highways england

# Post Opening Project Evaluation (POPE) of Major Schemes

## Main Report

Meta-analysis 2015

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# Executive Summary

Highways England (and its predecessor the Highways Agency) is responsible for operating, maintaining and improving England's strategic road network. One its roles is to deliver improvements through investment in the **Major Schemes Programme**, which covers improvements to the strategic road network costing more than £10m. In the Road Investment Strategy published in 2015, the Government committed to investing £15 billion in strategic roads to 2021. This financial responsibility requires Highways England to have the tools available to support effective investment decision making.

**Post Opening Project Evaluation** (POPE) studies are undertaken for all of the Highways Agency's and now Highways England's Major Schemes. The key objective of POPE is to identify the extent to which the expected impacts of highway schemes have materialised and to inform thinking on current and future national scheme appraisal methods. POPE also forms the mechanism whereby Highways England can determine:

- The extent to which Major Schemes offer value for money; and
- The level of accuracy associated with estimates of costs and predictions of benefits emerging from Major Schemes and the main factors affecting the accuracy.

POPE studies are undertaken for each Major Scheme one and five years after opening. The purpose of this report is to review the whole programme and identify emerging trends in relation to Major Scheme impact and scheme appraisal accuracy. Key points relating to the sample used in this study are as follows:

**81** Major Schemes which predominantly opened between 2002 and 2012 provide the evidence base for this Meta-analysis study.

**73%** Of these schemes are at the five year after evaluation stage, with 23% of schemes represented at the one year after opening evaluation stage.

**1** Smart Motorway is included in the sample. Other smart motorways built by Highways England have not yet entered the POPE process. The remaining schemes are Bypasses (32), widening (25), junctions (16) and upgrade from A road to motorway (4).

This **Meta-analysis** is structured around a number of key questions. The remainder of this Executive Summary is split into 6 sections presenting the key findings relating to each of these lines of enquiry, together with the associated page number in the main report in order to find further detail.

- **Scheme objectives** – Presents results to identify whether the Programme of Major Schemes is achieving its objectives.
- **Traffic** – Presents the impacts of schemes on traffic flows, journey times and journey time reliability, and compares them to forecast.
- **Safety** – Presents the impacts of Major Schemes on the numbers of collisions and compares the impacts to those forecast.
- **Economy** – Presents the outturn economic results and compares them against forecast, together with an assessment of whether Major Schemes are delivering value for money.
- **Environment** – Presents a comparison of forecast vs outturn impacts for the environment objectives together with a consideration of a number of specialist topics of interest to Highways England.
- **Further Analysis** – Presents the findings from detailed investigations of a number of specialist areas.

# Scheme Objectives

## Are scheme-specific objectives being achieved?

Major Schemes are successful at delivering against their scheme-specific objectives with 93% of objectives being achieved for all schemes and only 2% not achieved. The remainder are either partially achieved (4%) or have insufficient evidence at this stage.

This finding is consistent across all scheme types. A greater proportion of scheme objectives have been achieved at the five year after opening stage when compared to the one year after opening stage.

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# Traffic

## Do Major Schemes improve journey time reliability?

New bypasses, widening schemes and schemes upgrading A-roads to motorways significantly improve journey time reliability, with bypass schemes showing the greatest improvements.

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## Are Highways England traffic models accurately predicting traffic volumes?

A majority (68%) of schemes accurately forecast traffic flows (to within +/-15%), but there is much variability in accuracy between schemes.

There is evidence to suggest that the accuracy of traffic forecasting has improved over time.

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## Are Highways England traffic models accurately predicting journey times?

The limited forecast data available indicates that recorded peak hour journey time savings are lower than forecast. Journey time forecasts are more accurate for less congested periods, such as inter-peak and off peak, when compared to busy peak periods.

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## Does more complex traffic modelling improve forecasting accuracy?

Modelling guidance has changed to encourage consideration of the impact road schemes have on the demand for travel.

Use of 'elasticity models' has improved forecasting accuracy compared to fixed demand models. There are currently too few variable demand models to draw any conclusions as to any advantage over elasticity models

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## Is there evidence of induced traffic?

Sometimes road improvements can lead to more people travelling. This is phenomenon is referred to as 'induced traffic'.

The majority of schemes, of all types, do not appear to have induced traffic. It should be noted that the lack of induced traffic in recent years may be due to the economic downturn. The reduced background traffic growth may also have masked any induced traffic.

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## Is there evidence of a change in peak spreading?

The limited data available on peak spreading shows a reduction for the majority of schemes. However, the general rerouting of traffic onto the schemes from other routes, increasing traffic flows for all hours, can mask a reduction in peak spreading.

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# Safety

## What impact do Major Schemes have on the number of collisions?

The sample size available is too small to draw meaningful conclusions. However, there is evidence to suggest that:

- Major Schemes with a statistically significant impact on collisions are successful at reducing the numbers of collisions.
- Bypass schemes are the most successful type of scheme in terms of improving safety.

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## How accurate are safety predictions?

Accuracy of collision safety predictions is poor. Less than half of schemes have collision savings within 50% of the prediction.

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## What are the changes in observed collision rates and how does that compare to forecast?

Major Schemes which have involved improvements to A roads have seen a considerable decrease in the collision rate.

Motorways typically have low collision rates compared to other types of road. Major schemes involving improvements to motorways have resulted in little change to these rates. The DfT collision rate forecasts for four lane motorways are broadly in line with those observed.

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# Economy

## What are the main benefits of Major Schemes?

Journey time benefits are the key monetary benefits derived from Major Schemes, accounting for 79% of all monetary benefits. Safety benefits (as measured by reductions in numbers of injury collisions) form the second largest contribution.

The average total monetary benefit for schemes appraised over the standard 60 years is £117.5million, and £86.7million for schemes appraised over 30 years.

Other impacts which are appraised using a monetary value, positive or negative, include changes to the users' vehicle operating costs, indirect tax impact for the Treasury, and cost of delays during construction and future maintenance periods. In total, these average only an average 1% net impact.

The Treasury is expected to benefit from many schemes through a net increase in indirect tax revenue but, on average, this impact is less than £1million.

Widening schemes have substantially higher average total benefits per scheme than bypass and junction schemes. However, the greatest benefits are seen in the four schemes which were an upgrade to motorway and the one smart motorway scheme; all of these where larger schemes. Safety benefits are the highest for bypass schemes which is due to these types of scheme including the greatest step change in road standard.

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# Environment

## How accurate are the forecasts for the environmental sub-objectives?

An evaluation of the performance of each environment sub-objective against the forecast impact shows that overall:

- 70% of environmental sub-objectives are 'as expected'.
- 16% of environmental sub-objectives are 'better than expected'.
- 13% of environmental sub-objectives are 'worse than expected'.

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## What are the carbon impacts of Major Schemes?

The majority of Major Schemes result in increased carbon emissions in the opening year. However, in general the observed carbon impact is lower than forecast

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## Is Highways England successfully maintaining biodiversity mitigation areas?

Biodiversity mitigation measures have generally been provided for all schemes considered in this meta-analysis. For 44% of schemes, certain elements of mitigation would appear not to have been provided, were no longer required post Environmental Statement, had been slightly amended to suit site conditions, were underestimated or design issues were raised.

Monitoring was available for 57% of schemes.

Based on the site visits for POPE and information provided within the landscape evaluations, it would appear that habitats such as grasslands, woodlands and hedgerows are establishing. These evaluations are based on visual confirmation during POPE site visits and, when available, ecological surveys/reports received. Maintenance and management is generally being undertaken appropriately.

For fauna, issues tend to be scheme-specific caused by vandalism/damage, poor maintenance/management, slow establishment or lack of clarity on responsibilities for the specific features.

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## How successful is Highways England in mitigating the landscape and townscape impacts of Major Schemes?

Overall 80% of schemes assessed show that overall landscape objectives set in the ES are set to be achieved. It is noted that when compared with the Meta-analysis 2013 (84%) and Meta-analysis 2010 (93%), a reduction in target achievement is evident.

This evaluation identifies deterioration in landscape scheme target achievements when compared with ES predictions of impacts. It also serves to highlight issues within individual schemes that impact upon growth target achievements.

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Performance of schemes against targets set in their ESs is as follows:

- 7% of schemes had landscape impacts which were ‘better than expected’;
- 73% of schemes had landscape impacts which were ‘as expected’; and
- 20% of schemes had landscape impacts which were ‘worse than expected’.

Additionally, this section confirms that the use of locally appropriate materials within schemes where traditional resources identify location and history makes a positive contribution to scheme design and is generally welcomed by local councils and residents.

Assessment of the impact of schemes on designated sites confirms that 45 (56% of 81 schemes) schemes assessed for this Meta-analysis are located within or adjacent to designated landscapes which have included national designations such as National Parks or Areas of Outstanding Natural Beauty (AONB), greenbelt, historic parks and gardens or historic landscapes, as well as areas designated at a local level such as Areas of Great Landscape Value.

Finally, this section confirms that townscape/streetscape initiatives undertaken particularly during de-trunking and as included in the ES design are generally well received when returning a previously congested urban space to a more locally appropriate village/town.

# Further Analysis

## Are local communities satisfied with Major Schemes?

Local communities are generally satisfied with Major Schemes with 65% of questionnaire respondents (across 15 schemes) either agreeing or strongly agreeing that the scheme had made their community a better place to live.

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## How long does Highways England Major Scheme appraisal take?

The average duration of Major Scheme appraisal is just over four years (for schemes with a construction start date between 2004 and 2009), although there is a wide variety between individual schemes.

There has been little change in the duration of scheme appraisal between 2004 and 2009.

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## How accurate are the forecasts for the accessibility objective?

Accessibility is concerned with increasing the ability with which people in different locations and with differing availability of transport can reach different types of amenities such as places of education, worship, leisure, healthcare and employment.

90% of schemes were evaluated ‘as expected’ for accessibility.

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## How accurate are the forecasts for the integration objective?

Integration is concerned with ensuring that all decisions are taken in the context of the Government’s transport policy at the time of the scheme appraisal.

89% of schemes were evaluated ‘as expected’ for integration.

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# Table of Contents

# 1. Introduction

## 1.1 What is Post Opening Project Evaluation and why is it important?

Highways England is responsible for operating, maintaining and improving England's strategic road network. Prior to April 2015, it was an executive agency of the Department for Transport, the Highways Agency. The government has recently launched its first '**Road Investment Strategy**' (December 2014). These documents set out an ambitious, long term programme for the motorways and major roads in England with investment of over £15billion to 2021. The aim is to:

- Provide a **world class strategic network**
- Reduce **congestion**
- Support jobs and **economic growth**
- Improve road **safety**
- Minimise any negative impact on the **environment**.

One of the mechanisms for Highways England to achieve the above objectives is through investment in the **Major Schemes Programme**, which covers improvements to the strategic road network costing more than £10m. In the Road Investment Strategy published in 2015, the Government committed to investing £15 billion in strategic roads to 2021. This financial responsibility requires Highways England to have the tools available to support effective investment decision making.

All Highways England Major Projects are subject to a rigorous planning and appraisal process in order to demonstrate that the scheme is viable, delivers long term economic benefits, and minimises any impact on the environment and surrounding communities. The traffic impacts of Major Schemes are estimated using computer models. The outputs from these models are then used to predict the economic impact of major schemes.

**Post Opening Project Evaluation** (POPE) studies are undertaken for all of the Highways Agency's and now Highways England's Major Schemes and this was required by the DfT's Strategic Road Network Performance Specification 2013 to 2015. The key objective of POPE is to identify the extent to which the expected impacts of highway schemes have materialised and to inform thinking on current and future national scheme appraisal methods. POPE also forms the mechanism whereby Highways England can:

- **Meet HM Treasury's Green Book requirements** (and Magenta Book guidance)
- **Support the DfT's *'Monitoring and Evaluation Strategy'.***
- Give confidence in appraisal methods
- **Identify improvements** that could be made in appraisal and identify examples of **best practice.**
- Give **accountability** to stakeholders regarding commitments made at Public Inquiry
- Promote **transparency**.

For simplicity, this report uses the name Highways England throughout to include the Highways Agency and Highways England.

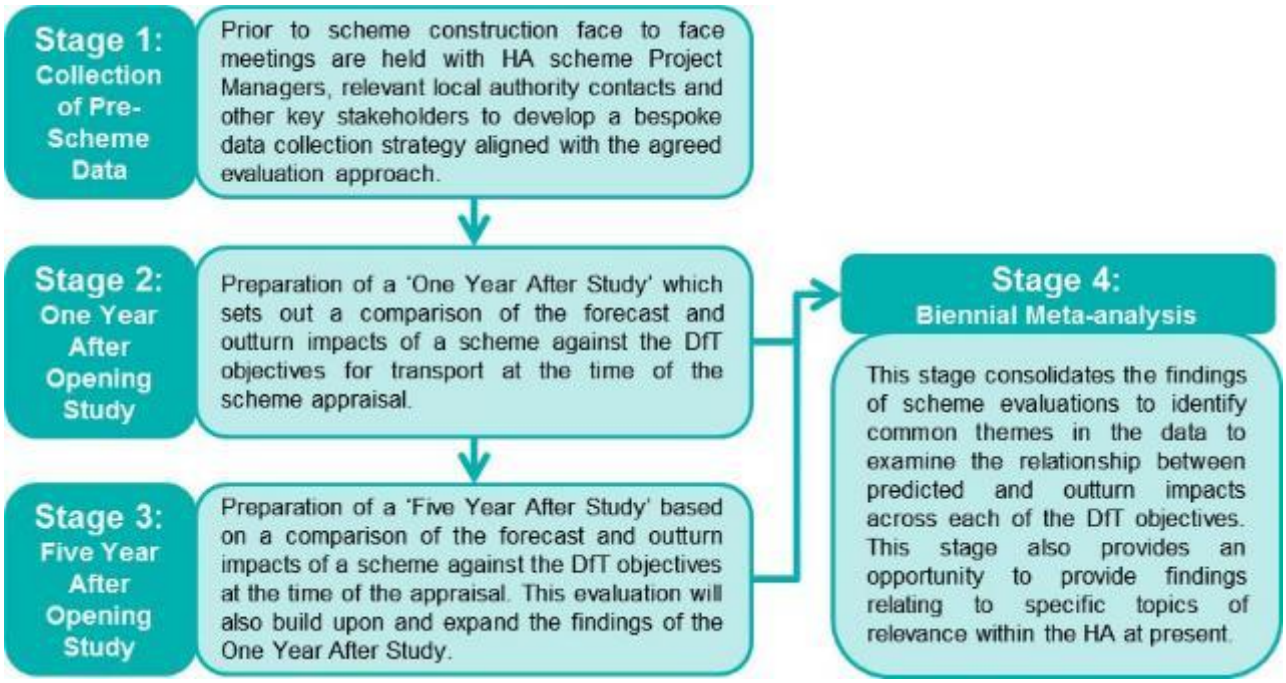
## 1.2 How are POPE results used?

By undertaking post opening evaluation and openly reporting findings (all evaluation studies are published online), Highways England and the DfT are making the outcomes of the Major Schemes Programme transparent to the public. Specific scheme lessons are fed into Highways England's dissemination processes to be shared by project staff. Highways England maintains a list of all the issues raised by POPE and track its response to them. Often, the follow up is in the form of giving feedback, either about issues or good practice to project managers and specialists.

## 1.3 What is the approach to POPE?

There are four key stages to the POPE process which are illustrated in Figure 1-1. Stage 4, the Biennial Meta-analysis is this report.

**Figure 1-1 Approach to the POPE of Major Schemes**




## 1.4 Structure of the POPE Meta-analysis

Following this introduction, this report is brown down into a further 7 sections and appendices:

- **Section 2:** Data Collection and Availability (page 14);
- **Section 3:** Scheme Objectives (page 19);
- **Section 4:** Traffic (page 23);
- **Section 5:** Safety (page 57);
- **Section 6:** Economy (page 69);
- **Section 7:** Environment (page 96);
- **Section 8:** Further Analysis (page 141);

- **Appendix A:** Environment Issues (page 148);
- **Appendix B:** Glossary (page 153);
- **Appendix C:** List of Tables and Figures (page 157);

# 2. Data Collection & Availability

**Scheme Photo: A30 Bodmin to Indian Queens, Five Years After Opening**

# 2. Data Collection & Availability

## 2.1 The Schemes

The 2015 meta-analysis has drawn upon the collective findings of all POPE evaluations of schemes which predominantly opened since 2002 and analyses information from 81 schemes. For the purposes of this meta-analysis, where two evaluations have been completed for any given scheme, results have been based on the most recent evaluation (Five Years After, FYA).

The schemes used to form the evidence base for this meta-analysis have been categorised into the following groups:

- **Bypass** schemes;
- Non Bypass schemes, comprising:
  - **Widening**;
  - **Junction Improvements;**
  - **Upgrade from A road to motorway** standard; and
- **Smart Motorways** (see case study opposite).

Figure 2-1 summarises the numbers of schemes that have been used within the 2015 meta-analysis, characterised by scheme opening year and type.

**M6 Junction 8 to 10a Smart Motorway**

Opened in March 2011, this is the only Smart Motorway which is considered within this meta-analysis.

The scheme comprises Variable Mandatory Speed Limits (VMSL), Hard Shoulder Running (HSR) and Through Junction Running (TJR) as part of a wider strategy to relieve congestion on the highway network in the vicinity of Birmingham.

Smart Motorway projects form a considerable proportion of Highways England's current and future Major Scheme investment. In recognition of the likely interest in the performance of Smart Motorway schemes, this scheme has been given is its own category ('smart motorway') to enable the results to be clearly identified in various sections of this report.

**The findings presented in this report should be treated with caution due to the small sample size.**

**Figure 2-1 Breakdown of Scheme Types by Opening Year[1]**

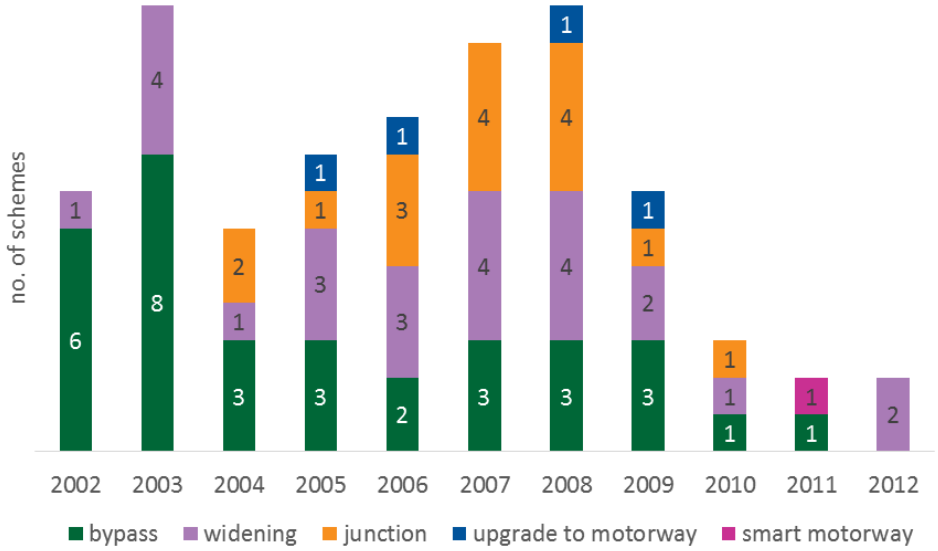
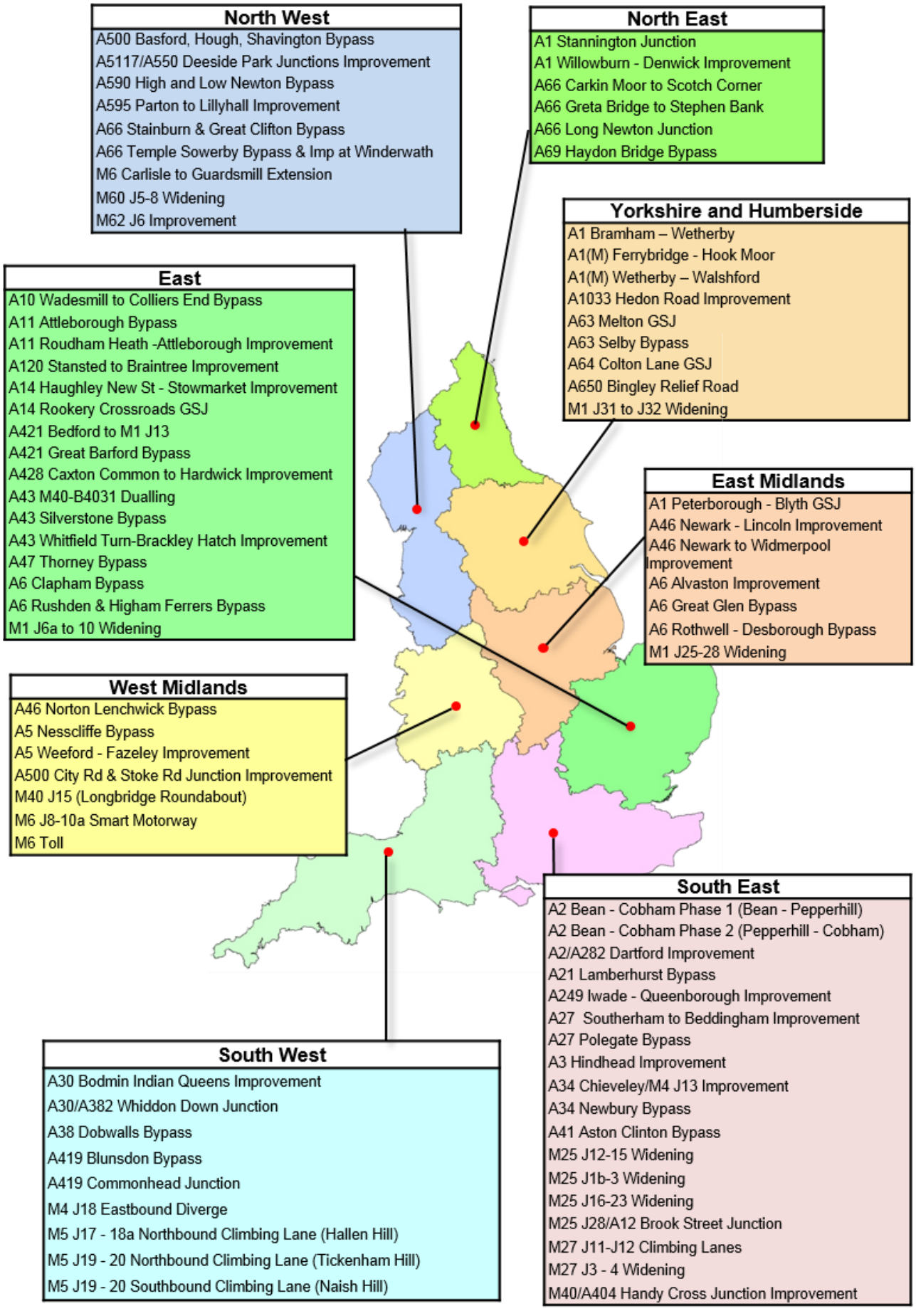



Figure 2-2 shows where the scheme are located. It should be noted that in order to ensure results were not skewed by exceptional examples, a small number of outliers have been removed from the various data-sets used throughout this meta-analysis, as noted in the individual analyses.

[1] A46 Norton Lenchwick Improvement and A34 Newbury Bypass are both excluded from this figure because their opening years were pre 2002.

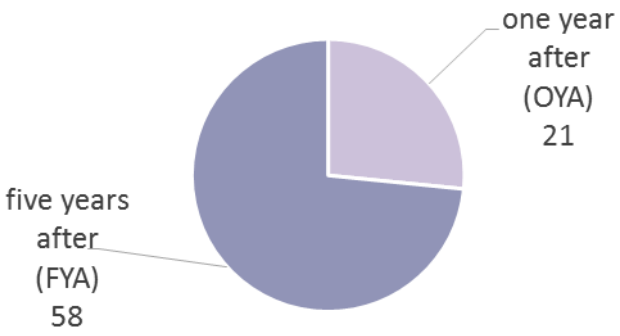
**Figure 2-2 Location of Schemes in 2015 meta-analysis**



## 2.2 Post Opening Evaluation Studies

This report is based on the most recent stage of evaluation which has been completed on each of the schemes. Figure 2-3 summarises the totals by One Year After and Five Year after studies.

**Figure 2-3 Stages of the POPE reports included in this 2015 Meta-analysis[2]**




## 2.3 Data Sources and Collection

A comprehensive data collection exercise is undertaken for all POPE scheme evaluations. This begins before construction and continues during the OYA and FYA evaluation stages, incorporating new data collection where required.

### 2.3.1 Forecast Impacts

Information regarding the forecast impacts of schemes is derived from a number of sources produced at the time of the scheme appraisal including:

- Appraisal Summary Table (AST);
- Traffic Forecasting Report (TFR);
- Economic Assessment Report (EAR);
- Environmental Statement (ES); and
- Cost Benefit Analysis files (COBA).

### 2.3.2 Observed Impacts

The scope of outturn information considered by POPE is determined by:

- Liaison with Highways England's Scheme Project Manager and Local Authority before scheme construction and at each evaluation stage to understand local perceptions and issues;
- Consideration of those areas forecast to observe significant changes due to the scheme, as reported in the appraisal documents, e.g. changes in traffic flows presented in the TFR.
- Ensuring a cost effective and proportional approach to data collection is maintained.

#### 2.3.2.1 Existing Sources of Observed Impacts

Various data is drawn from a range of existing sources to inform POPE evaluations. These primarily include:

- Traffic flow and classified data from:
  - HE Traffic Data System (TRADS) database; and
  - Local Authority traffic monitoring sites.
- Journey time data taken from Highways England Journey Time Database (JTDB) and use of satellite navigation data;
- Personal Injury Collision (PIC) data from STATS19 data collected by the police when attending accidents, sourced from Local Processing Units from either:
  - The Managing Agent Contractor (MAC); or
  - Local Authorities.
- Environmental impacts presented in:
  - Post opening survey, monitoring and reports produced on behalf of HE; and
  - As-built drawings.
- Scheme costs provided by Highways England's Regional Finance Managers; and

[2] A43 Norton-Lenchwick improvement is excluded from this graph because it's a ten year after opening study.

- Local media and Highways England publicity material for the scheme.

#### 2.3.2.2 Additional Data Sources

Having established what information is already available from existing sources, additional supplementary surveys are carried out as required. These primarily include:

- Temporary Automatic Traffic Counts (ATCs);
- Journey time survey (typically 'moving observer' surveys or data supplied from satellite navigation systems);
- Site visits;
- Surveys of non-motorised users for certain schemes where a particular requirement is identified; and
- Residents' surveys where the community impact is high.

# 3. Scheme Objectives

**Scheme Photo: A46 Newark to Widmerpool Improvement, One Year After**

# 3. Scheme Objectives

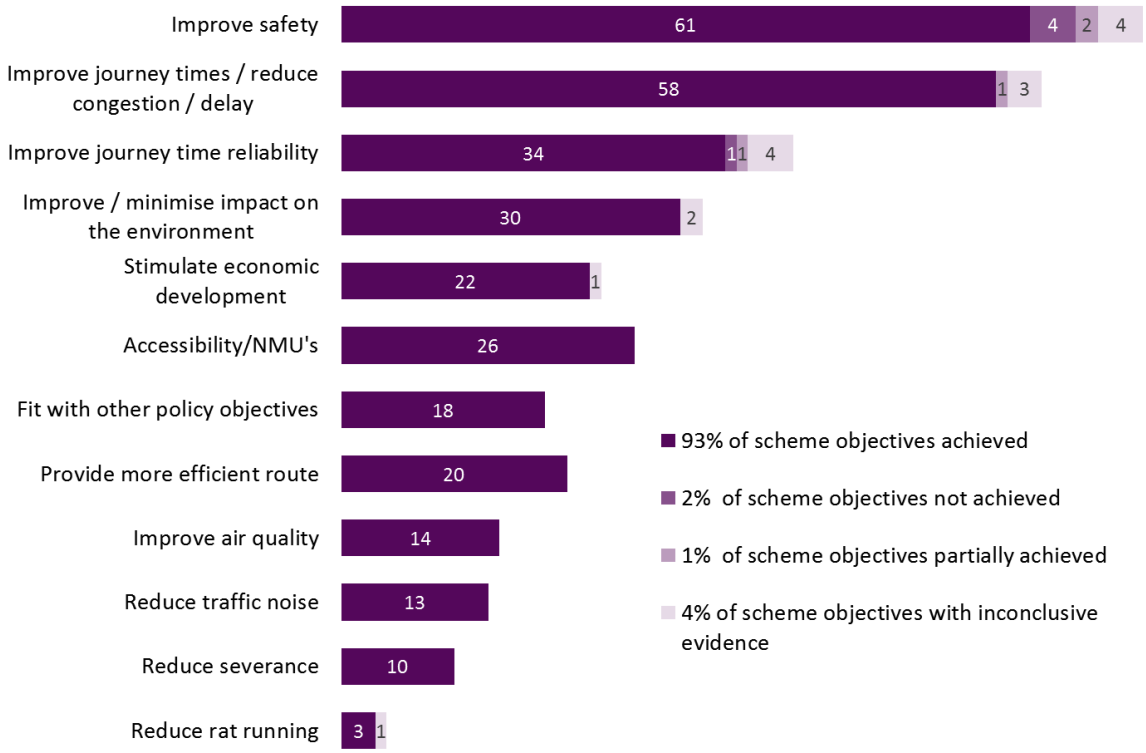
## 3.1 Are scheme-specific objectives being achieved?

**Major Schemes are successful at delivering against their scheme specific objectives with 93% of objectives being achieved for all schemes and only 2% not achieved. The remainder are either partially achieved (4%) or have insufficient evidence at this stage.**

**This finding is consistent across all scheme types. A greater proportion of scheme objectives have been achieved at the five year after opening stage when compared to the one year after opening stage.**

All Highways England's Major Schemes have their own objectives which are generally defined at the option identification and appraisal stage of the project. Figure 3-1 summaries the success of Major Schemes against their own scheme-specific objectives. The numbers in the bars show how many schemes has the objective and how the success has been categorised. It shows that **93% of all scheme specific objectives have been achieved**, with only 2% of objectives not achieved. Some objectives (4%) have inconclusive evidence[3] to demonstrate that whether they have been achieved or not and 1% of objectives are partially achieved[4].

**Figure 3-1 Success of Major Schemes against their scheme specific objectives (all schemes)** [5]




In order to determine whether the objectives were inconclusive because of the timing of the evaluation, Figure 3-2 presents results from schemes which have been evaluated at both one and five years after.

[3] Objectives that are inconclusive include those with insufficient evidence available at the time of the evaluation to determine whether the scheme has been successful in meeting the objective.
[4] Schemes with objectives that are partially achieved typically show some evidence to show that the objective is being achieved, but it is not possible using the evidence available to draw a firm conclusion.
[5] The numbers presented in this graph are rounded which explains why some figures do not add up to exactly 100%.

**Figure 3-2 Success of Major Schemes against their scheme specific objectives (OYA and FYA studies separated)**

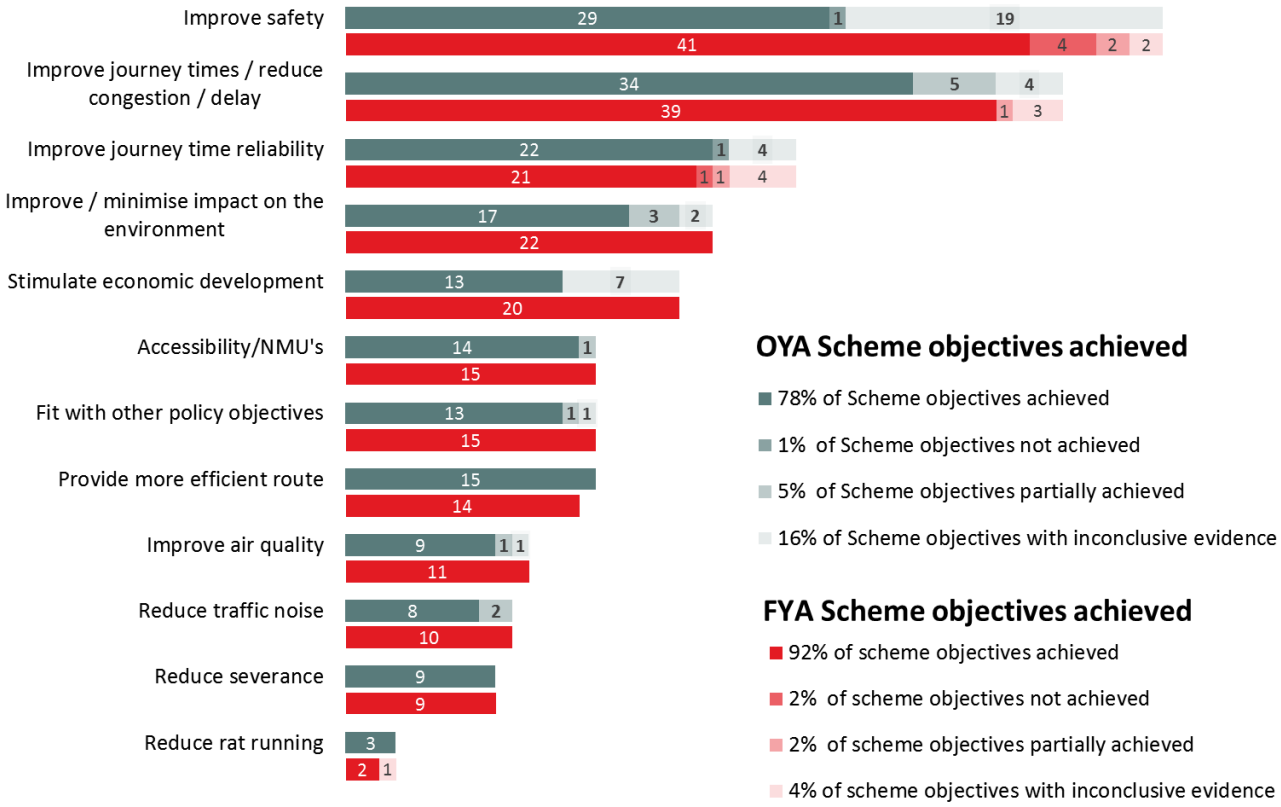



Figure 3-2 shows that a greater proportion of scheme objectives have been achieved at the five year stage, with fewer objectives having inconclusive evidence. The principal reason is due to safety benefits being realised at the five year after opening stage, when at the one year after opening stage the impact was inconclusive (usually do a shortage of sufficient post opening collision data).

In order to determine whether certain types of scheme are more successful than others, Figure 3-3 presents the results of an analysis of success against scheme objectives by scheme type (using the categories previously identified in Section 2.1 on page 14).

**Figure 3-3 Success of Major Schemes against their scheme specific objectives by scheme type[6]**

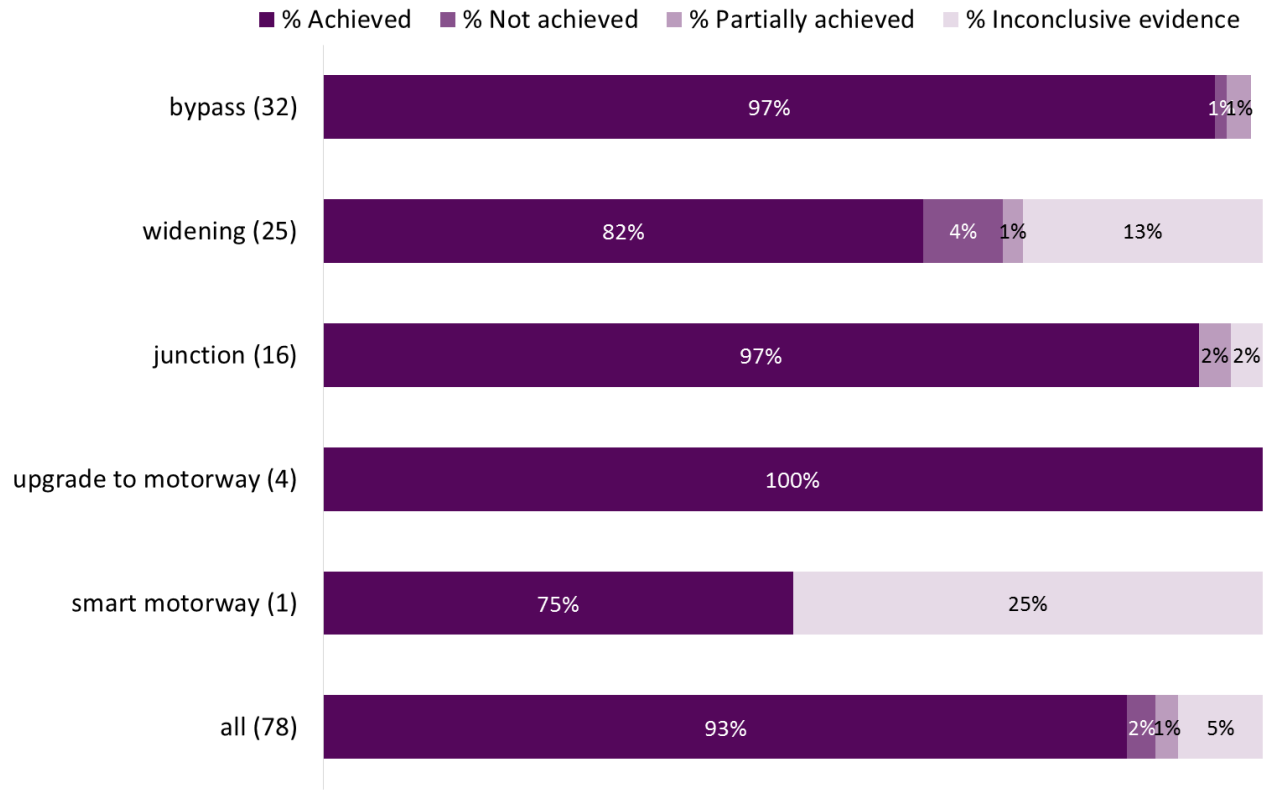



Figure 3-3 shows the following:

- Bypass schemes have achieved 97% of their objectives, with upgrades to motorway and smart motorways achieving all of their objectives (although it is noted that the sample size is small for both of these scheme types).
- For widening schemes 82% of objectives were achieved. 4% of objectives were not achieved. This was mainly due to safety benefits not materialising for 3 schemes.12% of objectives were inconclusive. On closer examination this is primarily due to insufficient evidence to demonstrate that journey times and reliability have improved (3 schemes) and safety benefits being inconclusive (2 schemes).
- The smart motorway scheme achieved 3 of its objectives. One of its objectives is currently inconclusive (safety).

## 3.2 Summary of Scheme Objectives

The results presented in this section provide strong evidence that Major Schemes are successful in meeting their objectives. However, the objectives for all of the schemes within this Meta-analysis sample are qualitative. Some examples of the types of objectives are given below:

- *'To improve safety'*
- *'To improve journey times'*
- *'To improve journey time reliability'*

In order for a scheme to demonstrate success against the above objectives, only a small change is required. For example, there could be a small reduction in journey times of only a few seconds, and the objective would be achieved.
The following chapters 4 to 7 of this report include the investigation of how effectively the major schemes are achieving the objectives based on the observations in the early years after opening.

[6] The numbers presented in this graph are rounded which explains why some figures do not add up to exactly 100%.

# 4. Traffic

**Scheme Photo: A419 Blunsdon Bypass, One Year After**

# 4. Traffic

## 4.1 Do Major Schemes improve journey time reliability?

**New bypasses, widening schemes and schemes upgrading A-roads to motorways significantly improve journey time reliability, with bypass schemes showing the greatest improvements**

### 4.1.1 Measuring Reliability

Reliability is a sub-objective of the Economy objective within the Government's objectives for transport and is defined as the variation in journey times, at the same time of day, which drivers are unable to predict. It is confined to random effects arising either from day-to-day variability in recurrent congestion or variability in non-recurrent congestion such as incidents.

There are a number of alternative methodologies for assessing reliability depending on the type of road, as detailed in WebTAG (Unit A1.3), including:

- Route Stress;
- MyRIAD( Motorway Reliability Incidents And Delays); and formerly
- INCA (Incident Cost Benefit Assessment).

Highways England's Journey Time Database (JTDB) can be used to determine the standard deviation of average journey times on a road at a given time of day. Satellite navigation data can also be used to evaluate changes in reliability using a range of indexes.

For the schemes included in this meta-analysis, POPE has tended to rely on the 'Route Stress' approach for evaluating reliability as this has been the predominant approach used in the appraisal of the schemes. It is also relatively simple to calculate. Route Stress is the ratio of Annual Average Daily Traffic (AADT) flow to the Congestion Reference Flow (CRF), which is a definition of capacity.[7] Reliability of journey times reduce as flows approach capacity.

Evaluation of the pre-scheme and outturn route stress levels are calculated using the before and after opening traffic volumes, the directional split of traffic and the percentage of HGVs. This methodology enables a direct comparison between the observed and predicted values.

The route stress approach, however, only provides a broad indication of the impact of a scheme on reliability. POPE has been exploring and piloting other methods of evaluating journey time reliability, and the use of satellite navigation data to measure the standard deviation of journey times is a preferred method for schemes which have data available before and after scheme opening. For the majority of schemes considered within this report, however, 'before' journey time data is not available.

The following sections consider the observed impacts on reliability of the POPE schemes using the following methodologies:

- Route Stress;
- Variability in average journey time, utilising Highways England's JTDB; and
- Variability in individual journey times using data from satellite navigation devices.

The difference between predicted and observed route stress is also assessed.

### 4.1.2 Observed Impacts on Reliability using Route Stress

The changes in observed route stress before and after scheme opening for bypass, widening and 'upgrade to motorway' schemes have been analysed using all observed data, as shown in Figure 4–1. It should be noted that this analysis utilises available data from 26 bypass schemes, 19 widening schemes

[7] The CRF of a link is an estimate of the Annual Average Daily Traffic (AADT) flow at which the carriageway is likely to be 'congested' in the peak periods on an average day.

and 4 'upgrade to motorway' schemes. WebTAG states that where stress values are less than 75% or greater than 125%, values of 75% and 125%, respectively, should be used. However, to demonstrate the extent of the changes in route stress due to the schemes, the values used in this figure and the following figures are based on the unadjusted route stresses.

**Figure 4–1 Level of Route Stress before and after scheme opening**

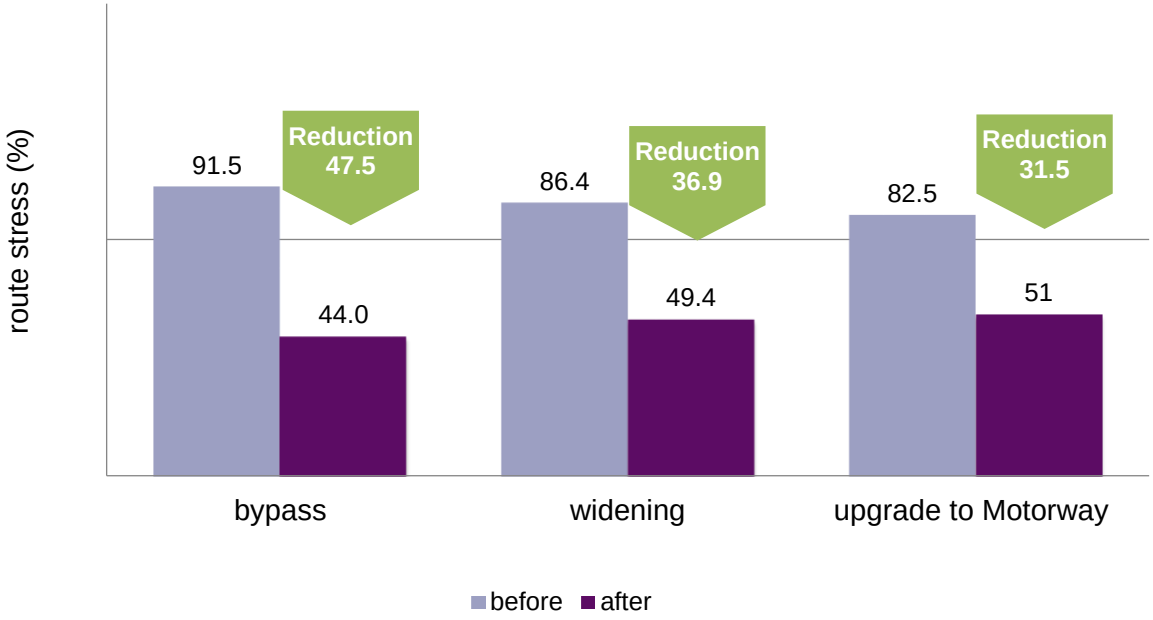



Figure 4–1 demonstrates that all types of scheme significantly improve journey time reliability, with the following key observations:

- Bypass schemes have the greatest reduction in route stress of all road types and the lowest level of route stress in the Do-Something scenario. Schemes of this type have the highest impact on reliability because they generally provide the most additional capacity;
- Widening schemes have a smaller reduction in average route stress than bypass schemes with a higher level of route stress in the Do-Something scenario, due to the generally lower level of additional capacity provided. However, these schemes still reduce route stress to below 50%;
- The 'upgrade to motorway schemes' have the lowest level of reduction in route stress. However, again it is clear that the increase in capacity has resulted in decreased congestion; and
- The observed reduction in route stress for all scheme types shows that the additional capacity provided by Major Schemes does result in a decrease in congestion.

### 4.1.3 Comparison between Observed and Predicted Impacts on Reliability using Route Stress

An analysis of the predicted and observed route stress percentages before and after opening has been undertaken for those schemes which have values for both predicted and observed, to determine the level of forecasting accuracy. These schemes consist of 21 bypass schemes, 13 widening schemes and 4 'upgrade to motorway' schemes. This sample size is smaller than that used for the analysis of observed changes in route stress as there were some schemes without predicted data. Junction schemes have not been included as route stress cannot be determined for schemes of this type.

Figure 4–2 to Figure 4–3 show the level of predicted and observed route stress before and after scheme opening for bypass and widening schemes, respectively. A comparison for 'upgrade to motorway' schemes and smart motorway has not been provided due to the small sample size.

