appearance and process of the AST to enable direct comparison between the two.

Table 7-2 Appraisal Summary Table

IMPACTS		SUMMARY OF KEY IMPACTS	ASSESSMENT				
			QUANTITATIVE			QUALITATIVE	MONETARY (NPV)	DISTRIBUTIONAL 7-PT SCALE/ VULNERABLE GRP
Economy	**Business users & transport providers**	The scheme would provide journey time benefits for business car and freight users. This would be partly offset by vehicle operating cost dis-benefits for all business users and also by delays to all business users during construction of the scheme.	**Value of journey time changes (£)**	£762.6m		-	£643.3m	-
			Net journey time changes (£)					
			0 to 2 min	2 to 5 min	> 5 min			
			£207.3m	£529.8m	£25.5m			
	Reliability impact on Business users	Incident-related reliability impacts have been assessed using the INCA program. The scheme would produce an overall benefit. Daily travel time variability (TTV) will improve due to the provision of additional capacity and variable speed limits. This would provide a benefit of £444.8m. Delay (due to collisions and incidents) would provide a dis-benefit of £379.9m reflecting the loss of the hard shoulder with the scheme.	Figures calculated pre-August 2012 to 2002 prices and present values and then updated to 2010 prices and present values by multiplying by 1.607			-	£64.9m	-
	Regeneration	The Project is not located within a regeneration area. The Regeneration Impacts have not been assessed.	-			-	-	-
	Wider Impacts	The Wider Impacts (agglomeration, change in output in imperfectly competitive markets and labour market impacts) have not been assessed.	-			-	-	-
Environment	**Noise**	9829 dwellings and 56 other noise sensitive receptors have been considered in the detailed study area. On scheme opening there are 258 dwellings and 4 other sensitive receptors predicted to experience a minor increase in noise (+1dB to +2.9dB change).On scheme opening there are 12 dwellings predicted to experience a minor decrease in noise (-1dB to -2.9 dB). All other changes are predicted to be negligible or no change on opening. Over the design period there are no significant increases in noise predicted, primarily due to low noise resurfacing works, whilst 1 dwelling is predicted to experience a minor decrease in noise (-3dB to -4.9 dB change). All other changes are predicted to be negligible or no change. Those living within income quintile 2 have a higher share of the net losers than the corresponding share in the total population of the assessment area and thus have large adverse impact. However income quintile 1 has a large beneficial impact as there are more properties experiencing a decrease than increase in noise. The other income quintiles receive moderate adverse impacts.	Population annoyed without scheme 3160. Population annoyed with scheme 3190. Net change 30 more people annoyed.			-	c. -£2.4m	Moderate Adverse
	Air Quality	Overall slight improvement in NO_2 and PM_{10} concentrations. 16 AQMAs for annual average NO_2 and 6 AQMAs for 24 hour PM_{10} within 200 m of the local air quality affected road network. Exceedances in 6 AQMA for annual average NO_2 (Brentwood AQMA No.1, Brentwood AQMA No.2, Enfield AQMA, Havering AQMA, Hertsmere AQMA No. 1, Thurrock AQMA) in opening year 2015. Changes in NO_2. Concentrations in NO_2 AQMAs of -0.4 to +1.9 µg/m^3 at 20m from the road. Changes in annual mean PM_{10} concentrations in PM_{10} AQMAs of -0.1 to +0.4 µg/m^3 at 20m from the road but PM_{10} AQMA are for 24 hour. Those living within Income quintiles 1, 3 and 4 receive net dis-benefits, ranging from slight to large adverse. Income quintiles 2 and 5 display net benefits. The overall proportion of properties experiencing a deterioration and improvement is very similar.	NO_2: Overall Assessment Score = -21 Properties with improvement 2321, deterioration 2345, no change 639. PM_{10}: Overall Assessment Score = -5 Properties with improvement 2079, deterioration 2055, no change 1171.			-	-£1.9m	Slight Adverse
	Greenhouse gases	Overall increase in carbon emissions with the scheme due to an increase of +24,178 million vehicle kilometres travelled over the 60-year appraisal period. Calculated using non-TUBA method. The non-traded carbon dioxide emissions in 2015 = +0.07 MtCO2e indicating an increase in CO2 emissions in opening year. Change in emissions in MtCO2e for 2013-2017 (actually 2015-2017) = +0.20, Change for 2018-2022 = +0.36, Change for 2023-2027 = +0.40.	Change in non-traded carbon over 60y (CO2e).	+5.47 MtCO2e		-	-£281.2m	-
			Change in traded carbon over 60y (CO2e).					
	Landscape	Gantries and signage would increase perception of urbanisation in the countryside, leading to a very minor loss to landscape features within the highway boundary, predominantly resulting in neutral to slight adverse effects on landscape and visual receptors.	-			-	-	Slight Adverse
	Townscape	Townscape areas within the study area are Potters Bar and Waltham Cross / North Enfield comprising residential estates, commercial and industrial properties which have a medium to low sensitivity to change. The Project is generally compatible with existing townscape character, resulting in an overall neutral effect.	-			-	-	Neutral
	Heritage of Historic resources	The Project would have a slight adverse impact on one Grade II* Registered Historic Park and Garden (Copped Hall) with regard to its historic setting. The Project would have a slight adverse impact on the historic settings of 1 Grade II listed building and 1 conservation area which are within the study area.	-			-	-	Slight Adverse