**Figure 4–2 Level of Route Stress before and after scheme opening – Bypass Schemes**

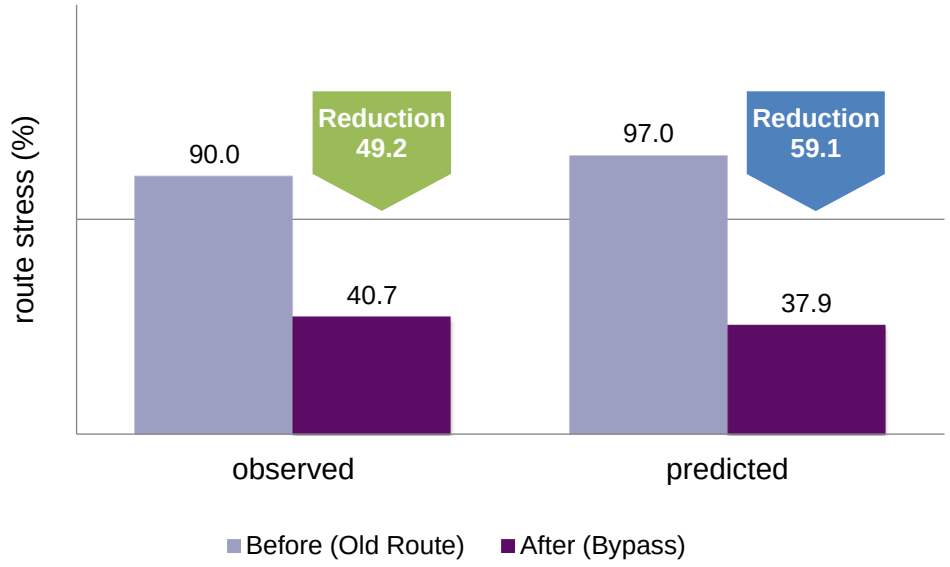
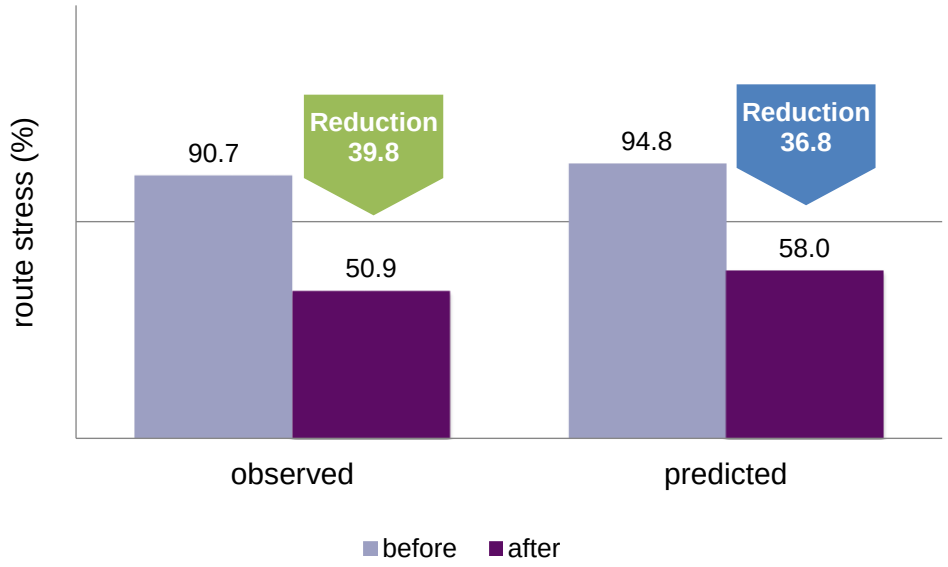



**Figure 4–3 Level of Route Stress before and after scheme opening – Widening Schemes**




The following can be observed from Figure 4–2 to Figure 4–3 in relation to the differences between the predicted and outturn average route stresses for the different road types:

- There is a good correlation between observed and predicted route stresses for both bypass and widening schemes;
- It is noted that observed levels of route stress are generally slightly lower than predicted. This is likely to be due to observed traffic flows being lower than predicted; and
- The observed reduction in route stress is generally accurate for both widening and bypass schemes. The accuracy for bypass schemes is slightly less than for widening schemes which is likely to be due to the inaccuracy in modelling of re-routing between the old route and the new bypass. This will be discussed in more detail in Section 4.2.

### 4.1.4 Observed Impacts on Reliability using Journey Time Database (JTDB) data

A proxy for journey time reliability can also be determined by examining the variation of journey times using data extracted from Highways England's Journey Time Database (JTDB). This is undertaken by calculating the standard deviation of mean journey times for each time period for the pre-scheme and one year and/or five year after periods. This approach has limitations because it is based on mean journey

times which therefore may hide variation in individual journey times. However, if there is a significant reduction in standard deviations between the before and after opening period then it is reasonable to assume that the Major Scheme has improved journey time reliability.

This extra level of evaluation has been undertaken for a total of thirteen schemes and the results show the following:

- 10 schemes (77%) showed a clear improvement in journey time reliability since the Major Scheme opened.
- For 3 schemes (23%) there was no clear evidence of improved journey time reliability. Although for one of these schemes there was a considerable increase in traffic volumes between the before and after opening periods.

### 4.1.5 Observed Impacts on Reliability using Satellite Navigation (GPS) Journey Time Data

There are currently only three schemes within the POPE dataset where GPS data has been used to assess the journey time reliability. As previously noted, this is due to the general unavailability of data for the time period before the scheme was constructed.

Although no standard methodology currently stands for comparing journey time reliabilities for different schemes, the Planning Time Index (PTI) has been used for this meta-analysis. The PTI is the ratio of the 95$^{th}$ percentile Journey Time / Free-flow Journey Time. For this analysis the 25$^{th}$ percentile journey time has been used to represent the free-flow journey time.

Table 4–1 shows the change in PTI for the three schemes and the average. A reduction in PTI represents an improvement in journey time reliability.

**Table 4–1 Change in Planning Time Index**

| Schemes | Change in Planning Time Index | | |
|---|---|---|---|
| | AM Peak | Inter-Peak | PM Peak |
| M6 J8-10A Smart Motorway | -14% | -18% | -24% |
| A421 Bedford to M1 J13 | -27% | -5% | -1% |
| M40 Junction 15 Longbridge Improvement | -67% | -38% | -59% |
| **Average** | **-36%** | **-20%** | **-28%** |

It can be observed from Table 4–1 that there is an improvement in JT reliability for all three schemes, with the reliability improving most during the AM and PM peaks, as would be expected due to the higher level of congestion.

## 4.2 Are traffic volumes accurately predicted?

**A majority (68%) of schemes accurately forecast traffic flows (to within +/-15%), but there is much variability in accuracy between schemes.**

**There is evidence to suggest that the accuracy of traffic forecasting has improved over time.**

This section examines the accuracy of forecast traffic flows compared to observed flows. In order to determine if there have been any trends in relation to traffic forecasting accuracy, the following have been considered:

- Range of forecasting accuracy levels by scheme type;

- Proportion of schemes with observed traffic flows within a ±15% threshold of those forecast;
- Proportion of schemes with observed flows higher and lower than forecast; and
- Changes in forecasting accuracy over time.

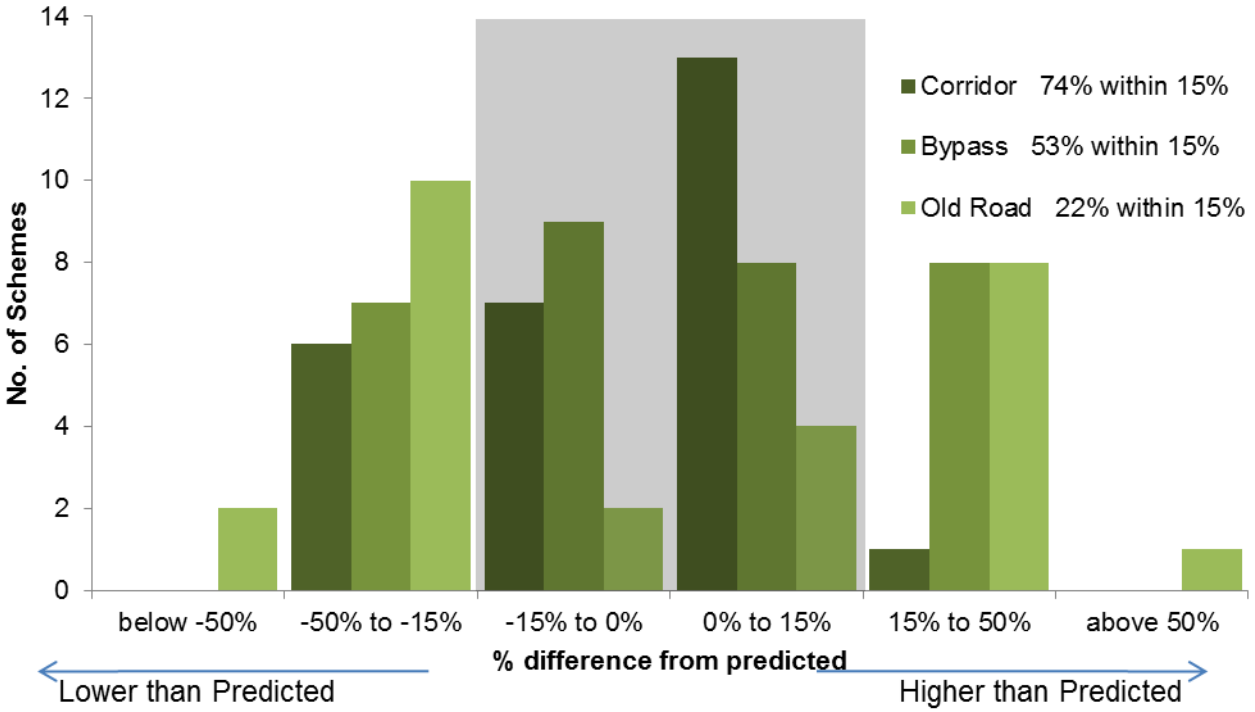
The range of accuracy for different scheme types is considered in more detail in the following sections, as well as any trends for observed flows to be higher or lower than predicted. A difference of less than ±15% between modelled and observed traffic flows is considered to be acceptable for base model validation in WebTAG Unit M3.1 (Table 2) and provides an appropriate threshold for determining accurate modelling in this analysis.

In Figure 4–4 to Figure 4–6 outliers have been excluded to ensure that the results are not skewed by exceptional examples. The Devore's 'Fourth-Spread' method has been utilised to identify and remove the outliers.[8] For bypass schemes, the traffic forecast accuracies have been provided for the old road, the new road and for the corridor (new bypass and old road combined).

### 4.2.1 Bypass Schemes

Figure 4–4 shows the range of accuracy of traffic flow forecasts compared to observed traffic flows for bypass schemes. The graph shows the range for the new bypass, the old road and the total flow in the corridor (new bypass and old road combined).

**Figure 4–4 Accuracy of Traffic Forecasts (Bypass schemes)**




It can be observed from Figure 4–4 that the forecasting of the overall traffic flow in the corridor is significantly more accurate than the forecasting of the traffic flows on the bypass and old road. This shows that although the forecast change in the overall traffic flow in the corridor is accurately reflected, the flow of traffic remaining on the old road is much less accurately predicted. This is due to the old road post opening numbers always being low with a greater proportional change than the roads on the strategic

[8] Devore's 'Fourth-Spread' method involves calculating the 25th and 75th percentile of a data-set and uses the differences between these values to exclude data around the median. The equation used to remove outliers is:
Outlier < Median – K(Interquartile Range)
OR
Outlier > Median + K(Interquartile Range), where K has been adjusted to '3'.
No. of outliers removed: 1 for Bypass-Old Road, 3 for Bypass – Corridor.

network hence wider variation from the base flows with 78% outside of ±15% accuracy although the number of bypassed old roads with flows above and below forecast are similar.

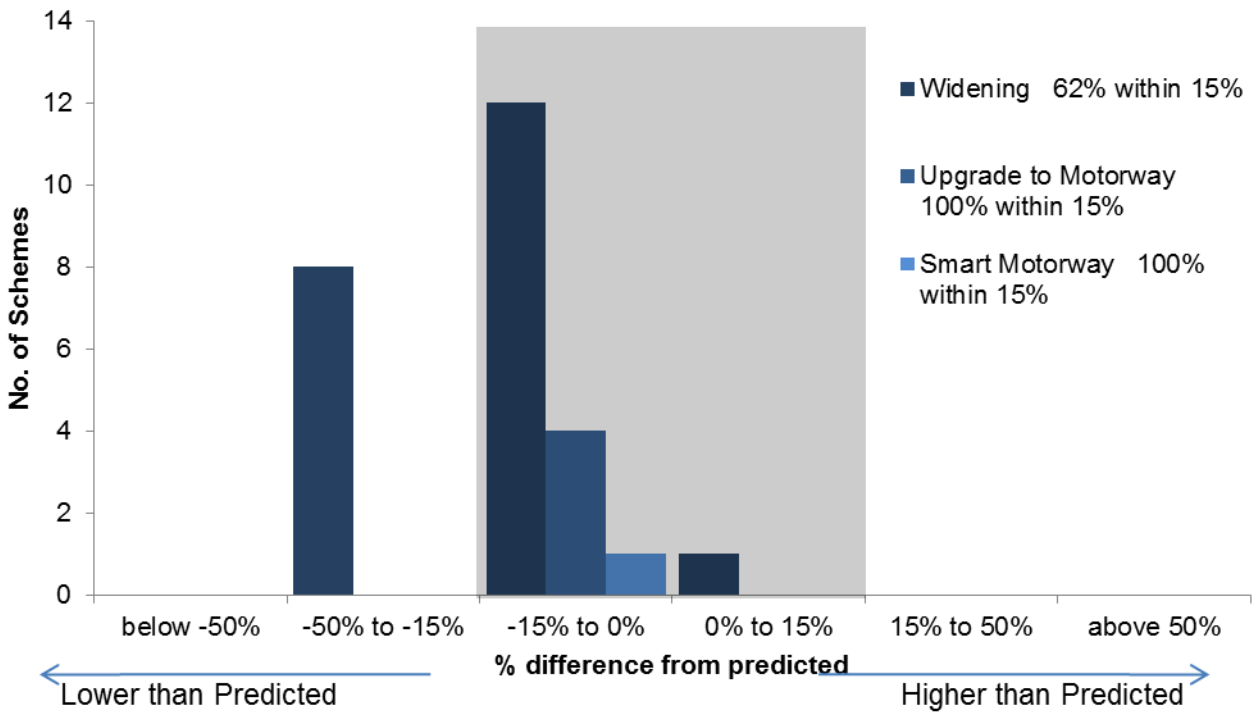
The even distribution of the frequency graphs for the corridor, old road and bypass demonstrates that the numbers of schemes with traffic flows either higher or lower than predicted, are approximately equal. There is, therefore, no identifiable trend in relation to the inaccurate modelling of reassignment between the old road and bypass (e.g. a trend towards predicting higher traffic flows on the bypass and lower traffic flows on the old road).

On average, observed corridor flows are 4% less than forecast, whilst the observed old road flows are 4% lower than forecast and observed bypass flows are 1% lower than forecast. It should be noted, however, that averaging the percentage differences for all schemes results in positive differences cancelling out negative differences and vice versa. As a result, these values should be treated with caution.

### 4.2.2 Widening and Upgrade to Motorway Schemes

Figure 4–5 shows the range of accuracy of traffic flow forecasts compared to observed traffic flows for widening and 'upgrade to motorway' schemes.

**Figure 4–5 Accuracy of Traffic Forecasts (Widening, Upgrade to Motorway and Smart Motorway schemes)**



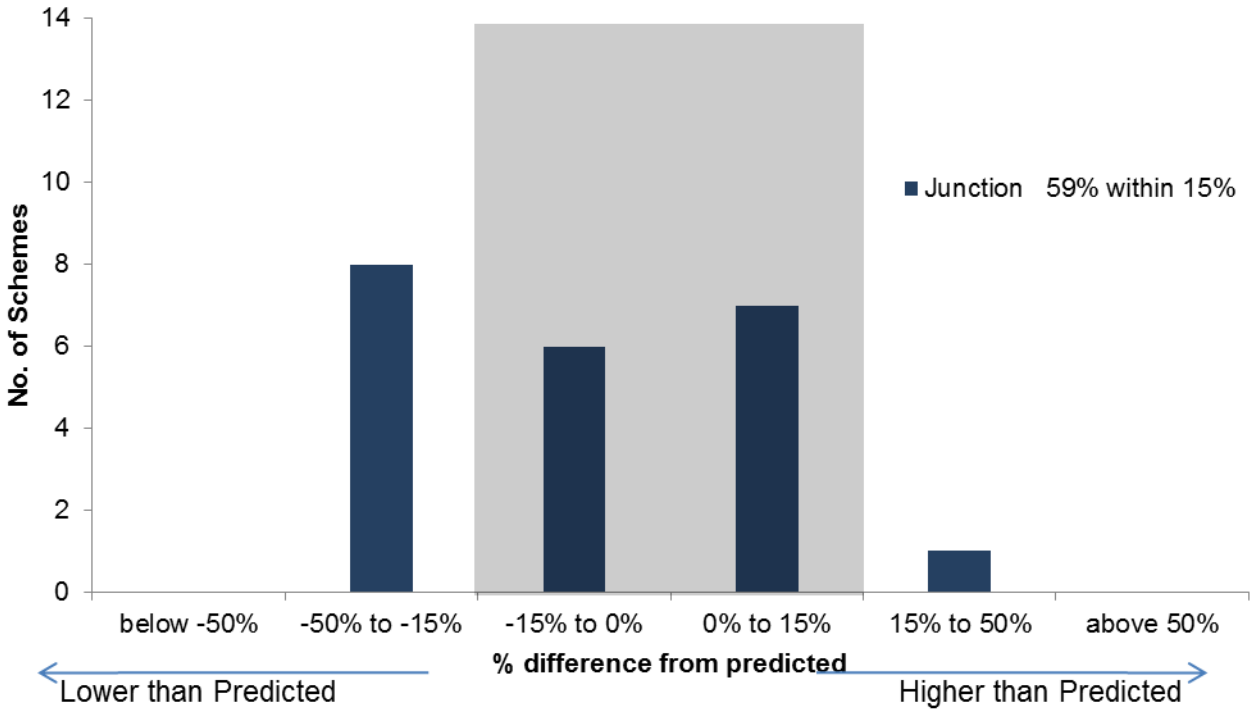

It can be observed from Figure 4–5 that there is a narrower range of frequencies for widening schemes than for the bypass scheme corridors, although only 62% of schemes have forecast traffic flows within ±15% of observed flows compared to 74% for bypass corridors. This is because the majority of widening schemes have observed traffic flows which are lower than predicted due to the overestimation of background growth. This affects widening schemes more than bypass schemes, as they generally have later opening years and have, therefore, been affected by the economic downturn in 2008.

The accuracy of upgrade to motorway schemes is high with forecast traffic flows for all four schemes within 15% of observed. However, it is noted that all of the schemes had lower observed traffic flows than forecast. It should be noted that the observed flows for the one Smart Motorway scheme are within 2% of observed which demonstrates a high level of forecasting accuracy, albeit for a small sample.

### 4.2.3 Junction Improvement Schemes

The varying degree of accuracy of the forecast traffic flows for junction improvement schemes is shown in the frequency graph of Figure 4–6.

**Figure 4–6 Accuracy of Forecasts (Junction Improvement schemes)**



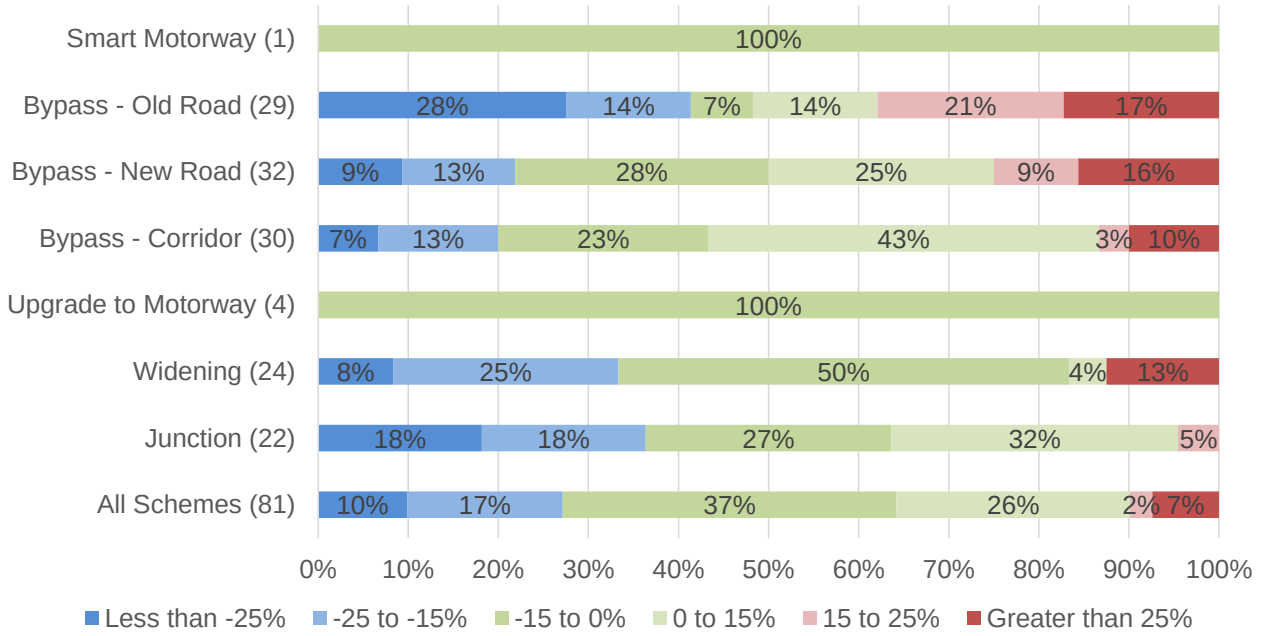

It can be observed from Figure 4–6 that although there is a similar level of accuracy for junction improvement schemes as for widening schemes, shown in Figure 4–5, there is a significant difference in the distribution of differences. Approximately 64% of junction schemes have observed traffic flows lower than forecast compared to 95% of widening schemes. Observed flows for junction schemes are on average 9% less than forecast whilst widening schemes are on average 13% lower. Junction improvement schemes, therefore, have a more even distribution of differences between observed and predicted traffic flows than widening schemes.

### 4.2.4 Scheme Type Comparison

A comparison of the accuracy ranges[9] for different scheme types is shown in Figure 4–7. It should be noted that the values given in this figure include all schemes where both observed and predicted traffic volumes were available for the Do-Something scenarios, including outliers.

[9] For example, -15 to -25% means the observed flow is 15 to 25% less than predicted

**Figure 4–7 Accuracy of Do-Something Traffic Forecasts**




The following can be observed from Figure 4–7 in relation to the general level of forecasting accuracy for different types of schemes:

- Other than the small number of upgrade to motorway schemes, bypass scheme corridors have the highest level of forecasting accuracy with 66% of schemes having observed traffic flows within 15% of predicted. However, the forecasting of traffic flows on the old and new roads, for these bypass schemes, are the least accurate with only 21% and 53%, respectively, within the threshold. This demonstrates that although the overall level of traffic flow in the corridor has been accurately modelled for a high proportion of these schemes, the reassignment of traffic between the old road and the new road has been less accurately modelled;
- Approximately 54% and 59% of widening and junction improvement schemes, respectively, have observed traffic flows within 15% of predicted, demonstrating that a large proportion of the forecast traffic flows are inaccurate;
- The majority of bypass schemes have higher observed traffic flows than predicted, whilst the other scheme types all have a larger proportion of schemes with observed flows which are lower than predicted. Some of this difference is due to the fact that many of the bypasses are among the older schemes in this study and therefore less affected by the economic downturn in 2008 and the change in traffic growth trend. Analysis of the change in accuracy over time is considered in more detail later in section 4.2.7 on page 40. It demonstrates, however, that inaccuracies in forecasting for bypass schemes are less related to lower than expected background traffic growth than the other scheme types; and
- The four 'upgrade to motorway' schemes and the Smart Motorway all have observed traffic flows within 15% of predicted, demonstrating a high level of accuracy for this scheme type, albeit for a small sample size.

Table 4–2 shows the proportion of schemes within a range of accuracy bands, for different scheme types.

**Table 4–2 Proportion of schemes within ranges of accuracy for observed flows compared to forecast**

| Accuracy Range (Observed compared to Forecast) | Proportion of Schemes | | | |
|---|---|---|---|---|
| | **Bypass – Corridor** | **Widening** | **Junction Improvement** | **Upgrade to Motorway** |
| Within 0% to +15% | 43% | 4% | 32% | 0% |
| Within -15% to 0% | 23% | 50% | 27% | 100% |
| **Total Within +/- 15%** | **67%** | **54%** | **59%** | **100%** |
| Within 0% to +25% | 47% | 4% | 36% | 0% |
| Within -25% to 0% | 37% | 75% | 45% | 100% |
| **Total Within +/- 25%** | **83%** | **79%** | **82%** | **100%** |
| Within 0% to +35% | 47% | 17% | 36% | 0% |
| Within -35% to 0% | 43% | 83% | 59% | 100% |
| **Total Within +/- 35%** | **90%** | **100%** | **95%** | **100%** |

It can be observed from Table 4–2 that over 79% of schemes for all scheme types have observed traffic flows within ±25% of forecast flows and over 90% of all schemes have observed flows within ±35% of forecast flows. This demonstrates that although a high proportion of schemes have observed flows which are not within ±15% of observed flows, the large majority of these are close to being within this range.

### 4.2.5 Do-Minimum Forecasting Accuracy

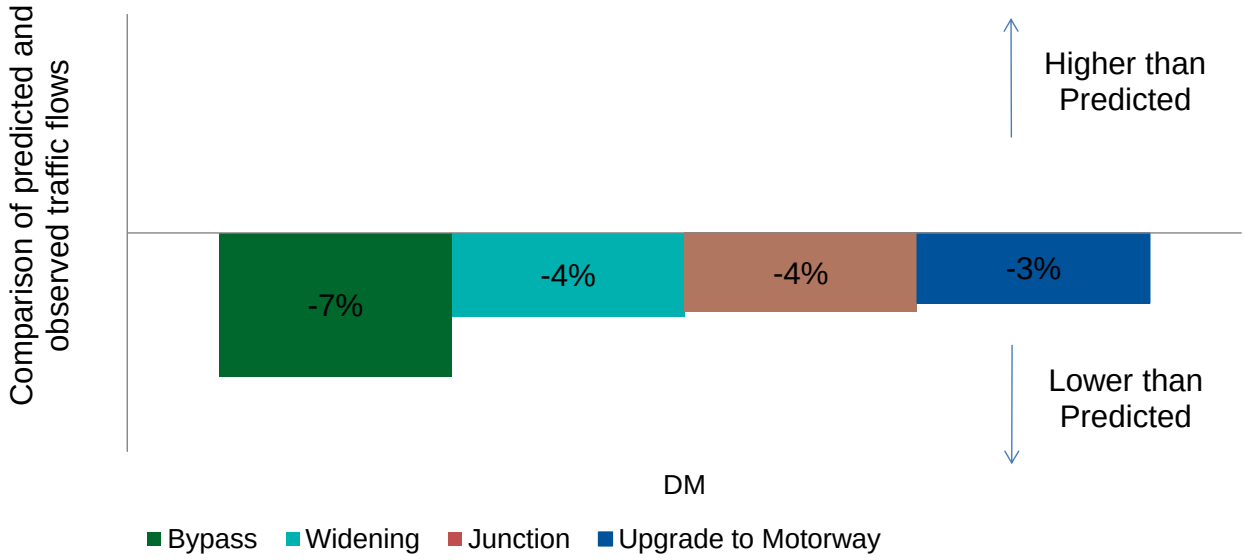
Traffic model forecasts include a prediction of traffic flows for two scenarios: Do-Minimum (without scheme) and Do-Something (with scheme). These are compared against each other to determine the impact of the scheme. The majority of causes of forecasting inaccuracy, discussed in more detail in the following section, will affect the accuracy of the Do-Minimum models and hence the Do-Something models. Traffic growth assumptions, land use assumptions, future highway schemes and modelling accuracy will all impact upon the Do-Minimum forecast accuracy. This section considers the accuracy of the Do-Minimum forecast traffic flows and the relationship between the Do-Minimum and Do-Something accuracies,

It has been possible to collate Do-Minimum data for 67 schemes (27 bypasses, 17 widening schemes, 19 junction improvement schemes and 4 motorway upgrade schemes). It is possible to determine the accuracy of the Do-Minimum traffic forecasts by comparing these to observed traffic flows before the scheme opened (or construction began). [10]

Figure 4–8 shows the average percentage variation between observed ‘before’ traffic flows and the forecast Do-Minimum traffic flows.

[10] It should be noted that although Do-Minimum forecasts are generally for the opening year, it is not normally possible to obtain observed data for the same year, as construction would have occurred for some time, usually 1-2 years, prior to scheme opening. The background change in traffic over the construction period is considered on a scheme by scheme basis to determine whether or not there is a noticeable impact. In the majority of instances, the rate of traffic growth is sufficiently low so that the time lag does not cause consistency issues.

**Figure 4–8 Accuracy of Do-Minimum Traffic Flow Forecasts**




It can be seen from Figure 4–8 that:

- On average, schemes have observed traffic flows before construction started that are below the Do-Minimum predictions;
- This indicates that Major Scheme appraisals have generally assumed traffic flows without the scheme to be higher than have actually occurred; and
- This is particularly the case for Bypass schemes which on average have observed 'before' traffic flows 7% lower than those predicted.

The reason that Bypass schemes could have shown the largest difference, is that the greater proportion of these schemes were appraised earlier in the years covered in this meta-analysis when NRTF '89 would have been used to estimate traffic growth. As will be discussed in greater detail in the following section, NRTF '89 is now considered to have overestimated traffic growth. The change in accuracy of model forecasts over time is considered in more detail in Section 4.2.7.

It should be noted that as the average of all schemes has been used in the analysis above, schemes with higher observed than predicted traffic flows will 'cancel out' schemes with lower observed than predicted traffic flows and vice versa. The resultant values, however, are an indication of the overall differences between predicted and observed. Further analysis has been undertaken of the schemes where Do-Minimum forecasts have been collated to determine the proportion of schemes which have observed 'before' traffic flows within ±15% of predicted, as shown in Figure 4–9.

**Figure 4–9 Accuracy of Do- Minimum Traffic Forecasts**

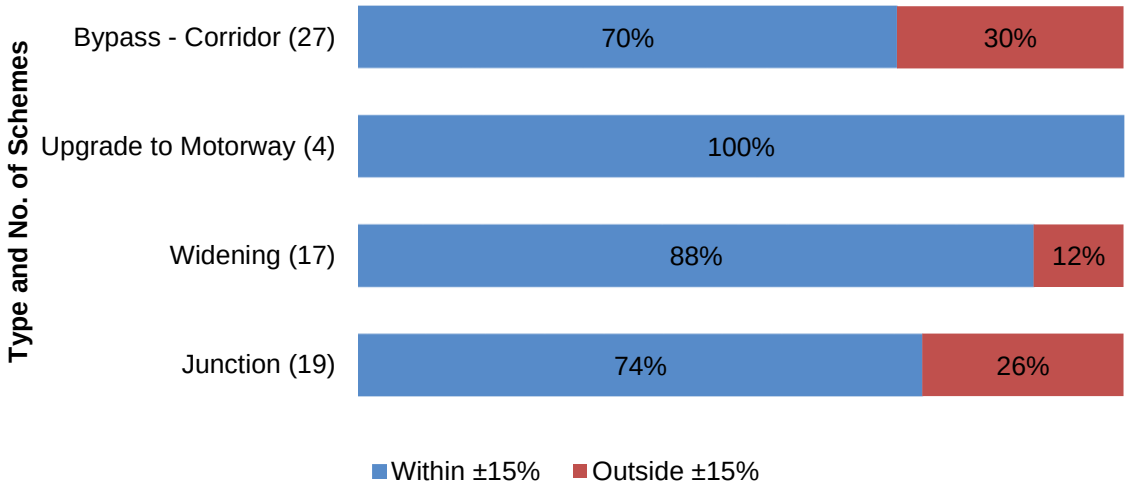



Figure 4–9 shows that:

- Junction and bypass schemes have the lowest proportion with traffic flows within ±15% accuracy. However, many of these schemes (particularly the bypasses) were appraised early on in the timeframe covered by this meta-analysis, when traffic growth forecasts were derived from NRTF '89; and
- Upgrade to motorway and widening improvement schemes have the highest proportion of traffic flows within ±15% of forecast. Conversely to the previous point, most of these schemes were appraised later in the timeframe covered by this meta-analysis when National Road Traffic Forecasts had been updated from NRTF '89 to NRTF '97. Therefore, this could have led to greater levels of accuracy for these scheme types.

Following on from this point, it is necessary to determine the importance of the Do-Minimum forecast accuracy in relation to the Do-Something (with scheme) predictions and to establish if the same proportion of error occurs in both. Figure 4–10 plots the percentage difference between predicted and observed traffic volumes for each scheme, for the Do-Minimum and Do-Something scenarios[11]. The error bars show the difference between the Do-Minimum and Do-Something percentages. Dotted lines mark the range where Do-Something and Do-Minimum forecast accuracies are within 10% of each other. If both the Do-Minimum and Do-Something flows are different to the observed flows by a similar margin, it is likely that it is a problem in forecasting background traffic which has led to the inaccuracy.

Schemes with a similar percentage difference for both the Do-Minimum and Do-Something scenarios will have had the expected impact (or net change effect on traffic). Therefore, regardless of whether the outturn traffic flows were different to forecasts in absolute terms, it can be seen whether the 'change' was predicted accurately.

[11] The Do-Minimum percentages have been plotted along the x=y slope. Note that a value of -40% means that the observed flows are 40% less than predicted.

**Figure 4–10 Relationship between Do-Minimum and Do-Something Traffic Forecast accuracy**

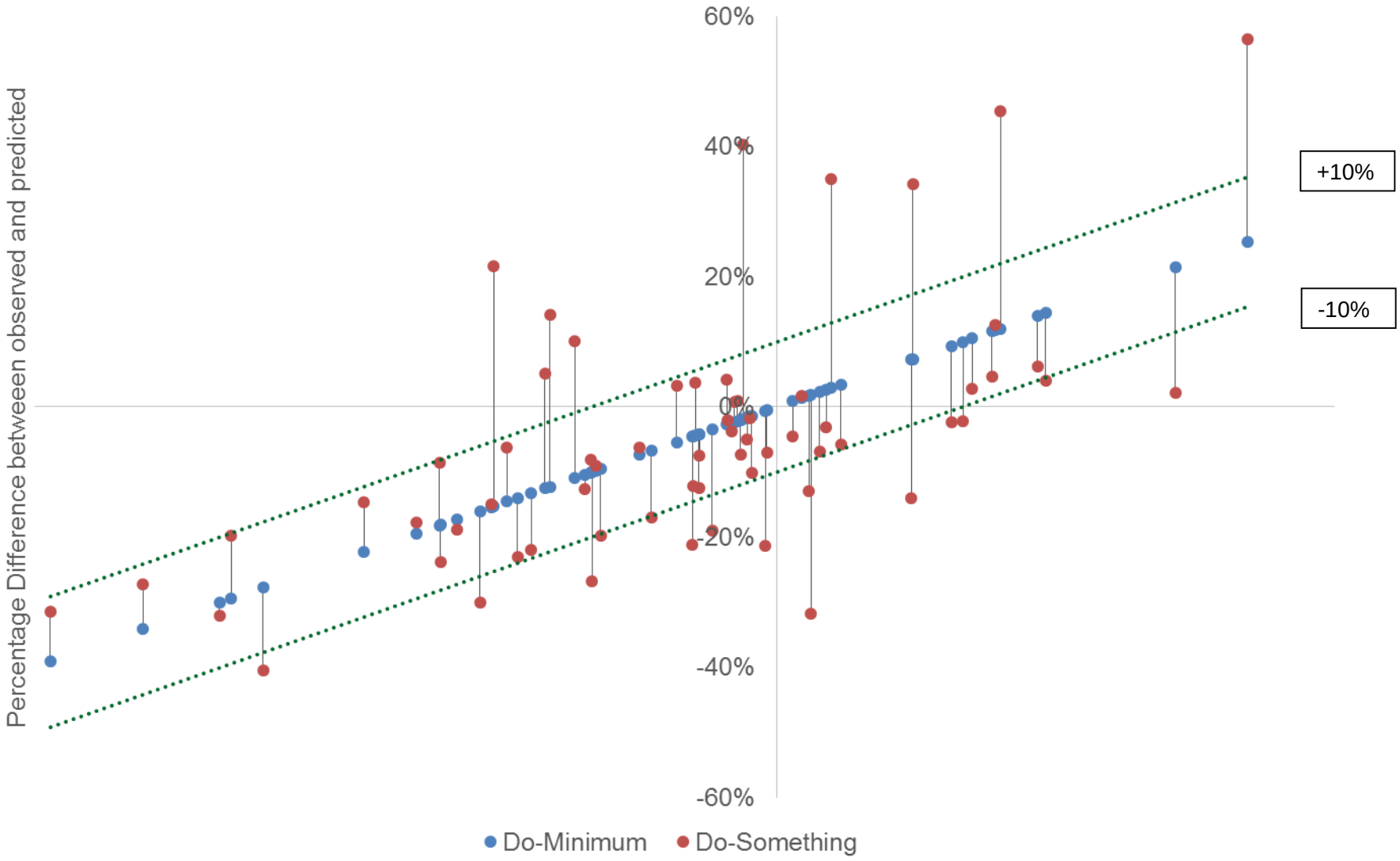


Figure 4–10 shows that:

- Of the sample of schemes where both Do-Minimum and Do-Something forecasts have been included, the vast majority have Do-Something accuracies that lie within 10% of the Do-Minimum level of accuracy. This is indicated by the majority of schemes falling within the dotted lines. This means that these schemes are generally having the expected or near to expected impact on traffic flows proportionally, although not in absolute terms;
- From this it can be inferred that there is a very strong link between Do-Minimum accuracy and Do-Something accuracy.

To conclude, the findings on Do-Minimum forecast accuracy, Figure 4–11 shows for those schemes where the Do-Minimum forecast was outside of the +/-15% threshold, the proportion which achieves Do-Something predictions within +/-15%.

**Figure 4–11 Accuracy of Do-Something prediction where Do-Minimum was outside of +/-15%**

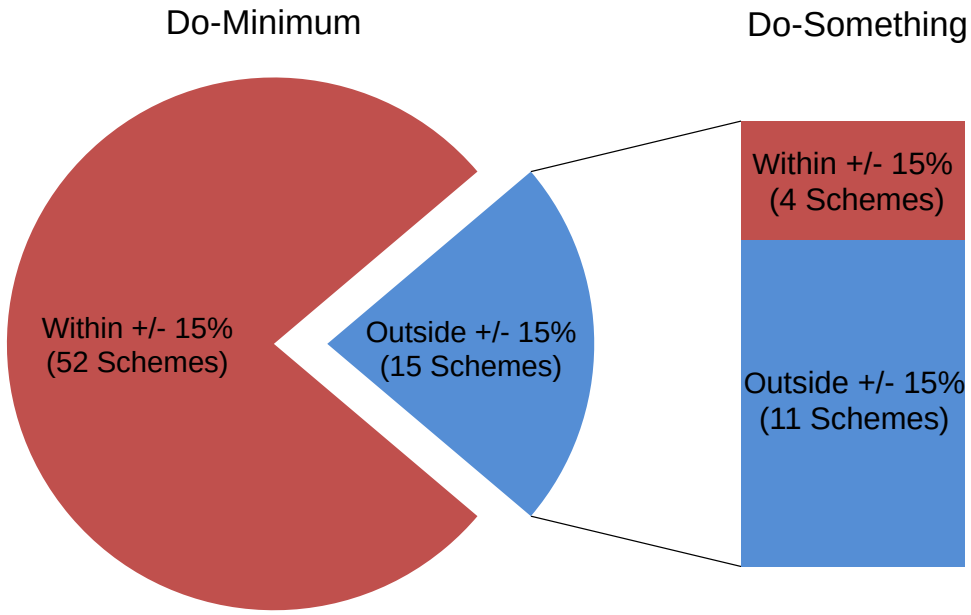



Figure 4–11 demonstrates the importance of the accuracy of the Do-Minimum forecasts, as only 27% of schemes (4 out of 15 schemes) where Do-Minimum forecasts were outside the +/-15% threshold achieved Do-Something accuracy within +/-15%.

It is clear that the accuracy of the Do-Minimum forecasts has an important link with the Do-Something forecast accuracy. The key reasons for this inaccuracy is discussed in the following section.

### 4.2.6 Key reasons for forecasting inaccuracy

Based on analysis of the traffic forecasting methodologies and forecasts for all of the schemes, the following are considered to have played an integral role where accurate traffic flow predictions have been made:

- Proposed major land use changes in the area of the scheme have been taken into account and realised;
- Model scale and complexity is appropriate and sufficient to capture all possible strategic and local reassignment;
- Do-Minimum traffic forecasts have generally been broadly in line with observed ‘before scheme’ traffic flows; and
- The growth forecast assumptions used have been broadly in line with observed growth, and local growth estimates have been used where appropriate.

A total of 30 schemes (out of 81[12] schemes i.e. 37%) have been identified as having observed traffic flows which differ from predicted flows by more than 15%. An analysis of the causes of these differences has been undertaken for each scheme and the following key factors have been identified:

- Local and strategic routing assumptions;
- Background growth assumptions;
- Land use issues;
- Other highway schemes; and
- Modelling accuracy issues which may stem from the following;
    - base year errors; or
    - network coding errors.

Each of these key factors are addressed in more detail on page The reasons for differences between observed and predicted traffic flows are now discussed in more detail under the following headings. The reasons for differences between observed and predicted traffic flows are now discussed in more detail under the following headings37 onwards, but Table 4–3 summarises the number of schemes where accuracy of traffic forecasts is considered to have been influenced by each factor, and whether traffic flows were under or overestimated. For bypass schemes, the summary relates to the combined corridor flow. It should be noted that the number of reasons does not equate to the number of schemes, as for some schemes, more than one reason was identified.

**Table 4–3 No. of schemes and reasons for predicted traffic flows higher or lower than predicted by more than ±15% (including outliers)**

| Reasons/ outturn flows being > +/-15% higher or lower than forecast | All Scheme types* | | Bypass-Corridor | | Online Widening | | Junction | |
|---|---|---|---|---|---|---|---|---|
| | Higher | Lower | Higher | Lower | Higher | Lower | Higher | Lower |
| Routing assumptions | 7 | 2 | 3 | 1 | 3 | 1 | 1 | 0 |
| Background growth assumptions | 2 | 17 | 1 | 5 | 1 | 7 | 0 | 5 |
| Land use issues | 2 | 6 | 2 | 1 | 0 | 2 | 0 | 3 |
| Other highway schemes | 1 | 6 | 1 | 3 | 0 | 1 | 0 | 2 |
| Modelling accuracy | 0 | 3 | 0 | 2 | 0 | 0 | 0 | 1 |
| **No. schemes outside +/-15%** | **8** | **22** | **4** | **6** | **3** | **8** | **1** | **8** |
| **Proportion of all schemes outside +/-15%** | 10% | 26% | 13% | 19% | 12% | 32% | 5% | 36% |

*including upgrade to motorway and smart motorway.

Table 4–3 shows the number of schemes influenced by each factor, identified as percentages of the total[13]. This demonstrates the level of importance of each factor for higher or lower forecast flows for each scheme type.

**Table 4–4 Reasons for predicted traffic flows higher or lower than predicted by 15% (including outliers), shown as percentages**

| Reasons/ outturn flows being > +/-15% higher or lower than forecast | All Scheme types* | | Bypass-Corridor | | Widening | | Junction | |
|---|---|---|---|---|---|---|---|---|
| | Higher | Lower | Higher | Lower | Higher | Lower | Higher | Lower |
| Routing assumptions | 58% | 6% | 43% | 8% | 75% | 9% | 100% | 0% |
| Background growth assumptions | 17% | 50% | 14% | 42% | 25% | 64% | 0% | 45% |
| Land use issues | 17% | 18% | 29% | 8% | 0% | 18% | 0% | 27% |
| Other highway schemes | 8% | 18% | 14% | 25% | 0% | 9% | 0% | 18% |
| Modelling accuracy | 0% | 9% | 0% | 17% | 0% | 0% | 0% | 9% |
| Total | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

[12] There are 84 schemes in total. However, two bypass schemes do not have comparable flows between observed and predicted for the corridor and one widening scheme does not have comparable flow.
[13] This is the total of schemes influenced by each factor which is greater than the number of schemes as for some schemes more than one reason was identified for the traffic flows being higher or lower than predicted by more than 15%.

*including upgrade to motorway and smart motorway.

The following can be observed from Table 4–3 and Table 4–4:

- The majority of schemes with observed flows outside the ±15% range have observed flows which are lower than forecast. This is predominantly due to background growth being lower than predicted; and
- For those schemes with observed flows over 15% higher than predicted, the primary reason is routing assumptions. This issue mainly impacts upon bypass schemes, where traffic can route via the new or old route, and widening schemes where the attractiveness of the scheme may be underestimated.

The economic downturn in 2008 has been a key factor in observed traffic flows being lower than forecast, in particular for widening and junction improvement schemes, as they are generally more recent. Assumptions in relation to specific developments have been overestimated with less coming to fruition than expected.

The reasons for differences between observed and predicted traffic flows are now discussed in more detail under the following headings:

- Local and strategic routing assumptions;
- Background traffic growth assumptions;
- Land use issues;
- Other highway schemes; and
- Modelling accuracy.

### *Local and Strategic Routing Assumptions*

A key factor in accurately forecasting traffic flows utilising a scheme is the modelling of reassignment of traffic from other routes. This can be 'strategic' rerouting from other major corridors (e.g. motorways and A-roads) or 'local' rerouting from, for example, a town centre route onto a bypass. The accurate reassignment of traffic is dependent on a number of factors including modelled journey times and generalised costs (values of time and distance for different journey purposes). There could also be other influences, for example, speed limits, traffic-calming measures, road signage which would influence drivers' route choices.

Analysis of causes of errors in forecast flows has demonstrated that the inaccurate modelling of rerouting has been a key factors in differences between observed and modelled flows for both bypass and widening schemes. For bypass schemes, the rerouting of traffic from the old road onto the bypass is key for a number of schemes, as demonstrated by the greater accuracy of modelled flows for the overall corridor.