IMPACTS		SUMMARY OF KEY IMPACTS	ASSESSMENT			
			QUANTITATIVE	QUALITATIVE	MONETARY (NPV)	DISTRIBUTIONAL 7-PT SCALE/ VULNERABLE GRP
	Biodiversity	Of the five statutory sites (including 2 internationally designated sites) present, there would be no long-term impacts. There are risks of a slight adverse effect on eight adjacent non-statutory sites. Overall, the Scheme is considered to have a "slight adverse" effect on ecological resources resulting from a reduction of buffering of adjacent designated sites and loss and severance of habitat within the Highways Agency soft estate that, although itself of lower value, contributes to the habitat of protected species, but this is not considered significant.	-	-	-	Slight Adverse
	Water Environment	Operational impacts of the Managed Motorways scheme on surface water have been scoped out as potential impacts have been mitigated through design. Operational impacts of the whole road on surface water have been scoped out as they will be picked up by the Priority Outfalls investigation that is assessing the impacts from all motorways and trunk roads.	-	-	-	Neutral
Social	**Commuting and Other Users**	The scheme would provide journey time benefits for all quintile groups, although the most vulnerable groups living within the assessment area experience fewer benefits of the scheme than those living in the least deprived areas. This would be more than offset by vehicle operating cost dis-benefits and also by delays during construction.	**Value of journey time changes (£)** £242.8m **Net journey time changes (£)** 0 to 2 min / 2 to 5 min / > 5 min £51.8m / £173.0m / £18.0m	-	-£56.8m	Slight Beneficial
	Reliability impact on Commuting and Other users	-	**Note:** See Reliability Impact for Business Users	-	-	-
	Physical activity	The Project will have no effect on the activity duration of pedestrians, cyclists or equestrians because there are no direct changes to existing NMU facilities or routes.	-	-	-	Neutral
	Journey quality	Overall improvement to driver stress as the Project would improve capacity, improve travel information which would help alleviate uncertainty of route and reduce driver stress levels. No overall change to views from the road, resulting in neutral effects on travellers' views. Overall slight beneficial effects on journey ambience are predicted.	-	-	-	Slight Beneficial
	Accidents	The Scheme would provide an overall reduction in accidents and casualties in all severity categories and has a slight beneficial impact for vulnerable groups and road users. The Hazard Log approach to accident assessment indicates an 11% reduction in accident rate across the scheme, regardless of road user group. This is partially offset by additional accidents during construction and future maintenance.	Accidents: -644.7 Fatal Casualties: -13.9 Serious Casualties: -122.4 Slight Casualties: -691.0	-	£48.4m	Slight Beneficial
	Security	No assessment undertaken		-	-	-
	Access to services	No assessment undertaken		-	-	-
	Affordability	As the overall impact on affordability is adverse then all income quintiles receive a moderate adverse impact as a result of the scheme as they are in line with the overall population distribution +/- 5%. This is with the exception of those living in income quintile 1 areas which experience a slight adverse impact.		-	-	Moderate Adverse
	Severance			-	-	-
	Option values			-	-	
Public Accounts	**Cost to Broad Transport Budget**	The cost to the Broad Transport Budget would be scheme investment cost and the scheme operating cost. There would be negligible additional future maintenance cost.	The impact would be on Central Government only. There would be no impact on Local Government, developer contributions or on revenues/fares.	-	£236.7m	
	Indirect Tax Revenues	The Indirect Tax Revenue is a consequence of the additional fuel duty derived from the additional fuel used by vehicle users.	The Indirect Tax Revenue is treated as a benefit to the scheme.	-	£278.5m	

Table 7-3 Evaluation Summary Table

IMPACTS		SUMMARY OF KEY IMPACTS	ASSESSMENT				
			QUANTITATIVE	QUALITATIVE	MONETARY (NPV)	DISTRIBUTIONAL 7-PT SCALE/ VULNERABLE GRP	EST Score
Economy	**Business users & transport providers**	The scheme has provided journey time benefits for business and freight users, but these are largely offset by vehicle operating costs.	**Value of journey time changes (£)**	-	£523.9m	-	-
	Reliability impact on Business users	Improvements in day to day variability in journey times.	-	-	-	-	-
	Regeneration	As the scheme is not within a regeneration area, regeneration impacts have not been assessed.	-	-	-	-	-
	Wider Impacts	Wider impacts have not been assessed.	-	-	-	-	-
Environment	**Noise**	Generally better than expected between junctions 23 and 25 (where AADT flows are lower than forecast), but as expected between junctions 24 and 25 anticlockwise.	-	-	-	Moderate Adverse	Better than expected
	Air Quality	Due to lower than expected traffic flows, the scheme's impact on air quality is better than expected between junctions 23 and 25.	-	-	-	Slight Adverse	Better than expected
	Greenhouse gases	The result of the evaluation of the carbon impact is a net increase in carbon emissions, but this is lower than forecast hence the level of the disbenefits of proportionately lower at -£96.9m over 60 years.	It was forecast that the scheme would result in a net increase in carbon emissions from M25 traffic. Due to lower than expected traffic the opening year impact has been a much lower increase than expected.		-£96.9m	-	Better than expected
	Landscape	Although there has been a reduction in the quality of infrastructure proposed at preliminary design, this has not significantly altered the scheme's impact. To ensure the full long-term potential of planting proposals, continued aftercare operations and remedial operations at Woodgreen Lane underbridge are required.	-	-	-	Slight Adverse	As expected
	Townscape	No changes from the AST were identified, and settlements remain well separated from the road by embankments and vegetation.	-	-	-	Neutral	As expected
	Heritage of Historic resources	There has been a reduction in the quality of infrastructure proposed at preliminary design, but this has not significantly altered the scheme's impact on heritage assets. It is too early to evaluate mitigation planting. Confirmation is required regarding the effects of landscape bunds on Skinner's Farm and Holly Hill Farm.	-	-	-	Slight Adverse	As expected
	Biodiversity	There have been changes in vegetation clearance and proposed planting in detailed design, but this is unlikely to have materially changed the scheme's impacts. Construction phase impacts on species are unlikely to have been significant, however, it is not possible to the scheme's impact on species or habitat due to availability of post-opening information.	-	-	-	Slight Adverse	As expected
	Water Environment	On the site visit, there was no observed evidence to suggest that drainage facilities were unable to function in any other way than expected. There has not been any information indicating that incidents have occurred during construction or post-opening.	-	-	-	Neutral	As expected
Social	**Commuting and Other Users**	As for business users above.	Included with business users and transport providers benefits	-	Included with business	Slight Beneficial	-
	Reliability impact on Commuting and Other users	Improvements in day to day variability in journey times. Monetised benefits combined with business above.	-	-	-	-	-
	Physical activity	Desk studies and a site visit undertaken has found no reason to suppose that there have been any significant changes to NMU facilities.	-	-	-	Neutral	As expected