Overall, the accuracy of 9 schemes have been impacted by inaccurate modelling of strategic routing and 6 schemes by local routing issues. These included bypasses, widenings and one junction scheme. All of the schemes impacted by local routing were also affected by strategic routing issues. Approximately 20% of schemes affected by strategic and/or local routing issues had lower observed than predicted flows and 80% had higher. Of the 9 schemes with routing issues, 7 of these were appraised in 2000 or earlier and 6 of the schemes opened in 2002 and 2003. This seems to be an issue, therefore, which affects older schemes.

Model size is an important factor in enabling strategic reassignment to be represented. For a number of schemes assessed, the modelled area was insufficient to enable wider reassignment of traffic to be modelled resulting in inaccurate forecast traffic flows. The model detail is also important as the exclusion of minor roads within a model can result in local reassignment being under-represented.

### *Background Traffic Growth Assumptions*

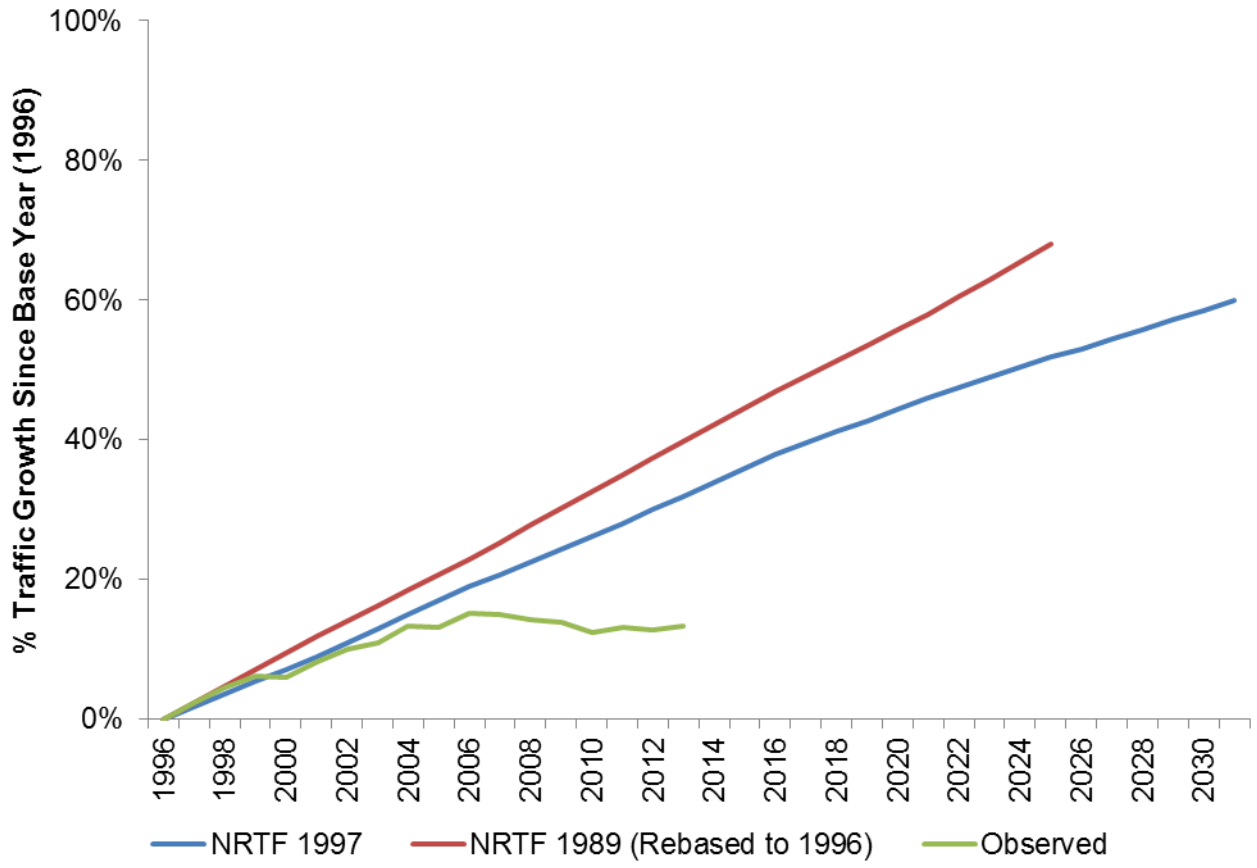
Background traffic growth is the natural growth in traffic flow over time, which would occur with or without a scheme, due to factors such as changes in income and levels of car ownership. Historically, traffic growth has been derived using National Road Traffic Forecasts, with NRTF'89 and NRTF'97 used for a significant number of schemes included in this meta-analysis. More recently, growth forecasts from the National Trip End Model (NTEM) are utilised using TEMPRO which provide more up-to-date forecasts. It

is noted that NTEM/TEMPRO produces trip end forecasts and NRTF produces vehicle kilometre forecasts.

It has been noted that a number of schemes in this meta-analysis have observed flows lower than predicted due to background growth forecasts. This is primarily due to the effect of economic downturns in the early 1990s and in 2008 which were not foreseen in the NRTF and NTEM traffic forecasts. It is noted that the impact of these downturns have been taken into account in the latest NRTF and NTEM forecasts.

Figure 4–12 shows the traffic growth profile taken from NRTF '89 and NRTF '97 between 1996 and 2030. For information, it also shows the observed national growth in traffic between 1996 and 2013. These values are based on growth in traffic Billion Vehicle Kilometres (bvkm).

**Figure 4–12 NRTF '89 and NRTF '97 Traffic growth trends**



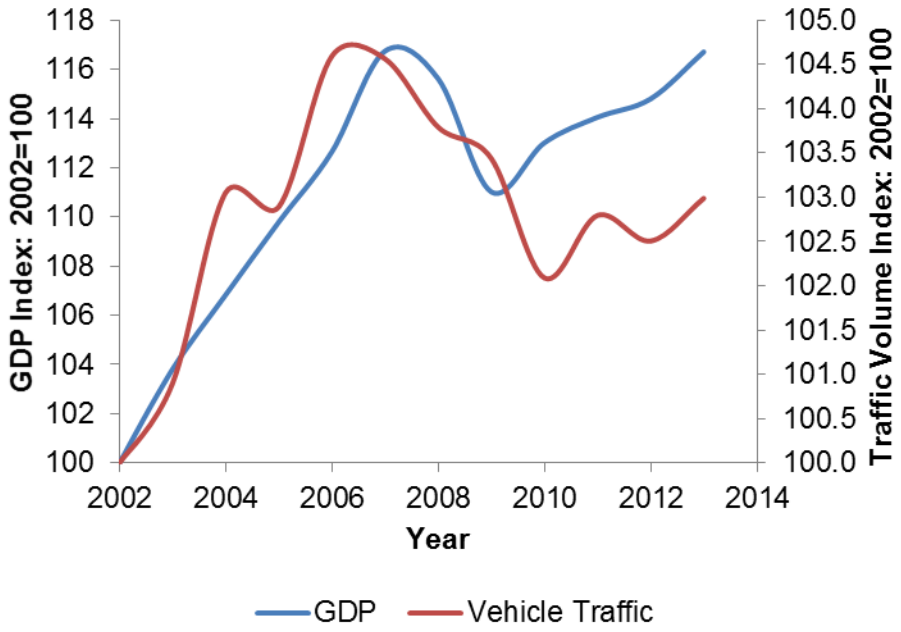

It can be observed from Figure 4–12 that NRTF 1997 has lower predicted growth than NRTF 1989 and that both have significantly higher growth predicted than observed, in particular after 2004. The predicted growth between 1996 and 2013 was predicted to be 40% and 32% for NRTF 1989 and 1997 respectively, whilst observed growth was only 13%.

Traffic growth forecasting has increased in complexity over time, with detailed planning data utilised in the NTEM, and this meta-analysis indicates that it is a critical factor in producing accurate model forecasts.

The observed traffic growth on major roads since 2002 and its correlation with the growth in Gross Domestic Product (GDP) are shown in Figure 4–13[14]. The GDP and traffic levels are indexed relative to the values in 2002.

[14] GDP Data from HM Treasury: The Pocket Databank Table 3 dated 18/3/13. Traffic Growth based on motor Vehicle Traffic (vehicle kilometres) for All Major Roads (Table TRA0202) from Department for Transport Statistics.

**Figure 4–13 Relationship between traffic growth and UK GDP**




The following can be observed from Figure 4–13:

- GDP grew consistently between 2002 and 2007 before dipping in 2009 during the economic downturn. Since 2009, GDP has continued to grow albeit at a slower rate than before the downturn;
- Traffic volumes on major roads have generally grown between 2002 and 2006, with a slight fall in volume between 2004 and 2005. Between 2007 and 2010, traffic volumes reduced down to 2003-2004 levels. Since 2010, however, traffic volumes have started to increase again; and
- There is a clear correlation between the fall in traffic between 2008 and 2009 and the economic downturn at this time, as well as a growth in traffic following a rise in GDP after 2010.

The difference between the forecast and actual opening year has implications for the comparison of forecast and observed traffic flows for the following reasons:

- Additional background traffic could have accrued between the forecast and actual opening year; and
- Highway schemes and land-use changes could have been implemented which were not included in the appraisal.

For schemes with a different actual opening year to that forecast, POPE evaluations derive a proxy forecast for the actual opening year using interpolation, assuming the same traffic growth assumptions as in the original appraisal. However, this cannot take account of highway schemes and land-use changes that may have occurred.

### *Land Use Issues*

The modelling of major developments is a key factor in the accurate distribution of traffic growth within a modelled area. There are schemes where major developments were not modelled, thus under-predicting the level of traffic flow. There are also schemes where developments have been modelled which have not occurred or have been reduced in size, due to the economic downturn for example.

It is important, therefore, that the modelling of developments is accurately detailed in forecasting reports (which they generally are) so that POPE can assess the extent of the development that has actually occurred and how this has impacted upon the scheme. The provision of uncertainty tests, in line with the latest WebTAG guidance, which consider alternative development scenarios will also be particularly useful for the current economic climate, as development and regeneration may not occur at the pace and proportions initially planned.

*Other Highway Schemes*

Forecast models include a number of proposed highway schemes in the Do-Minimum scenario. The inclusion or exclusion of highway schemes can have a significant influence on forecast traffic flows due to their influence on capacity and route choice. It is noted that current guidance is to undertake uncertainty testing with sensitivity tests which may include additional highway schemes. These tests should provide additional confidence over the reliability of predicted traffic flows.

*Modelling Accuracy*

Traffic models are calibrated and validated to a base year, with key indicators of the level of validation being comparisons between modelled and observed traffic flows and journey times. The model development and validation process is detailed in the Local Model Validation Report (LMVR) which provides a valuable source for identifying potential sources of inaccuracies in model forecasting. For example, if modelled journey times are longer in the base year than observed, this could result in overestimated journey times in forecast years and subsequent issues with rerouting resulting in inaccurate traffic forecasts.

It should be noted that LMVRs have only been obtained for a minority of the schemes assessed by POPE to date, although it is expected that the improved availability of these reports for more recent schemes will enable POPE to undertake a more thorough analysis of causes of forecasting inaccuracies. The use of manual counts as a basis for base year traffic volumes could be a factor in forecast flow errors, as these have a lower level of accuracy than long-term counts due to daily variability. This highlights the importance of using permanent count sites where possible, so that the accuracy of the traffic forecasts are not compromised by the use of manual surveys and the methodology used to handle the seasonal characteristics of the roads in question. POPE however uses ATC data, which provides 24 hour traffic flows.

Finally, model coding errors could have been made which influenced the accuracy of both the Do-Minimum and Do-Something forecasts. However, detailed analysis of the individual scheme models which are often no longer available, would be required in order to identify such cases. Whilst this approach was undertaken in the previous version of post opening scheme evaluation (PIES), which evaluated annually 1-2 schemes in great detail, this level of analysis is no longer applied.

### 4.2.7 Change in traffic flow forecasting accuracy over time

The percentage difference between observed and forecast traffic flows by scheme type and appraisal year is shown in Table 4–5 and Figure 4–14 shows the change in individual and average scheme forecasting accuracy by appraisal year. It should be noted that each bar in Figure 4–14 represents an individual scheme.

It can be observed from Figure 4–14 that schemes appraised between 2001 and 2006 are more accurate than those appraised between 1990 and 2000. However, schemes appraised after 2006 reduce in forecasting accuracy. This is likely to be due to the change in traffic growth resulting from the economic recession in 2008 which had an impact on traffic flows for a number of years as already discussed.

Although it can be observed that the average difference between observed and predicted traffic flows is within 15% for the majority of years, it should be noted that in 1996 and 1997, there are significant over and under-predictions in traffic flows which are averaged out. Table 4–5 shows a clear reduction in the range of scheme accuracies and the standard deviation of differences. This suggests that consistency of modelling forecasts has improved. It is noted that in later years, 2007 onwards, the observed flows are lower than predicted due to lower than expected traffic growth rather than modelling deficiencies.

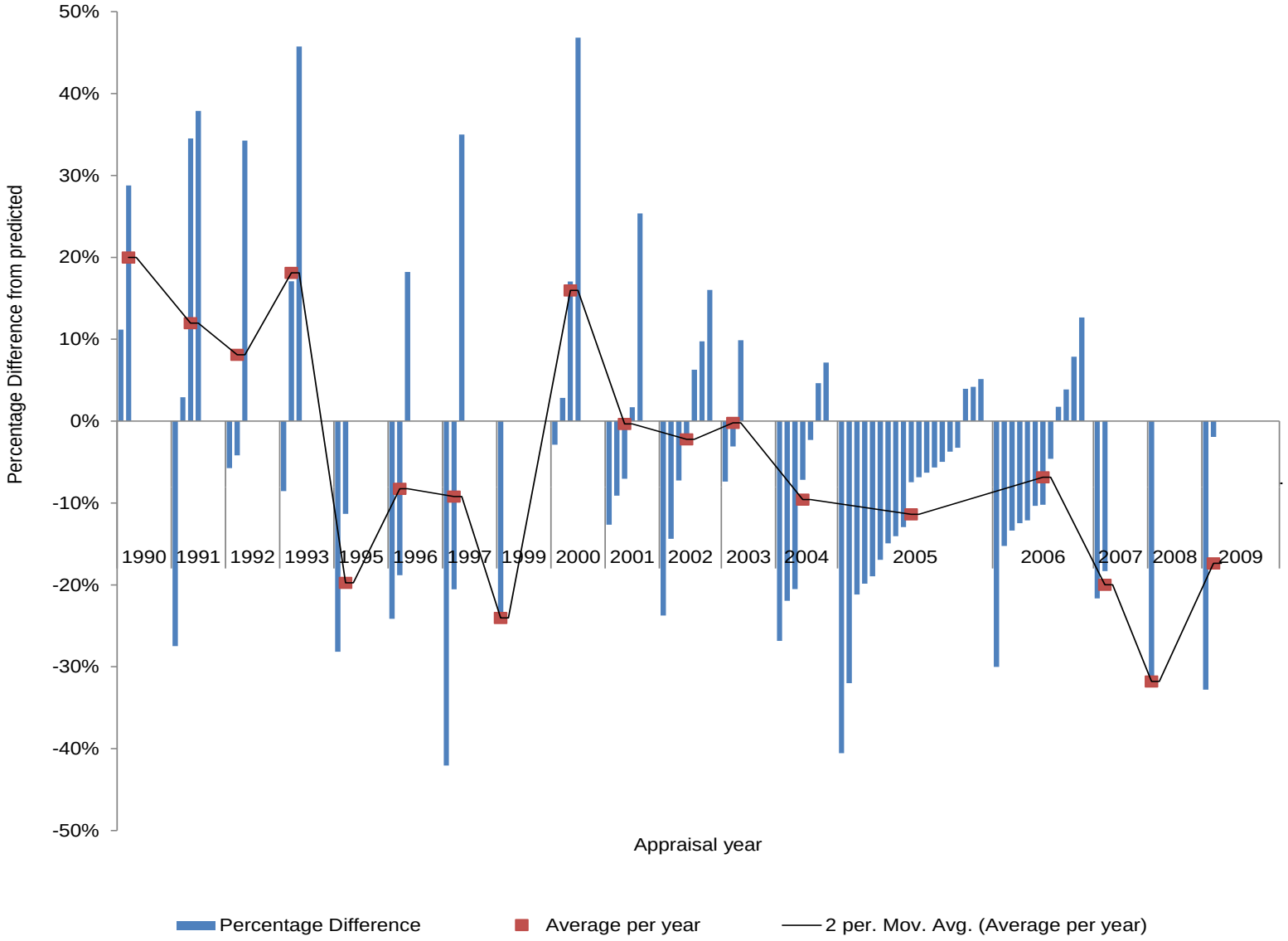
**Table 4–5 Standard deviation of observed traffic flows compared to forecast traffic flows**

| Appraisal Year | Number of Schemes | Lower Bound Percentage Difference | Average Percentage Difference | Upper Bound Percentage Difference | Range | Standard Deviation of Differences |
|---|---|---|---|---|---|---|
| 1990 to 1994 | 12 | -27% | 14% | 46% | 73% | 23% |
| 1995 to 1999 | 9 | -42% | -13% | 35% | 77% | 24% |
| 2000 to 2004 | 26 | -27% | -1% | 47% | 74% | 16% |
| 2005 to 2009 | 36 | -41% | -11% | 13% | 53% | 12% |

There are a number of reasons why the accuracy of forecasts has improved over time:

- Background traffic forecasts have improved with more frequent updates to take account of changes in trends. The introduction of TEMPRO (Trip End Model Presentation Program) in the mid 1990s and its wider use by the late 1990s has enabled planners to access and make better use of the NTEM data, improving forecasting accuracy. Although forecast traffic flows derived shortly before periods of economic downturn are always likely to overestimate traffic flows, uncertainty testing with low growth scenarios should resolve this issue for schemes modelled in line with the latest WebTAG guidance;
- The development of improved guidance, distributed in WebTAG, may have contributed to the improved accuracy of forecasting through the wider use of best practice; and
- The more detailed modelling of scheme impacts may have enabled improved accuracy of forecasts. Fixed demand matrix assessments, which only modelled rerouting, have been replaced by elastic assignments, which also model changes in demand, and more recently by variable demand modelling which model a range of demand responses explicitly (trip frequency, mode choice, distribution and time period choice). These improvements have been made possible through developments in computing software and hardware.

**Figure 4–14 Accuracy of Traffic Forecasts by Appraisal Year**



### Heavy Goods Vehicles Forecasting Accuracy

A total of 23 POPE scheme evaluations have included analysis of HGV impacts (12 bypass schemes, 8 widening schemes, 2 junction improvement schemes and 1 'upgrade to motorway' scheme). For many schemes there has not been classified traffic flow data before scheme construction in order to allow a meaningful comparison with data collected after opening. Changes in the classification of HGVs within Highways England's TRADs system from 5.2m length to 6.6m has also made it more difficult to evaluate HGV impacts on a like-for-like basis.

POPE has also found that there is often a lack of information in the scheme Traffic Forecasting Reports about the predicted changes in HGV volumes.

A comparison between observed and forecast HGV traffic flows has only been undertaken for four schemes which is an insufficient sample from which to draw any clear conclusions. This analysis, however, demonstrates that, for three of the schemes, observed HGV levels were approximately in line with predictions, whereas they were considerably different for one scheme.

## 4.3 Are Highways England's traffic models accurately predicting journey times?

**The limited forecast data available indicates that recorded peak hour journey time savings are lower than forecast. Journey time forecasts are more accurate for less congested periods, such as inter-peak and off peak, when compared to busy peak periods.**

This section examines the accuracy of forecast journey times and savings. It should be noted that there is limited data available for this analysis as the majority of schemes only provide Design Year journey time savings in their appraisal. When an opening year journey time saving is provided in the AST, it is often unclear which peak period (AM or PM) and in which direction the estimates are for, what hours represent the inter-peak, and what the start and finish points are for the journey measured.

Although WebTAG guidance[15] formerly suggested that the AST could include "the total vehicle hours saved, and the opening year peak and inter-peak journey time changes in minutes" to demonstrate the magnitude and source of benefits, a number of schemes included in the meta-analysis predate this guidance and others do not adhere to it.

Due to these limitations, it has only been possible to make comparisons between forecast and observed journey times for 43 schemes. It should be noted that some schemes only have journey time savings data, rather than Do-Minimum and Do-Something journey times. As with the traffic flow forecasting accuracy analysis, outliers have been excluded from the journey time analysis to avoid the results being skewed by a small number of exceptional examples.

In order to determine if there have been any trends in relation to journey time forecasting accuracy, the following have been considered:

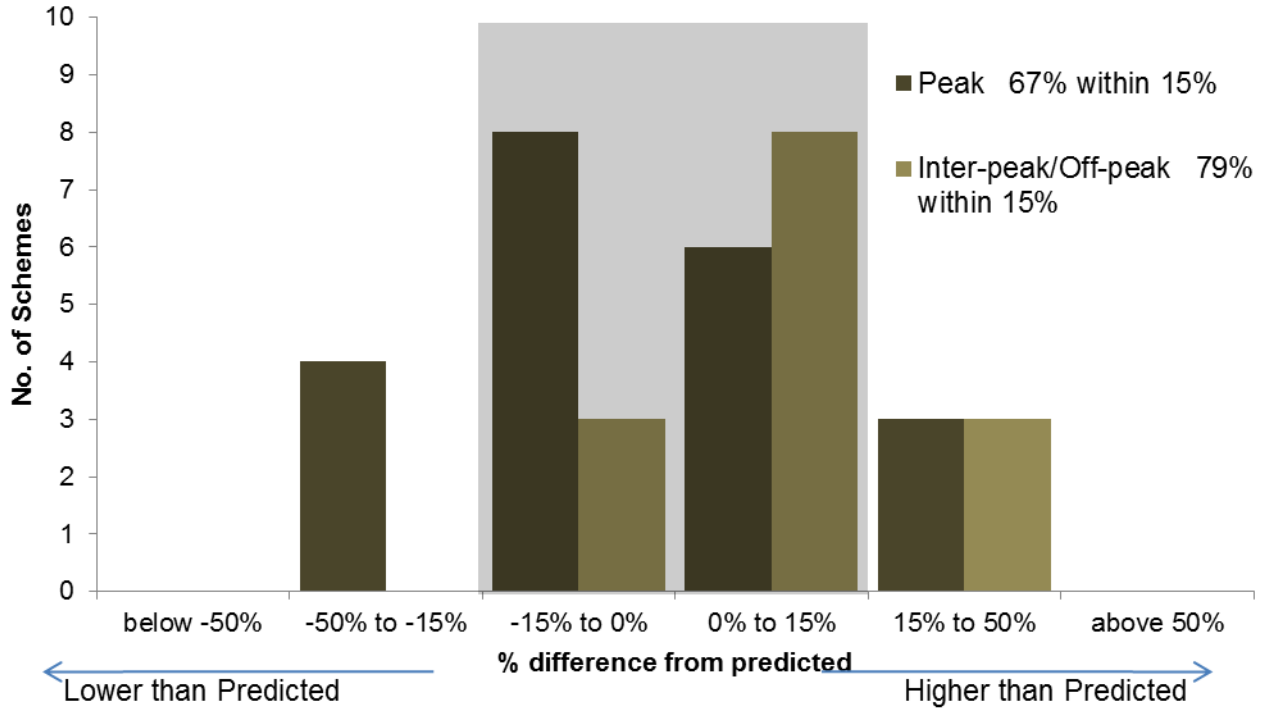
- Accuracy of forecasting for AM and PM peaks compared to Inter-peak and Off-Peaks;
- Accuracy by scheme type; and
- Changes in forecasting accuracy over time.

### Journey Time accuracy by time period

The varying degree of accuracy of the forecast journey times for the peaks (AM and PM) and the Inter-Peak/Off-Peaks for the Do-Minimum scenario is shown in the frequency graph of Figure 4–15. This figure is based on data from 11 bypass schemes, 7 widening schemes and 3 junction improvement schemes for the peak periods. For the Inter-peak/Off-Peak periods, the data is based on 9 bypass schemes, 4 widening schemes and 2 junction schemes (one of which is an outlier).

[15] WebTAGUnit 3.5.2 has now been superseded by Unit A1.1 which only states that "total vehicle hours saved" should be included.

**Figure 4–15 Accuracy of Journey Time Forecasts for Do-Minimum Scenario by Time Period**

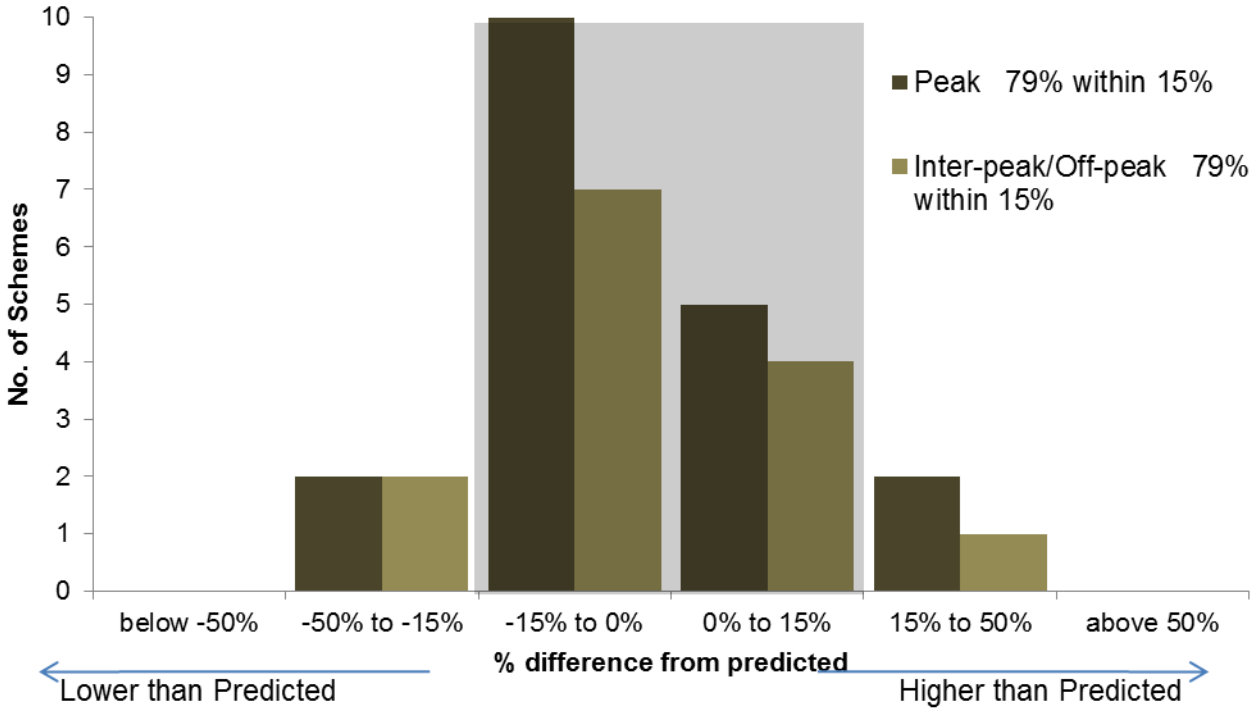



It can be observed from Figure 4–15 that the forecast journey times for the Do-Minimum scenario are more accurate for the Inter-Peak/Off-Peak than for the peak periods. The journey times for the Inter-peak/off-peak are more predictable than the peak periods as traffic conditions are less congested and more free-flowing. Delays increase significantly when traffic flows are close to the road or junction's capacity so small changes in traffic flow can have a significant impact on journey times.

It is noted that the majority of observed journey times for the peak hours are shorter than predicted. This is in line with the observed traffic flows being lower than predicted, thus reducing the level of delay.

Figure 4–16 shows the varying degree of accuracy of the forecast journey times for the peaks (AM and PM) and the Inter-Peak/Off-Peaks for the Do-Something scenario. This figure is based on data from 10 bypass schemes, 7 widening schemes and 3 junction improvement schemes (one of which in an outlier) for the peak periods. For the Inter-Peak/Off-Peak periods, the data is from 9 bypass schemes, 4 widening schemes and 2 junction improvement schemes (one of which is an outlier).

**Figure 4–16 Accuracy of Journey Time Forecasts for Do-Something Scenario by Time Period**




A high level of accuracy is achieved for the forecasting of journey times for the Inter-Peak and Off-peak time periods for the Do-Something scenario, as in the Do-Minimum.

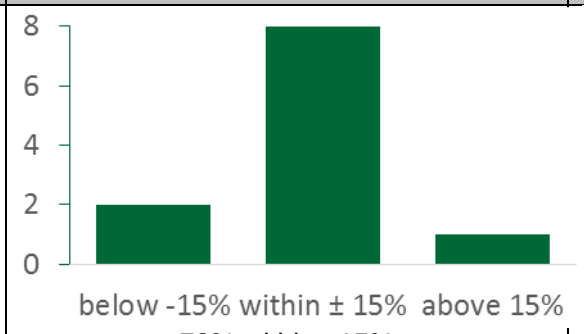
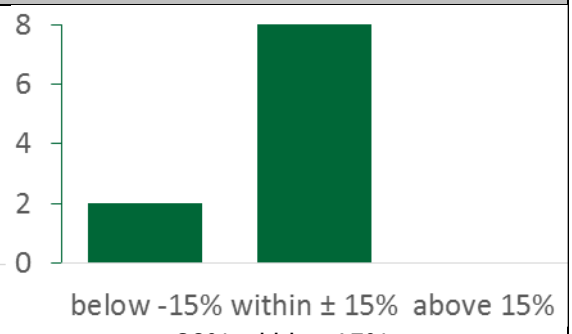
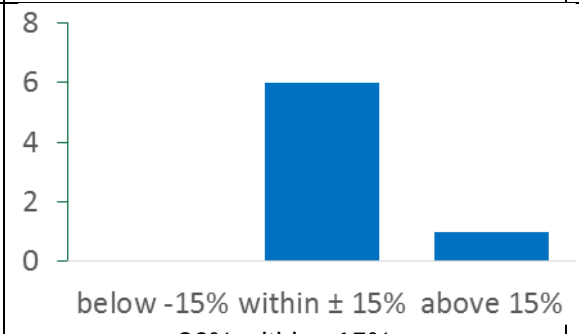
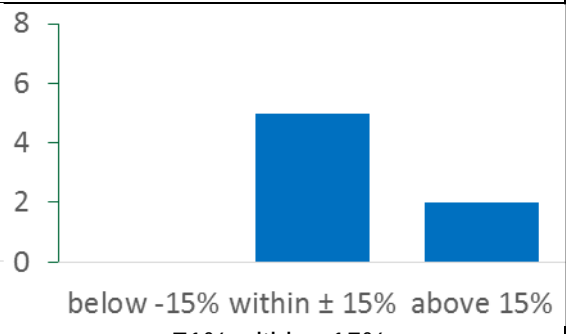
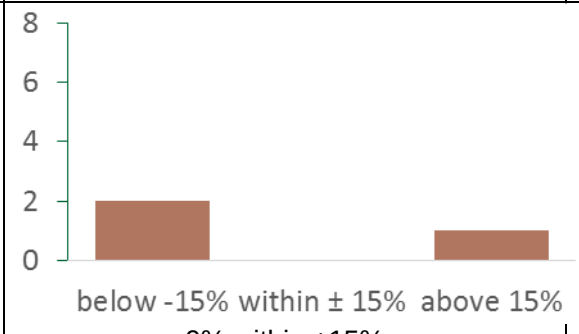
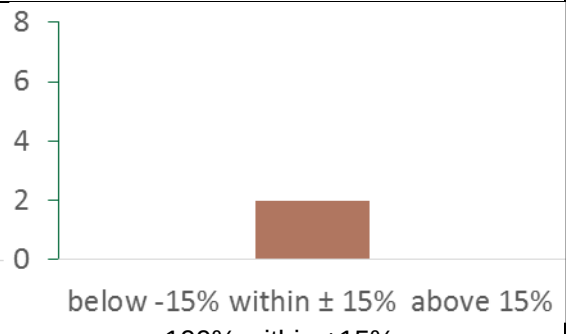
It can also be observed from Figure 4–16 that a higher level of accuracy is achieved for peak period journey times forecasts for the Do-Something scenario than for the Do-Minimum scenario, shown in Figure 4–15. This is due to the lower level of congestion in the Do-Something scenario, compared to the Do-Minimum, increasing the ease of predictability.

## Journey Time accuracy by scheme type

Figure 4–17 shows the journey time forecast accuracy by scheme type for the Do-Minimum and Do-Something scenarios, for the peak periods. For the Do-Minimum scenario, the data is based on 11 bypass schemes, 7 widening schemes and 3 junction improvement schemes. For the Do-Something scenario, the data is based on 10 bypass schemes, 7 widening schemes and 3 junction improvement schemes, one of which is an outlier.

For bypass schemes, the journey times on the new road have been utilised. It should be noted that as only two junction improvement schemes have been included in this analysis, these do not necessarily provide a representative sample of all schemes of this type.

**Figure 4–17 Accuracy of Journey Time Forecasts by Scenarios and Type**

| Type | Do Minimum accuracy : Number of schemes | Do Something accuracy: Number of schemes |
|---|---|---|
| Bypass |  73% within ±15% |  80% within ±15% |
| Widening |  86% within ±15% |  71% within ±15% |
| Junction |  0% within ±15% |  100% within ±15% |

The following can be observed from Figure 4–17

- The journey time forecast accuracy for widening schemes is higher than for bypass schemes, for the Do-Minimum scenario. This is due to the higher level of traffic flow forecasting accuracy for widening schemes than for old and new roads for bypass schemes;
- The observed journey times for bypass schemes are predominantly shorter than forecast for the Do-Minimum and Do-Something scenarios. This is because on average, those bypass schemes have lower observed than forecast traffic flows; and
- The number of junction improvement schemes included in the analysis is too small to draw any conclusions.

## Journey Time Savings

Figure 4–18 and Figure 4–19 show the relationship between observed and predicted journey time savings for the peak periods and the Inter-Peak/Off-peak, respectively. The schemes have been ordered based on increasing predicted journey time savings. The peak hour analysis is based on data from 16 bypass schemes, 19 widening schemes, 5 junction improvement schemes and one Smart motorway scheme. The inter-peak/off-peak analysis is based on data from 16 bypass schemes, 11 widening schemes and 3 junction improvement schemes.

**Figure 4–18 Accuracy of Peak Hour Journey Time Savings (seconds)**

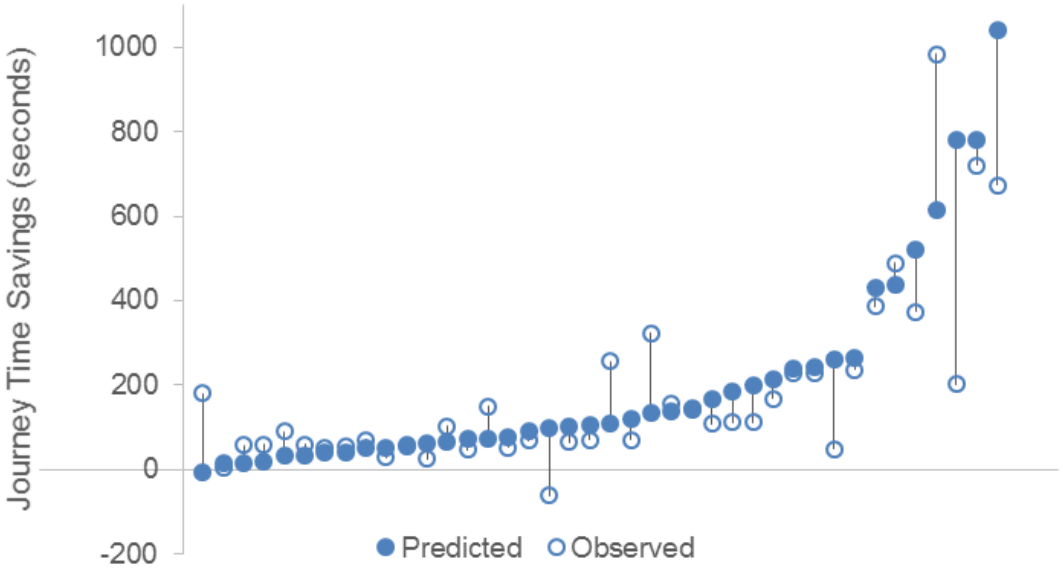
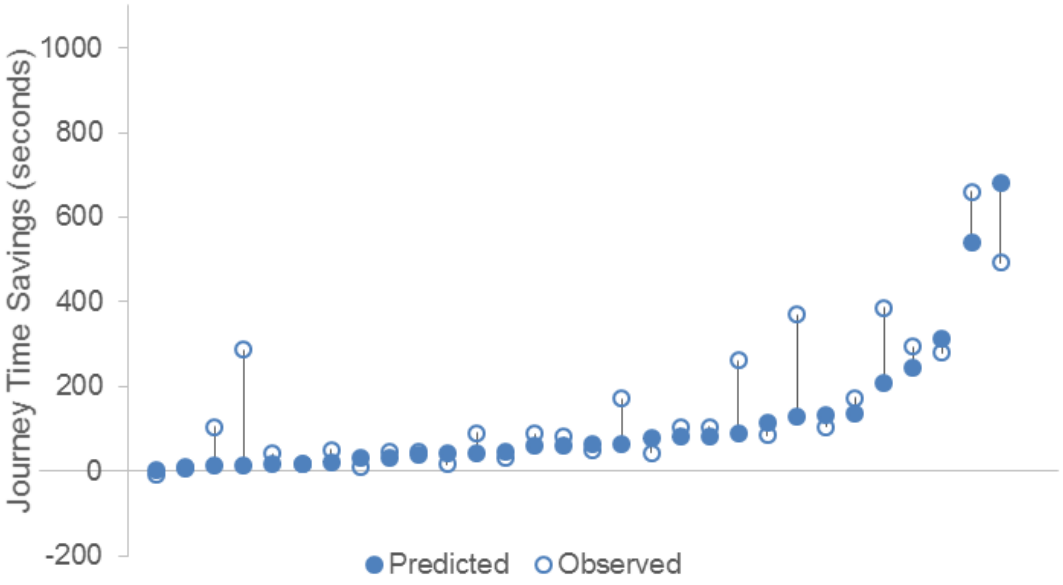



**Figure 4–19 Accuracy of Inter-Peak/Off-Peak Journey Time Savings (seconds)**




The following can be observed from Figure 4–18 and Figure 4–19:

- There is a good correlation between the predicted and observed journey time savings during both the peak hours and the inter-peak/off-peaks;
- The largest difference between observed and predicted journey time savings mainly occur for those schemes with the highest predicted savings. These are likely to be highly congested routes where journey times are less predictable;
- There are a number of significant differences in predicted and observed savings during the inter-peak/off-peak, when journey times should be easier to predict due to the lower levels of congestion. For the majority of these schemes the observed journey time savings are higher than predicted;
- 65% of the observed peak hour journey time savings are less than predicted, whilst only 32% of observed inter-peak/off-peak journey time savings are lower than predicted.

For the single Smart Motorway scheme, only journey time savings in the peak periods have been compared between forecast and observed. This demonstrates that the observed savings during the AM peak were lower than predicted and savings occurred during the PM peak when an increase in journey times had been predicted. This shows a low level of forecasting accuracy which is connected with the much higher than expected frequency of activation of the Hard Shoulder Running including the setting of the 60mph signals. However, a larger sample size would be required to draw any conclusions.

## Reasons for variance between observed and forecast journey times

There are a number of reasons for differences between observed and forecast journey times, including:

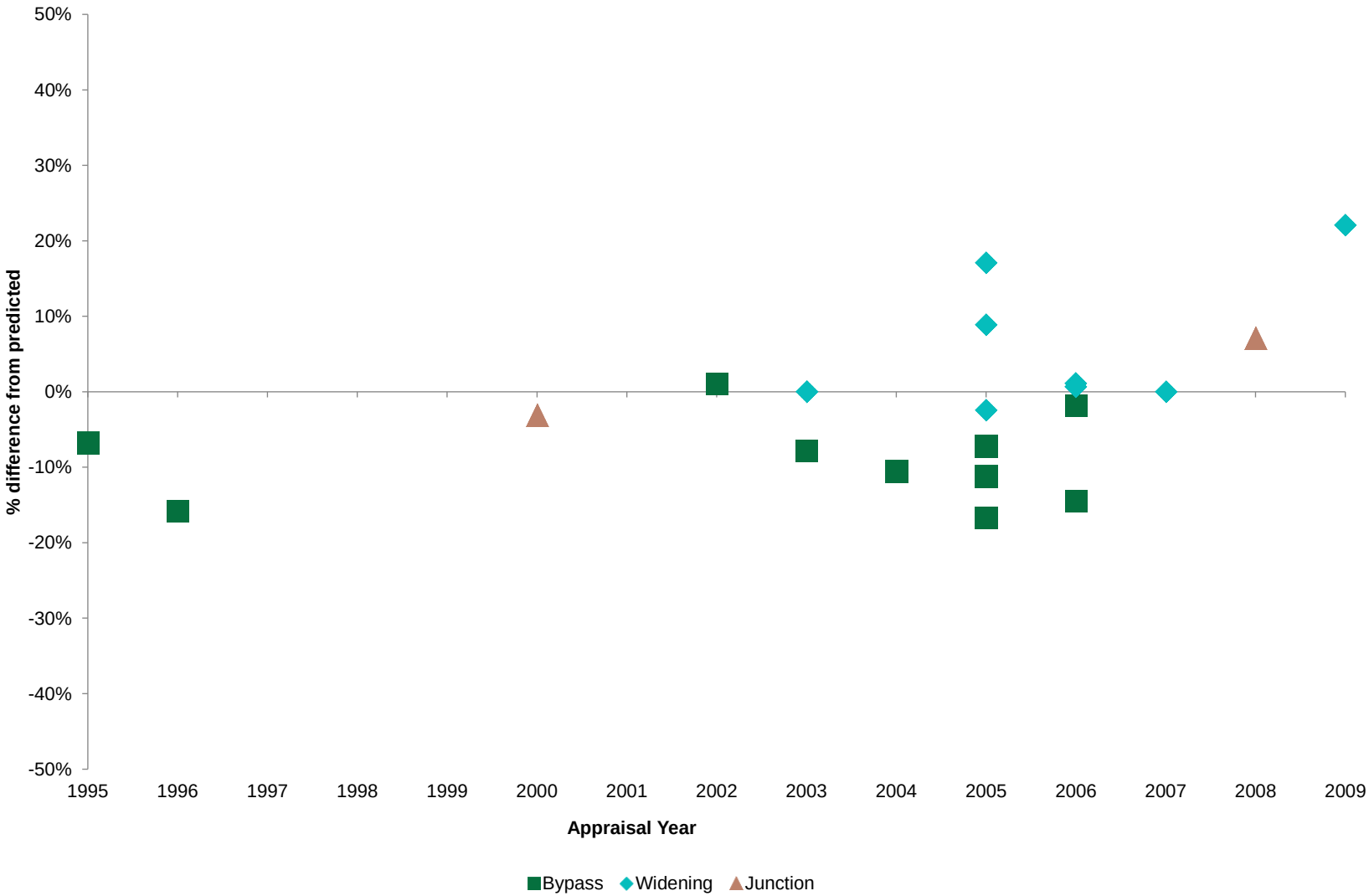
- Traffic flows notably higher or lower than forecast;
- Speed limit enforcements, such that observed speeds are limited to different speeds to those modelled; and
- COBA coding errors, such that junction delays are not modelled accurately.

It is noted that some schemes are affected by more than one of these reasons. It should also be noted that there is not a direct relationship between differences in traffic flows and journey times. For example, a higher observed than predicted journey time may be caused by higher traffic flows than predicted or the cause of lower traffic flows.

## Accuracy of forecast journey times over time

The percentage difference between observed and forecast journey times by scheme type and appraisal year for the Do-Something scenario is shown in Figure 4–20. It can be observed that there has been no notable improvement in accuracy of journey time forecasting over time, although there is insufficient data from a wide enough range of years to draw any firm conclusions.

**Figure 4–20 Accuracy of Journey Times Predictions for Do-Something Scenario by Scheme Type and Appraisal Year**



## 4.4 Does more complex traffic modelling improve forecasting accuracy?

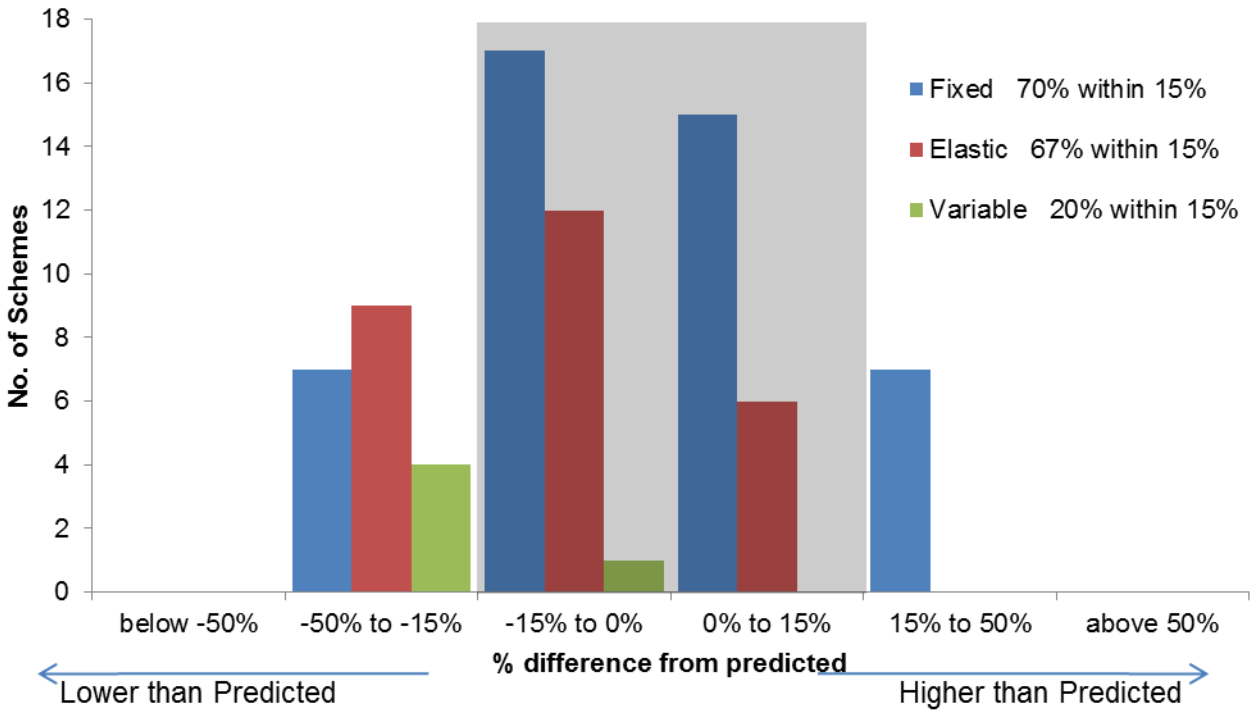
**Modelling guidance has changed to encourage consideration of the impact road schemes have on the demand for travel.**

**Use of 'elasticity models' has improved forecasting accuracy compared to fixed demand models. There are currently too few variable demand models to draw any conclusions as to any advantage over elasticity models.**

This section considers how the use of elastic assignments and variable demand modelling has affected the accuracy of forecast traffic flows. It should be noted that, at present, only five schemes using variable demand models are included in the schemes analysed. The comparison, therefore, is predominantly between fixed demand models and elasticity models, with 48[16] and 27 schemes, respectively.