IMPACTS		SUMMARY OF KEY IMPACTS	ASSESSMENT				
			QUANTITATIVE	QUALITATIVE	MONETARY (NPV)	DISTRIBUTIONAL 7-PT SCALE/ VULNERABLE GRP	EST Score
	Journey quality	Regarding traveller care, no changes were identified during site visits and this has not been evaluated further. Impact on traveller views was as expected; while views along the route have generally been retained, there is likely to have been a slight increase in the perception of urbanisation due to the additional infrastructure. Traveller stress has reduced, as was expected, with the M25's increased capacity providing more opportunities for overtaking and a greater likelihood of free-flowing traffic.	-	-	-	Slight Beneficial	As expected
	Accidents	Analysis of observed collision data for the M25 J23-27 within scheme shows a decrease (when compared to the counterfactual) one year after opening, with severity also improving. The collision saving is not statistically significant at this stage.	Collision numbers fell by 34 (36%) within the scheme, however, this is based on 12 months of data for J23-25 and 6 months of data for J25-27.	-	-	Slight Beneficial	As expected
	Security	The scheme has had a neutral impact on security.	-	-	-	-	-
	Access to services	No assessment undertaken.	-	-	-	-	-
	Affordability	The disbenefit through vehicle operating costs was less than expected.	-	-	-	Slight Adverse	Better than expected
	Severance	No assessment undertaken.	-	-	-	-	-
	Option values	No assessment undertaken.	-	-	-	-	-
Public Accounts	**Cost to Broad Transport Budget**	Investment cost was 24% lower than expected. Ongoing operating costs assumed as forecast.	-	-	£123.8m	-	-
	Indirect Tax Revenues	Indirect tax is lower than forecast due to lower traffic volumes than forecast and lower changes in volumes after opening when compared to forecasts	-	-	119.6m	-	-

Appendix B. Information requested for Environmental Evaluation

Environment Specific Requirements	OYA Response
Environment Statement (ES) or Stage 3 Scheme Assessment Report (SAR) or Environmental Assessment Report (EAR) including Environmental Masterplan (EMP) drawings.	• Stage 3 Preliminary Design, Environmental Assessment Report (November 2012) • EMP issued For Construction (October 2013)
AST.	• Provided (Rev. C, November 2012)
Any amendments / updates, additional surveys or reports since the ES / SAR / EAR.	• M25 J23-27 Twelve Month Evaluation Report (January 2016)
Any changes to the Scheme since the ES / SAR / EAR e.g. to lighting and signs, retention of material on site in earthworks in the form of landscape bunds or other, or to proposed mitigation measures.	• Alternative Design Proposal - Landscape Bund at Holly Hill Farm, Enfield (August 2013) • Alternative Design Proposal – Skinners Farm Landscape Bund (November 2013)
As built drawings for landscape/ biodiversity/ environmental mitigation measures/ drainage/ fencing/ earthworks etc.	• Advance Environmental Design drawings, marked up As-Built (February 2014)
Construction Environment Management Plan (CEMP), Landscape and Ecology Aftercare Plan (LEAP), Landscape Management Plan (LMP) or Handover Environmental Management Plan (HEMP).	• CEMP (September 2013) • Draft HEMP (November 2014)
Health and Safety File – Environment sections (to include all environment As-Built reports).	
Relevant Contact Names for consultation.	• Sourced by POPE
Archaeological Reports (popular and academic).	
The Road Surface Influence (RSI) value of any low noise surface installed.	
The insulation performance properties of any noise barriers installed (The BS EN 1794-2 result provided by the noise barrier manufacturer).	• N/A
List of properties eligible for noise insulation.	• Received
Employers Requirements Works Information - Environment sections.	
Reports for any pre/ post opening survey and monitoring work e.g. for noise, biodiversity, water quality).	• Detailed Design, Scheme Visual Impact Assessment Review (October 2013) • Final Use Assessment – Noise Insulation Regulations Assessment (December 2014)

Environment Specific Requirements	OYA Response
Animal mortality data.	• Provided for the eight-year period between 2009 and 2016 inclusive
Pre or Post opening Non-motorised User (NMU) Audits or Vulnerable User Surveys.	
Information may be available regarding environmental enhancements to streetscape/townscape for bypassed settlements	
Scheme Newsletters/ publicity material/ Award information for the Scheme.	• M25 Widening Information Leaflet (August 2005) • Managed Motorways: M25 J23-27 Public Exhibition Leaflet (pre-October 2012) • Highways England webpage (M25 J23 to J27 Resurfacing) The Skanska Balfour Beatty Joint Venture (SBBJV), involved in upgrading the M25 motorway between J23-25 and J5-7, received three CEEQUAL (Civil Engineering Environmental Quality Assessment and Award Scheme) awards in May 2015. CEEQUAL is the evidence based sustainability assessment, rating, and awards scheme for civil engineering, infrastructure, landscaping, and the public realm, and celebrates the achievement of Schemes with high environmental and social performance. The SBBJV team picked up a "whole project" award with a score of 86%, rating Excellent, for the M25 Widening and Hatfield Tunnel Refurbishment.

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Appendix D. Glossary

Term	Meaning
A carriageway, B carriageway	Directional labelling of carriageway in which the A carriageway is clockwise.
AADT	Average of 24 hour flows, seven days a week, for all days within the year.
ACW	Anticlockwise
ADP	Alternative Design Proposal
ADS	Advanced Direction Sign
AED	Advance Ecological Design
ALR	**All Lane Running** is the type of smart motorway in which all lanes are open to traffic at all times. There is no lane which dynamically varies between operating as a hard shoulder or operating as a normal lane.
AIES	Assessment of Implications for European Sites
AQMA	Air Quality Management Area
AST	**Appraisal Summary Table** This records the impacts of the scheme according to the Government's five key objects for transport, as defined in DfT guidance contained on its Transport Analysis Guidance web pages, WebTAG
BCR	**Benefit Cost Ratio** This is the ratio of benefits to costs when both are expressed in terms of present value i.e. PVB divided by PVC
CEMP	Construction Environmental Management Plan
CM	Controlled Motorway
CRTN	**Calculation of Road Traffic Noise** The methodology used to determine entitlement under the Noise Insulation Regulations 1975 (as amended 1988) (NIR) and is the accepted method for the prediction of traffic noise in the UK.
CW	Clockwise
D3M, D4M	Dual 3 or 4 lane motorways
DHSR	Dynamic Hard Shoulder Running
Discount Rate	The percentage rate applied to cash flows to enable comparisons to be made between payments made at different times. The rate quantifies the extent to which a sum of money is worth more to the Government today than the same amount in a year's time.
Discounting	Discounting is a technique used to compare costs and benefits that occur in different time periods and is the process of adjusting future cash flows to their present values to reflect the time value of money, e.g. £1 worth of benefits now is worth more than £1 in the future. A standard base year of 2010 was used in the appraisal and used in this report.
DMRB	**Design Manual for Roads and Bridges** This is a series of 15 volumes that provide standards, advice notes and other documents relating to the design, assessment, and operation of trunk roads, including motorways, in the United Kingdom.
Do Minimum (DM)	In scheme modelling, this is the scenario which comprises only the existing road network and other committed schemes.
Do Something (DS)	In scheme modelling, this is the scenario detailing the planned scheme plus improvement schemes that have already been committed
EAR	Economic Assessment Report
EnAR	Environment Assessment Report
EIR	Economic Impact Report
EM	Environmental Masterplan