Figure 4–21 shows the varying degree of accuracy of the forecast traffic flows for the Do-Something scenario for fixed demand, elastic and variable demand model approaches.

**Figure 4–21 Accuracy of Forecast Traffic Flows by modelling methodology**




It can be observed from Figure 4–21, that both fixed demand and elasticity models have approximately 70% of schemes with observed traffic flows within 15% of observed. It is noted that observed flows for fixed demand assignments are equally higher and lower than forecast. For elastic assignments however, observed flows are predominantly lower than predicted. Although this could indicate that elasticity is overestimating the increase in traffic flow due to a scheme, it is also likely that these schemes have been affected to a greater extent by the economic downturn which began in 2008.

The frequency graph for elasticity models has a narrower bandwidth than for fixed demand models, demonstrating that elastic assignments are more accurate. For example, 93% of observed traffic flows

[16] Including one outlier.

for elastic assignment schemes are within 25% of forecast flows. For fixed demand model schemes, however, only 81% of observed traffic flows are within 25% of forecast flows.

Schemes utilising variable demand models have the highest difference between predicted and observed traffic flows, with only 60% of observed traffic flows within 25% of forecast flows. It should be noted, however, that the sample size is small and as these schemes are the most recent they are likely to have been affected by the economic downturn more than the schemes undertaken using fixed and elastic models.

Figure 4–22 shows the percentage difference between observed and forecast traffic flows by modelling methodology and appraisal year for the Do-Something scenario.

**Figure 4–22 Accuracy of Traffic Flow Forecasts for Do-Something Scenario by Modelling Methodology and Appraisal Year**

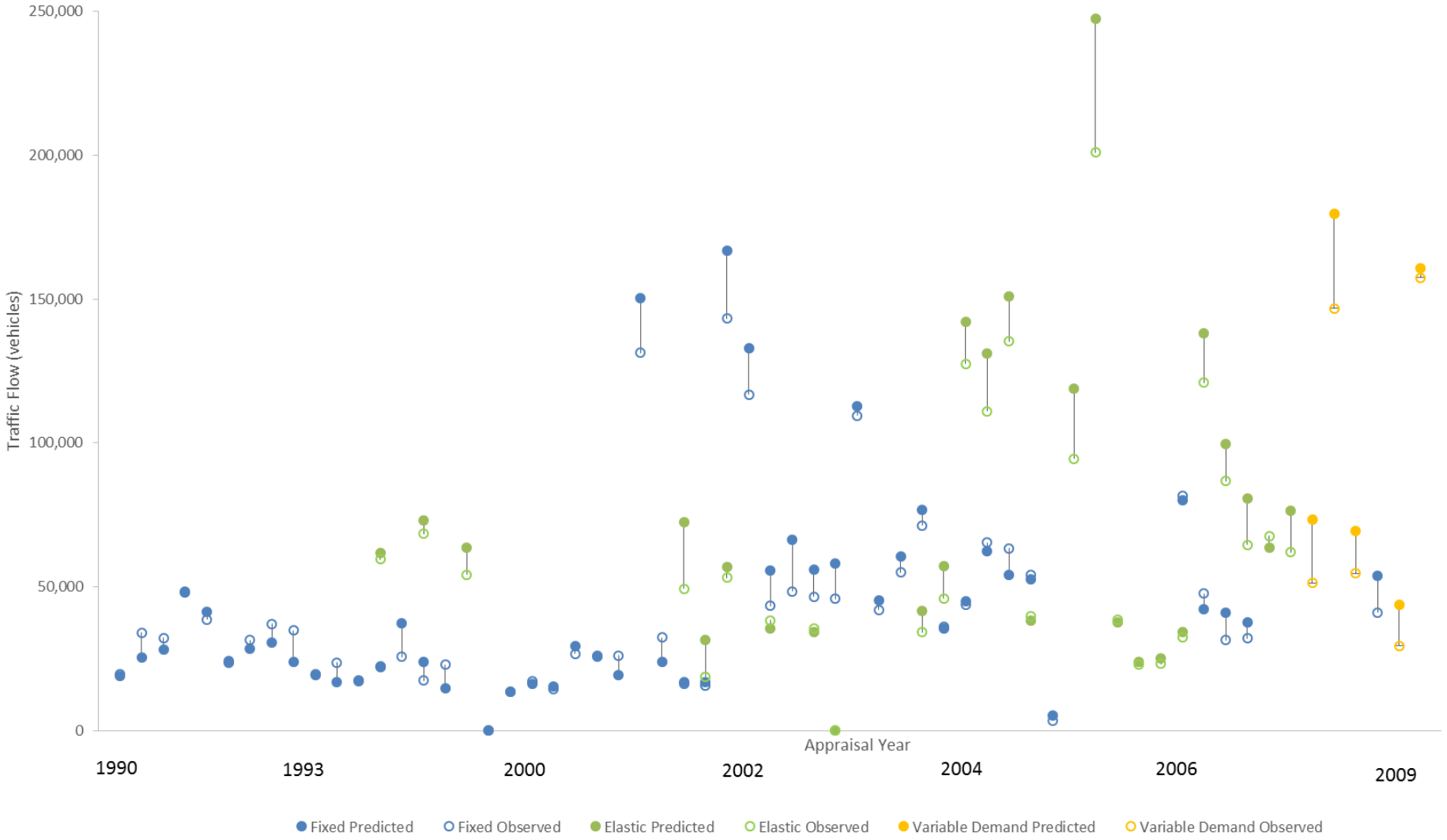


Figure 4–22 shows that due to the wide range of model forecasts, it is difficult to draw any firm conclusions over whether forecasting accuracy has improved over time for fixed, elastic or variable demand models.

## 4.5 Is there evidence of induced traffic?

**Sometimes road improvements can lead to more people travelling. This is phenomenon is referred to as 'induced traffic'.**

**The majority of schemes, of all types, do not appear to have induced traffic. It should be noted that the lack of induced traffic in recent years may be due to the economic downturn. The reduced background traffic growth may also have masked any induced traffic.**

Highway improvement schemes can impact upon traffic patterns over a significant area, leading to a number of demand responses. Changes in traffic flows on a road after the implementation of a scheme could be for a range of reasons including:

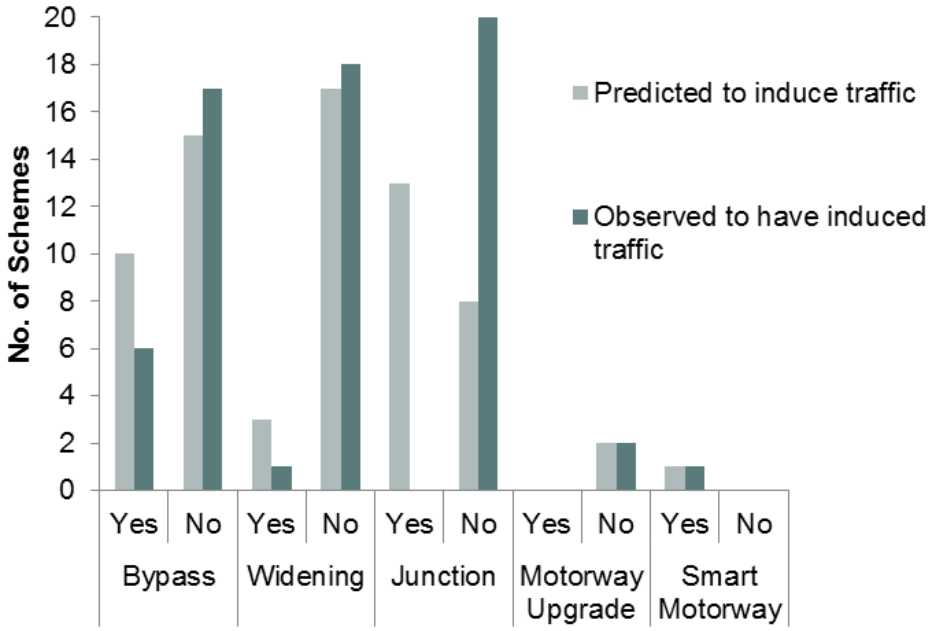
- General background traffic growth (that would have happened with or without the scheme);
- Reassigned traffic (people changing their route);
- Mode change (i.e. switching to or from public transport);
- Destination change;
- Time of travel change;
- Trip frequency increase; and
- Generated or new trips (e.g. from different land use patterns).

In the context of POPE, changes in background traffic growth and reassigned traffic can be identified using observed data. It is not possible, however, to distinguish between the other reasons for traffic flow changes listed above. For the purpose of this analysis, therefore, additional traffic due to changes in mode, destination, time and frequency, as well as new trips, are considered to be 'induced' traffic.

A review of individual scheme evaluations has been undertaken to determine whether induced traffic was predicted and observed. The predicted the level of induced traffic (if applicable) is usually referred to in the Traffic Forecasting Report. The level of observed induced traffic is generally derived through the analysis of pre and post opening 'screenlines' which aims to capture changes in traffic movements across a series of roads. It should be noted that there are limitations to the extent and confidence of conclusions that can be drawn from the data available. However, a considered approach has been taken in order to identify the most likely reasons for traffic flow increases and whether induced traffic has contributed to this increase.

Figure 4–23 shows the number of schemes with predicted and observed induced traffic for each scheme type.

**Figure 4–23 Numbers of Schemes by Induced Traffic Prediction and Observation and Scheme Type**




The following can be observed from Figure 4–23:

- Bypass schemes have the highest number of schemes observed to have induced traffic, with a total of 6. It is noted, however, that this is less than predicted and significantly less than the number of schemes which did not induce traffic;
- Almost all of the widening schemes were predicted not to induce traffic and this was observed to be the case. Similarly the 'upgrade to motorway' schemes were not predicted or observed to induce traffic; and
- For junction improvement schemes, the majority (13 No.) were predicted to induce traffic but none were observed to do so. In contrast, 20 junction improvement schemes were observed not to induce traffic.

The majority of all scheme types, therefore, were observed not to induce traffic. The following should be noted:

- Induced traffic may not have been realised for some schemes with later opening years due to the impacts of the economic downturn; and
- Induced traffic may have been masked by the reduced background growth due to the downturn. Hence this analysis should be treated with caution.

For the eight schemes that were observed to induce traffic, further analysis has been undertaken to determine the type of modelling undertaken (fixed, elastic or variable demand) and the level of forecasting accuracy for traffic flows. This shows that elastic and variable demand assignments were undertaken for 62% of the schemes with observed induced traffic. Of the five schemes using elastic and variable demand assignments, 60% had forecast traffic flows within 15% of observed. There is no clear evidence that the use of elastic or variable demand models have improved forecasting of induced traffic based on the POPE schemes available.

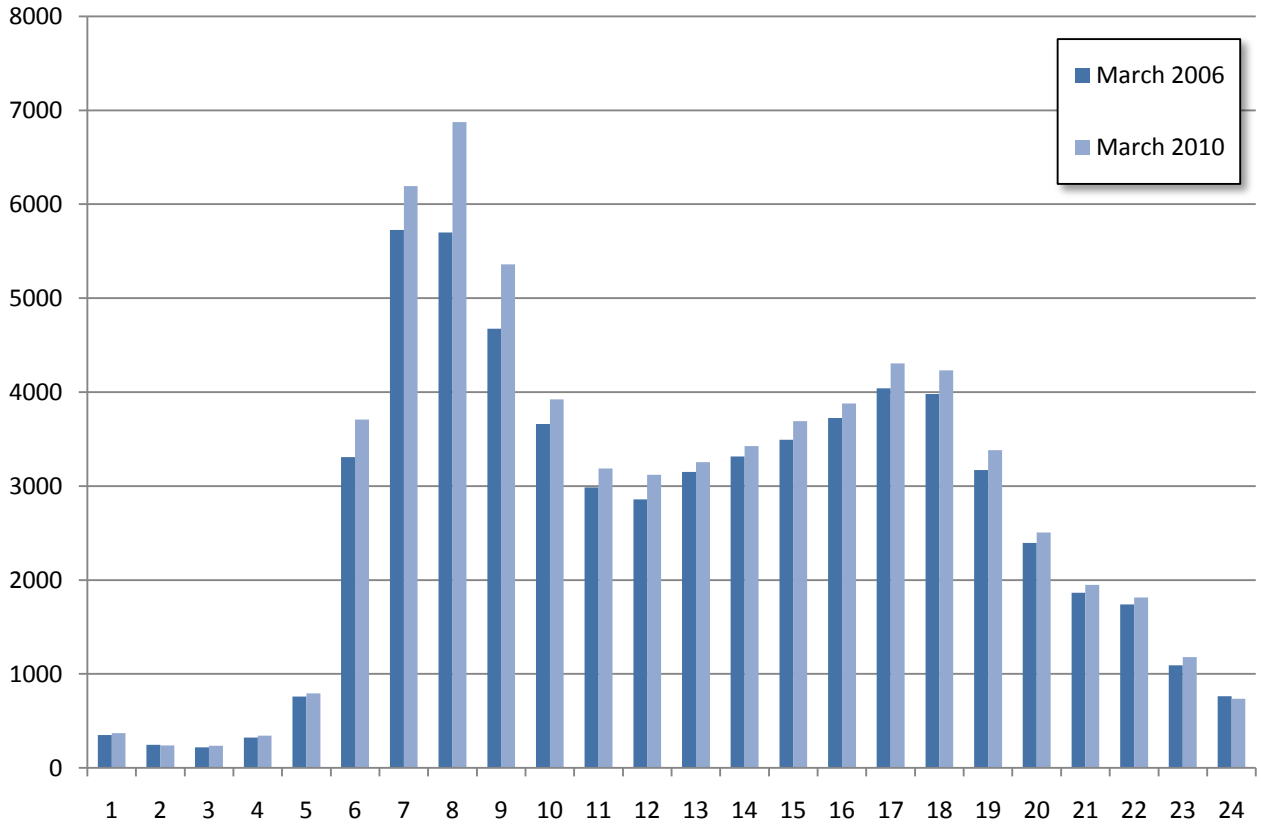
## 4.6 Is there evidence of change in peak spreading?

**The limited data available on peak spreading shows a reduction for the majority of schemes. However, the general rerouting of traffic onto the scheme road from other routes, increasing traffic flows for all hours, can mask a reduction in peak spreading.**

The 'before' and 'after' hourly traffic flows have been analysed for 15 schemes to determine whether there has been a change in peak spreading. It should be noted that for the majority of schemes, there is an increase in traffic flow for all hours of the peak periods and inter-peak due to rerouting of traffic onto the scheme from other routes. This rerouting can mask a reduction in peak spreading which is identified as a sharpening of the peak (i.e. more traffic during the peak hours and less traffic on the peak shoulders or inter-peak).

An example of a reduction in peak spreading is shown in Figure 4–24 for the A2-A282 Dartford Improvement scheme.

**Figure 4–24 A2 westbound between M25 J2 and Bean hourly flows (weekdays in early March)**

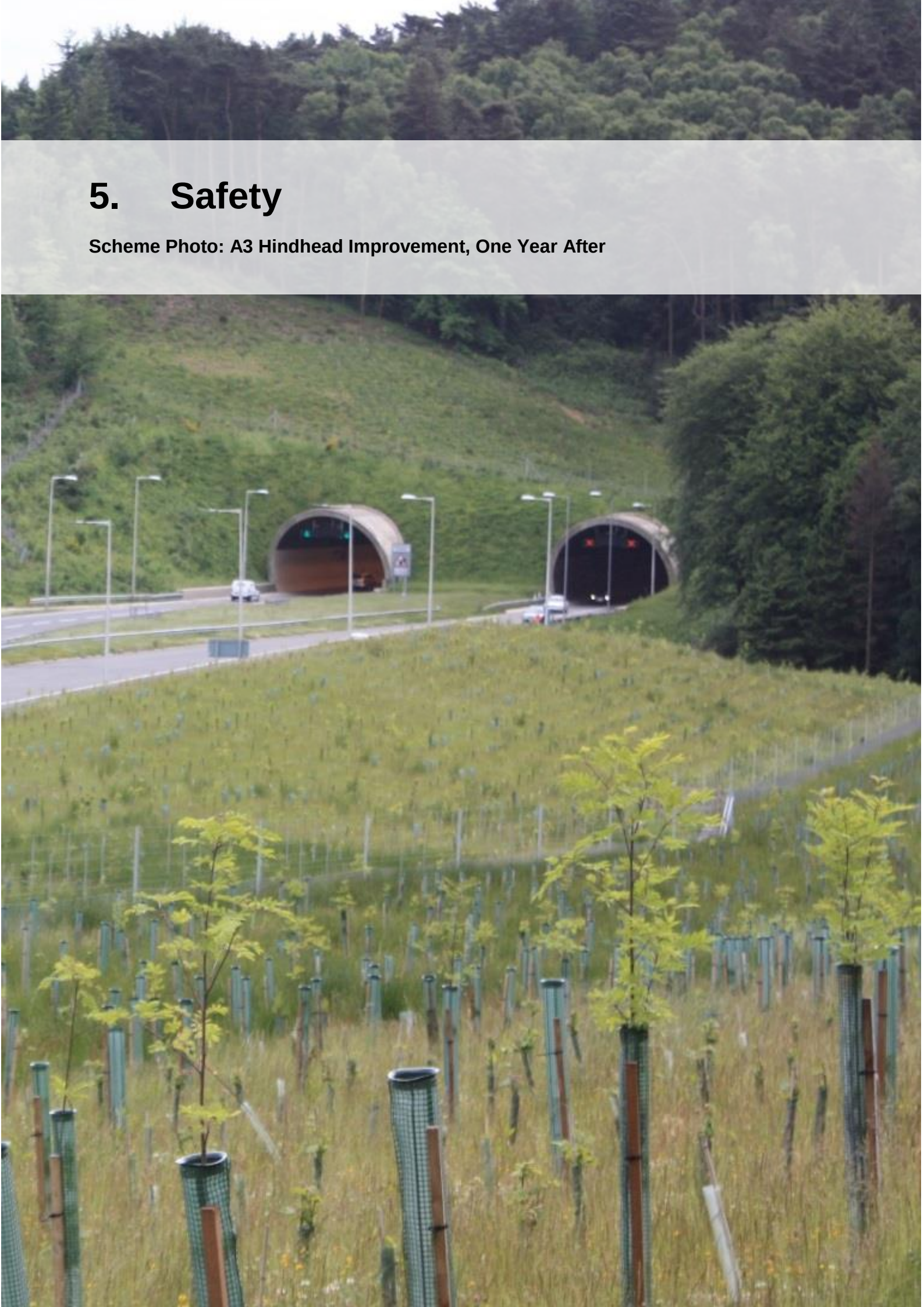



It can be observed from Figure 4–24 that during the 2006 AM peak, the traffic volume flow profile has flattened due to a lack of capacity. Following the scheme improvement, in 2010, there is a sharper peak with the traffic flow at 07:00-08:00 significantly higher than 06:00-07:00. This demonstrates that the level of traffic during the peak hour is suppressed in the Do-Minimum scenario resulting in traffic travelling during other hours. The scheme provides additional capacity enabling more traffic to travel at its preferred time.

For the 15 schemes analysed (5 bypass schemes, 7 widening schemes, 2 junction improvement schemes and 1 smart motorway), nine of the schemes potentially reduced peak spreading. These consisted of 4 bypass schemes, 4 widening schemes and 1 junction improvement.

# 5. Safety

**Scheme Photo: A3 Hindhead Improvement, One Year After**



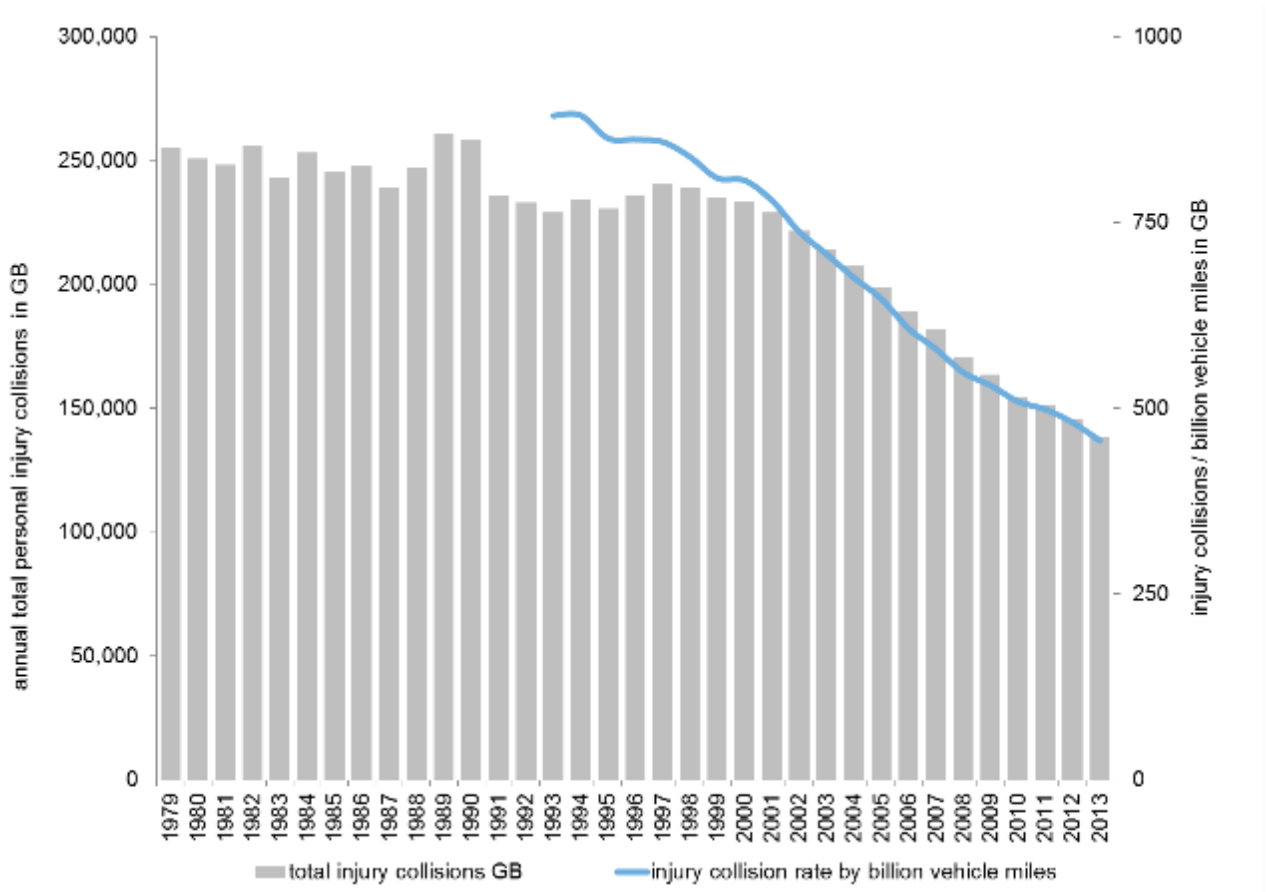
# 5. Safety

The DfT guidance on the appraisal of transport schemes (WebTAG) has a specific objective relating to considering the safety impacts of transport interventions. Also, one of the objectives contained within the Highways Agency Business Plan 2014-2015 is to 'ensure the safe operation of the network'. The majority of Major Schemes have a scheme-specific objective relating to safety.

POPE assesses the impact of Major Schemes on safety primarily through the use of accident data collected by the police. This data, known as STATS19, only covers personal injury collisions, not damage only collisions. Although the data used is not necessarily derived from the nationally validated statistics provided by the DfT, as it is sourced from Local Processing Units through either the HE's Managing Agent Contractors (MACs) or Local Authorities, it is considered sufficiently robust for use in this context.

The POPE approach to the evaluation of safety impacts compares the annual average number of injury collisions in a defined road network in the five year period prior to the start of construction with the annual average for the same area, including any new road sections constructed as part of the Major Scheme, in the post opening period. Previously, the net change in the annual average number of injury collisions has been deemed to be primarily attributable to the scheme as that is typically the greatest change to have occurred to the road network during that time period. This assumption used as the basis of the POPE approach was reasonable at the time POPE commenced in 2001. Long term trends in collision numbers only became clear with hindsight, and it is now clear that that there has been a substantial year-on-year reduction in the collision rate since 1998. This trend is shown in Figure 5-1 for the numbers of collisions and the rate taking into account traffic levels.

**Figure 5-1 National trend in Personal Injury Collisions 1979-2013[17]**




[17] Source: DfT tables RAS10002, RAS10013 Reported personal injury road accidents, by severity, Great Britain, 1979-2013.

Further investigation of data collected by the DfT shows that this reduction applies to all road types and across the country.

Now that the background decline in collisions in an established trend, it is clear that POPE scheme evaluations should not be ignoring this trend. In theory, if the Major Scheme had not been built the chances of collisions occurring and resulting in injury would have reduced due to a range of factors unconnected to the scheme including improved vehicle safety and a reduction in younger drivers. The POPE methodology for the evaluation of collisions has now been revised. For the before and after comparison, a counterfactual scenario is now created for the 'without scheme' in which, if the scheme had not been built, it is assumed that the collision rate within the study area would be that observed in the before period but reduced in line with the national trend. This adjustment is based on the national trend derived from the DfT collision data between the middle years of the two time periods being compared. The reported net impact on collision numbers now becomes the difference between the before data (adjusted for background trend) and the observed after data. It should be noted that this approach of including the national trend data will mean that collision benefits of Major Schemes are reduced and in some cases there may be net disbenefits.

Fifteen schemes have been evaluated using the new collision methodology. To ensure consistency, the majority of the analysis presented in this section of the report is based on the fifteen schemes. Any conclusions drawn from this analysis should be taken with caution due to the small sample size involved. For sections of the analysis where the entire dataset has been used, this will be clearly indicated.[18]

The remainder of this section considers the following lines of inquiry:

- What impact do Major Schemes have on the number of collisions?
- How accurate are safety predictions?
- What are the changes in observed collision rates by road type?

## 5.1 What impact do Major Schemes have on the number of collisions?

**The sample size available is very small to draw meaningful conclusions. However, there is evidence to suggest that**

- **Statistically significant reductions in collision numbers, as noted for some Major Schemes, confirms the safety benefit.**
- **Bypass schemes are the most successful type of scheme in terms of improving safety.**

Figure 3-1 on page 19 earlier in this report shows that 71 schemes had an objective relating to safety, and 62 (87%) of these schemes were successful in achieving their safety objective. It should be noted that the majority of these schemes were evaluated using the POPE methodology which ignored the background change in injury collisions shown in Figure 5-1 earlier.

This section looks in more detail at the 15 schemes which were evaluated using the new POPE approach of taking account the background reduction.

Figure 5-2 presents the annual change in collision numbers (and percentage change) by scheme type for all 15 evaluations, irrespective of whether the POPE evaluation is a one or five year after opening study. This does include results from a number OYA reports, some of which are not statistically significant. These were included to increase the sample size.

[18] The Meta-analysis 2013 contained a bigger sample size because it considered all Highways England Major Schemes evaluated at this stage, with no schemes removed due to a change in evaluation methodology. All the schemes excluded here were included in the 2013 report.

**Figure 5-2 Annual change in collision numbers by scheme type (OYA and FYA evaluations)**

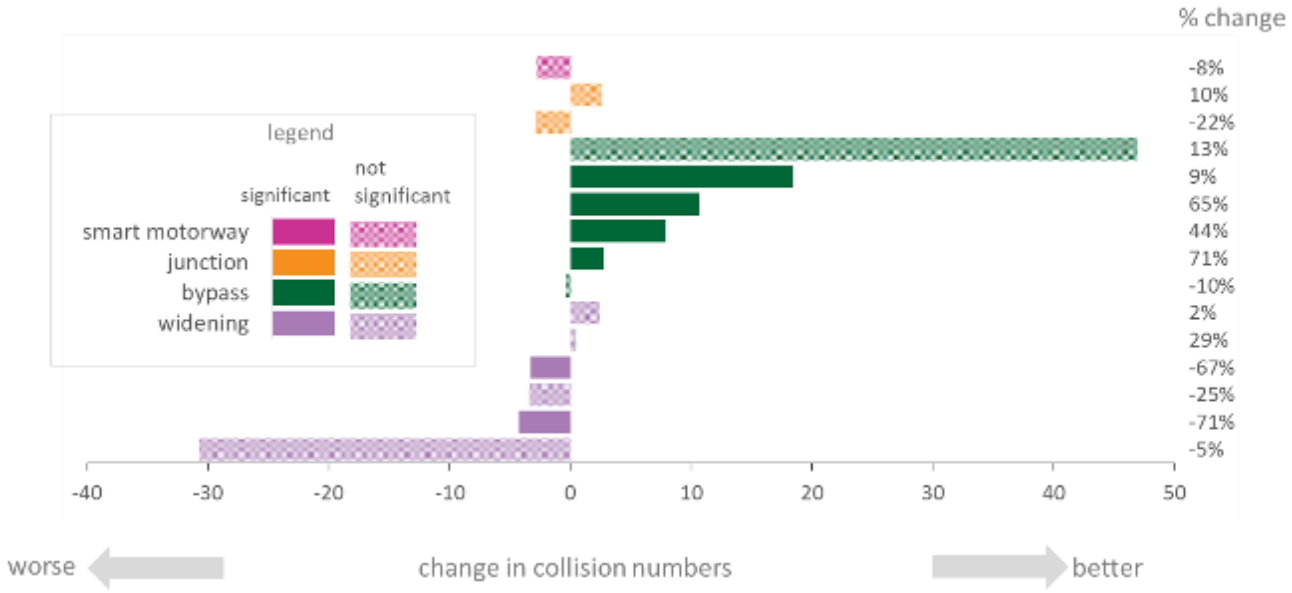


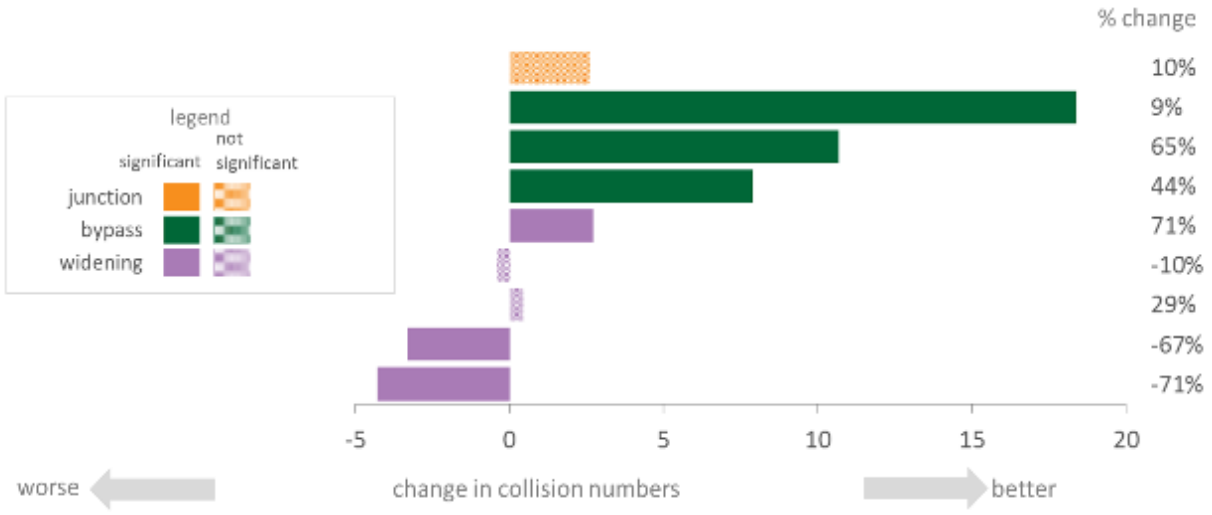

Figure 5-2 shows that:

- Eight schemes have experienced a reduction in collision numbers. Seven schemes have experienced an increase. (However, some of these changes are not necessarily statistically significant[19]).
- It is clear that bypass schemes have been the most successful in reducing the numbers of collisions. These types of schemes typically provide savings for users of both the new route and former route, and for the roads in the wider network due to traffic rerouting to the safer road. Therefore it is not surprising that bypass schemes are providing a large benefit.
- The collision numbers have typically increased on the widening schemes. This category encompasses many different sizes of scheme ranging from climbing lanes to major motorway widening schemes.
- The sample size for junctions and smart motorways is too small to draw meaningful conclusions.
- Four of the six schemes with statistically significant results experienced a reduction in collision numbers.

Collision data observations are generally considered to be more robust when observed over a greater time period and it may be the case for some schemes that, in the first year post opening traffic behaviour may be atypical of long term trends. Figure 5-3 therefore presents the results for the FYA evaluations within this dataset. This reduces the sample from 15 to nine schemes. This shows that the patterns relating to bypasses showing an improvement and widening schemes showing a worsening remains.

[19] Statistical significance of changes in collision numbers is assessed through the use of the chi squared test.

**Figure 5-3 Annual change in collision numbers by scheme type (FYA evaluations only)**




### 5.1.1 Are collision savings improving over time?

Figure 5-4 presents the annual collision saving over time (using scheme opening year) for all 15 schemes. This shows that although the two largest net changes in collision numbers occurred on schemes opened in 2012 (OYA studies), the small sample size means that there is no clear evidence to suggest that collision savings derived from Highways England's Major Schemes are getting better or worse over time.

**Figure 5-4 Annual collision saving by scheme opening year**

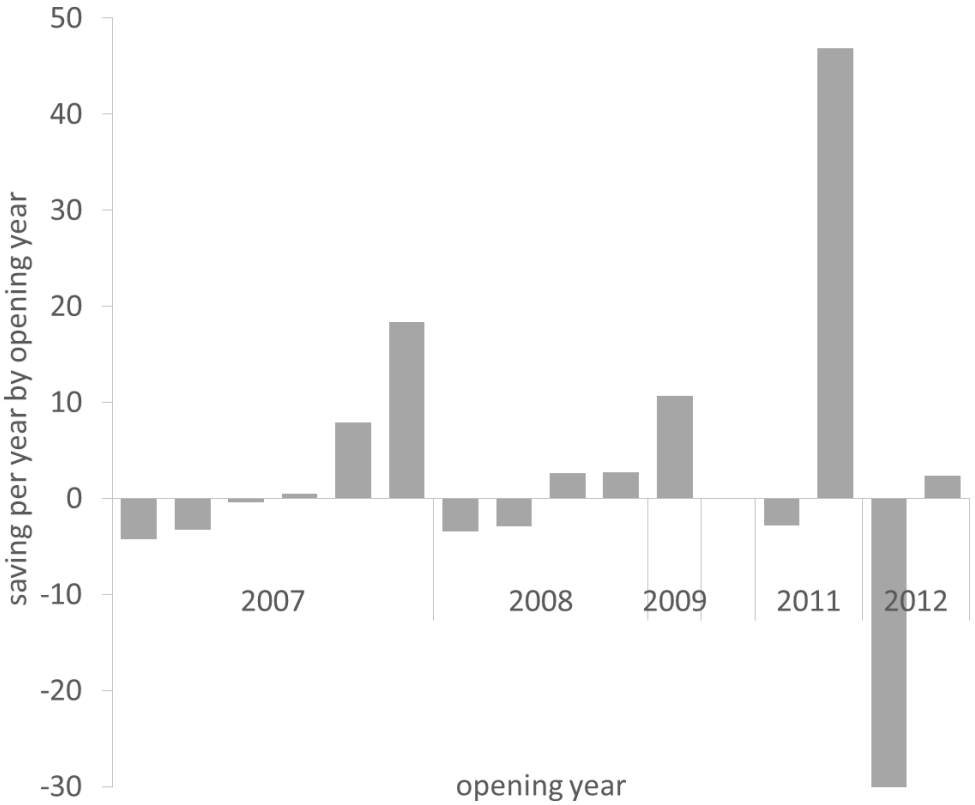



Figure 5-5 presents the median savings in fatal and serious collisions by opening year for all the schemes within this Meta-analysis sample. However, it should be noted that that no allowance has been made for

the background reduction in collisions in this analysis. The recent schemes have had their opening years grouped together to ensure a sufficient sample size.

**Figure 5-5 Median savings in fatal and serious collisions by scheme opening year (all schemes)**

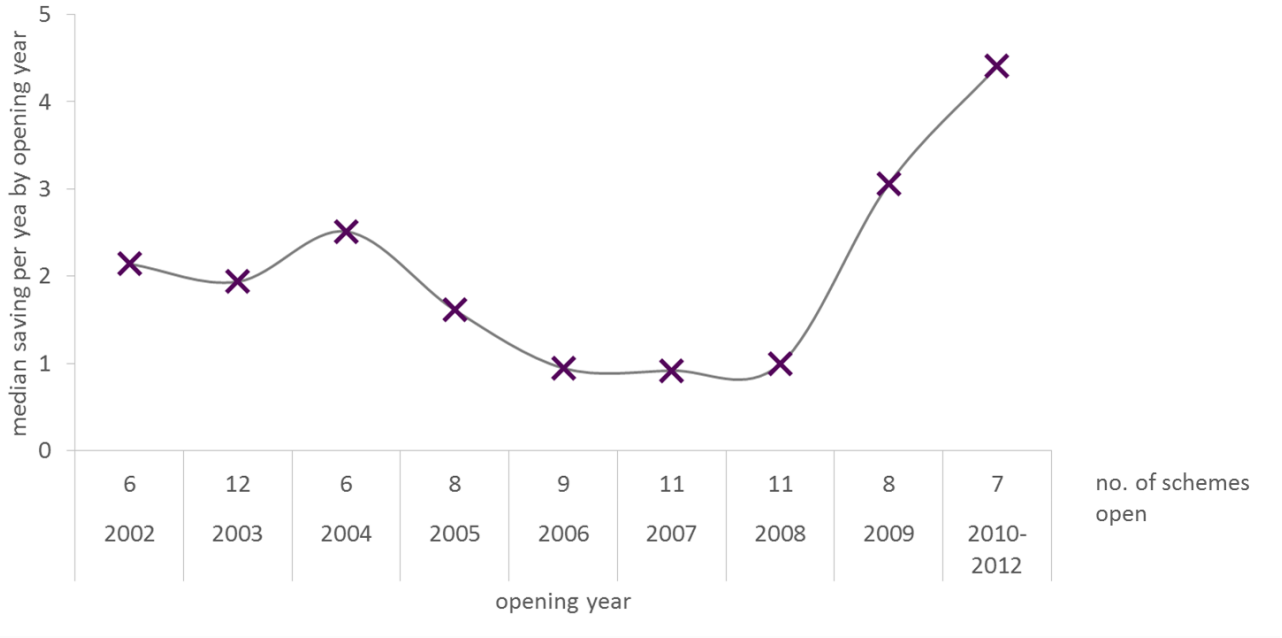



Figure 5-5 shows that the schemes with more recent opening dates have experienced a greater reduction in the numbers of serious and fatal collisions.

### 5.1.2 Collision savings by area

Where possible, the POPE evaluation will undertake an analysis of the before and after collisions over the following areas:

- Study area – This is typically the same area (or as close as possible) as that used for the appraisal of the collision impacts.
- Narrow area – These are for the 'key links' which are all of the roads which have been altered as part of the scheme.

It is not always possible to undertake a POPE analysis over both areas because of one or more of the following factors:

- The study area used in the appraisal of collision impacts may be unknown.
- The study area used in the appraisal may be very large making it impractical to collect observed data over such a large area.
- The study area used in the appraisal may be very small because the impacts are localised. (I.e. the study area is the same as the narrow area).

Figure 5-6 presents the collision savings for each scheme by opening year. Nine of the schemes have results for both the study area and the narrow area. Six of the schemes have results for the narrow area only because of one or more of the reasons outlined above.

**Figure 5-6 Comparison of collision savings over study area and narrow area by opening year**

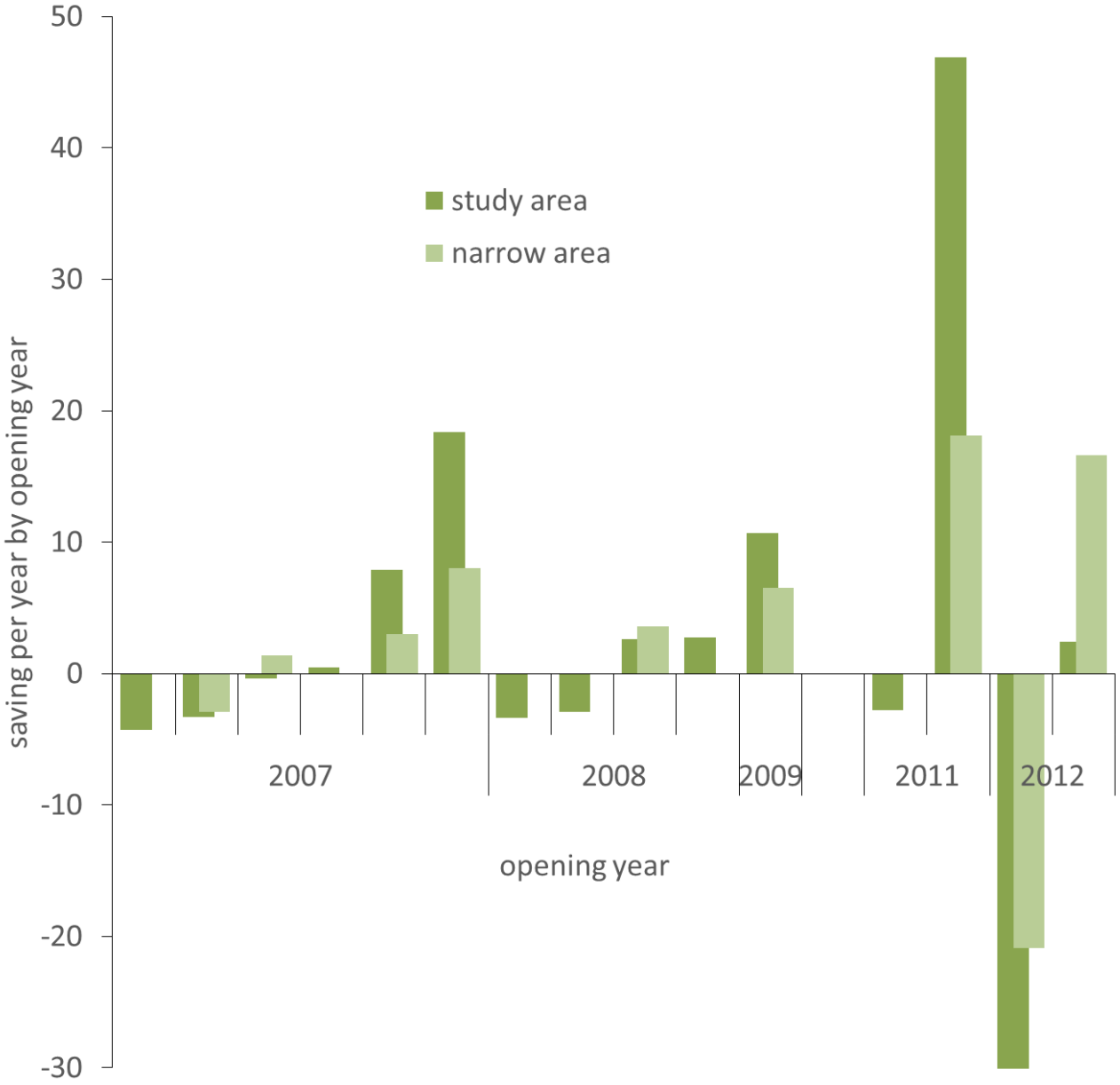



Figure 5-6 shows little pattern in the results for those schemes where a wide/narrow area analysis has been undertaken. Of the nine schemes with analysis carried out over the two areas, 5 have better results within the narrow area of the scheme's key links, meaning that the wider area showed a net increase in collisions over the same period.

### 5.1.3 Statistical significance of collision savings

The statistical significance of collision savings is presented in Figure 5-7. This shows that six schemes did not have a significant saving, so the change could have occurred by chance and may not necessarily be attributed to the scheme. Six schemes had collision savings over the wider area and three of schemes had a saving over the narrow area (but not the wider area).

**Figure 5-7 Statistical significance of collision savings**

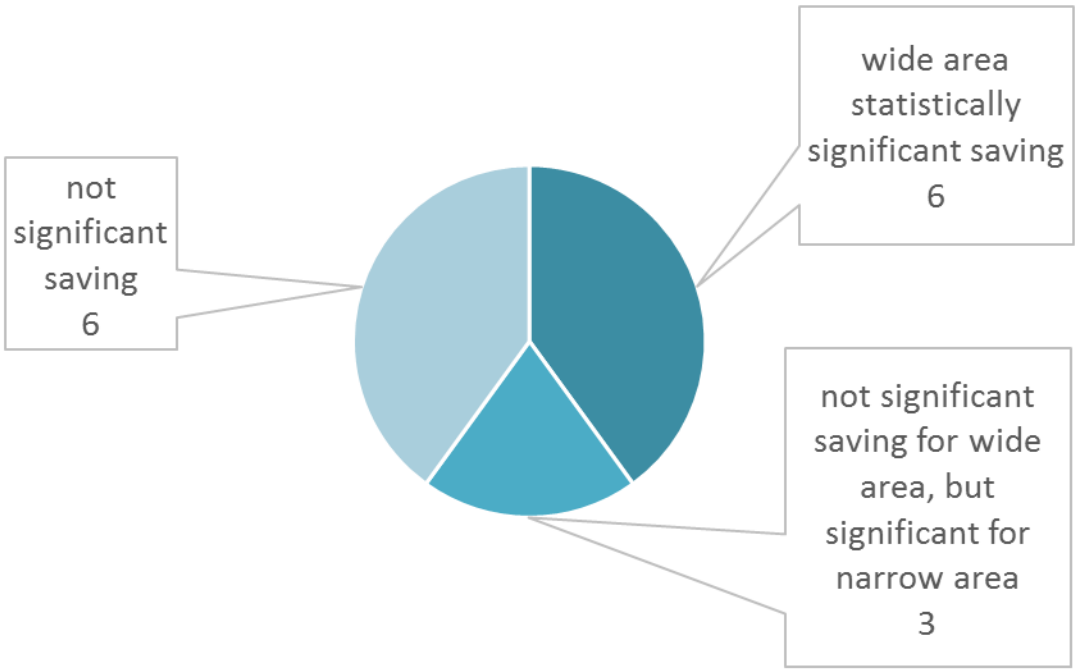
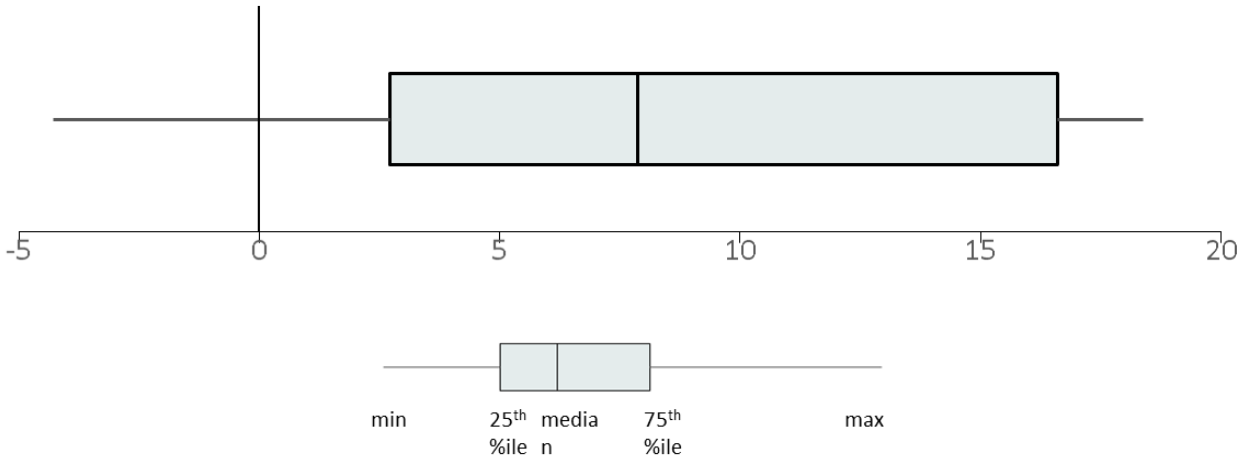



Figure 5-8 presents the collision savings for the nine schemes with statistically significant impacts. This takes the savings from the wide area if statistically significant, if not statistically significant, then it considers the savings from the narrow area (but only if this is statistically significant). This shows that these schemes are delivering safety improvement with a median saving of 8 collisions per year. The range of collision impacts is quite large with -4 saving on one scheme and +17 saving on another scheme.

**Figure 5-8 Range of collision savings for the schemes with statistically significant impacts**




## 5.2 How accurate are safety predictions?

**Accuracy of collision safety predictions is poor. Less than half of schemes have accident savings within 50% of the prediction.**

POPE evaluations undertake a comparison of the observed collision savings with the forecast collision savings made at the time of the scheme's appraisal to determine if the forecasts were accurate. The meta-analysis of safety impacts explores the accuracy of the forecasts to determine if there are any trends, such as under or over prediction of collision savings. The 2013 Meta-analysis included an analysis

of forecasting accuracy by scheme type. This analysis has not been repeated because the sample size is not sufficient to undertake a robust assessment.

Collision savings for Major Schemes are typically forecast using modelling software called COBA (**CO**st **B**enefit **A**nalysis). This gives predictions of the numbers of injury collisions. This gives predictions of the numbers of injury collisions in a defined network of roads with and without the scheme in place (known as Do-Minimum and Do-Something scenarios). Although this tool is primarily for predicting the longer term impacts of the scheme, it does also provide forecasts for the impacts in the opening year and design year (15 years after opening). From these forecasts, POPE has identified that the predicted annual savings for each of the first 15 years tend to be very similar, this is reasonable to assume for POPE FYA studies to compare the predicted opening year saving with the average annual saving in the first five years post opening.

Figure 5-9 presents the accuracy of collision savings by scheme type. Positive numbers denote a saving, negative numbers denote a disbenefit.

**Figure 5-9 Accuracy of collision saving forecasts by scheme type**

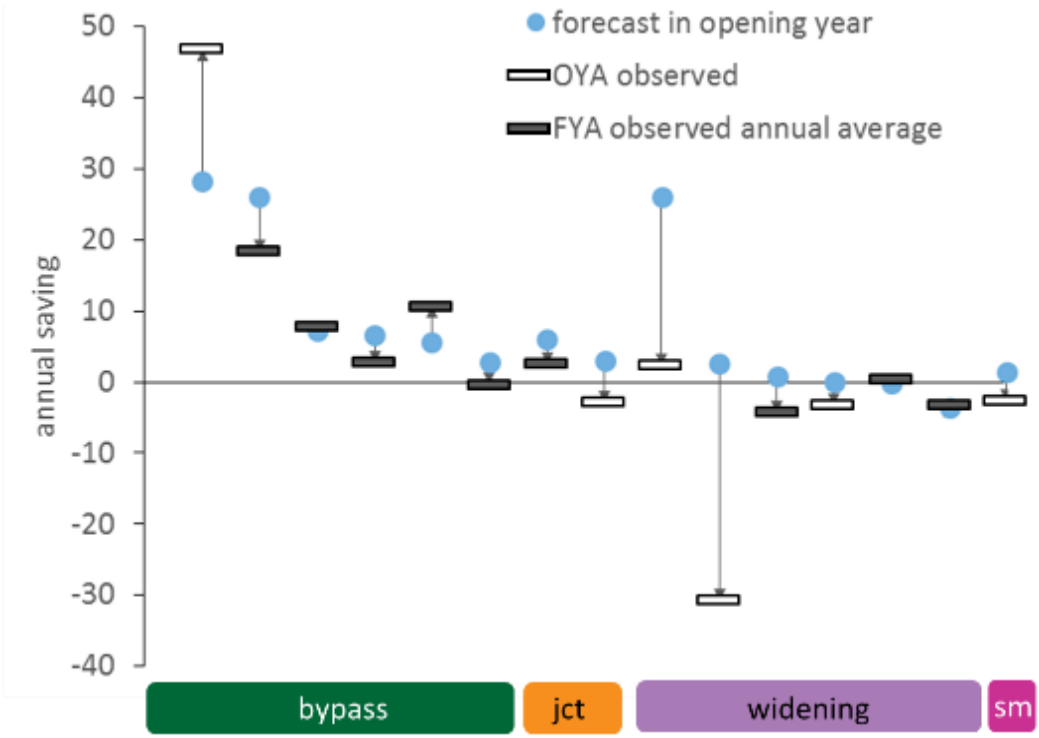



Figure 5-9 shows that:

- There is high degree of variability between the forecast opening year collision saving and the observed annual average saving, particularly for bypass schemes.
- Four (27%) of schemes had collision impacts which were better than expected. Eleven (73%) of schemes had collision impacts which were worse than expected. The background collision reduction factor applied to the observed data will have impacted upon these results.

Although not shown on the graph, these results show that two schemes have a forecasting accuracy between ± 15% and three schemes within ± 50%. The majority of schemes (67%) are worse than 50% out.

## 5.3 What are the changes in observed collision rates and how does this change compare to forecasts?

**Major Schemes which have involved improvements to A roads have seen a considerable decrease in the collision rate.**

**Motorways typically have low collision rates compared to other types of road. Major schemes involving improvements to motorways have resulted in little change to these rates. The DfT collision rate forecasts for four lane motorways are broadly in line with those observed.**

The collision rate is produced by dividing the number of personal injury collisions by the number of vehicle kilometres travelled (PIC/mvkm).

### 5.3.1 Observed collision rates

Excluding one junction scheme[20], the before and after collision rates for the 14 schemes with the background collision reduction considered are shown in Figure 5-10. The results have been grouped by post opening road type.

**Figure 5-10 Change in observed collision rates by road type**

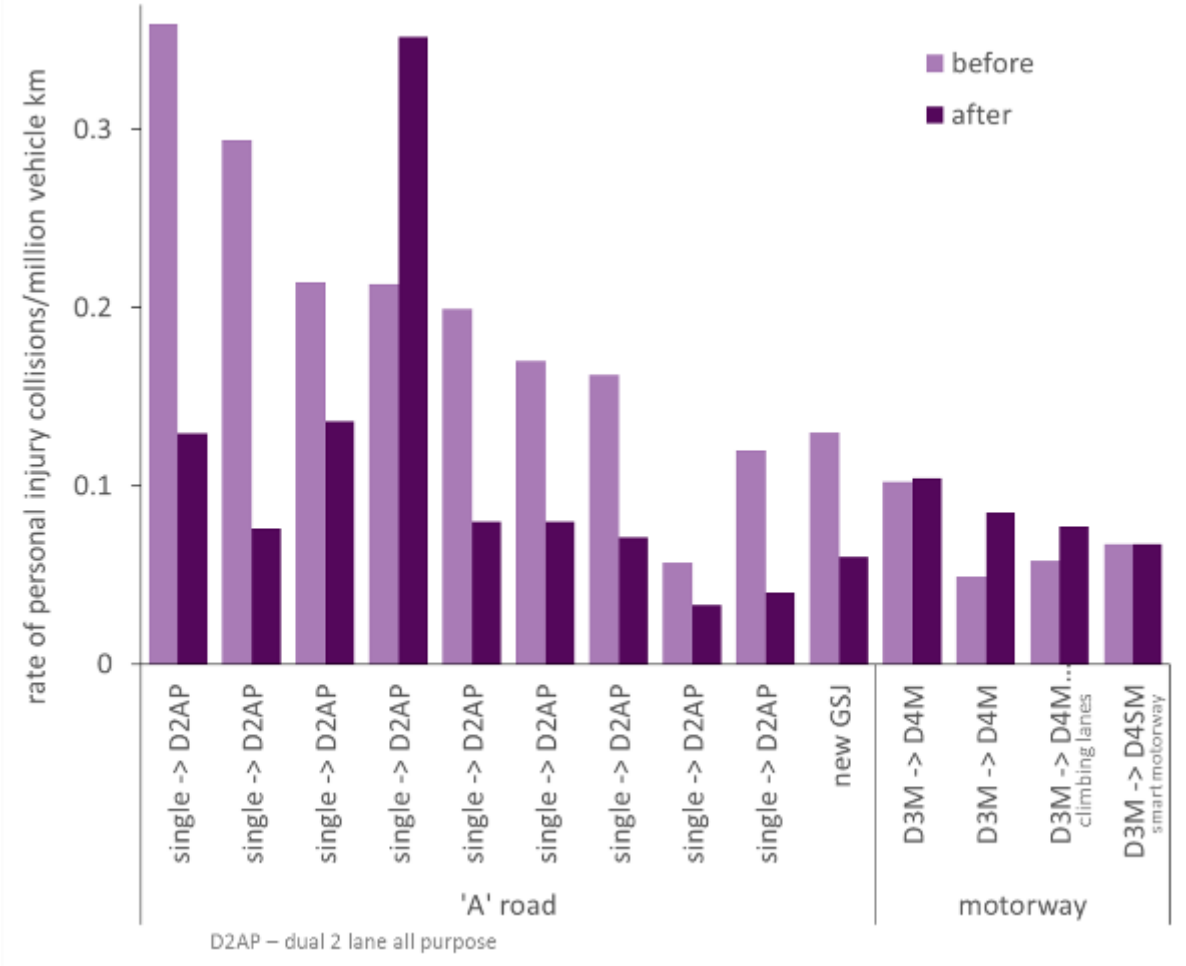



Figure 5-10 shows that:

- Nine out of 10 (90%) of schemes involving improvements to A-roads have been successful in reducing the collision rate. In many instances it can be seen that the collision rates have more than halved. This is likely to be due to the nature of the schemes implemented in this category which often involve a considerable change to the quality of the route through segregating traffic

[20] It is not possible to calculate a collision rate by distance for a junction scheme.

by direction, improved junctions, removal of local road accesses and improved alignment and visibility of the road in line with modern standards.

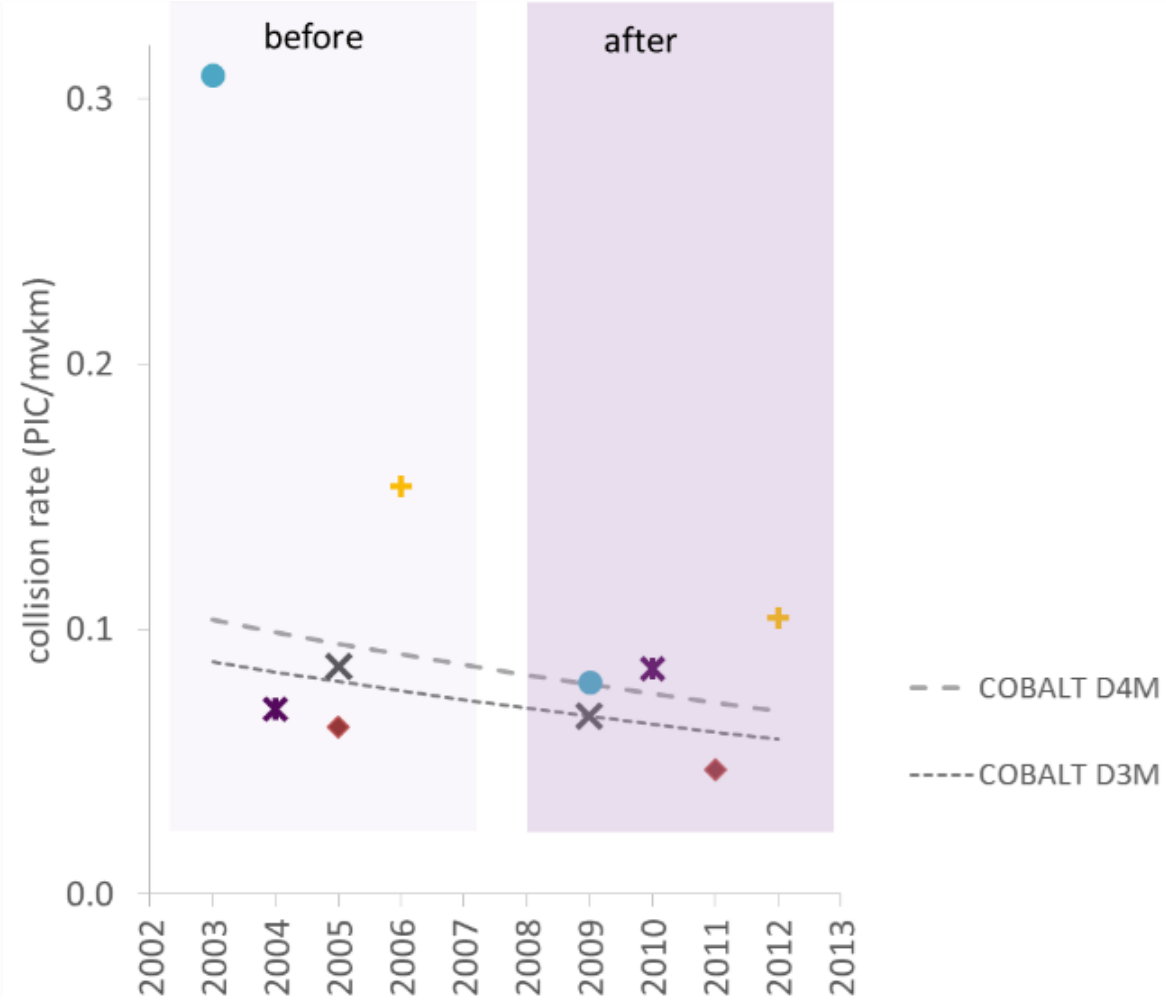
- Motorways typically have lower collision rates than 'A' roads, even dual carriageways, due to restricted access and full grade separation and the four schemes here were not showing higher collision rates in the before period.
- The impact of Major Schemes on motorway collisions rates is negligible with two schemes showing little change and two schemes showing a worsening. This is likely to be due to the fact that the motorway schemes (such as widening and climbing lanes) do not result in such a step change in the quality of the network compared to the 'A' road improvement schemes.

### 5.3.2 Comparison of observed and forecast collision rates on motorways

COBALT (**Co**st and **B**enefit to **A**ccidents – **L**ight **T**ouch) is a computer programme developed by the DfT to undertake the analysis of the impact on collisions as part of the economic appraisal for a road. It was introduced in 2013 to supersede COBA and is the current package used by Highways England to appraise the safety impacts of Major Schemes in line with the DfT's webTAG guidance

Figure 5-11 presents a comparison of the observed before and after collision rates for the five motorway widening schemes which were from three to four lanes (D3M to D4M) and compares these rates to the current assumptions used in the COBALT[21] software. Collision rates by road type are a key input into COBALT and these are provided by the DfT to ensure consistency in analysis across multiple schemes. The collision rates are modelled to change through time (as shown by the dashed lines presented in Figure 5-11 which shows that the COBALT collision rate for motorways depends on the number of lanes).

**Figure 5-11 Comparison of observed collision rates[22] compared to the modelled collision rates within the COBALT software**




[21] COBALT version 2014.3.
[22] The observed before scheme collision rates in this graph have not been adjusted to take into account the background change in collisions. This adjustment is not required in this instance because the results are presented by year.

Figure 5-11 firstly shows that the observed collision rates for three lane motorways (D3M) before construction of the widening schemes vary considerably which may be due to the impact of problems experienced on all of them, as identified by their inclusion within the Major Scheme programme. Congestion issues are generally the primary objective behind motorway widening schemes, rather than safety but the before scheme collisions rate may be untypically high as a consequence of the congestion problems.

# 6. Economy

**Scheme Photo: A2/A282 Dartford and M25 Junction 1b-3 Improvement, Five Years After**

# 6. Economy

## 6.1 What are the main benefits of Major Schemes?

**Journey time benefits are the key monetary benefits derived from Major Schemes, accounting for 79% of all monetary benefits. Safety benefits (as measured by reductions in numbers of injury collisions) form the second largest contribution.**

**The average total monetary benefit for schemes appraised over the standard 60 years is £117.5million, and £86.7million for schemes appraised over 30 years.**

**Other impacts which are appraised to have monetary benefits, positive or negative, include changes to the users' vehicle operating costs, indirect tax impact for the Treasury, and cost of delays during construction and future maintenance periods. In total, these average only an average 1% net impact.**

**The Treasury is expected to benefit from many schemes, through a net increase in indirect tax revenue but on average, this impact is less than £1million.**

**Widening schemes have substantially higher average total benefits per scheme than bypass and junction schemes. However, the greatest benefits are seen in the four schemes which were an upgrade to motorway and the one smart motorway scheme; all of these where larger schemes. Safety benefits are the highest for bypass schemes which is due to these types of scheme including the greatest step change in road standard.**

Highways England's Major Schemes are subject to cost-benefit analysis (CBA) when they are appraised. This compares the costs of building the scheme against the monetised long term impacts following the completion of the scheme, here termed benefits.

The period in question is defined by the Treasury for major Government investments. During the period in which the Major Schemes within this Meta-analysis were appraised, the time period has changed from 30 to 60 years. The post opening evaluation of the benefits for each scheme has been undertaken on the basis of using the same period as that in the appraisal, to allow a like-for-like comparison between predicted and outturn benefits

The post opening economic evaluation is based on using observed outturn data (including traffic flows, journey times and collision information) to calculate a reforecast of the benefits stream now expected over the appraisal period. This reforecast is termed the 'outturn benefit'. These figures for outturn benefits are critical to answering the question as to whether the scheme will be value for money discussed later in Section 6.4.

The cost benefit analysis of transport schemes is based on monetising a range of impacts in line with the current DfT guidance set out in WebTAG. The impacts which are applicable for highway Major Schemes and the POPE evaluation are summarised in Table 6-1. For highway schemes, the predicted monetised benefits are normally positive, but can also be negative, in which case they are termed disbenefits.

Table 6-1 shows the main benefit streams associated with highway schemes and briefly explains how they are considered as part of the POPE process.

**Table 6-1 Monetisation of Major Scheme Benefits**

| Period | Impact | Post Opening Project Evaluation approach | |
|---|---|---|---|
| | | Outturn evaluation | Background |
| Construction phase | Delays to journey times for road users<br>Change in collision numbers and severity | No | Study of the observed impacts construction period is not covered by POPE as changes in journey times can vary widely during construction phases and changes in collision numbers are sufficiently significant to conclude a robust trend. |
| Appraisal period (30 or 60 years) | Change in journey times for users | Yes | Based on observed data on traffic flows, journey times and speeds. |
| | Change in collision numbers and severity | Yes | Based on observed data on personal injury collisions. |
| | Change in Vehicle Operating Costs for users | Some | Generally small compared to journey time impact.<br>Evaluated where impact is larger. |
| | Change in road operating cost for HE | No | Only important in the appraisal of a few schemes.<br>In these cases, assume that original forecast for long term impact still holds true. |
| | Change in carbon emissions | No | Introduced in recent guidance but only included in few appraisals of the schemes evaluated to date. |
| | Change in noise impact on local community | No | Introduced in recent guidance but this was not included in original appraisals of the schemes evaluated to date. |
| | Change to indirect tax revenue | Yes | Although treated as a costs impact in most appraisals, it has presented as part of the benefits for the results for all schemes in this meta-analysis in line with current guidance. |
| | Change in Journey Time Reliability | No | No reliable source of long term incident data that is comparable with previous years |
| Future maintenance periods within appraisal period | Change in net cost of maintenance works | Assessed to be same as forecast | Only important in the appraisal of a few schemes. In these cases, assume that original forecast for long term benefits still holds true. |
| | Change in collision numbers and severity | | |
| | Delays to journey times | | |

As shown in Table 6-1, the key monetary benefits of the Major Schemes as measured in POPE are derived from changes in safety (measured by the net change in the recorded number of personal injury collisions) and journey times (measured in savings for road users).

POPE studies mainly focus on these elements of benefit as they constitute a majority of the monetised benefits and disbenefits measured in scheme appraisal. These benefits are forecast to accrue over the whole appraisal period of 60 or, in the case of older schemes, 30 years. As POPE evaluation is at the stages of one and five years after opening, these outturn benefits are essentially reforecasts of the long term benefits based on evidence from the observed impacts from the post opening period.

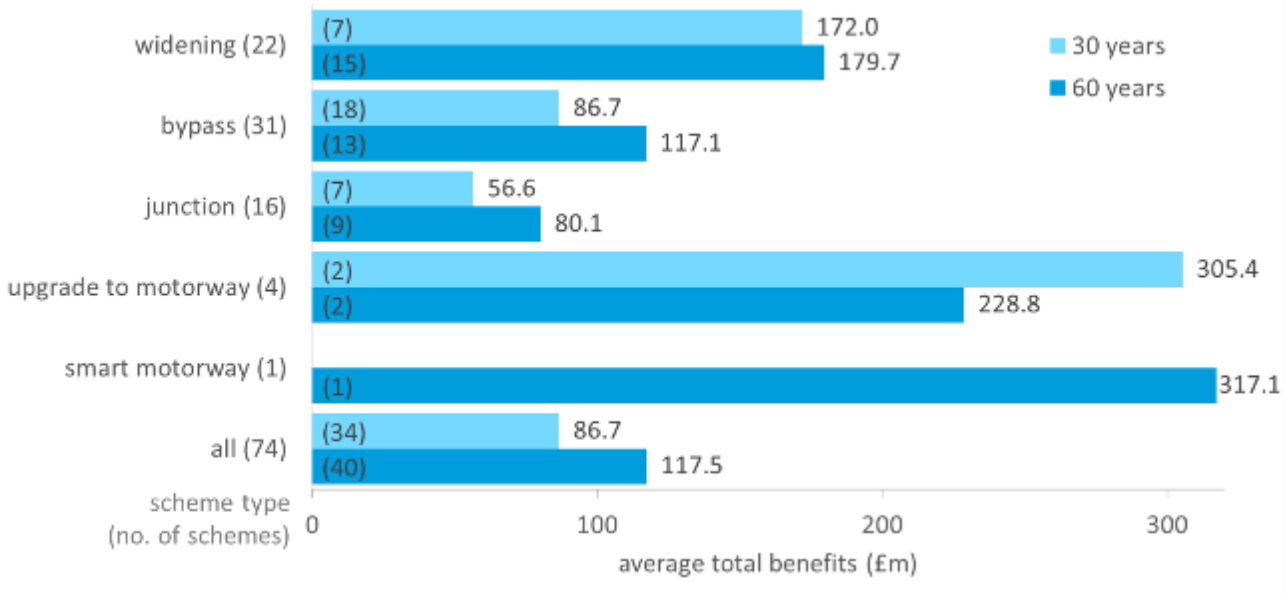
Section 5 of this report commencing on page 57 outlined that the POPE approach to the evaluation of safety benefits has changed to account for the general background reduction in collisions over time. This section of the report includes all schemes regardless of the collision evaluation methodology used. The reasons for this are twofold:

- To ensure that the sample size is sufficient for the findings to be meaningful.
- Because the safety benefits only form a small proportion of overall scheme benefits (as shown later in Figure 6-2), so the impact of the change of methodology is minimal.

Cost benefit analysis of a Major Scheme requires 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. Discounting is defined by the Treasury Green Book and under current guidance uses a discount rate of 3.5% for the first 30 years and 3% thereafter. All the results presented here are expressed in terms of present value of 2002 prices and values using this discount rate. A small number of schemes are omitted from the results presented in the economic results section here as their benefits were assessed in older time periods and discounting rates.

For the 74 schemes where the results are presented in 2002 prices and values, the average (median) total benefits by scheme type are summarised in Figure 6-1. These include the benefits are set out in Table 6-1 and include indirect tax revenue impact, where it was covered.

**Figure 6-1 Average Total Outturn Monetised Benefits per scheme (£m)**

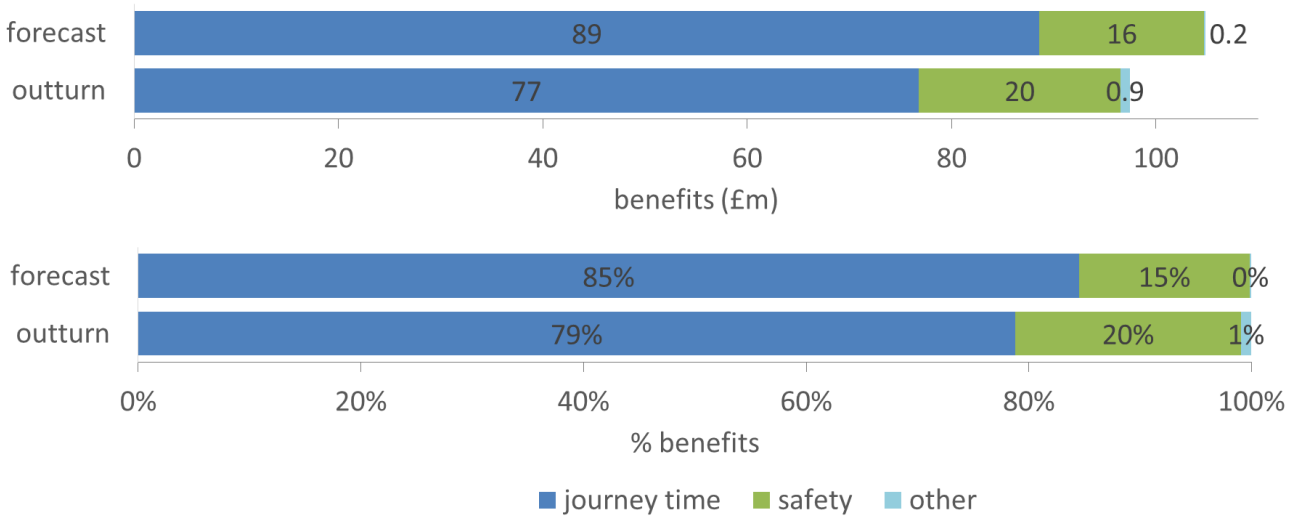



The key points of interest on the average benefits are:

- Junction schemes show the lowest benefits due almost all of them to being smaller in scale.
- Upgrade to motorway and the one smart motorway scheme were assessed as having the greatest benefits, but as noted later in the costs section 6.3, these are the most expensive schemes.
- Widening schemes also had above average benefits, but likewise this group included many of the more expensive schemes, for example motorway widening.

The breakdown of these benefits by benefit type is shown in Figure 6-2. These are the average (median) benefits. The category ‘other’ refers to the additional types of the users’ vehicle operating costs, indirect tax impact and others as listed in Table 6-1; this is based on only those schemes in which these other benefits were assessed.

**Figure 6-2 Average Benefit split by type (£m) and proportion (%)**

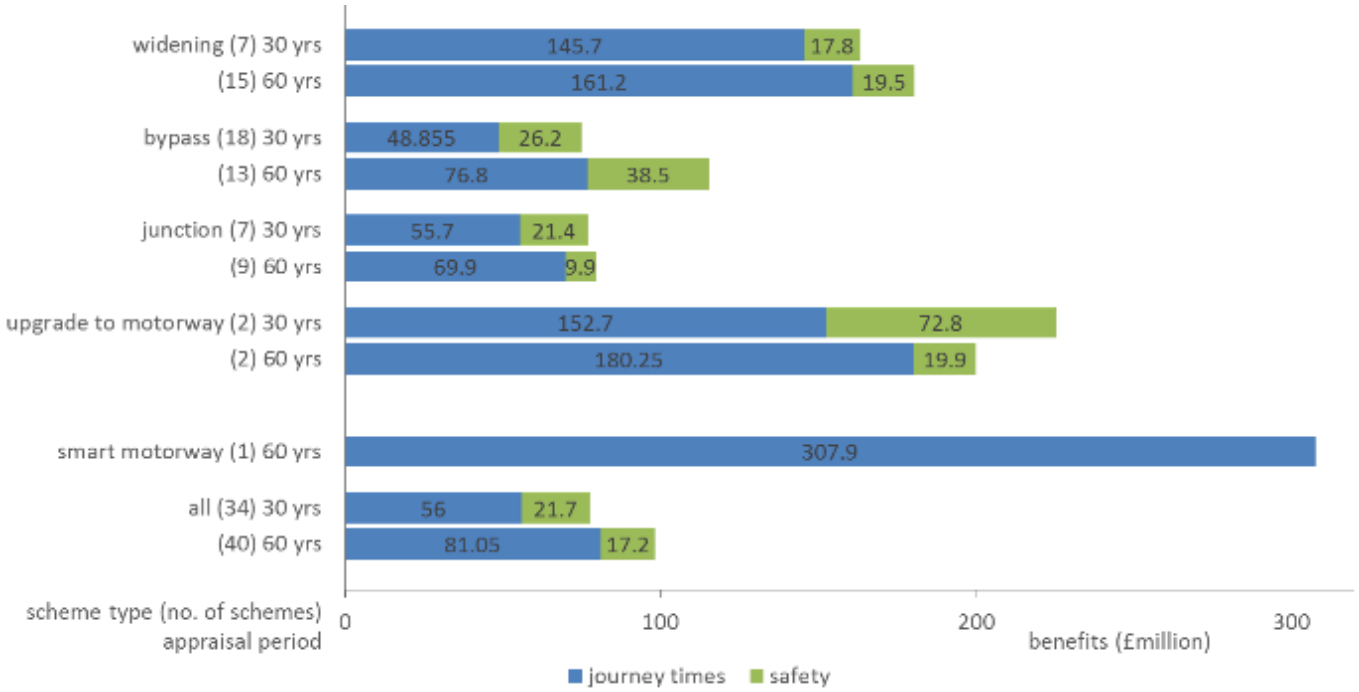



From the split of benefits presented here, the main points are:

- Journey time provide the majority of benefits. An outturn average of £77m per scheme.
- Safety benefits are the remainder of the benefits, on average 20% in the outturn assessment which is greater than the average forecast.
- The net total of the other benefits forms a very small proportion of the overall benefits, even considering only those evaluated impacts. However the low net impact obscures the fact that unlike the journey time benefits which are overwhelmingly assessed to be positive benefits, these other benefits include both positive and positive benefits as discussed later.

For the two key benefits types of journey times and safety, the level of benefits varies between schemes, which can be partly understood by examining the average level of outturn benefits by type of schemes as shown in Figure 6-3.

**Figure 6-3 Outturn Benefits split by scheme type and benefit type (£m)**




This shows:

- The greatest level of safety benefits is found in bypasses and upgrade to motorway schemes. This safety benefit is clearly associated with the greater change in road standard which is a key aspect of most of these schemes. For example, bypasses replacing single carriageways in built up areas and motorways replacing older dual carriageways.
- Of the three most common types of schemes (widening, bypasses, and junctions), widening schemes include the highest average benefits, despite lower safety benefits.

The range of benefits achieved for the individual schemes of all types and evaluation periods in shown in Figure 6-4, Figure 6-5, Figure 6-6 and Figure 6-7.

**Figure 6-4 Journey Time benefits (£m)**

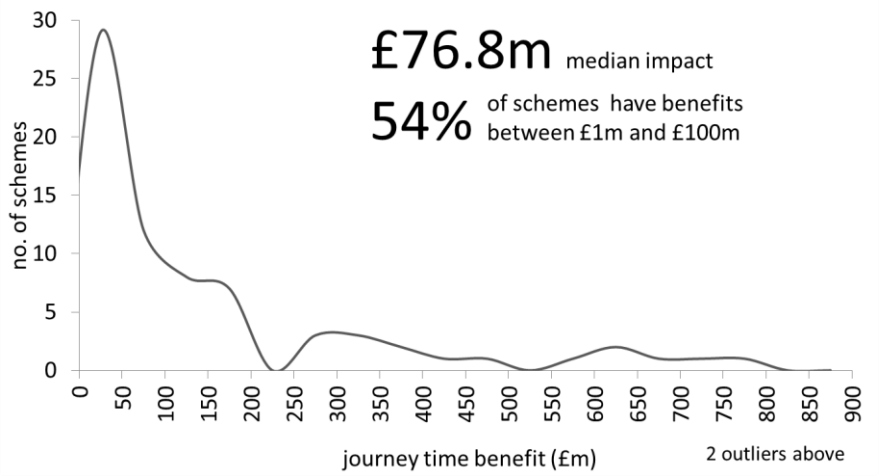



**Figure 6-5 Safety Benefits (£m)**

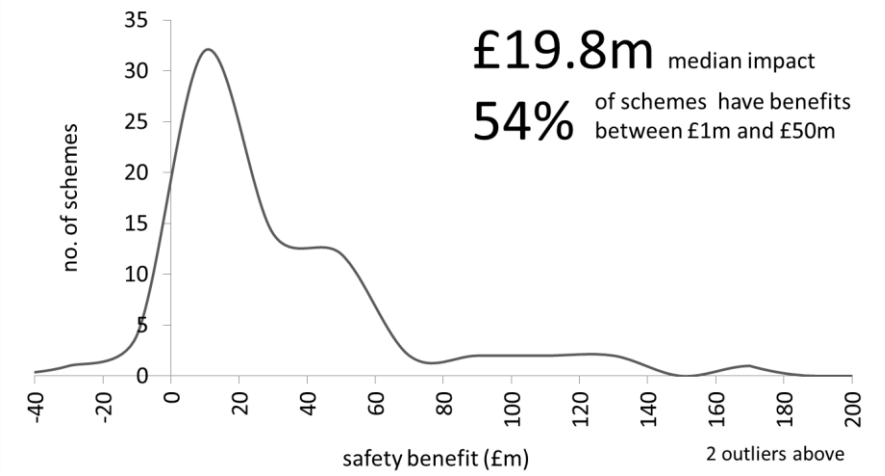



**Figure 6-6 Indirect Tax impact on Benefits (£m)**

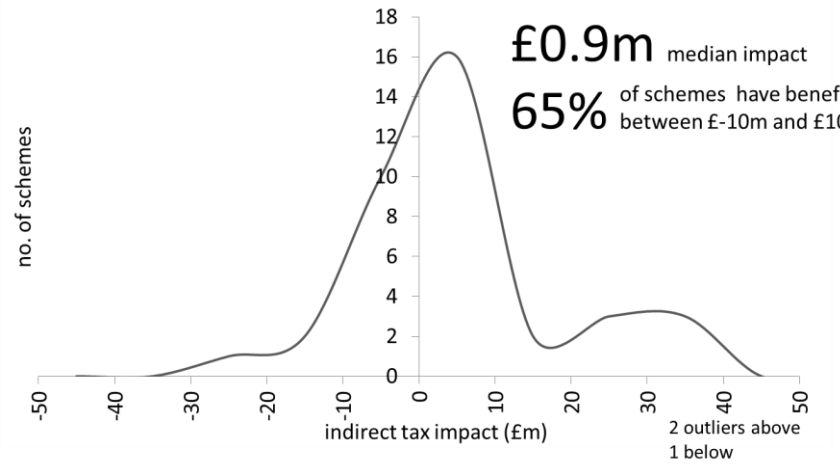
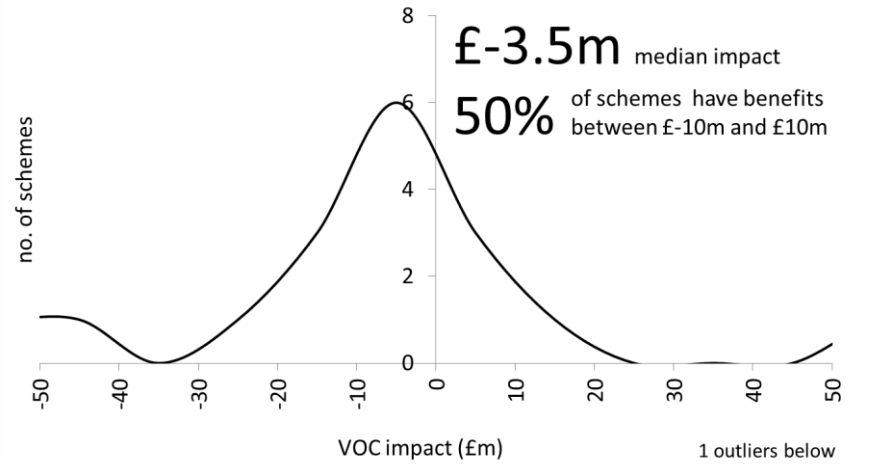



**Figure 6-7 Vehicle Operating Costs (VOC) Benefits (£m)**




Journey time and safety results are based on the evaluations undertaken for all schemes, whereas indirect tax results are based on 40 schemes and VOC for 18.

As noted earlier, the greatest benefits are from the journey time impact. This has produced only positive results. Safety benefits are positive for the large majority of schemes.

The impact of other types of benefits varies considerable between the positive and negative impacts as shown in Figure 6-6 and Figure 6-7. The indirect tax impact is the net impact for the Treasury on taxation revenue, primarily fuel duty and VAT.

A further impact which is important for some schemes is the impact of the construction period and future maintenance periods. Of those schemes where this has been considered, the median impact is £-2.6m but the range includes large negative benefits (e.g. due to delays to road users during the construction period) and large positives (future periods of maintenance will cause less delay to road users e.g. due to the wider road).

## 6.2 How accurate is the forecasting of Major Scheme benefits?

**Benefits arising from journey time savings are moderately accurate for most schemes. 28% of schemes have journey time benefits within 15% of that forecast and 74% of schemes are within 50%.**

**Safety benefit forecasts, however, are inaccurate for the majority of schemes with only a third having outturn benefits within 50% of forecast.**

**Net change in Vehicle Operating Costs and indirect tax impacts are mostly lower than forecast.**

**There is some indication of an improvement in benefit forecasting accuracy over time since 2000.**

This section examines the differences between the forecast monetised benefits and POPE calculation of the outturn benefits on a like-for-like basis.

All figures presented here are given according to the guidance on expressing monetary values for an appraisal period in terms of present value. When the evaluations included in this Meta-analysis were undertaken this was 2002 prices and values through the use of discounting. Differences between the forecast and outturn benefits have been measured by the percentage difference between the forecast figures in the schemes' appraisals and the latest POPE outturn evaluations for each scheme.

The benefits considered here have been split by the benefits for journey times and for safety in Figure 6-8 and Figure 6-9. Note that a number of motorway widening schemes predicted no monetary benefits arising from safety, thus, although benefits have been evaluated in POPE, the percentage difference from the forecast cannot be shown.

**Figure 6-8 Accuracy of forecast monetised journey time benefits**

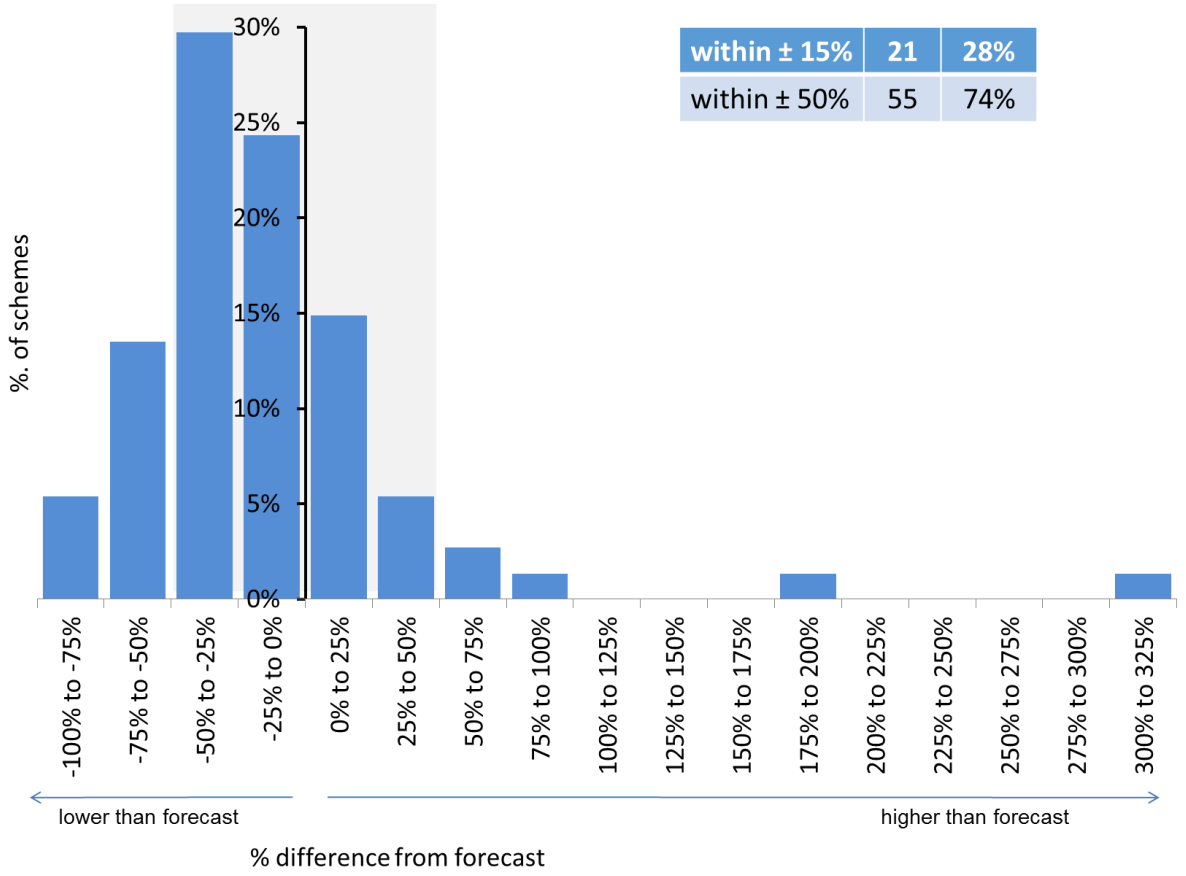
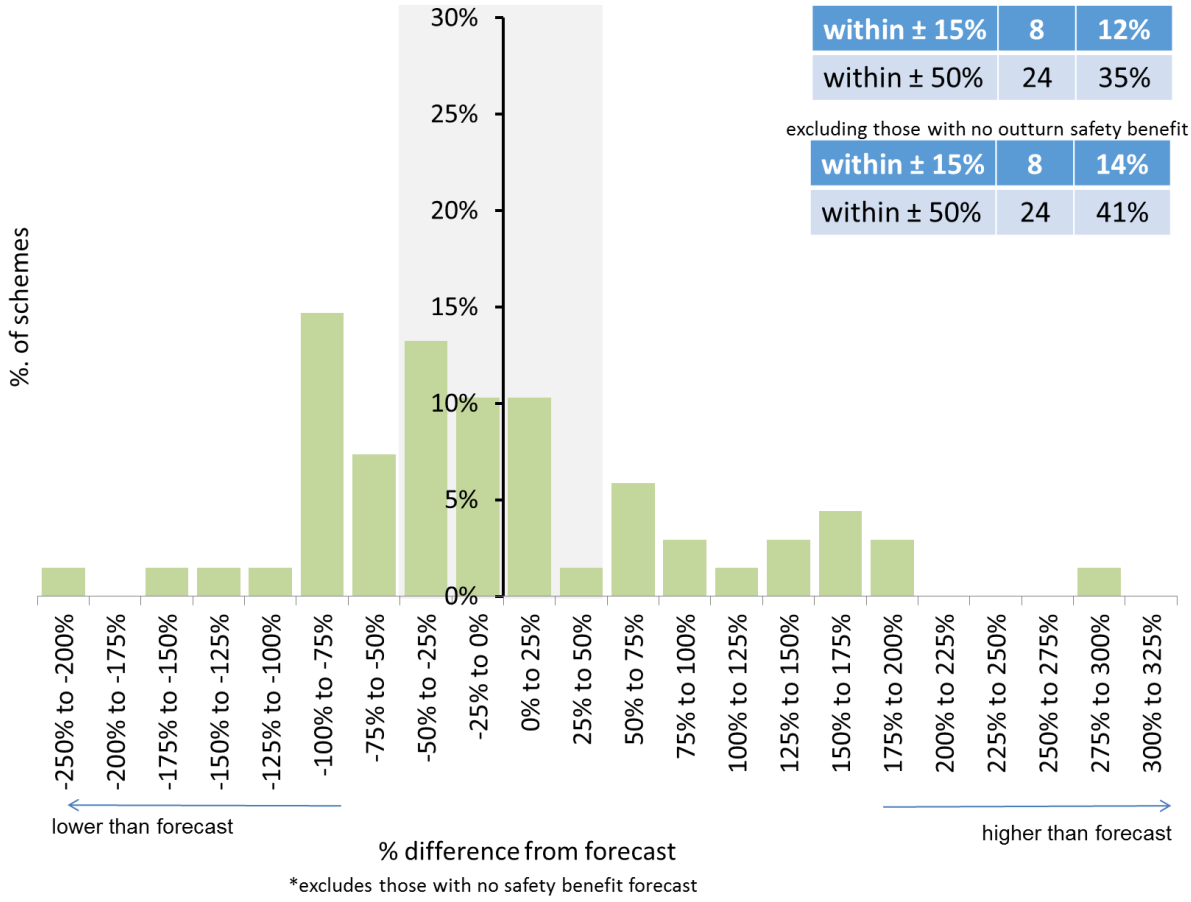



**Figure 6-9 Accuracy of forecast monetised safety benefits**



This analysis of the journey time and safety benefits forecasting accuracy shows:

- Journey time benefits are clearly more accurately forecast than safety benefits for most schemes;
- Journey time benefits for the majority of schemes (74%) are within 50% of the original forecasts;
- A greater proportion of schemes had journey time benefits which were rather lower than predicted. However it should be noted that the economic downturn in recent years has reduced the observed measure of benefits and that POPE outturn evaluation takes a conservative approach to the calculation of journey time benefits over the wide area as these are likely to be small impacts which are difficult to confidently attribute to the one change in the road network when there have been other changes affecting traffic patterns over the same time period.;
- A minority of schemes have journey time benefits which are substantially higher than predicted.
- Safety benefit forecasts have a much lower level of accuracy than those for journey times, with less than a third having outturn benefits within 50% of the forecast; and
- Assessment of outturn safety benefits accuracy shows an even split between half above that forecast and half below.