EPS	European Protected Species
ERA	Emergency Refuge Area
EST	**Evaluation Summary Table** In POPE studies, this is a summary of the evaluations of the TAG objectives using a similar format to the forecasts in the AST.
FUNIRA	Final Use Noise Insulation Regulations Assessment
FWI	Fatal & Weighted Injuries This figure is a combined measure of casualties based on the numbers of fatal, serious and slight casualties. It is weighted by severity of injuries, with fatalities having the highest weighting.
FWI/bvkm	FWI measure by volume of traffic
FYA	Five Years After
GCN	Great Created Newt
Halogen Data	**Halogen Data** is the record of the overhead gantry settings and message screens forming part of a smart motorway scheme over time.
HEMP	Handover Environmental Management Plan
INCA	**Incident Cost Benefit Assessment** can be used to estimate the benefits of reduce delay and travel time variability caused by unforeseen incidents that reduce capacity such as breakdowns, accidents and debris on the carriageway and major disruptions such as spillages.
KSI	Killed or Seriously Injured
LED	Landscape and Ecology Design
LEAP	Landscape and Ecology Aftercare Plan
LESR	Landscape and Ecology Summary Report
LMP	Landscape Management Plan
LUS	**Later Upgraded Sections** Following plans in 2000 to examine widening of the M25, it was divided into a number of sections, of which the last two became known as the LUS. This is the study of LUS section 2.
MAC	Managing Agent Contractor
MIDAS Data	MIDAS data is held by Highways England which contains lane by lane traffic flows and speeds
MM-ALR	Manage Motorways – All Lanes Running
MtCO2e	Million metric tons of carbon dioxide equivalent
MSA	Motorway Service Area
N	Nitrogen
NMA	Network Managing Agent
NMU	Non-motorised User
NO_2	Nitrogen dioxide
OYA	One Year After
PCF	Project Control Framework
PIC	**Personal Injury Collision** Data on these is obtained from records of road collisions collected from by police officers attending collisions.
PIC/mvkm	Ratio of PIC to the level of travel measured in **million vehicle kilometres** (mvkm)
PM_{10}	Particulate Matter
Present Value	Present Value is the value today of an amount of money in the future. In cost-benefit analysis, values in differing years are converted to a standard base year by the process of discounting giving a present value.
PMW	Precautionary Method of Working

PVB	**Present Value Benefits** Value of a stream of Benefits accruing over the appraisal period of a scheme expressed in the value of a Present Value
PVC	Present Value Cost
RCB	Rigid Concrete Barrier
RSA	Road Safety Audit
RSI	Road Surface Influence
SAC	Special Area of Conservation
SSBJV	Skanska Balfour Beatty Joint Venture
SSSI	Sites of Special Scientific Interest
Smart Motorway	Referred to previously as “managed motorways”: a motorway which uses technology to vary speed limits in response to driving conditions. These smart motorways make the hard shoulder available to traffic. This could be permanently or at particularly busy times of the day.
SNCI	**Site of Nature Conservation Interest** Designations used by local authorities in England for sites of substantive local nature conservation value
SRN	Strategic Road Network
SVIAR	Scheme Visual Impact Assessment Review
TMER	Twelve Month Evaluation Report
TFR	Traffic Forecasting Report
Traveller Care	In the context of journey ambiance, this covers aspects such as cleanliness, level of facilities, information and the general transport environment.
TTV	Travel Time Variability
VfM	Value for Money
VMSL	Variable Mandatory Speed Limit
WEBTAG	Department for Transport’s website for guidance on the conduct of transport studies at http://www.webtag.org.uk/