Reasons for the size of the differences between the forecast and outturn assessments of the safety benefits are as follows:

- For some schemes, the sample size of the available observed data is too small for confident prediction of long term trends. Safety benefits are based upon the monetisation of the net difference in the numbers of injury collisions with and without the scheme and of the changes in the severity levels of the casualties from these collisions. These predictions are based on established national data on such rates by type of road, (for example single carriageways with national speed limit have higher rates of fatal and severely injured casualties per collision than dual carriageways) and observed trends on the key roads when the scheme was appraised. These predicted impacts are monetised based on costs assigned to the casualties, with fatalities having the highest cost. Savings in the numbers of fatal and seriously injured casualties are recognised as being of high importance but, because these collisions only comprise a small proportion of all recorded collisions, long term trends in reduction of these severe collisions can only be based on national figures based on the road type.
- Where the collision forecasts are based on a small area, the strategic road does not have high traffic flows, or in a scheme with a low safety impact, the relatively low numbers for the net change mean that random variation plays a part in the observed results, especially for the more recent schemes which only have a year of post opening data, therefore under- or over-indicating the possible long term trend. To guard against this, the POPE methodology uses tests of statistical confidence in the findings and where net change is not significant, no monetised benefits are attributed. These are omitted from the results presented in Figure 6-9 as are the scheme which had a zero predicted monetised safety benefit.
- Appraisals of schemes' safety impacts were undertaken using the collision modelling software (COBA) which included the expectation of a collision rate reduction over time, except for motorways. However, the observed trend in collision reduction seen nationally as set out in section 5 has been falling substantially more steeply than expected for over a decade meaning it is likely that in many locations, collision rates could have reduced even without the scheme in place. The POPE methodology has been revised to more conservatively attribute safety benefits using national trends in collision reduction by road type. As the original predictions were based on higher rates of collisions in the COBA modelling based on the earlier national defaults by road type or as observed on key links within the scheme network, there was a greater safety impact. Outturn evaluations of the safety benefits taking the new trends into account are mostly lower than expected due to this.

Safety and journey time benefits make up the large majority of the benefits of Major Schemes and have been evaluated in all the POPE studies. Of the other benefits of schemes which are monetised and can be evaluated using post opening data, the assessment of the indirect tax impact and vehicle operating cost (VOC) have been undertaken for a number of schemes and findings are summarised in Figure 6-10 and Figure 6-11. Note that these plots only include the results where an evaluation was made based on observed data and omits schemes where it was not included or cases in which the impact was assumed to be as forecast.

**Figure 6-10 Accuracy of forecast Vehicle Operating Cost (VOC) benefits**

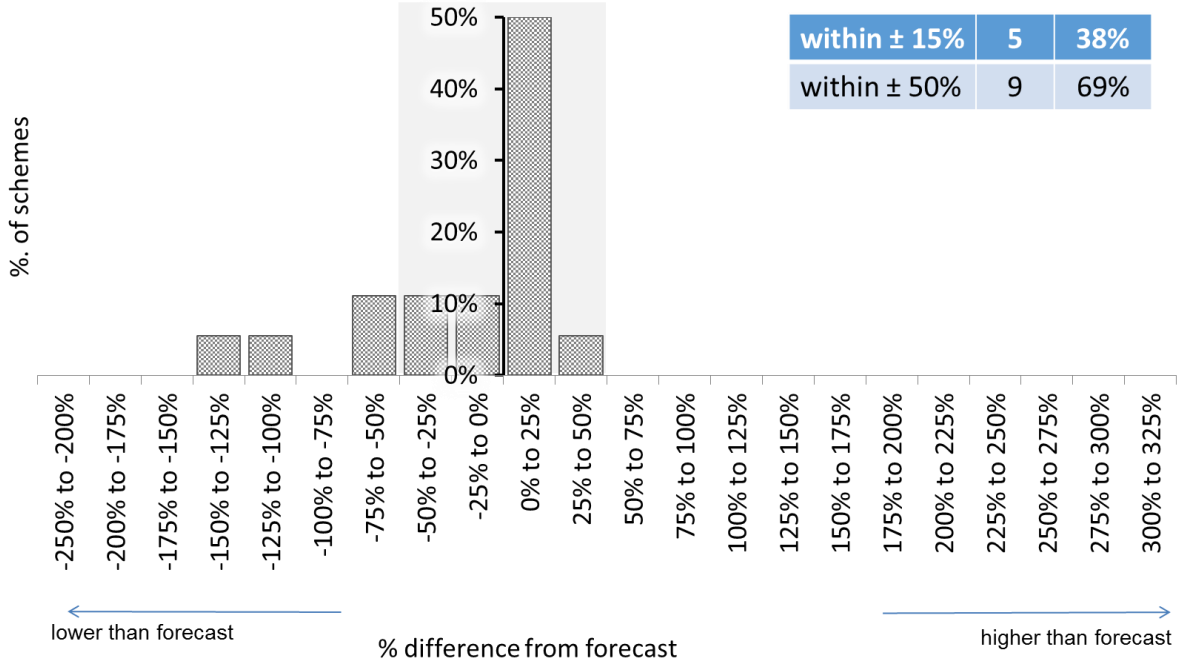
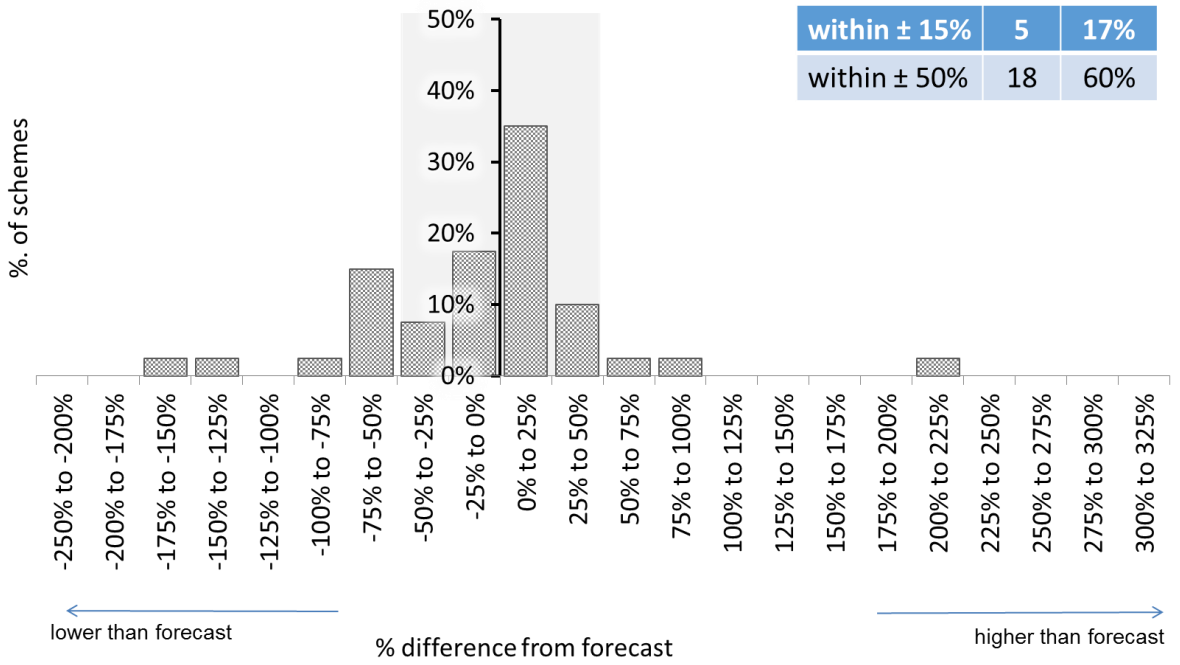



**Figure 6-11 Accuracy of forecast indirect tax impacts**




These plots of the accuracy of the other monetised benefits show:

- Vehicle Operating Cost and indirect tax impacts are mostly lower than forecast; and
- Over half of schemes have benefits within 50% of the forecast although this is a lower level of accuracy than noted for journey time savings in in Figure 6-8.

The accuracy of other monetised benefits is not considered here as their accuracies have not been evaluated within POPE or have been undertaken for only very few schemes.

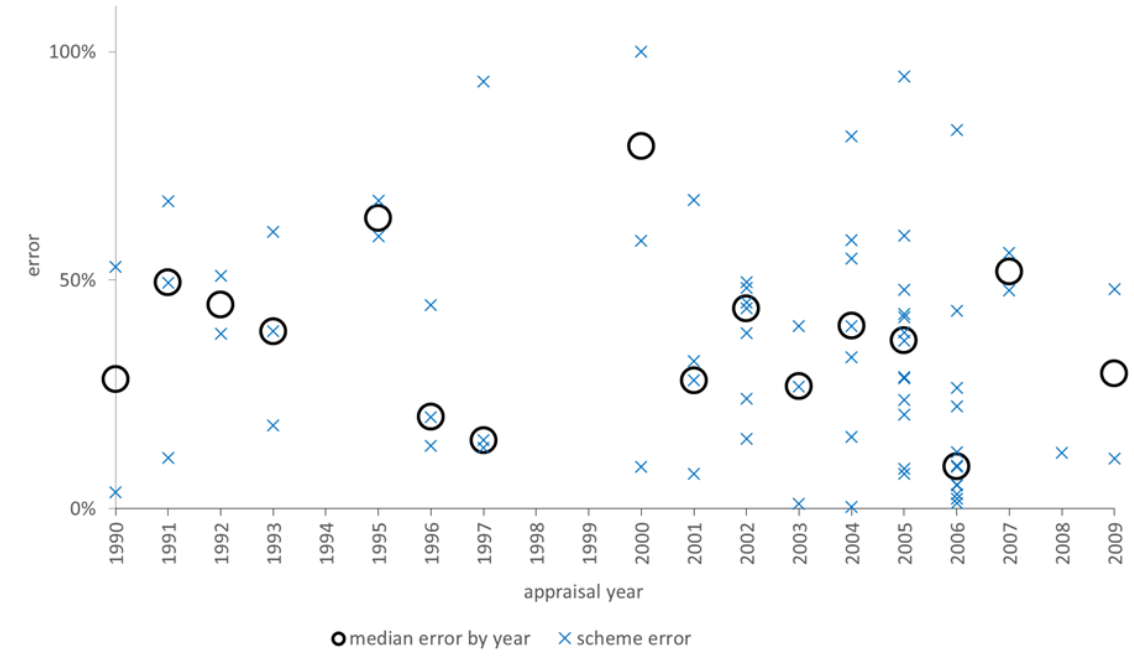
### 6.2.1 Breakdown of monetary benefits over time

The schemes in this meta-analysis have opening years between 2002 and 2012 and were appraised over a wider range of years from the early 1990s onwards.

The accuracy of the monetary forecasts of the benefits over time is illustrated in Figure 6-12 and Figure 6-13. Differences between the forecast and outturn benefits have been measured by the percentage difference between the forecast figures in the schemes' appraisals and the latest POPE outturn evaluations for each scheme. These include FYA results, where available, else OYA findings. This includes schemes with appraisal periods of both 30 and 60 years but, as the evaluation method is the same and the outturn benefits period matches the length of the appraisal, the same proportional difference is applicable. Appraisal years are grouped for the 1990s years and fore the most recent schemes in order to give a reasonable sample size.

Values per year for time period here are for all individual scheme results, excluding two outliers for each, and the averages (median) by year. Fewer schemes are included in the safety benefit accuracy sample due to the omission of those with no safety benefit prediction. There are however nine schemes in which, although a benefit was predicted, the outturn evaluation was zero hence a 100% margin of error.

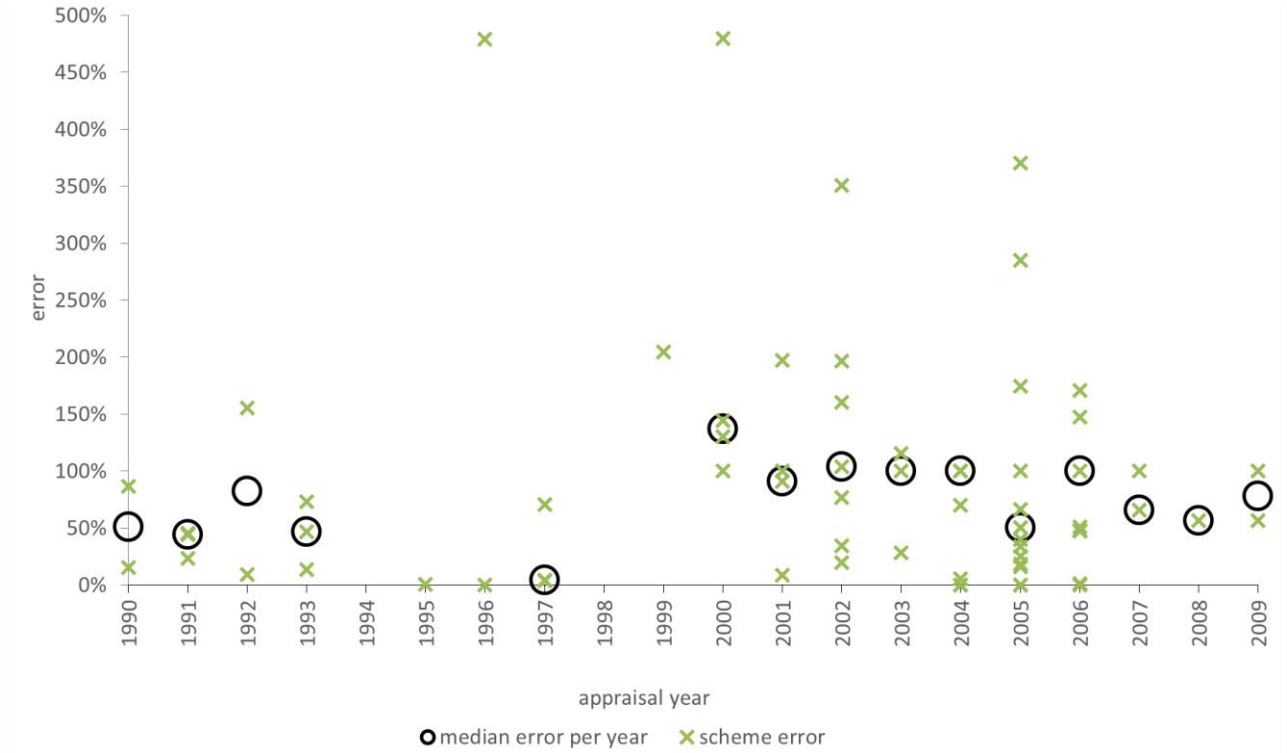
**Figure 6-12 Journey time benefit forecasting accuracy over time**




The plot of benefits forecasting accuracy grouped by appraisal year in Figure 6-12 shows:

- Journey time benefits are consistently more accurate than safety benefits, except for the very oldest appraisals (early 1990s).
- Journey time benefits show some evidence for an improvement in accuracy over time from 2000 to 2006, a period which covers two-thirds of the schemes here. The handful of 2007-2009 appraisals is too small to draw firm conclusions of a worsening.

**Figure 6-13 Safety Benefit forecasting accuracy over time**




The plot of safety benefit forecasting accuracy grouped by appraisal year in Figure 6-13 shows:

- Safety benefits, as shown earlier, have a much larger margin of error than journey time benefits; and
- There is some indication of an improvement in accuracy over time post 2000.

## 6.3 How accurate is the forecasting of Major Scheme costs?

**Half of the Major Schemes had estimated costs in the business case within 15% of the outturn cost.**

**Since 2004, accuracy of cost estimating in scheme appraisal has been consistently improving.**

For all of the Major Schemes evaluated within POPE, we have compared the outturn capital cost of the scheme at the time of the POPE study with estimated cost in the business case. As with the scheme monetary benefits, costs have been compared on a like-for-like basis through conversion to a common 2002 price base year. 73 schemes for which it was possible to present the costs in 2002 prices have been included in the assessment in this section.

POPE does not include detailed investigation of the reasons behind the inaccuracies of the cost predictions, but one of the main reasons has been found to be the length of the time period between the appraisal and the start of works. It is known, for example, that cost increases have occurred due to changes in the scheme following the economic appraisal such as additional flood prevention measures.

The sizes and hence costs of Major Schemes covers a wide range from £10m to over £400m, so here we focus on the size of the difference between the estimated and outturn costs, as shown in Figure 6-14.

**Figure 6-14 Net margin of error in between estimated and outturn scheme capital costs (£m)**

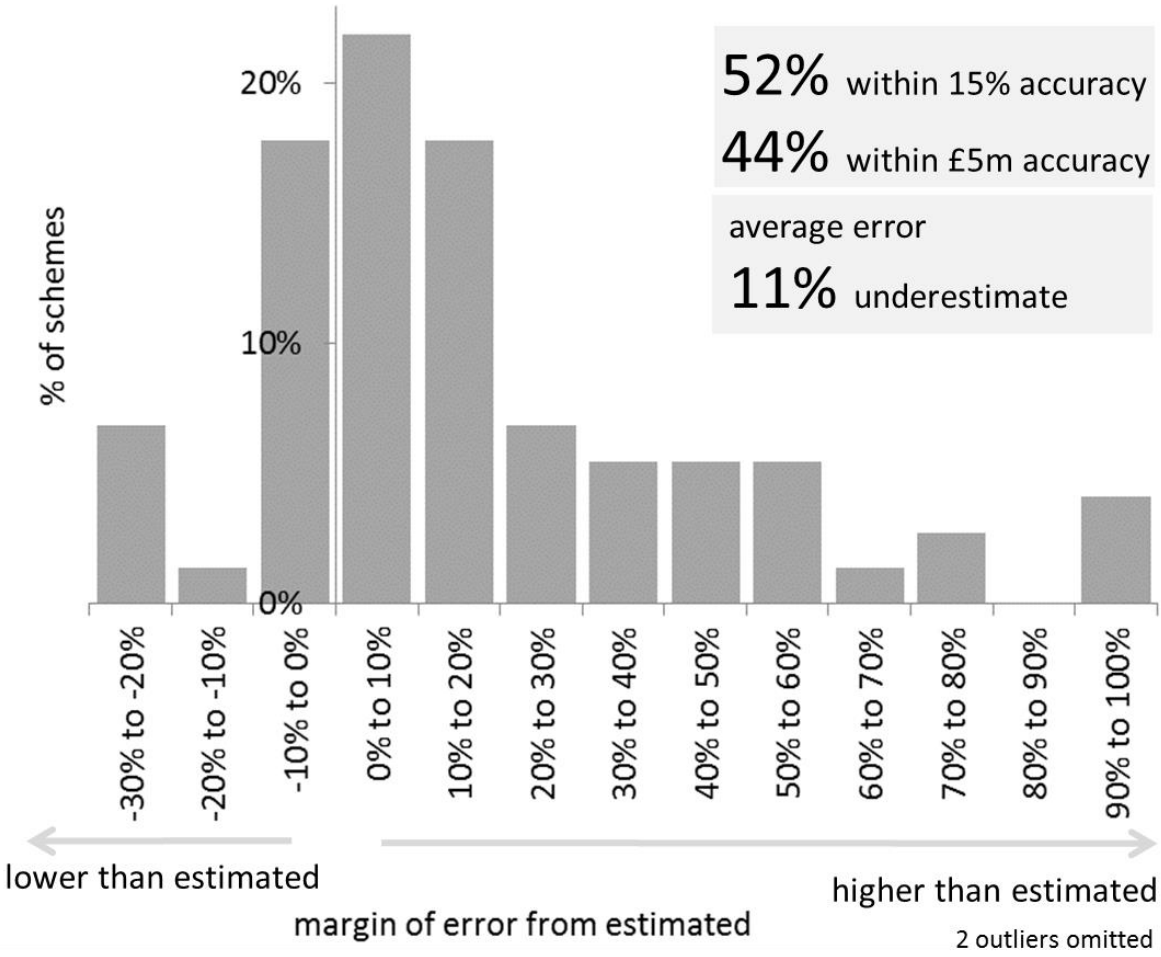



Figure 6-14 shows that the margin of error was most commonly between zero and 10%, although the average (median) error was an 11% underestimate. There was a handful of schemes with much higher levels of underestimation and, more rarely, overestimation.

Just over half (52%) were accurate within 15% of the original forecast costs set out in the business case.

To evaluate whether cost estimating has got better over time, the size of the margin of error as a proportion of the outturn cost has been plotted against the year the scheme was appraised. Appraisal of the individual Major Schemes in this meta-analysis has often taken place over a number of years. During this time there may have been several updates to the estimated capital costs. Here we consider only the estimated cost in the business cases. Figure 6-15 shows the average (median) margin of error between the estimated and outturn costs over time and the range of error is shown by period in Figure 6-16.

**Figure 6-15 Margin of error of capital cost estimates by appraisal period**

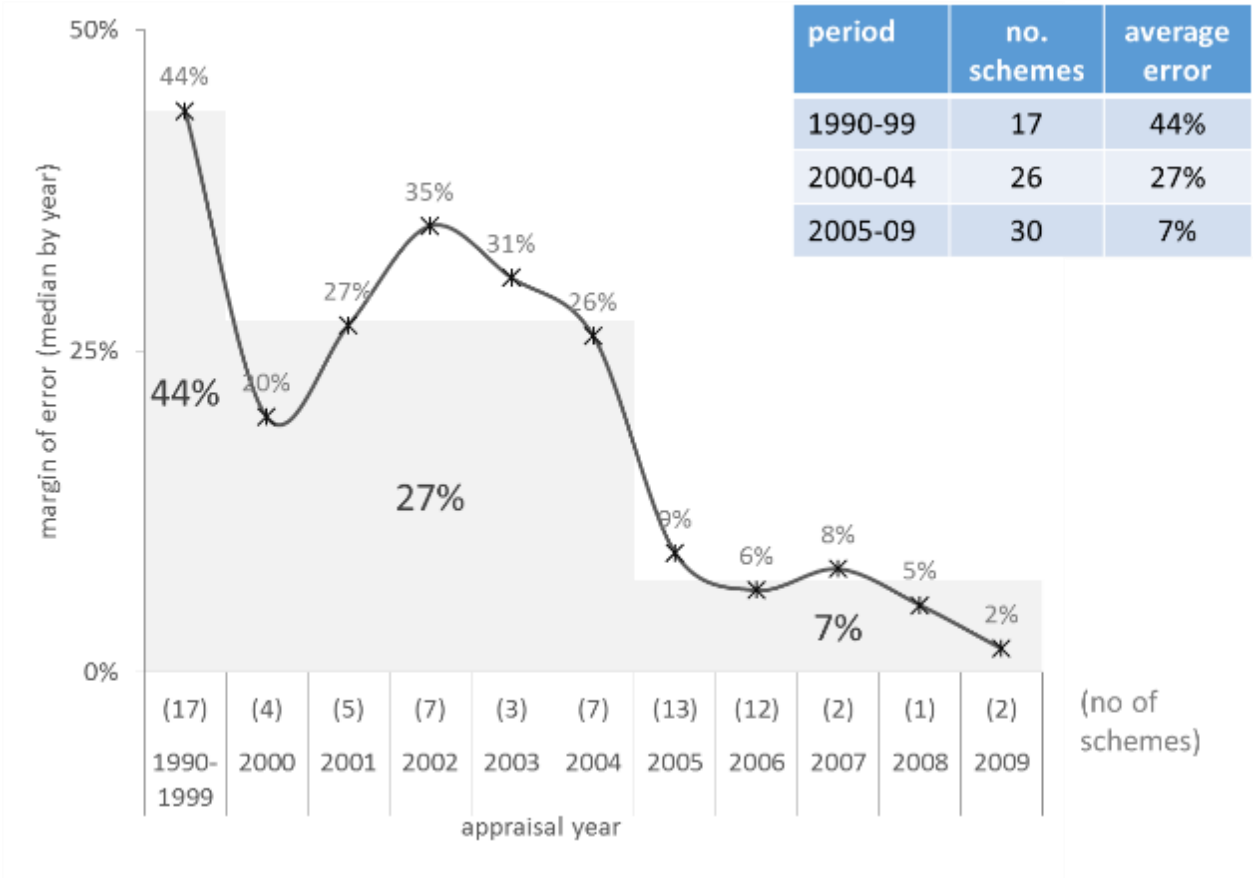
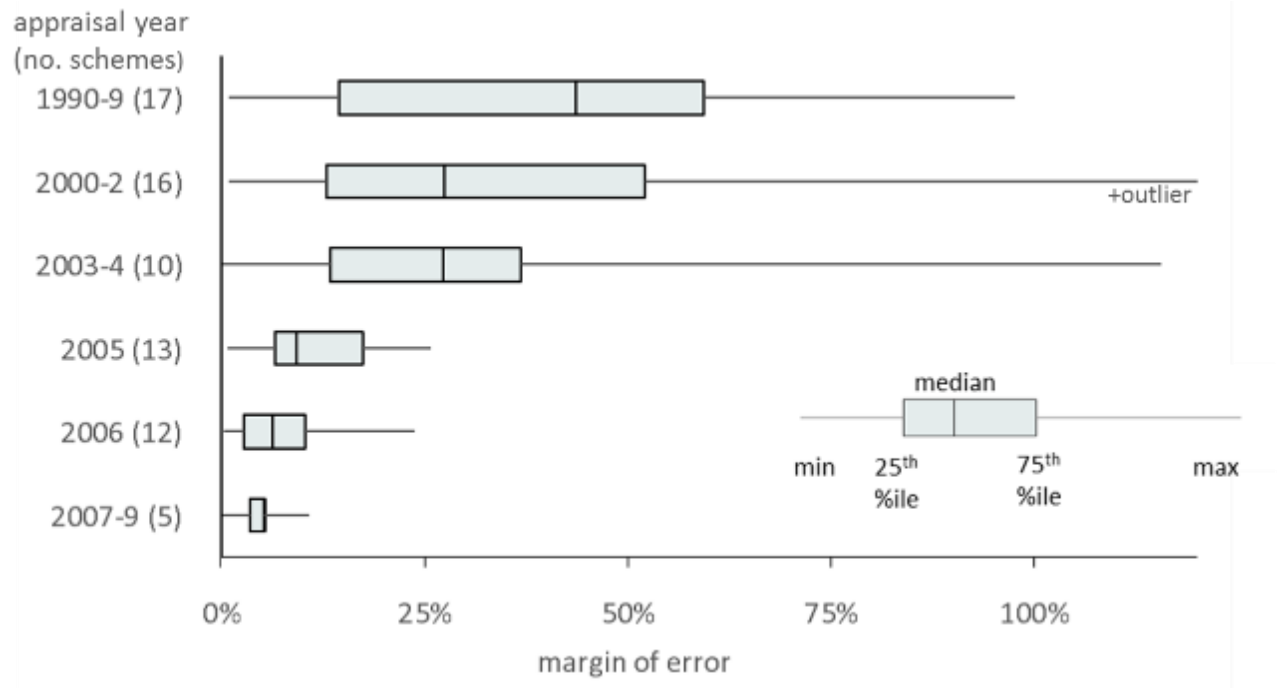



**Figure 6-16 Range of Cost Margin error by appraisal period**




The schemes included in this meta-analysis were appraised over a wide period. Highways England changed its cost forecasting methods in 2007 ('three point cost estimating'). Two schemes in the 2007-9 period used this method.

It is early at this stage to be confident that this has led to an improvement in cost accuracy but the data presented here gives a good indication of a trend for reduced margin of error in recent years.

Although in recent years, Major Schemes have generally been appraised at only a short period prior to construction; the same cannot be said for the oldest schemes included within the POPE studies which date back to the start of the TPI (Targeted Programme of Improvements) begun in the late 1990s, now known as the Major Schemes programme.

The main trends highlighted by Figure 6-15 and Figure 6-16 are:

- In the most recent years, from 2005 onwards, the average cost difference is only 7%;
- In the five years to 2004, there was a greater average margin of error and no trend in cost accuracy over time; and
- Most of the larger errors are from the schemes where the costs were estimated in the 1990s. The gap of a decade before these were built is likely to be the main reason for the errors of these schemes.

### 6.3.1 What is the average cost of a Major Scheme?

**Major Schemes cost £39.5million in 2002 prices on average, and 60% of these schemes cost below £50million.**

The sizes and hence costs of Major Schemes cover a wide range from £10m to over £400m. Here we give an overview of the average costs (Figure 6-17) and the range based on the types of schemes (Figure 6-18). These are based on 74 schemes and are given in 2002 prices.

**Figure 6-17 Average outturn cost by scheme type**

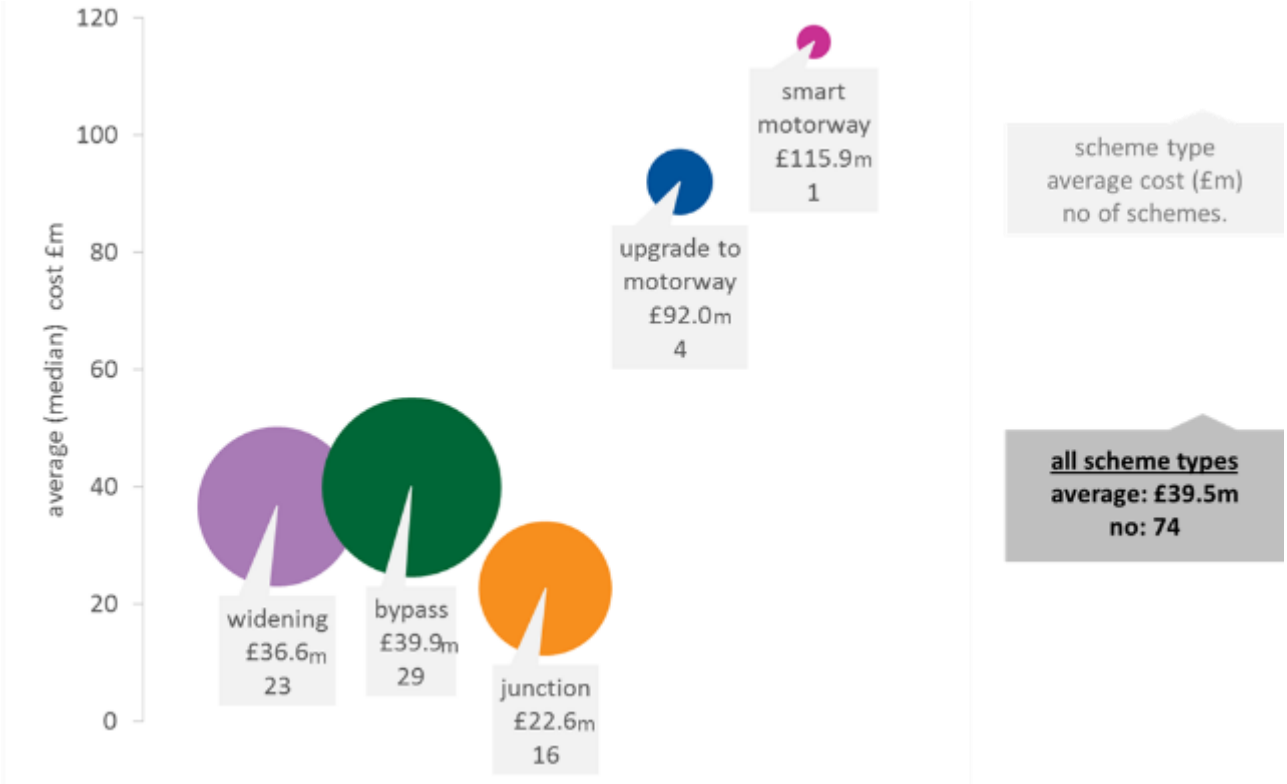
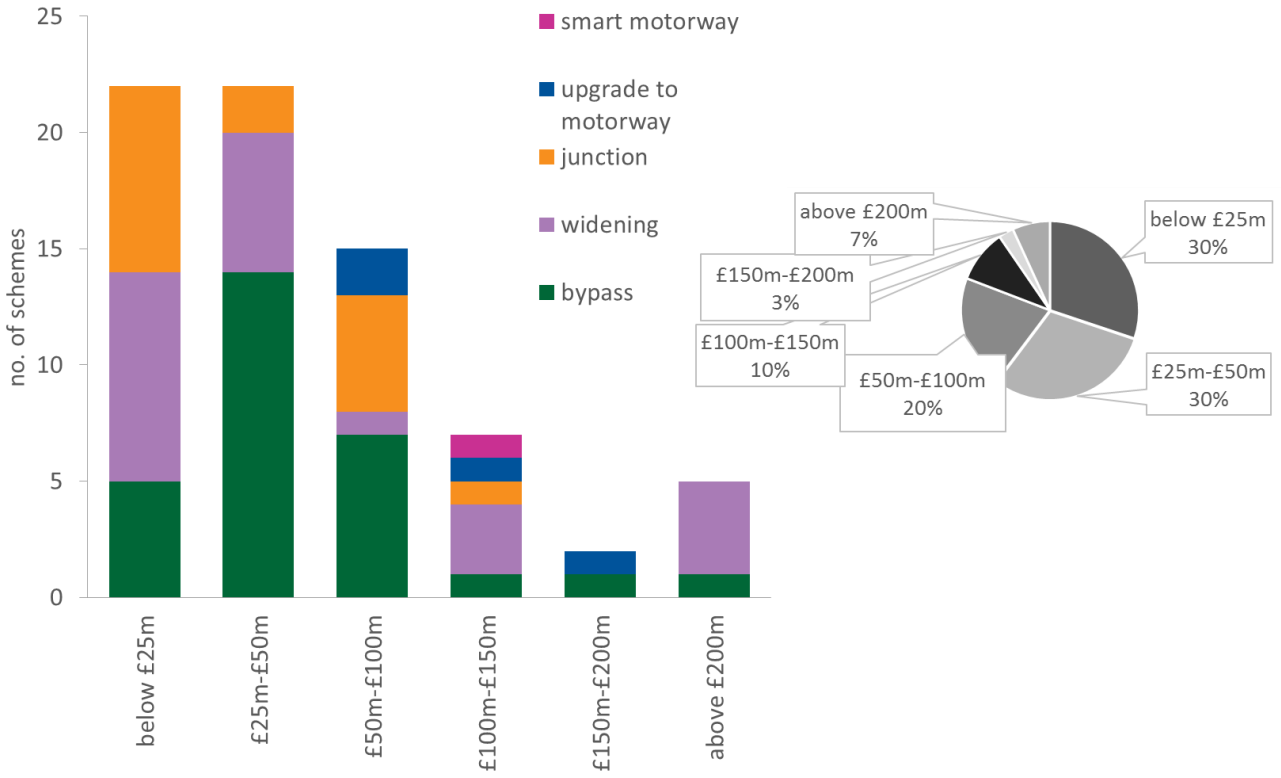


**Figure 6-18 Outturn costs by scheme type**




The range of scheme costs shows that:

- 60% of scheme costs less than £50m and the average cost overall was £39.5m;
- 20% of scheme costs were over £100m;
- Widening and bypass schemes included the lowest and highest costs reflecting the variation in the scope of these from motorway widening to smaller improvements in quieter parts of the SRN; and
- Upgrading to motorway schemes and the one smart motorway were all expensive, reflecting the greater scale of these types of schemes

## 6.4 Are Major Schemes offering value for money?

**Post opening evaluation shows that the average Benefit Cost Ratio of major schemes is 2.7, which means that on average, for every £1 spent on the scheme, the return will be £2.70 in long term economic benefits.**

**73% of schemes achieved high value for money and 88% achieved medium or high value for money. A scheme is high value for money if the benefits are over double the cost.**

Cost-benefit analysis is used to assess the value for money of Major Schemes. This involves the comparison between the cost of a scheme and its long term benefits.

In 2004, the DfT introduced a process which assigns an overall Value for Money (VfM) rating to a scheme. The VfM rating is an internal management measure used to inform decisions about a scheme. The VfM rating is also used to inform the ranking of schemes within a limited budget. The benefits to which WebTAG currently assigns market, or monetary, values, are the effects of the scheme on: the time and operating costs for consumers and business users; risk of fatality, injury or accident; physical fitness; carbon emissions; and noise. However, this would be to ignore other impacts which, while not being

monetized, may have a significant effect on welfare. These impacts could be material to whether or not a scheme is worth implementing or its priority and are taken into account in the VfM process.

Submissions for the funding of a proposed Major Scheme must set out the VfM in accordance with DfT guidance. VfM is based on a number of indicators, key among which is the ratio between the costs and benefits, known as the Benefit Cost Ratio (BCR).

BCR is calculated by dividing the present value benefits by the present value costs. Expressing all costs and benefits in terms of present value means that values of money in the future (in particular the benefits which will extend for decades into the future) can be compared with costs which are spent earlier.

DfT guidance on Value for Money uses the following ranges of BCR used to categorise schemes as:

Benefits are less than costs (below £1 of benefits for every £1 spent):

- Poor value for money if BCR is less than 1;

Benefits are greater than costs (for every £1 spent, there will be more than £1 of benefits):

- Low value for money if BCR is between 1 and 1.5;
- Medium value for money if BCR is between 1.5 and 2;
- High value for money if BCR is between 2 and 4; and
- Very high value for money if BCR is over 4.

Non-monetised impacts are also considered and, if significant, can shift the VfM categorisation up or down from that derived by the BCR.

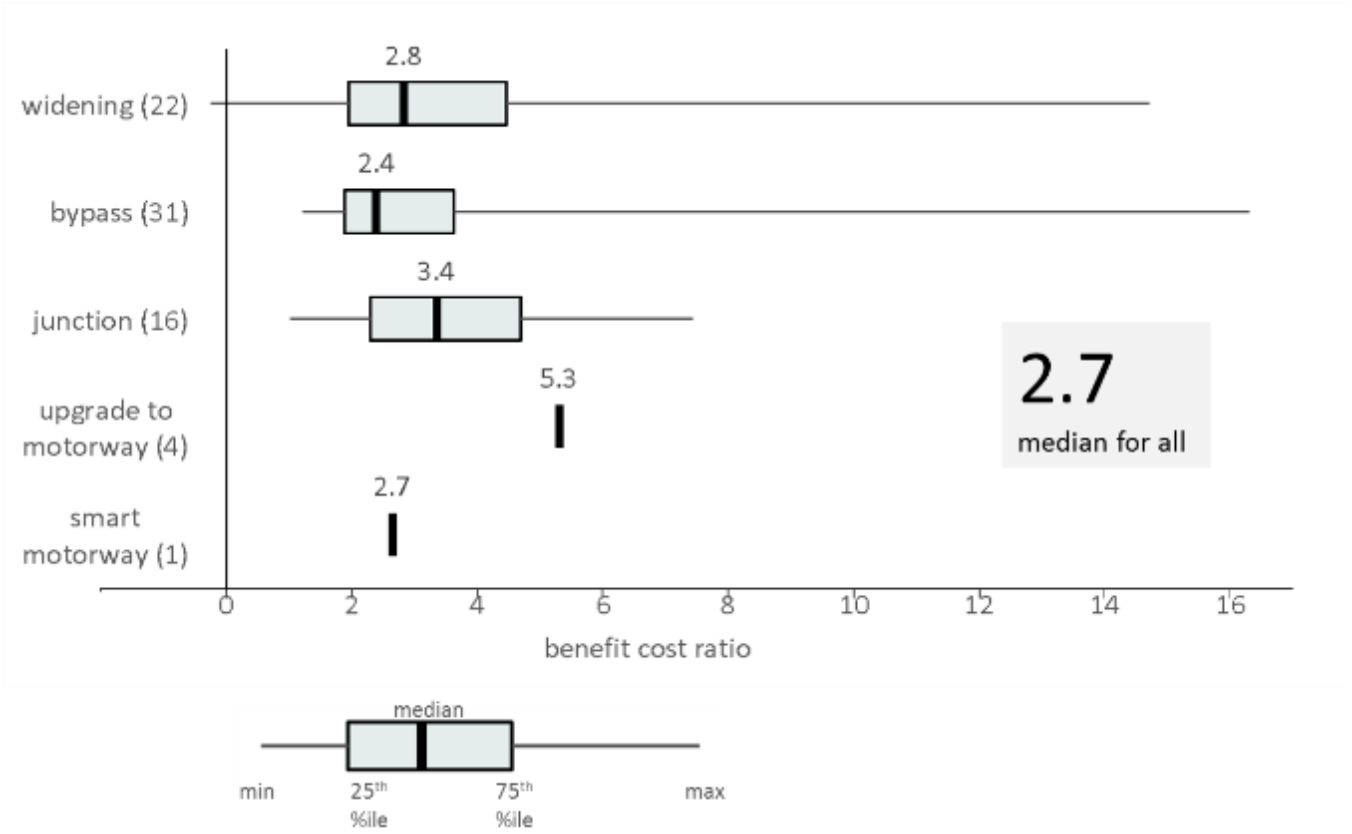
Using the outturn costs and the evaluations of the monetary benefits, Benefit Cost Ratios have been calculated for the evaluated schemes in POPE[23] and VfM categories determined. Non-monetised benefits are not considered here.

As noted in Table 6-1, in this meta-analysis the indirect tax impact is treated as part of the benefits rather than part of the costs, and this approach is in line with current guidance. Therefore it should be noted that the assessment of BCR likewise uses this approach and not that which was used in many of the schemes' original appraisals where indirect tax was included in a scheme's costs.

The averages and the range of the outturn Benefit Cost Ratios which have been achieved are shown by type of scheme in Figure 6-19.

[23] 73 schemes with costs and benefits expressed in 2002 prices and values for appraisal periods of 30 or 60 years

**Figure 6-19 Outturn Benefit Cost Ratios by scheme type**



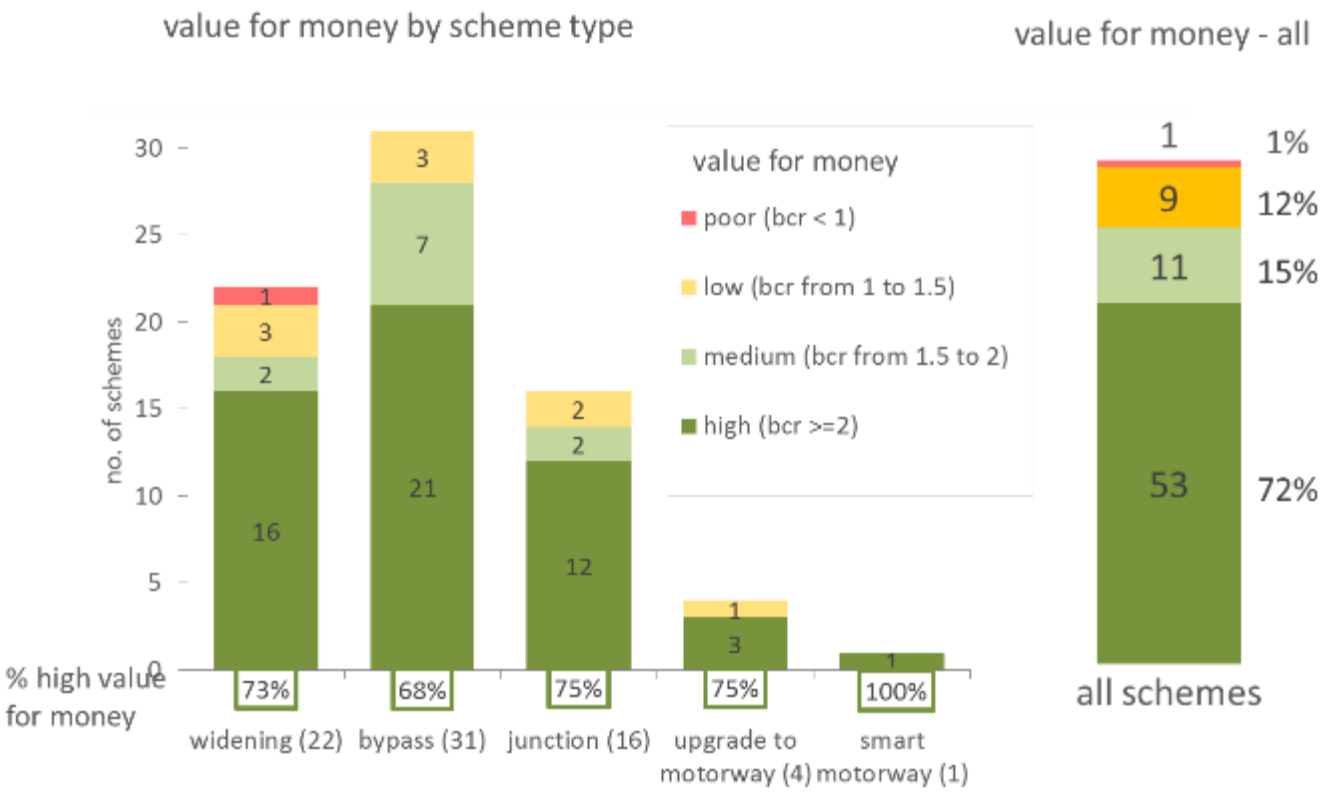

The range of BCRs in Figure 6-19 shows:

- All of the types of schemes have an average (median) BCR of 2.7, indicating that on average, the benefits will be more than double the cost;
- On average junction schemes had the highest average BCR of the types with a good sample size;
- All types of scheme show a wide range of BCRs, reflecting the variety of types of improvements undertaken within the categories presented here and their varying levels of success; and
- The majority of outturn evaluations of the benefit costs ratios are above two, meaning the benefits are more than double the costs.

Further analysis of value for money is the calculation of the ratio of the net present value to the cost (NPV/£). The average for all schemes is 1.7 (median) and 3.3 (mean).

The outturn BCRs have been used to categorise each scheme in the assessment of value for money according to the DfT criteria as set out above and the results are shown in Figure 6-20.

**Figure 6-20 Outturn Value for Money Assessments of schemes**




The key points regarding the value for money for the different scheme types are:

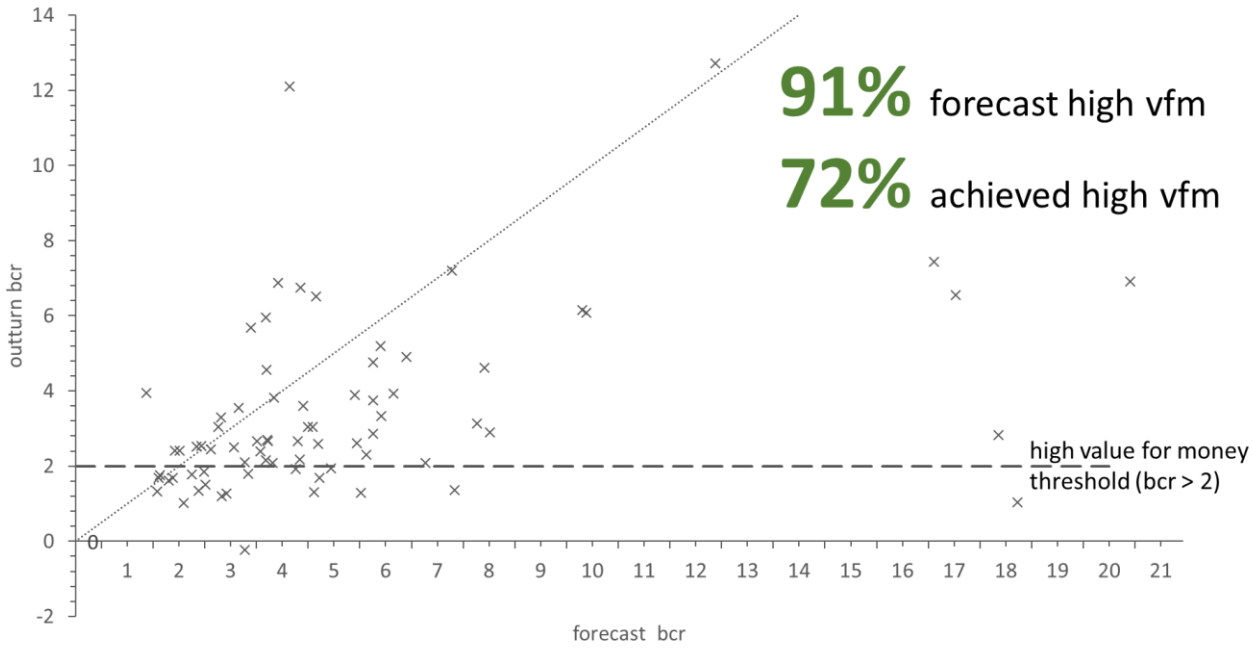
- The majority (72%) of all schemes show high value for money;
- 87% of schemes achieve medium or high value for money; and
- Schemes which fall into the lower value for money categories are most commonly bypasses. It is noted at the start of this report that this type of scheme was mainly completed in the earlier years of the period covered by this study (Figure 2-1) and this contributes to the change in VfM over time as discussed in Section 6.4.1.

It was noted earlier in section 5, that safety benefit evaluation methodology has been revised to more accurately reflect background trends in collision reduction. This means that the collision saving is lower than forecast, based on the assumption that without the scheme in place, there would have still been some collision reduction. This means that the monetised benefit of the safety improvement which is attributed to the scheme rather than other influences is lower and in some cases, may not be sufficiently large to be statistically significant, therefore reducing the overall monetary benefits and hence the BCR. Three schemes which were evaluated using the new approach have VfM categories which are lower than the 'high value for money' classification which had been expected, and this is partly due to the safety benefits being lower than forecast, although it should be noted that these three schemes are among the smallest of all the Major Schemes evaluated in POPE and are located on some of the least busy 'A' roads on Highways England's network.

Further to the examination of the outturn benefit cost ratios is the comparison against the original forecast ratios per scheme and expected value for money assessments.

Figure 6-21 presents the forecast and outturn benefits costs ratios.

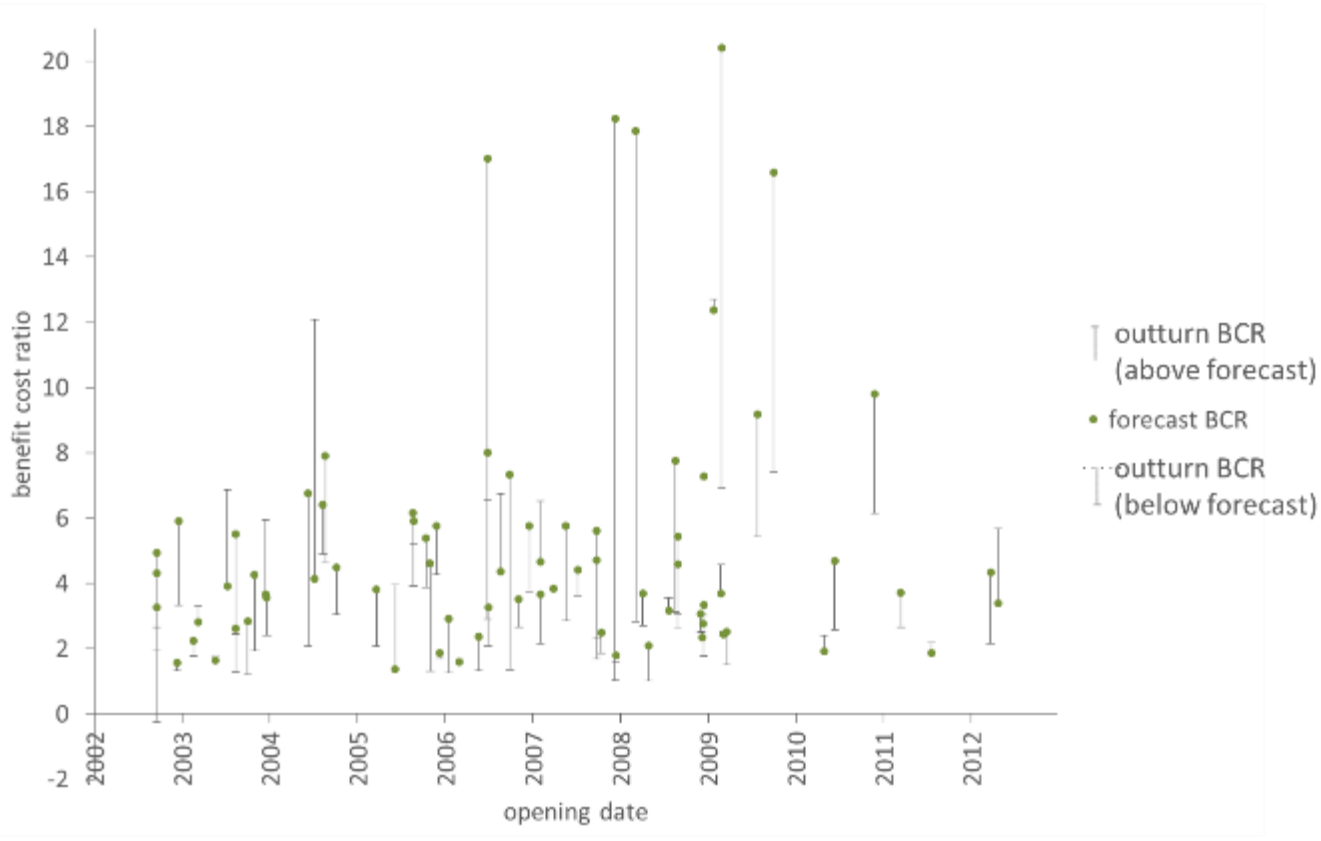
**Figure 6-21 Comparison between forecast and outturn benefit cost ratios by scheme**




This shows that although the majority of schemes are high value for money, the benefit costs ratios are mostly below forecast.

Figure 6-22 shows the trend over time in the margin of error showing all schemes.

**Figure 6-22 Margin of error of benefit cost ratio forecasts over time**



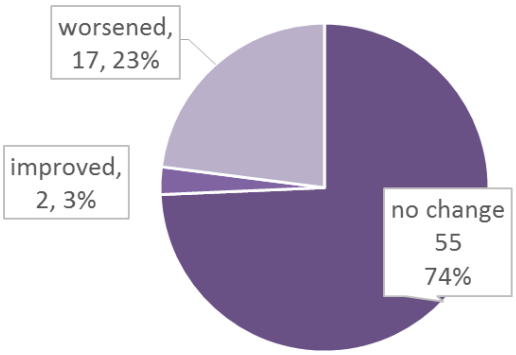

This graph presenting the individual margins of error shows:

- The accuracy of the forecast BCR varies widely. Only 18% were within 15% of that forecast

- There is no clear evidence of a trend over time.

Although this accuracy appears of concern, what is more important is the categorisation by value for money. This accuracy by scheme is summarised in Figure 6-23.

**Figure 6-23 Difference between forecast and outturn value for money (VfM) assessments (based on monetised results only)**




They important point illustrated here is that over three-quarters of schemes achieved the expected category of VfM or better.

As those schemes which have been evaluated to have a VfM assessment in a category lower than expected, further investigation has been undertaken of the reasons behind this which shows the following for the 17 which have an outturn VfM lower than forecast:

- 29% cost increase;
- 24% lower or no safety benefit;
- 29% lower journey time savings than predicted;
- 35% lower traffic volume using the scheme than predicted; and
- 18% predicted benefits in wider area could not be confidently identified.

The two schemes in which the VfM category was improved from that forecast achieved this through better than expected safety benefits.

It should be noted that the VfM analysis presented here excludes several impacts which are included in the VfM categories used by ministers when making decisions. This includes journey time variability (JTV) which, because it improves with reduced congestion, will tend to enhance a scheme's VfM category were it to be included.

### 6.4.1 Has value for money changed over time?

**In recent years, from 2008 onwards, the proportion of schemes achieving high value for money has improved compared with that seen in the earlier part of the decade.**

Evidence for a trend in value for money assessments over time for completed schemes has been investigated by plotting the numbers of schemes falling into each category, as assessed by the outturn BCR, grouped by the opening year. This is shown in Figure 6-24.

**Figure 6-24 Outturn Value for Money assessment over time**


This histogram shows:

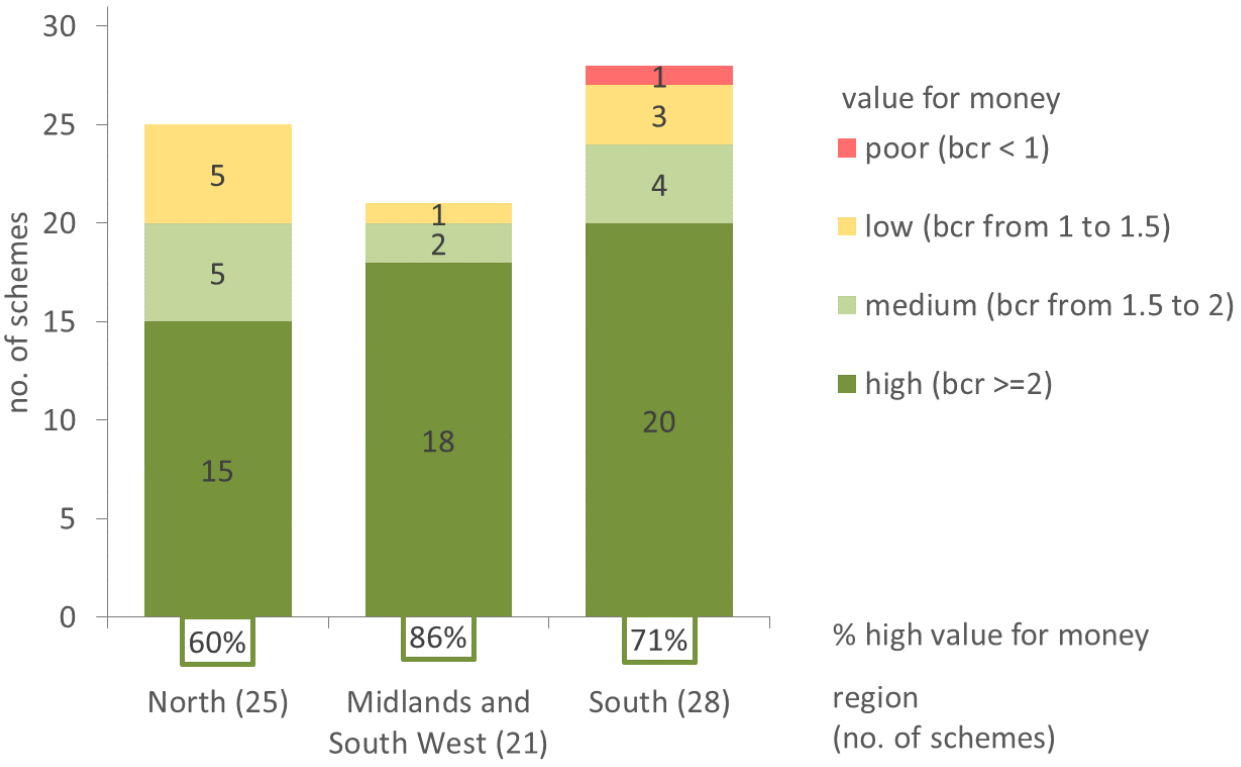
- Strong indication of a trend towards a greater proportion of schemes achieving a high value for money assessment over time; and
- Although few schemes are categorised as low or poor value for money there appears to be a trend for this to fall.

### 6.4.2 Do value for money assessments vary between Highways England's regions?

**There is no evidence in the outturn value for money assessments of Major Schemes for differing trend between Highways England's regions.**

The Major Schemes considered within this meta-analysis are spread throughout England, as illustrated in Figure 2-2, and within Highways England, these are managed within three different regions. The outturn value for money assessments for all the schemes have been grouped by region and this is shown in Figure 6-25.

**Figure 6-25 Outturn Value for Money by Highways England's Major Projects regions**




This shows that:

- The majority of the schemes in each region have achieved high value for money; and
- Schemes which are rated as lower value for money are spread across the regions showing that there is no evidence here of a problem in a particular region.

## 6.5 Are Major Schemes stimulating economic development?

**There is anecdotal evidence to show that Major Schemes have assisted local and regional economic development through congestion reduction and improved journey time reliability which provides improved access to potential employment centres.**

The government sees the strategic road network as being vital to British businesses and to the successful functioning of local and national economies[24]. The network not only provides England's main freight and logistics arteries, which connect international gateways, logistics interchanges and distribution centres, but also inter-urban connections, which can help put more people within reach of a wider range of jobs. The Road Investment Strategy (December 2014) states:

*'There is strong evidence that transport investment, including in roads, can improve productivity and GDP. The SRN is a major facilitator of economic growth and having roads that meet the needs of all users, especially the freight and logistics sector, is vital for economic prosperity'*

Many of the direct impacts of Highways England's Major Schemes such as changes in journey times and the numbers of collisions are monetised through the transport scheme appraisal process. However, there may be wider economic impacts, which can be either positive or negative, that are much more difficult to measure and quantify. WebTAG guidance now includes methods for estimating the wider economic and employment impacts of schemes, in detail. The appraisals for the majority of schemes included within this meta-analysis consisted of a basic qualitative assessment, or no assessment at all (in line with the guidance available at the time.

[24] Road Investment Strategy: Strategic Vision, Department for Transport (December 2014).

The POPE evaluation of wider impacts has been proportional depending on the forecast impact, and whether references were made to regeneration in the scheme-specific objectives. Due to the inherent difficulties in isolating impacts that are directly attributable to the scheme and not due to other factors (such as the economic downturn), POPE evaluations have typically focused on a qualitative 'desktop' analysis.

Figure 3-1 earlier in this report on page 19 showed that there were 22 schemes with a specific objective relating to 'stimulating the economy' and 21 achieved this objective, with 1 scheme with inconclusive evidence.

The remainder of this section provides case studies of schemes where the POPE process has been able to identify (albeit anecdotally) that the highway improvements have led to a beneficial economic impact.

**Table 6-2 Case studies of schemes with wider economic impacts**

| Scheme | Evaluation of Wider Economic Impacts | |
|---|---|---|
| | **Description** | **POPE evaluation (comparison to forecast)** |
| **A30 Bodmin to Indian Queens Improvement**  | Upgrading of the A30 between Bodmin and Indian Queens to dual standard was expected to assist in reducing physical and perceived peripherality, thereby **assisting local and European Union regeneration objectives** of improving connectivity in Cornwall and the South West Region. Whilst it was not possible to quantify the wider economic benefits of the scheme, it was concluded that the scheme had been successful in supporting the local economy through enhanced connectivity. | Slight Beneficial<br><br>(As expected) |
| **M6 Junctions 8-10a Smart Motorway**  | The M6 J8-10a Smart Motorway scheme was designed to tackle severe congestion on this section of motorway. The secondary objectives of the scheme related to the wider economic benefits that reduced congestion would deliver, including improved network resilience and agglomeration impacts for businesses. The appraisal of the scheme included welfare benefits as a result of the Smart Motorway implementation.<br>The evaluation found that the increased capacity resulting from the scheme during certain hours of the day would drive wider economic benefits. The evaluation concluded that the scheme has **contributed to the growth aspirations of the West Midlands** region by providing additional capacity and improved journey times and reliability on the main strategic highway through the area. | Beneficial<br><br>(As expected) |
| **A3 Hindhead Improvement**  | The improved transport connectivity achieved by dualling and tunnelling the A3 at Hindhead was forecast to have a wider economic impact on South Hampshire. In addition, by relieving Hindhead of through traffic, the blighted part of Hindhead was expected to experience an economic recovery.<br>The scheme evaluation concluded that the improved journey times and reliability delivered by the scheme will have had economic benefits for South Hampshire given **better connectivity between Portsmouth and London**. The impact on Hindhead itself was also found to beneficial, with **evidence of new commercial activity** and house building following the scheme opening. | Moderate Beneficial<br><br>(As expected) |
| **A11 Attleborough Bypass**  | The scheme was expected to deliver economic regeneration benefits at a regional strategic level, given the importance of the A11 to Cambridgeshire, Suffolk and Norfolk, linking their centres of population and employment as well as connecting ports and major areas of agricultural production.<br>Although there was no quantifiable evidence to show the scheme had supported the economy in the area, the evaluation concluded that improvements to journey times and reliability will have **improved connectivity** and benefited the wider economy. | Slight Beneficial<br><br>(As expected) |
| **A595 Parton to Lillyhall Improvement**  | The upgrading of the A595 to dual carriageway standard, as well as the bypassing of Distington was forecast to have a beneficial impact on the economy. This forecast was based on the fact that the A595 is the main north-south route in West Cumbria, with the scheme improving accessibility to employment and the potential for business markets to expand. This would support regional and European Union regeneration objectives.<br>The evaluation concluded that the journey time improvements and increased road capacity delivered by the scheme were likely to have helped promote a more efficient transport system in the area, **improving north-south access to regional centres in West Cumbria** and aiding a large proportion of the population in terms of access to job opportunities and regional businesses. | Slight Beneficial<br><br>(As expected) |

The case studies presented in this section are intended to provide a snapshot of the typical economic impacts of Major Schemes for both nationally important schemes (such as the M6 J8-10a Smart Motorway) to local schemes (such as the A595 Parton to Lillyhall Improvement).

This section demonstrates that there are a number of examples of schemes which are likely to have led to wider economic impacts over and above the direct scheme impacts (such as changes in traffic flows, journey times and collisions).

# 7. Environment

**Scheme Photo: A14 Haughley New Street to Stowmarket Improvement, Five Years After**

# 7. Environment

## 7.1 How accurate are the forecasts for the Environmental sub-objectives?

**An evaluation of the performance of each environment sub-objective against the forecast impact shows that overall:**

- **70% of environmental sub-objectives are 'as expected'.**
- **16% of environmental sub-objectives are 'better than expected'.**
- **13% of environmental sub-objectives are 'worse than expected'.**

The environment objective consists of a number of sub-objectives which in simplistic terms are appraised and evaluated as per the methodologies outlined in Table 7-1.

**Table 7-1 Summary of Appraisal and Evaluation Approaches for WebTAG sub-objectives**

| Environment Sub Objective | Appraisal Method | Evaluation Method |
|---|---|---|
| **Noise** | Consideration of changes in traffic flows, speed, composition (% HGVs) and road surface and definition of relevant mitigation measures. | Traffic volumes play a key role in determining noise impacts when comparing ES predicted figures with observed traffic flows and speeds. Noise measurements are not undertaken as part of POPE. |
| **Local Air Quality** | Consideration of changes in traffic flows, speed, composition (% HGVs) and identification of appropriate mitigation measures. | Traffic volumes and speeds play a key role in determining local air quality impacts. Where available, local air quality monitoring data is used. |
| **Greenhouse Gases** | Calculation of the fuel consumption changes (and associated greenhouse gas impact) arising from the scheme proposals. | Changes in carbon emissions measured against those predicted. Emissions are calculated based on traffic volumes, speeds and vehicle types. |
| **Landscape** | Examine the extent to which the road will be visible and definition of appropriate mitigation measures to integrate the road into the landscape. | The evaluation considers how the scheme has impacted on local landscape character, as well as its visual impact. Planting, earth mounding, screen fences and use of natural landforms (e.g. cuttings) are evaluated to ensure compliance to the commitments within the ES. |
| **Townscape** | Considers the impact of the scheme on the urban environment with emphasis on townscape features rather than the natural environment. | |
| **Biodiversity** | Considers habitat loss, severance of habitats, effects of lighting, road spray, impacts during construction and definition of mitigation measures. | The evaluation is based on consultation with key stakeholders, review of ecological monitoring data and a site visit to confirm that mitigation measures are in place. |
| **Heritage** | Physical changes to archaeology through site activities leading to loss or damage of remains. Impacts on historic buildings through visual intrusion. | Relies on receiving Archaeological Evaluation Reports detailing the effects of the scheme and consultation feedback. Without these, only visual assessments of historic buildings and landscapes as noted in the appraisal are evaluated. |

| Environment Sub Objective | Appraisal Method | Evaluation Method |
|---|---|---|
| **Water** | Considers impact on quality of watercourse or groundwater from either routine highway drainage runoff or spillages. Definition of appropriate mitigation | The evaluation consists of site inspections to determine whether the mitigation measures are in place and performing as expected. Consultation with key stakeholders is also undertaken. |
| **Physical Fitness** | Examines how a scheme changes journey lengths, severance of routes for non-motorised users by considering changes to public rights of way. | The evaluation aims to confirm that changes to the public rights of way network, identified as being required as a result of the scheme, have been implemented during the site visit. Consultation with key stakeholders is also undertaken. |
| **Journey Ambience** | Examines impact of a scheme on traveller care (rest facilities), traveller views and driver stress (fear of accidents, frustration, route uncertainty). | Traveller stress - Improvements in journey times can be evaluated as having a positive effect on driver frustration.<br>Traveller views - based on the views of the wider landscape available to the motorist and are determined by local landform and individual scheme earthworks features, and screen planting required for visual receptors and PROWs (public rights of way).<br>Traveller care - Amenities available to the motorist; this includes rest stops and lay-bys introduced as a part of a scheme. |

An analysis of the accuracy of environmental impact forecasts has been undertaken by comparing the AST and EST (Evaluation Summary Table) scores for each environmental sub-objective. The predicted impacts are assesed based on a seven point scale ranging from 'large beneficial' to 'large adverse'. This analysis makes a comparison between predicted and outturn impacts and identifies whether each sub-objective scored 'better than expected','as expected' or 'worse than expected' (based on a change of at least one point on the 7 point scale). The results are summarised in Table 7-2 followed by a brief commentary of the findings by sub-objective.

**Table 7-2 Outturn Evaluation of Environment sub-objectives**

| Sub-objective | Outturn score | | | | Comparison with prediction | | |
|---|---|---|---|---|---|---|---|
| | Neutral | Adverse | Benefit | Not assessed | Better than Expected | As Expected | Worse than Expected |
| Noise | 36% | 18% | 45% | 1% | 27% | 59% | 14% |
| Local Air Quality | 25% | 18% | 56% | 1% | 28% | 61% | 11% |
| Greenhouse Gases | 21% | 62% | 6% | 11% | 51% | 13% | 37% |
| Landscape | 18% | 76% | 5% | 1% | 7% | 73% | 20% |
| Townscape | 14% | 7% | 17% | 61% | 0% | 96% | 4% |
| Biodiversity | 30% | 61% | 5% | 4% | 6% | 78% | 16% |
| Heritage | 33% | 54% | 12% | 1% | 14% | 81% | 5% |
| Water | 45% | 33% | 22% | 1% | 13% | 79% | 7% |
| Physical Fitness | 47% | 1% | 39% | 13% | 2% | 92% | 6% |
| Journey Ambience | 12% | 0% | 80% | 8% | 0% | 94% | 6% |
| **All sub-objectives** (excluding greenhouse gases) | | | | | **16%** | **70%** | **13%** |

The key point to note from Table 7-2 is that the majority of the environmental sub-objectives were evaluated 'as expected' (70%), with 16% evaluated as 'better than expected' and 13% evaluated as 'worse than expected'. This shows that Highways England are mostly successful in delivering schemes with the expected impact occurring. However, the landscape and biodiversity sub-objectives scored

'worse than expected' with assessments of 20% and 16% respectively when compared with the Meta-analysis 2013 report which recorded 'worse than expected' assessments of 13% and 11% respectively. This is of further concern when scoring is compared against outturn scores which are 'adverse' in 76% and 61% of schemes respectively. All other sub-objectives assessed more schemes 'worse than expected' than in 2013.

A brief summary of the findings by sub-objective is below:

- **Noise** – 59% of schemes were 'as expected'. 27% of schemes were 'better than expected', which is primarily due to lower than forecast traffic volumes. The 14% of schemes which were 'worse than expected' are primarily due to higher than forecast traffic volumes.
- **Local Air Quality** – 61% of schemes were 'as expected'. 28% of schemes were 'better than expected', which is primarily due to lower than forecast traffic volumes. The 11% of schemes which were 'worse than expected' are primarily due to higher than forecast traffic volumes.
- **Greenhouse gases –** The results shown here indicate that most of the post opening impacts on greenhouse gases vary widely from the forecasts although the majority (51%) of schemes were 'better than expected'. 13% of schemes were 'as expected' and 37% of schemes were 'worse than expected'. Although heavily based on traffic volumes, the results differ from the noise and air quality results because of the importance of other factors such as speed and HGV numbers.
- **Landscape** – 73% of schemes were 'as expected'. 7% of schemes were 'better than expected' and 20% 'worse than expected'. A more detailed consideration of the performance of schemes against the landscape objective is contained in Section 7.4 on page 113.
- **Townscape** – Only a small proportion of schemes had a post opening evaluation against this objective as locations of many of the schemes are rural so the sub-objective is not applicable. Also, on many early AST's, townscape was often considered under the 'landscape' sub objective. The vast majority of schemes (96%) where townscape was considered were 'as expected' with only 4% being 'worse than expected'. Where a scheme includes a bypass, a significant reduction in traffic, particularly in HGVs along the old road has a positive impact on the local amenity and improves environmental conditions for villages and towns along the former route which had previously been subject to high traffic volumes. For some schemes, townscapes have been further enhanced by the provision of streetscape improvements often associated with de-trunking and this aspect is considered in more detail in Section 7.4.5 on page 129.
- **Biodiversity** – 78% of schemes were as expected and 6% were better than expected. However, 16% of schemes were 'worse than expected'. A more detailed consideration of biodiversity is contained in Section  on page 101.
- **Heritage** – 5% of schemes were 'worse than expected' with the remaining being 'as expected' or 'better than expected'. This indicates that Highways England is successful in delivering the objectives for heritage as outlined in the individual scheme ES's.
- **Water** – 79% of schemes were 'as expected', 13% were 'better than expected' and 7% 'worse than expected'. POPE confirms that drainage facilities are in place and are being maintained as expected. Consultation responses received from the Environment Agency, Internal Drainage Boards and Councils are included where received. Schemes are generally found to be 'as expected' or 'better than expected' in most schemes. In instances where a 'worse than expected' assessment is made, maintenance issues are usually identified and include silting, blockage of outlets and general lack of maintenance within the confines of balancing pond sites.
- **Physical Fitness** – 92% of schemes were 'as expected' with only 6% being 'worse than expected'. Where schemes have been assessed as 'worse than expected', it is noted that issues include height clearances for bridleways which do not conform to DMRB standards, delays experienced through junctions and restricted access for users after scheme opening.
- **Journey Ambience** – 94% of schemes were evaluated 'as expected' with only 6% evaluated as 'worse than expected'. This is primarily due to higher than expected traffic volumes resulting in the worse than expected driver frustration levels.

## 7.2 What are the carbon impacts of Major Schemes?

**The majority of Major Schemes result in increased carbon emissions in the opening year. However, in general the observed carbon impact is lower than forecast.**

The Government's 'Road Investment Strategy' (December 2014) places particular emphasis on mitigating the local air quality and carbon emission impacts of Highways England's network. This section of the meta-analysis will focus on the evidence obtained through the POPE process relating to greenhouse gases where carbon dioxide is the most abundant of the greenhouses gases arising from road transport and it is measured in terms of the equivalent amount of CO2.

The tools used for predicting the greenhouse gas impacts of the Major Schemes considered in this sample typically involved one of the following approaches:

- The modelling tool COBA (**Co**st **B**enefit **A**nalysis);
- The modelling tool TUBA (**T**ransport **U**sers **B**enefits **A**ppraisal); or
- The DMRB (**D**esign **M**anual for **R**oads and **B**ridges) air quality spreadsheet.

The predictions of the carbon impact are published in the AST under the 'greenhouse gases' sub-objective and in the ES under Regional Air Quality. For some of the older Major Schemes with Environmental Statements dating back to the 1990s, it was not included on a consistent basis. For the schemes in this sample, the predictions of the net greenhouse gas emissions impact are normally for the scheme opening year.

The POPE process for evaluating carbon emissions is based on using the most appropriate methodology to assess the emissions on the key links. Normally this involves the use of the DMRB air quality spreadsheet approach. The focus is on the net emissions resulting from the scheme i.e. the difference with and without the scheme. The outturn evaluation uses observed traffic volumes, HGVs and average speeds.

There are two key elements to the POPE evaluation of Carbon:

- Firstly in order to enable the most informative like-for-like comparison of the outturn evaluation with the forecast, it is necessary to recreate a forecast based on:
    - Known set of links with predicted traffic data; and
    - Known methodology.
- Secondly the evaluation of the outturn net impacts for the same links in the road network and using the same methodology. This is based on observed data.

This analysis will focus on the POPE results that have been presented in the Scheme Evaluation Table (SET) which is published on Highways England's website and considers the results from one year after opening studies only.

Figure 7-1 summarises the observed impacts of Major Schemes on carbon emissions in the opening years.

**Figure 7-1 Impact of Major Schemes on changes in carbon emissions in opening year[25]**

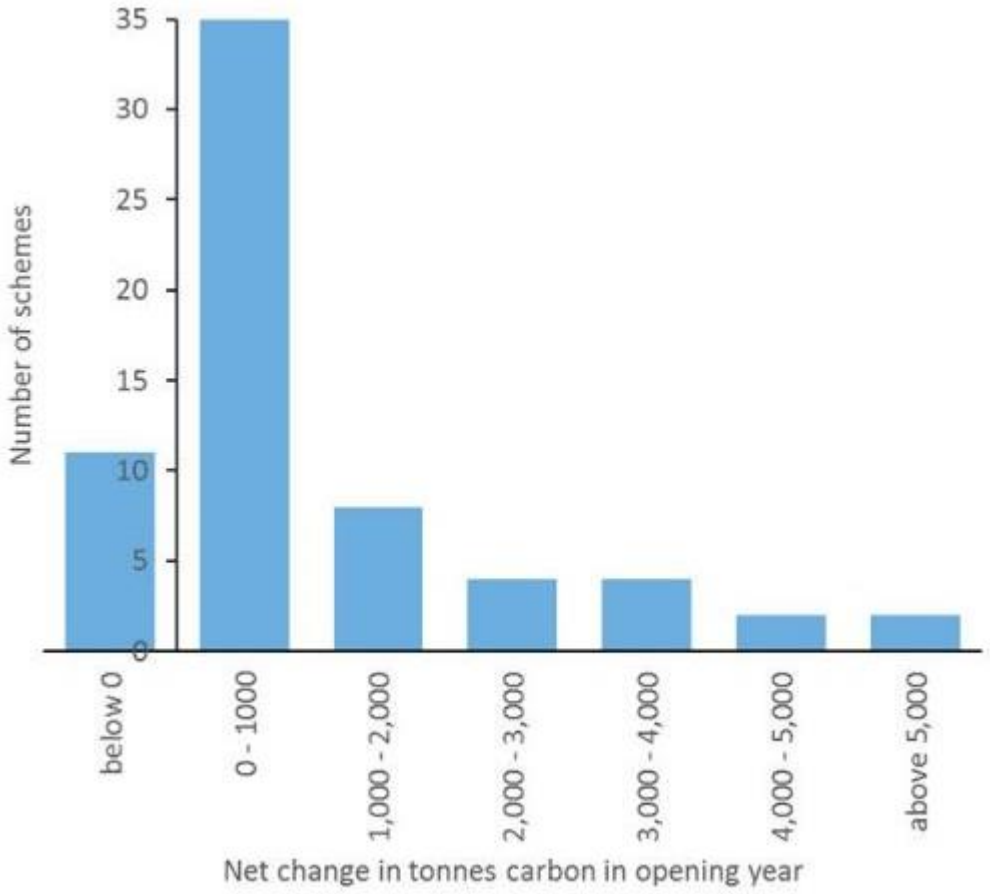



Figure 7-1 shows that the majority of Major Schemes result in an increase in carbon emissions in the opening year. This is typically due to one or a combination of a number of factors:

- Changes in traffic volumes – an increase in traffic using the scheme may result in increased carbon emissions.
- Changes in distance – the layout of the Major Scheme may result in vehicles having to travel further or shorter distances than before, which can have a corresponding impact on the emissions.
- Changes in vehicle composition - different types of vehicles emit different levels of greenhouse gases.
- Changes in speeds – some speeds are more efficient in terms of fuel consumption (and therefore greenhouse gas emissions) than others. As with the DMRB air quality assessment spreadsheet, the POPE approach to the evaluation of greenhouse gases is based on average speeds, which does not accurately consider the detail of the impact of peak period congestion's stop-start conditions which are typically more inefficient than average speeds.

The findings of increased emissions arising from the completion of most major schemes is unsurprising, as in most cases this was forecast. The accuracy levels are examined in Figure 7-2 which presents a comparison of the percentage difference between the forecast outturn carbon impacts in the opening year.

[25] Two outliers have been removed (from the +5,000 category).

**Figure 7-2 Spread of schemes forecast vs. outturn opening year carbon impacts**

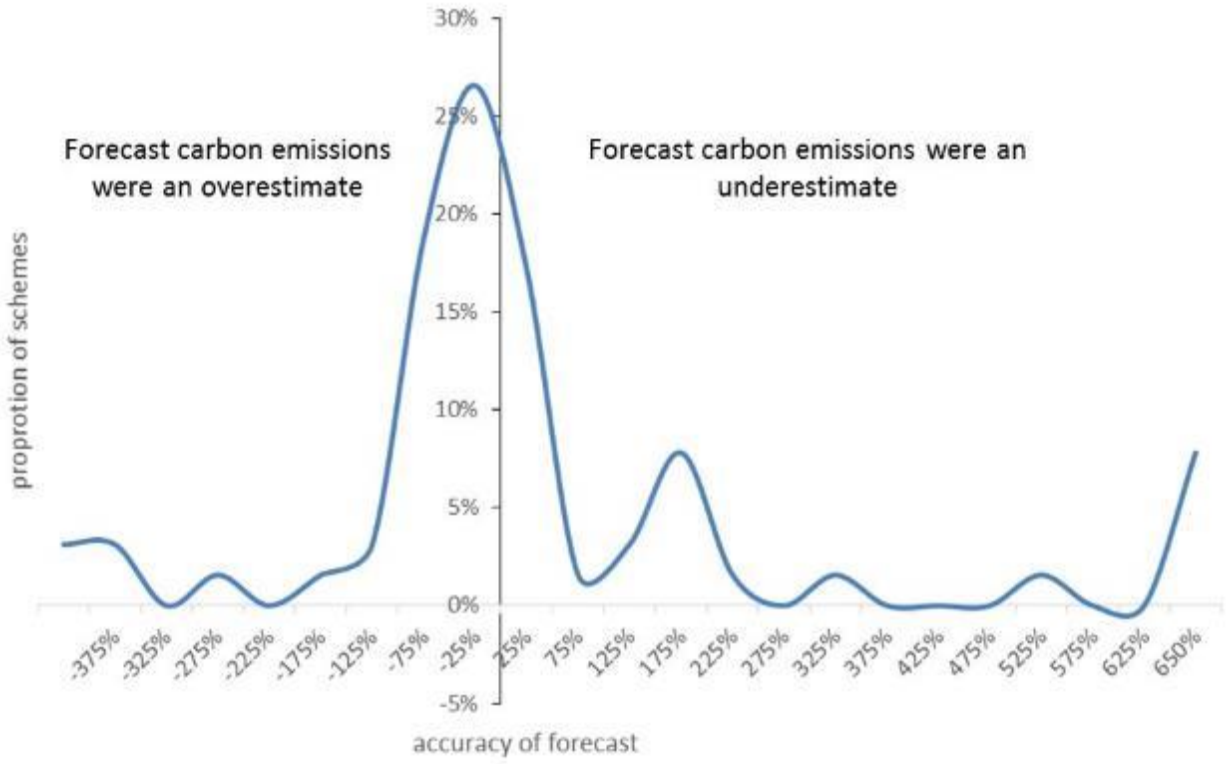



Figure 7-2 shows that:

- The majority of schemes (63%) had an outturn impact within +/-50% of the forecast impact
- Most of the schemes had forecasts which were overestimations of the actual impact. This is likely to be due to traffic forecasts having a tendency for to overestimate the actual level of traffic as shown in Figure 4–7 earlier in this report on page 30.

## 7.3 Is Highways England successfully maintaining biodiversity mitigation areas?

**Biodiversity mitigation measures have generally been provided for all schemes considered in this meta-analysis. For 44% of schemes, certain elements of mitigation would appear not to have been provided, were deemed to be no longer required post Environmental Statement, had been slightly amended to suit site conditions, were underestimated or design issues were raised.**

**Monitoring was available for 57% of schemes**

**Based on the site visits for POPE and information provided within the landscape evaluations, it would appear that habitats such as grasslands, woodlands and hedgerows are establishing. These evaluations are based on visual confirmation during POPE site visits and, when available, ecological surveys/reports received. Maintenance and management is generally being undertaken appropriately.**

**For fauna, issues tend to be scheme-specific caused by vandalism/damage, poor maintenance/management, slow establishment or lack of clarity on responsibilities for the specific features.**

This line of enquiry considers the following key questions:

- Have biodiversity features been installed as presented within the published ES?
- Is biodiversity monitoring available?
- Are biodiversity mitigation features being maintained as required within the CEMP, HEMP or equivalent document?

**56%** of schemes (44) including both OYA and FYA are set to achieve their mitigation targets.

**57%** of schemes (46) have biodiversity monitoring information available.

**35%** of schemes (28) identified biodiversity mitigation issues, including slow establishment of flora and maintenance.

### 7.3.1 Have biodiversity mitigation features been installed as outlined in the ES?

For 80 of the 81 schemes[26] considered for this meta-analysis, biodiversity mitigation measures have mostly been provided and are generally in line with those proposed. However some elements of these mitigation measures have not been provided in 36 schemes.

It is also evident that for some schemes, ecological mitigation has been implemented to a greater extent than indicated in the ES. This is usually as a result of later surveys indicating the presence of species and habitats not originally found and which would be affected by the scheme, or due to the requirements of the statutory consultees or changes in environmental legislation since the ES was prepared.

Thirty six (44%) schemes were identified by POPE where elements of mitigation have not been provided or have required amendment. Common themes are identified as follows (some schemes had multiple amendments), as a percentage of all schemes. Further details regarding individual schemes are shown in Table 7-3.

- Mitigation for fauna not provided **7%**
- Mitigation no longer required post ES following further surveys **6%**
- Mitigation changed **5%**
- Mitigation underestimated in ES **7%**
- Mitigation for habitat enhancement not taken forward **12%**
- Concerns raised regarding Drainage Design **9%**

**Table 7-3 Summary of schemes where elements of biodiversity mitigation have not been provided**

| Theme | Scheme Name | OYA/ FYA | Comments |
|---|---|---|---|
| Mitigation for fauna not provide | **M40 J15 Longbridge Roundabout** | OYA | The local authority noted that measures for overwintering lapwing were not included in the ES and Lapwing are now lost to the area as a result of the scheme. |

[26] For one new scheme (Birmingham Box Phase 2) specific species mitigation was not included in the ES as impacts were not expected and insufficient information has been made available at OYA for POPE to comment further i.e. to confirm whether mitigation was required or not.

| Theme | Scheme Name | OYA/ FYA | Comments |
|---|---|---|---|
| | **A66 Greta Bridge to Stephen Bank Improvement** | OYA | No fencing provided to channel otters towards the safe crossing provided within the scheme. MAC identified that although a new culvert has mammal ledges, the old structure does not and the ledges only allow mammals to gain access to the central reserve but not beyond. |
| | **A66 Stainburn and Great Clifton Bypass** | FYA | No specimen trees to channel bats, log pile hibernacula or woodland edge works to stabilise retained woodland. |
| | **A500 City Road Improvement** | FYA | No installation of artificial bat roost cavities. |
| | **A120 Stansted to Braintree Improvement** | FYA | Bat boxes at two bridges not provided. |
| | **A595 Parton to Lillyhall Improvement** | FYA | No information relating to Amphibian tunnels has been made available to POPE and it is thought that these were not included within the final scheme. |
| **Mitigation no longer required post ES following further survey prior to construction** | **A419 Blunsdon Bypass** | OYA | Reptile hibernacula not required as pre-scheme surveys found no reptiles. |
| | **M62 J6 Improvement** | OYA | Mitigation for reptiles and water voles was not provided. |
| | **A27 Polegate Bypass** | FYA | Less badger fencing was required. |
| | **M25 J16-23 Widening** | OYA | New ponds not required as verification surveys found that water voles were absent from watercourses probably due to predation by mink. River corridor habitat was improved for water voles should they return, |
| | **A595 Parton to Lillyhall Improvement** | FYA | Red squirrel nest boxes not provided as these would encourage grey squirrels, which had recently moved into the area, to the detriment of the reds. |
| **Mitigation changed** | **M1 J25-28 Widening** | OYA | An otter ledge was not added to a culvert, as it was considered unlikely to flood. |
| | **A421 Bedford to M1 J13 Improvement** | OYA | The otter ledge was removed following agreement between Highways England and the Internal Drainage Board (IDB) on the basis that it could cause a restriction in flow in times of flood. It was considered that the route through the adjacent railway bridge would offer a suitable alternative route. |
| | **A595 Parton to Lillyhall Improvement** | FYA | To avoid the wide grassed central reserve becoming suitable foraging areas for barn owls and the possible increase in mortality due to exposure to traffic. Extra Heavy Standard Alder trees have been planted. Where low-maintenance grass remained in the central reserve it was likely that it would require cutting more frequently than envisaged, to ensure that it did not become colonised by small mammals. |
| | **A500 City Road Stoke** | OYA | At Fowlea Brook due to stability issues during construction grassed slope had to be changed to a solid concrete retaining wall, with potential impact on mammal passage in times of high flood. |
| **Mitigation underestimated in ES** | **M6 Carlisle to Guardsmill Extension** | OYA | M6 and A6 - The number of reptiles/amphibians requiring to be translocated exceeded the numbers expected and required alternative receptor sites to be provided, including off-site habitat areas some distance from the schemes. |
| | **A6 Alvaston Improvement** | FYA | |
| | **A500 Basford, Hough, Shavington Bypass** | FYA | Mitigation included in the 1991 ES was not as extensive as was expected by the time of |

| Theme | Scheme Name | OYA/ FYA | Comments |
|---|---|---|---|
| | | | construction, at which time additional land for mitigation could not be acquired through the CPO process. This meant that mitigation measures had to be fitted into the space available and in some instances a compromise had to be accepted by the nature conservation agencies. |
| | **A30/A382 Whiddon Down Junction** | OYA | Dormice were found outside the original area covered by the licence at a remote location of the works and a new licence had to be applied for causing delays to the build. |
| | **A66 Carkin Moor Improvement** | FYA | Based on the increased incidence of wildlife fatalities it would appear that more ecological mitigation could have been included within the scheme design. |
| | **A66 Greta Bridge Improvement** | FYA | |
| **Mitigation for habitat enhancement not taken forward** | **A46 Newark Lincoln Improvement** | FYA | Wildflower seeding proposals not taken forward and replaced with open/amenity grassland. For the A1 Peterborough-Blyth junctions, it was expected that wildflower seeding would be undertaken as remedial measures by the Contractor. For Newark it was listed as a possible mitigation measure rather than a firm ES commitment. For Stannington it is understood that since the FYA site visit the MAC has undertaken some targeted wildflower plug planting on the cutting slopes around the junction where low fertility soils are suitable. |
| | **A1 Peterborough Blyth Junctions** | OYA | |
| | **A1 Stannington Junction** | FYA | |
| | **A120 Stansted to Braintree Improvement** | FYA | Translocation of turves not possible due to contract timetable, with nowhere for translocation at time of site clearance. |
| | **A1033 Hedon Road Improvement** | OYA | Opportunity lost to safeguard local habitat of interest at Hedon Road due to lack of survey. For Caxton Common, the ES did not specifically include mitigation for bluebells despite noting that they should be retained.<br>A1(M) Ferrybridge: an opportunity was lost with regard to stripping and storing woodland soils disturbed by the road works separately for re-use near to the original locations.<br>A5 ES requested that the material from the peat bodies disturbed during construction should be reused in the creation of wetland areas nearby. However, at the stage that the peat bodies were discovered, the inflexibility of the implementation process and inability to acquire more land resulted in the peat not being used. |
| | **A428 Caxton Common to Hardwick Improvement** | OYA | |
| | **A1 (M) Ferrybridge to Hook Moor** | FYA | |
| | **A5 Nesscliffe Bypass** | OYA | |
| | **M25 J16-23 Widening** | OYA | The ES proposed management to remove conifers and rhododendron from Denham Marsh Wood (between J16 and 17) as compensation for loss of ancient woodland. At OYA POPE is not aware whether this management has been undertaken. |
| | **M25 J28 (A12 Brook Street)** | FYA | Provision of reptile hibernacula and refugia were not undertaken; as the pre-scheme embankment had been replaced on a like-for-like basis; further enhancement for reptiles was not considered necessary. |
| **Co nc er ns** | **A30 Bodmin to Indian Queens Bypass** | OYA | Water run-off from construction activities led to siltation of local watercourses affecting biodiversity |

| Theme | Scheme Name | OYA/ FYA | Comments |
|---|---|---|---|
| | **A69 Haydon Bridge Bypass** | OYA | and requiring remedial measures to be agreed with EA during construction. |
| | **A590 High & Low Newton Bypass** | OYA | |
| | **A46 Norton Lenchwick** | 10YA | EA raised ecological issues post opening over the design of watercourse crossings and diversions and noted that box culverts lacked mammal passes. |
| | **A500 City Road Stoke** | OYA | EA identified that river channel design incorrectly built on site and required remediation of the River Trent channel. |
| | **A21 Lamberhurst Bypass** | OYA | EA commented that the design provides suitable access under the bridge for wildlife to use during normal and high flows but not for otters or other mammals to use during severe flooding, when access under the bridge may be restricted. |
| | **A27 Southerham to Beddingham Improvement** | OYA | The new ponds (one created for drainage purposes, one for ecological benefit) could have been more wildlife friendly with less steep sides and variable depths. |

### 7.3.2 Is biodiversity monitoring available?

It would appear from consideration of scheme evaluation reports for this meta-analysis that monitoring has generally been undertaken where protected species Defra licences have been required, and mitigation measures have been included in schemes. Mitigation licences are a legal requirement under The Conservation of Habitats and Species Regulations 2010 (as amended) which implements the EC Directive 92/43/EEC in the United Kingdom where European protected species are affected by development proposals.

Based on information provided, monitoring is in place or expected to be undertaken by FYA for 46 (**57%**) of the 81 schemes.

POPE is not aware whether monitoring post-opening is being carried out or not for 15 schemes (**19%**) because no information has been made available, however, 3 of those are at OYA and it may well be that by FYA information will be available (M6 Birmingham Box, A419 Blunsdon and M27 J3-4). At one FYA scheme it is understood that post opening monitoring was due to take place from year 6 onwards i.e. outside the reporting period for POPE. For mitigation measures such as mammal underpasses and fencing inspected as part of ongoing routine maintenance rather than a specific Mitigation Licence requirement, POPE does not always receive information confirming whether this monitoring has happened or not – it depends whether individual Scheme aftercare inspection reports are provided and also whether they include such detail.

For 20 schemes (**25%**) monitoring was not a scheme requirement and this includes some older schemes where monitoring was not always considered as part of the ES, together with others where the biodiversity impacts were minimal and therefore monitoring was not considered necessary. Table 7-4 highlights 32 (**40%**) schemes where issues have been identified based either on monitoring received or site visit information. For the remaining schemes no particular issues were noted or POPE cannot comment because although monitoring was understood to have been / or was being undertaken no data was provided to POPE.

**Table 7-4 Summary of scheme specific biodiversity themes from monitoring data**

| Species | Scheme Name | OYA / FYA | Comments |
|---|---|---|---|
| **Bats** | **M1 J6A to 10 Widening** | OYA | |

| | | | |
|---|---|---|---|
| | **M62 J6 Improvement** | OYA | Lighting of underpasses has deterred expected use by bats, with suggestions for amending the level of lighting to make these routes more likely to be used by bats. |
| | **A21 Lamberhurst Bypass** | OYA | A programme of monitoring should be set up for bats to act as indicator species for successful operation of the land bridge for a minimum of 3 years or as requested by the Defra licence, but it would appear this did not happen. |
| | **A419 Commonhead Junction** | FYA | The HEMP notes that a misunderstanding on boundaries between the MAC and Contractor meant that supposed monitoring of bat and bird boxes did not happen. |
| | **A47 Thorney Bypass** | FYA | 30 bat boxes were located on a golf course just to the north of the scheme, but there has been no monitoring since installation so it is not known if they are being used. |
| | **A3 Hindhead Improvement** | OYA | Scheme monitoring indicates that the bat boxes have not been successful as none were found to be used by bats - may be due to availability of other roosting opportunities within habitat surrounding the scheme. |
| | **A590 High and Low Newton Bypass** | FYA | Mixed results from bat monitoring, some mitigation less effective than was hoped for. The bat guidance structure was to be monitored in summer 2013. It was agreed with the Lake District National Park Authority that it would be removed if it was no longer being used by bats. POPE is not aware whether or not this monitoring took place. |
| | **A428 Caxton Common to Hardwick Improvement** | FYA | Monitoring of bat boxes confirmed that those surveyed had not been used. |
| | **A595 Parton to Lillyhall Improvement** | FYA | Monitoring indicated a decrease in bat activity through the culverts during periods of high flow of water.<br>Monitoring of the bat guide bridge indicated that in 2011 numbers using the commuting route had not yet recovered to pre-construction levels. |
| **Badgers** | **A6 Clapham Bypass** | FYA | *Lack of use of badger mitigation:*<br>A6: An artificial badger sett was provided but never used and removed after some months.<br>M25: Monitoring to date has not recorded any use of an existing badger tunnel refurbished and extended at both ends following the works, possibly due to lack of vegetative cover.<br>A34: Badgers were using the tunnels under the slip roads but the mainline tunnel was not generally used, possibly because the length was too great for the badgers to want to use and further work on maximum viable length of badger tunnels would be of value. |
| | **M25 J16-23 Widening** | OYA | |
| | **A34 Chieveley to M4 J13 Improvement** | FYA | |
| | **A6 Alvaston Bypass** | FYA | *Issues with badger fencing*<br>(A6 and A43) Badger fencing not continuous or section missing.<br>A46: Badger fencing implemented not in line with current standards.<br>A5: A balancing pond was not enclosed by badger fencing and observations noted that the access gate had been left open allowing badgers to enter the site through the gate which gives access to the A5.<br>A1: It was not expected in the ES that there would be badger fences provided as part of the scheme, however there have been some badger deaths and the Local Authority would like fences to be provided. |
| | **A43 Whitfield Turn -Brackley Hatch Improvement** | FYA | |
| | **A46 Norton Lenchwick Improvement** | 10YA | |
| | **A5 Nesscliffe Bypass** | OYA | |
| | **A1 Bramham-Wetherby Bypass** | OYA | |

| | | | |
|---|---|---|---|
| | **A34 Chieveley** | FYA | A34: during the aftercare period two incidents of badger deaths possibly attributed to the construction of an environmental barrier preventing badgers from moving west across the A34 - this might be resolved by new badger fencing on the east side of the A34. |
| | **A6 Great Glen Bypass** | FYA | *Periodic flooding at tunnels.* |
| | **A421 Great Barford Bypass** | OYA / FYA | (For A428 Caxton Common and A421 Great Barford at OYA but not noted at FYA potentially due to dry conditions). |
| | **A6 Rushden and Higham Ferrers Bypass** | FYA | For A1(M) Ferrybridge at OYA but no information available at the FYA stage. |
| | **A428 Caxton Common to Hardwick Improvement** | OYA / FYA | |
| | **A1(M) Ferrybridge to Hook Moor** | OYA / FYA | |
| | **M6 Toll** | FYA | |
| | **A30 Bodmin to Indian Queens Improvement** | FYA | |
| | **A14 Haughley New Street to Stowmarket Improvement** | OYA | Badger tunnel exited into contractor's compound rather than into agricultural field as expected in ES due to compound being retained on site for a separate scheme in agreement with landowner. |
| | **A43 M40-B4031 Dualling** | FYA | The use of a combined mammal tunnel and drainage culvert may discourage badgers from using the culvert when it is holding water |
| | **A63 Selby Bypass** | FYA | Site visit observations indicated that the diameter of one of the mammal tunnels appeared to be less than the 600mm recommended in DMRB. |
| **Otters** | **A1 Willowburn to Denwick** | FYA | The local Wildlife Trust considered that 600mm diameter culverts were too small for otters in times of flood when they become impassable. In these conditions, otter are likely to cross the carriageway. However, there was no evidence that the otter population had been adversely affected by the A1 dualling. |
| **Water voles** | **A249 Iwade to Queenborough Improvement** | FYA | Initial water vole translocation was not successful, with Natural England suggesting that habitat creation would be a better solution than translocation, particularly for fast breeding species. |
| **Barn Owls and raptors** | **A64 Colton Lane GSJ** | FYA | Failure of larger sized trees reduced effectiveness of planting to deflect barn owls and raptors up and above traffic. |
| | **A66 Temple Sowerby Bypass and Improvement** | FYA | MAC undertook additional planting in response to the increased numbers of barn owl mortalities; aiming to increase the height of owl flight paths, consequently reducing the number of mortalities. |
| | **A1 Stannington Junction** | FYA | MAC records indicated 2 barn owl casualties in 2007 and one in 2009 noting slow establishment of the new landscape planting together with good foraging habitat in the vicinity of the scheme may have contributed to the barn owl fatalities post opening. |
| **Birds** | **A5117 Deeside Junction Improvements** | OYA | Bird boxes were not used in 2009 and the monitoring report recommended repositioning them higher up. |

| | | | |
|---|---|---|---|
| **Great Crested Newts** | **A6 Alvaston Improvement** | FYA | Initial failure of Great Crested Newt (GCN) ponds and translocation worse than expected. This was primarily due to an underestimation of the population size. Monitoring highlighted the failure of mitigation ponds and remediation works took approximately five years to be satisfactorily delivered. The GCN population was less than a tenth of the pre mitigation size at FYA. |
| | **A27 Southerham to Beddingham Improvement** | FYA | Monitoring did not identify any GCN It was concluded that the negative result does not necessarily imply that GCN are now absent from the water bodies, since only 1 survey was undertaken in order to comply with the DEFRA licence (4 surveys are more usually undertaken), that bottle traps are not a reliable search method, and that there was too much vegetation present, or the water too turgid, for torching to be effective. |
| | **A595 Parton to Lillyhall Improvement** | FYA | Stickleback were noted in one of the four ponds which were likely to be detrimental to the GCN population over time. |
| | **A428 Caxton Common to Hardwick Improvement** | FYA | Lower GCN numbers were recorded in 2011 - wildfowl using the pond may be the reason for the reduction in aquatic vegetation which is used by GCN as substrate for egg laying. 2011 also a significantly dry year and nationally reduced GCN counts were noted. |
| **Reptiles** | **A3 Hindhead Improvement** | OYA | Populations of adder, common lizard and slow worm were translocated from an area of habitat in Boundless Copse to a receptor site on National Trust land near Highcombe Edge. A population of grass snake was translocated from the same location in Boundless Copse to a receptor site on Forest Enterprise land at Hurthill Copse. No reptile monitoring surveys had been undertaken at OYA and the success or otherwise of the translocation cannot be determined. |
| | **A30 Bodmin to Indian Queens Improvement** | OYA | NE commented that with regard to relocating reptiles from the road area without ongoing monitoring it was not possible to confirm how successful the mitigation has been. |
| **Butterflies** | **A30 Bodmin to Indian Queens Improvement** | OYA/ FYA | Specific monitoring of the new Marsh Fritillary breeding habitat has not been undertaken as part of the scheme. This was identified as required in the English Nature/HE Butterfly Handbook where the A30 Bodmin scheme has been used as a case study for butterfly mitigation. By FYA, NE has monitored the site and has seen flying adults in June of 2011 and 2010 but no larval webs. NE notes that the Marsh Fritillary butterfly has declined markedly across the Goss Moor area during this time although there is no direct link to the scheme. |
| **Dormice** | **A3 Hindhead Improvement** | OYA | By 2012 many dormouse boxes (approx. 50%) could not be found and of those checked few were found to have evidence of use by dormice. No records were available to show whether dormice are using the dormouse bridges, and generally there is no data from any UK highways scheme of usage of dormouse bridges of similar design being used by dormice. |
| | **A21 Lamberhurst Bypass** | FYA | A programme of monitoring should have been set up for dormouse to act as indicator species for successful operation of the land bridge for a minimum of 3 years or as requested by the Defra licence, but it would appear this did not happen. Some dormouse monitoring did take place in adjacent woodland as part of a national programme. |

| | | | |
|---|---|---|---|
| | **A30 Bodmin to Indian Queens Improvement** | FYA | Monitoring results in 2012 confirmed that dormice are still present within Black Acre Farm and Innis Downs. Several nest tubes had been lost and several could not be accessed due to the dense vegetation. The dormouse-boxes were not checked as the boxes had degraded. No evidence of dormice was recorded from the hair-tubes along the dormouse access bridges. |
| **Invertebrates** | **A3 Hindhead Improvement** | OYA | Beetle monitoring indicated a likely significant effect on saproxylic (dead wood) invertebrate habitat through reduced dead wood resource and change of microclimate. Habitat improvements undertaken (additional planting and dead wood) with monitoring to be undertaken in 2014. |
| **Issue** | **Scheme Name** | **OYA / FYA** | **Comments** |
| **Funding Issues** | **A590 High and Low Newton Bypass** | FYA | There has been less extensive monitoring of bats than originally envisaged. |
| | **A27 Southerham to Beddingham Improvement** | OYA | The ES suggested extensive monitoring, however, only monitoring required as a condition of Defra Licences (bats and GCN) has been undertaken, along with monitoring of barn owls. |
| | **A595 Parton to Lillyhall Improvement** | FYA | The ES suggested 'best practice' ecological monitoring but where no formal commitment had been made or there was no obligation associated with wildlife legislation, it was not taken forward. |

*Conclusions*

Monitoring information has been made available for 57% of schemes evaluated compared with 55% in 2013. Scheme monitoring provides evidence of the effectiveness of biodiversity mitigation measures and, of equal importance, also highlights where measures could be improved or are performing less well than anticipated. Issues with badger mitigation features are the more common which is not surprising given the widespread distribution of badger. It is also worth pointing out that of the 5 (4 OYA and 1 FYA) schemes being considered in this Meta-analysis for the first time, monitoring was available for 4 and may not have been a scheme requirement for the other. In addition, for the 2 schemes now at the FYA stage and where it was expected at OYA that monitoring data would become available – this has been the case, which could indicate that for more recent schemes monitoring reports are becoming more readily available to POPE.

The scheme survey/monitoring reports are not always made available to POPE for a variety of reasons including archiving of hard copy information, corruption of electronic files or lack of continuity of personnel leading to difficulties in tracing information. A requirement for all scheme survey and monitoring reports (pre, during and post construction) to be available digitally from a central data base or via the MACs and ASC's would help improve the availability of information and therefore the confidence in post-opening evaluation outcomes. Ensuring that all parties (including the MACs and ASCs) are made aware of the environmental commitments relevant to each scheme would also overcome any confusion relating to areas of responsibility for on-going biodiversity monitoring and maintenance.

Monitoring would appear to be undertaken when it is an ES or Defra licence requirement. More general monitoring, for example for the establishment of species-rich grassland or habitat areas, is generally not undertaken. It is not clear to POPE why monitoring appears limited as there are clearly requirements in the ES for targets to be achieved. It has been identified as a potential issue in this meta-analysis and could become an emerging trend for future evaluations.

### 7.3.3 Are biodiversity mitigation features being maintained as required in the HEMP or equivalent document?

Based on the site visits undertaken as part of the POPE process and information provided within the landscape evaluations, it would appear that habitats are generally being maintained and managed appropriately. There are however, examples where species rich/wildflower seeded areas or marginal

aquatic planting associated with ponds were not establishing as expected, where translocated plants / hedges have not been managed/maintained and where noxious weeds were prevalent.

Specific issues relating to fauna mitigation have been identified in 28 (35%) schemes with details on individual schemes shown in Table 7-5. In addition many schemes identified issues with habitat creation areas, but have not been detailed individually here. Common themes for fauna are identified as;

- Lack of maintenance / management **22%**
- Vandalism **6%**
- Slow establishment **11%**
- Storm damage **1%**

**Table 7-5 Summary of schemes with specific problems with mitigation measures for fauna**

| Theme | Scheme Name | OYA / FYA | Comments |
|---|---|---|---|
| Lack of Maintenance and/or Management | **Common issues affecting at least 10 schemes** | | Problems with habitat creation areas due to lack of maintenance/management, including where location outside the highway boundary. |
| | **A14 Haughley New Street to Stowmarket Improvement** | OYA | A mammal ledge at Tot Hill culvert was broken (to be repaired). |
| | **A43 Silverstone Bypass** | FYA | Great Crested Newt (GCN) habitat not maintained, and the condition of dormouse nest box/tubes indicated they had not been maintained, and bat boxes would not be physically checked or moved for health and safety reasons. |
| | **M5 J17-18 Improvement** | FYA | Slight issue with GCN pond outside Highway Boundary and whether it would be subject to on-going maintenance – overgrown at FYA |
| | **M1 J31-32 Widening** | FYA | Although results of the GCN monitoring were positive there was no standing water in the pond located off site; pond not due to be managed in the future i.e. beyond the period discharged in the licence. |
| | **A63 Melton Grade Separated Junction** | FYA | Litter was a likely hindrance to badgers at one of the tunnels. |
| | **A419 Commonhead Junction** | FYA | Misunderstanding over boundaries resulted in bat and bird boxes not being maintained as expected in the HEMP. |
| | **A34 Newbury Bypass** | FYA | Management issues led to deterioration in the internationally recognised Desmoulin's whorl snail habitat. |
| | **A5117/A550 Deeside Park Junctions Improvement** | OYA | Badger fencing had been damaged at some locations (to be repaired). |
| | **M60 J5-8 Widening** | FYA | Pond not operating as expected and possibility that without continued management the effectiveness of wetland ditches may cease to perform their functions as habitats for smooth and palmate newts. |
| | **M6 Toll** | FYA | Many recommended remedial works e.g. repairs to otter and badger fencing remained outstanding. |
| | **A428 Caxton Common to Hardwick Improvement** | FYA | Badger fencing breached at base and required maintenance to avoid increases in animal mortality. May not have been installed to required specification.<br>Water vole habitat mitigation considered sub-optimal and remedial works recommended. |

| Theme | Scheme Name | OYA / FYA | Comments |
|---|---|---|---|
| | **A3 Hindhead Improvement** | OYA | Nearly all dormouse boxes checked in 2012 were damp, or in need of repair. Those not found were presumed to have fallen from their tree. Recommended replacement to allow monitoring to continue and to improve their suitability for dormice |
| | | OYA | Only 80 bat boxes out of the 171 were found and most were in poor condition, wet inside and therefore unsuitable for roosting bats. |
| | **A30 Bodmin to Indian Queens** | FYA | Positive use of dormouse nest tubes and barn owl boxes during monitoring but they required replacement and had degraded before the end of the five year maintenance period |
| | | FYA | Issues with litter and rubble at badger tunnel entrances and vegetation overgrowth |
| | **A595 Parton to Lillyhall** | FYA | Emergence surveys of the bat hibernation chamber in 2008, 2009, 2010 and 2011 have revealed no bats emerging from the structure; nor have bats yet been recorded using the heated chamber which was noted to be damp due to water ingress. |
| | **A6 Rothwell Desborough** | FYA | The integrity of the GCN exclusion fence had been compromised. |
| | **A10 Wadesmill** | FYA | Some instances of gaps at the base of badger fencing and gates. |
| | **A421 Great Barford** | FYA | Whilst the GCN permanent fencing has been maintained in place, it is noted that the vegetation has not been strimmed away from the fence which would allow newts to climb over. |
| | **A21 Lamberhurst Bypass** | FYA | Wetland habitat mitigation could have been further enhanced by removing the amphibian fencing allowing amphibians using the toad tunnel to access the ponds.<br>Temporary plastic sheeting may be preventing amphibian movement into/out of the adjacent woodland unnecessarily. |
| **Vandalism** | **M1 J25-28 Widening** | OYA | Some bat boxes vandalised and required to be moved and others exhibited damage by squirrels and the weather. |
| | **A6 Alvaston Bypass** | FYA | Vandalism and lack of maintenance of badger fencing. |
| | **A10 Wadesmill Bypass** | FYA | Vandalised bat cave and a pedestrian gate at pond allowing a complete break in deer and badger fencing. |
| | **A1(M) Ferrybridge to Hook Moor** | FYA | Vandalised deer gate and short section of badger fencing missing. |
| | **A595 Parton to Lillyhall** | FYA | 3m section of otter ledge vandalised and unlikely that otters would be able to use ledge in the current condition. |
| **Slow establishment** | **M62 J6 Improvement** | OYA | Great Crested Newt habitat not establishing as well as expected. |
| | **A66 Temple Sowerby Bypass** | OYA / FYA | 'Green bridge' planting not establishing as well as expected to act as a guide for foraging bats and badger connectivity.<br>At FYA, although planting not thriving, it is slowly establishing and bats have been observed foraging |

| Theme | Scheme Name | OYA / FYA | Comments |
|---|---|---|---|
| | | | along the road embankments and utilising the structure to cross the road. |
| | **M6 Toll** | FYA | The 2008/2009 GCN surveys found that further mitigation measures needed to meet the requirements of the great crested newt licence. |
| | **A64 Colton Lane** | FYA | Failure of larger sized trees reduced effectiveness of planting to deflect barn owls and raptors up and above traffic. |
| | **A66 Temple Sowerby** | FYA | MAC undertook additional planting to raise owl flight paths in response to the increased numbers of barn owl mortalities. |
| | **A3 Hindhead Improvement** | OYA | Acid grassland seeding on the old A3 has been moderately successful, however it would appear that the heather restoration of the old A3 has not been successful. |
| | **A66 Long Newton** | FYA | The failure and poor performance of significant elements of the landscape proposals are likely to have impacted on habitat diversity and resulted in localised ecological effects that are worse than expected. |
| | **A30/A382 Whiddon Down Junction** | FYA | Although reptiles still inhabit the monitoring area, albeit in low numbers, there is little evidence to suggest that the regeneration of habitat has achieved favourable conditions. |
| | **M25 J28 (A12 Brook Street)** | FYA | Heavy grazing by deer has resulted in a break in continuous vegetation - potentially disruptive to bat movements and could give rise to altered foraging behaviours leading to roost/ foraging habitat severance. |
| **Storm Damage** | **A27 Southerham to Beddingham Improvement** | OYA | Barn owl box and tree destroyed by storm damage. (NB successful breeding had occurred at 2nd box, and attempted but failed breeding at the 3rd box). |

### *Conclusions*

Maintenance and management of habitats varies across schemes. For fauna, issues tend to be scheme-specific caused by vandalism/damage, poor management or lack of clarity on responsibilities for the specific features. For some of the issues either Highways England or the MAC/ASC were already aware of the problem and remedial measures were programmed to be carried out e.g. A14 Haughley and A5117 Deeside.

Possible reasons for lack of maintenance/management could be down to the timing of aftercare activities, potential funding issues playing a part in the level of maintenance and management, or lack of clear environmental commitments at the time of the ES, although further study would be required to be able to draw any firm conclusions.

## 7.4 How successful is Highways England in mitigating the landscape and townscape impacts of Major Schemes?

**Overall 80% of schemes assessed show that overall landscape objectives set in the ES are set to be achieved. It is noted that when compared with the Meta-analysis 2013 (84%) and Meta-analysis 2010 (93%), a reduction in target achievement is evident.**

**This evaluation identifies deterioration in landscape scheme target achievements when compared with ES predictions of impacts. It also serves to highlight issues within individual schemes that impact upon growth target achievements.**

**Performance of schemes against targets set in their ES is as follows:**

- **7% of schemes had landscape impacts which were 'better than expected';**
- **73% of schemes had landscape impacts which were 'as expected'; and**
- **20% of schemes had landscape impacts which were 'worse than expected'.**

**Additionally, this section confirms that the use of locally appropriate materials within schemes where traditional resources identify location and history makes a positive contribution to scheme design and is generally welcomed by local councils and residents.**

**Assessment of the impact of schemes on designated sites confirms that 45 (56% of 81 schemes) schemes assessed for this Meta-analysis are located within or adjacent to designated landscapes which have included national designations such as National Parks or Areas of Outstanding Natural Beauty (AONB), greenbelt, historic parks and gardens or historic landscapes, as well as areas designated at a local level such as Areas of Great Landscape Value.**

**Finally, this section confirms that townscape/streetscape initiatives undertaken particularly during de-trunking and as included in the ES design are generally well received when returning a previously congested urban space to a more locally appropriate village/town.**

This line of enquiry considers the following key questions:

- What are the landscape impacts of Major Schemes?
- Is landscape mitigation in place at the One Year After stage set to achieve its target at the five year after opening stage?
- How does Highways England use locally appropriate materials in its schemes?
- How accurately are impacts forecast for designated landscapes?
- How often do suggested townscape/streetscape improvements identified in the ES get provided?

Landscape definition with relevance to this report:

The term landscape commonly refers to the view or appearance of the land. However, the landscape is a combination of both cultural and physical characteristics or components, which give rise to patterns that are distinctive to particular localities and help to define a 'sense of place'. The landscape is not therefore

simply a visual phenomenon but relies upon other influences including topography, land use and management, ecology and historical and cultural associations[27].

Landscape is not only a rural phenomenon as it encompasses the whole external environment, including cities, towns and small settlements. The character of the urban environment can be defined as townscape. Townscape is the interaction of both the physical and social characteristics of the urban environment and the way in which they are perceived. Physical characteristics include urban structure and grain and the spaces between buildings which together combine to create the layout of the urban environment. Other physical characteristics include the height and mass or scale of buildings and their appearance in terms of both construction materials and detailing or decoration. The social characteristics of a townscape are determined by how these physical characteristics are used and it is the interrelationship of these characteristics that give a place its character and distinctive identity.

*Landscape & Visual impact Assessment for Highway Schemes*

Within the ES / EAR for each scheme, a Landscape and Visual Impact Assessment is undertaken which identifies:

- The baseline conditions of the existing landscape and the impact that a scheme will have on it; and
- Mitigation measures, including landscaping to mitigate the visual intrusion of the scheme on the wider landscape.

POPE landscape reports refer to the requirements identified within the ES and determine whether the impacts as identified within the ES are as expected based on mitigation measures installed, planting conditions during construction and aftercare maintenance undertaken to ensure growth targets are to be met. This Meta-analysis picks up on these expectations to identify possible trends linked to overall mitigation success or failure, growth target attainment and the effects of reduced aftercare.

Common aims of landscape works include[28]:

- Mitigation of the loss of landscape features such as hedgerows, mature vegetation and field ponds;
- Minimising the visual impact of the proposals on properties and public areas and where possible improve on the existing situation;
- Compliance with and support of local landscape management and restoration strategies;
- Generally enhance the landscape within the road corridor, both for local amenity and the benefit of road users;
- Consider various landscape, cultural heritage and ecological designations; and
- Wherever possible, the planting and seeding works should aim to provide value for wildlife

### 7.4.1 What are the landscape impacts of Major Schemes?

Earlier in this report in the summary of the environmental impacts of Major Schemes (Table 7-2 on page 97) it was noted that the majority of schemes (**76**%) had some adverse effect on the landscape sub-objective and in **73%** of cases this was in line with the forecasts. To examine this further the landscape evaluation results by different type of scheme are presented in Table 7-6.

[27] Definitions taken from the A3 Hindhead ES Volume 1 Chapter 13.

[28] Some examples taken from A5117 Deeside HEMP.

**Table 7-6 Summary of Landscape evaluation results by scheme type**

| Scheme type | Number of scheme evaluations | | | | Comparison with prediction | | |
|---|---|---|---|---|---|---|---|
| | Neutral | Adverse | Benefit | Not assessed | Impact Better than Expected | Impact As Expected | Impact Worse than Expected |
| **All Schemes** | 18% | 76% | 5% | 1% | 7% | 73% | 20% |
| Bypass | 6% | 84% | 9% | 0% | 9% | 75% | 16% |
| Junction | 29% | 67% | 0% | 5% | 10% | 65% | 25% |
| Widening | 16% | 80% | 4% | 0% | 4% | 72% | 24% |
| Upgrade to Motorway | 50% | 50% | 0% | 0% | 0% | 100% | 0% |
| Smart Motorway | 100% | 0% | 0% | 0% | 0% | 100% | 0% |

Table 7-6 above demonstrates that the predicted impact on the landscape as a whole is most affected for **Bypass** and **Online Widening** schemes due to the immediate impact on surrounding residents and landscape character. After scheme opening POPE assessments show that **20%** of schemes are **'worse than predicted'** which is concerning when compared with the mostly adverse impacts predicted in the ES.

When assessing the impact of schemes on the landscape, it is noted that **73%** of schemes are assessed as 'As Expected', with **7%** as 'better than expected' and **20%** 'worse than expected. When compared with the 2013 Meta-analysis and 2010 Meta-analysis (see Table 7-7) a trend towards a worsening impact on the landscape sub-objective overall is noted. It is noted that the majority of schemes assessed in the 2010 Meta-analysis were OYA schemes which attract a higher percentage 'as expected' assessments due to their early stage in target achievement. This may skew the overall statistics comparison. It is suggested that a further comparison be undertaken in the 2017 Meta-analysis to confirm whether the worsening effect on landscape is a trend for investigation especially targeting planting conditions during construction and aftercare maintenance regimes.

**Table 7-7 Landscape evaluation changes over time**

| Year of Meta-analysis | POPE Evaluation | | |
|---|---|---|---|
| | Better than expected | As expected | Worse than expected |
| **2010** | 4% | 89% | 7% |
| **2013** | 8% | 76% | 16% |
| **2015** | 7% | 73% | 20% |

### 7.4.2 Is landscape mitigation in place at the One Year After stage set to achieve its target at the five years after opening stage?

ES predictions for landscape mitigation planting measures are based on the 'design year' which is fifteen years after scheme opening, by which time it is expected that planting will have met its objectives for screening and integration into the wider landscape. Mitigation planting is evaluated for POPE at the one year after scheme opening stage where it is often noted that it is too early in the establishment phase to judge the likelihood of growth target achievement, but determines the expected success based on planting in accordance with the ES. Where schemes have reached or exceeded their five year after scheme opening stage, OYA targets are compared with FYA achievements to determine whether continued growth and required maintenance has resulted in a higher likelihood of target achievement. POPE evaluations are only undertaken up to five years after opening. Planting is evaluated to be 'as expected' if plant establishment is in line with average growth rates for the location and species, together with any scheme-specific targets at the stage (year) of development.

*Key Findings*

Overall planting in place at OYA was set to reach its growth targets as required in the ES within most schemes, with isolated planting plots showing slow growth which could in part be due to exposed locations, poor or compacted soils or lack of maintenance including noxious weed control. Overall this interrogation shows that:

- For schemes currently at the OYA only stage of assessment, landscape mitigation is set to achieve its targets for **90%** of schemes.
- Considering all schemes assessed for this Meta-analysis (excluding those schemes where an assessment at OYA was not undertaken), OYA landscape mitigation targets are set to be achieved for **64%** of schemes with OYA and FYA landscape mitigation targets set to be achieved for **73%** of schemes.
- Overall **17%** of schemes identified landscape mitigation issues at OYA.
- **22%** of schemes were assessed where the aftercare period was noted to be between two and three years. Of these schemes, **12%** showed no effects of a reduced aftercare period.

### Analysis of landscape mitigation impacts with particular relevance to growth target achievement and aftercare maintenance

In order to analyse the assessment made by POPE for the Landscape sub-objective, this Meta-analysis has considered how successful ES identified landscape and visual impacts and proposed mitigation measures have been through the interrogation of growth targets set and aftercare maintenance required to ensure landscape and visual impacts of schemes do not exceed those identified in the ES.

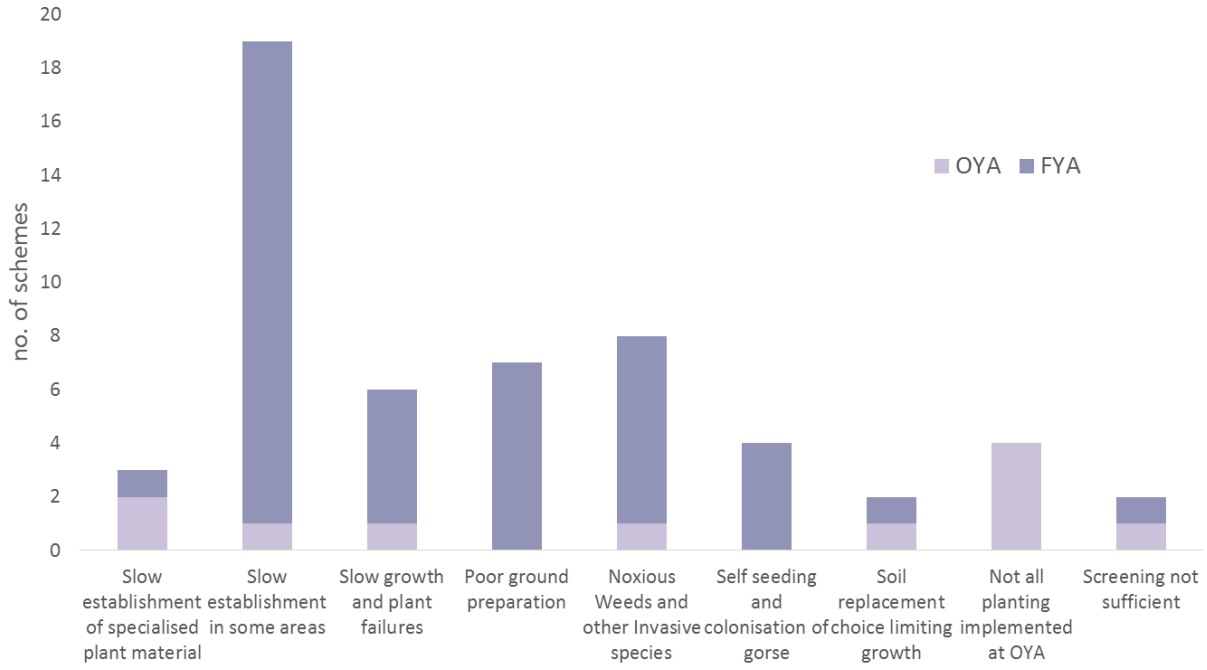
## Are landscape growth targets being met for major schemes?

This line of enquiry considers growth target achievement and factors impacting upon this achievement and success of aftercare maintenance. Table 7-6 on page 115 demonstrates that the majority of schemes fulfil their overall commitments required in the Environmental Statement (ES). However, an increasing number of schemes as shown in Table 7-7 on page 115 are showing a deterioration in reaching or exceeding their ES targets for landscape.

When considering whether schemes have fulfilled their ES commitments, common aims of each individual scheme have to be considered to determine whether this has indeed been achieved. An important part of the success of landscape planting is to provide visual screening, landscape integration and compensation for the loss of existing planting including habitats. Growth target assessments considered in each POPE report forms an important part of this examination.

Whilst the statistics overall for the achievement of targets set for landscape mitigation are generally positive, 55 issues identifying individual or multiple issues within 36 (45%) schemes were noted. Nineteen of these issues are for slow establishment of landscape planting. This is of particular concern where ground preparation issues are identified as a contributory factor as ground preparation in line with DMRB requirements is required to ensure good plant growth. All 19 schemes identified with slow establishment have ground preparation issues. Additionally, slow growth with high failure rates is recorded for eight schemes with a high incidence of noxious weeds and other invasive species recorded in eight further schemes. Figure 7-3 details common themes and concerns of these 55 issues. Detail regarding which schemes make up each category is shown in Appendix A.

**Figure 7-3 Landscape mitigation – common themes identified during POPE evaluations**




Where schemes require particular vegetative species mitigation to fulfil the commitments in the ES, it is especially important that aftercare maintenance ensures that this mitigation performs as required. Three schemes have been identified that appear to not meet the requirements for particular growth success, although this is at the OYA stage and therefore planting has time to develop before the FYA assessment:

- The **A3 Hindhead** scheme (OYA stage) report notes that the establishment of **heather** along the restored alignment of the old A3 through the Devil's Punch Bowl has not been successful as yet. The vegetation monitoring undertaken as part of the aftercare has not found any evidence of heather establishment to date, although a general herb layer has established. The report notes that this is not unusual with trials and extensive research on similar sites by others has shown that heather establishment is very fickle – being heavily affected by the fertility of seeds in any one year, slow growth rates and extent of disturbance. The report concludes that the maintenance strategy should ensure that invasive weeds or aggressive species such as Gorse are kept under control during the Aftercare Period in an effort to aid colonisation / establishment.
- The **A1 Braham – Wetherby** scheme (OYA stage) report notes that the **cowslip plug planting** within the verge in some locations does not appear to have been successful. As this scheme assessment is at the OYA stage it is assumed that any replanting of the cowslip will be noted in the FYA report, including the success or failure of those plants noted as successful at OYA.
- The **A30 Bodmin – Indian Queens** Improvement scheme (FYA stage) notes that the **Devil's Bit Scabious** (required for the success of the **Marsh Fritillary butterfly**) was recorded as unsuccessful as germination had not proven successful. The report notes that the designers suggested that plug planting should be used to ensure successful establishment but this was rejected due to the additional cost.

## Are landscape growth targets being affected by aftercare length reductions?

In addition to the analysis of landscape mitigation targets, aftercare periods have been analysed to determine the effect that the length of the aftercare period has on landscape targets being met. An aftercare period of five years is the accepted period in which landscape maintenance is required to ensure growth targets (of scheme vegetation are met. Although varying between each scheme, aftercare maintenance generally includes:

- Grass cutting regimes outside of MAC maintained areas;
- Watering to all standard, heavy and extra heavy standard trees to ensure establishment and survival in times of drought;

- Maintenance of stakes and individual tree / shrub guards;
- Maintenance of weed free circles to a radius of 500mm around each plant station in all tree and shrub plots;
- Physical or chemical control of noxious and other identified undesirable vegetation;
- Regular weeding of ornamental planting areas;
- Annual inspections to identify defective / failed planting stock to be replaced and any defective / failing grass sward to be re-seeded as necessary; and
- Diversity of species establishment maintenance to areas of habitat creation.

### Aftercare period identification

Forty three (53%) schemes recorded an aftercare period of five years or more. The aftercare period was not recorded in POPE reports in 22 (27%) schemes. Sixteen (20%) schemes were assessed where the aftercare period was noted to be between two and three years.

- Of the 43 schemes with a known aftercare period of five years or more, **93**% were set to achieve their targets.
- Of the 22 schemes where an aftercare period has not been confirmed by POPE, **86%** were set to achieve their targets.
- Of the 16 schemes assessed with a reduced aftercare period of two or three years, **73%** of schemes were set to achieve their targets. However individual issues have been identified within these sixteen schemes that may impact on their design year targets if not actioned

Of these 16 schemes, common themes are identified as follows, and scheme-specific information is included in Appendix A.2:

- Handover issues (10) **63%**
- Gorse establishment with potential to outcompete planting plots (4) **25%**
- Impact on growth targets (2) **13%**
- A reduction in aftercare had no effect on growth target achievements (2) **13%**

It should be noted that the above totals include where more than one issue was identified per scheme (A590 High and Low Newton Bypass, A64 Colton Lane GSJ, A34 Newbury Bypass and M27 J11-J12 Climbing Lanes).

### Does the contract type have any impact landscape mitigation targets?

Contract types making up the 81 schemes assessed for this Meta-analysis included:

- Early Contractor Involvement (with orders)
- Early Contractor Involvement (without orders)
- Design and Build (with orders)
- Design and Build (without orders)
- Design, Build, Finance and Operate
- Managed Motorways Framework

No significant trends were identified for landscape mitigation targets when assessed by contract type.

## Conclusions

This assessment highlights the need for ensuring correct planting conditions for planting plot types at construction stage and the continued stipulated aftercare maintenance requirements during the establishment stage (as highlighted in DMRB[29] volumes 10 and 11) to ensure the commitments made in the ES are fulfilled. When referenced together with the summary of the environmental impacts of major schemes (Table 7-2) it is clear that landscape and visual impacts of schemes have increased over the last five years at least. However, 86% of schemes assessed for this Meta-analysis, are set to achieve their growth target predictions. These targets are applicable to visual screening, landscape integration and compensation for the loss of existing planting including habitats. Additionally, success of visual

[29] Design Manual for Roads and Bridges.

screening is critical to protect sense of place for the built heritage and integration of road corridors into sensitive landscapes and habitats.

### 7.4.3 How does Highways England use locally appropriate materials in its schemes?

This section considers how Highways England uses locally appropriate materials and introduces vernacular style into its road schemes, including those which have incorporated sculptural elements, focal planting, 'gateway' features and landmark bridges as these all help provide a sense of place[30] within the local landscape. The analysis is based on examples of schemes where the use of locally appropriate materials and vernacular detailing has been discussed within the reports.

**Vernacular Design Detailing –** the incorporation of vernacular style using locally appropriate materials has been used to achieve a sense of place as part of scheme design to integrate schemes into the landscape and reflect local character; including stone walling, Cornish hedges, use of stone facing at structures and locally characteristic timber fencing.

One example, to illustration this aspect of scheme design, is the A590 High and Low Newton Bypass scheme located at the edge of the Lake District National Park (LDNP). The evaluation notes that local landscape elements have been incorporated into the scheme to good effect; the great attention to detail has also helped the scheme sit well within the landscape at the edge of the LDNP. Structures including the underpass wing walls and culvert head walls have been faced with locally sourced stone in keeping with the local vernacular style. Approximately 8.4km of new dry-stone walls, 1.4m high, have been used along the highway boundary incorporating gate posts from existing walls into new field accesses. They link with existing walls and help integrate the scheme into the local landscape. Figure 7-4, Figure 7-5 and Figure 7-6 illustrate vernacular elements of the scheme design.

**Figure 7-4 New dry stone walls replicate local boundary patterns, reuse field gateposts and tie into existing walls**

[30] Sense of place. Either the intrinsic character of a place, or the meaning people give to it, but, more often, a mixture of both.

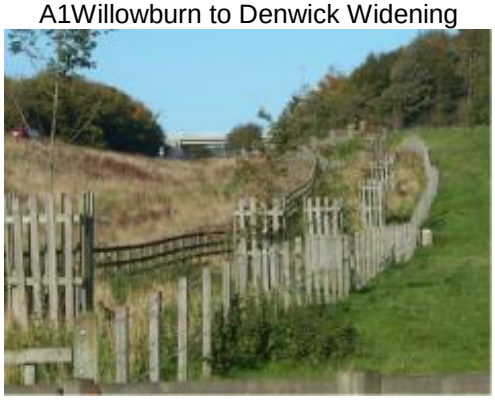
**Figure 7-5 Locally sourced stone used to face the bridge wing walls**

**Figure 7-6 Stone faced headwalls at new culvert/mammal tunnel below the A590 High and Low Newton Bypass**

**Gateway Features** – 'Gateway' features can also engender a sense of place by using local materials or by incorporating landscape features with local significance e.g. sculpture, landmark bridges or focal planting and several are included in Table 7-8. For balance, examples are also included where evaluations considered that the highway design could have been more focussed in providing local distinctiveness.

**Table 7-8 Examples of schemes incorporating landscape features**

| Theme | Scheme | POPE Observation |
|---|---|---|
| **Sculptural feature** | A1(M) Ferrybridge to Hook Moor upgrade to motorway  | One landscape feature has been provided instead of the three proposed in the ES. Ideas came via a design competition and the winning design reflects the local cultural heritage of the area representing burial mounds. The conical limestone sculptures, located adjacent to the Ferrybridge Power Station and near the Holmfield Interchange, were required to be of sufficient size to make an impact for drivers; visual interest being a key objective. |
| | A421 Great Barford Bypass  | Before the bypass construction started, a metal Black Cat was located on the roundabout which gave a sense of place to this busy junction with the A1. It has subsequently been reinstated and the Black Cat roundabout balancing ponds have been designed as a feature with grass seeded sculptural banks. |

| | | |
|---|---|---|
| | A5117 Deeside Park Junctions improvement<br>  | Near to the border of England and Wales on the A5117 scheme lion and dragon emblems have been created using stone chippings on embankments at the Woodbank Junction. Grass and weed species are beginning to establish within the areas of stone chippings and unless maintained these gateway features will lose their definition and visual appeal. |
| **Focal planting** | A1Willowburn to Denwick Widening<br>  | The A1 widening scheme is on low embankment where it passes though the historic Alnwick Castle parkland and is clearly visible. It would appear that the landowner has planted an avenue of trees in traditional park style tree guards alongside the A1 to provide a formal landscape framework to the road corridor, in keeping with the adjacent parkland. Although there are some intermittent groups of trees on the highway embankments, more formal planting by Highways England might have been more appropriate in this particular location. |
| | A1033 Hedon Road Widening<br>  | The roundabouts are an important feature of the route provided at major junctions, however, a lack of maintenance by FYA meant that the strong designs no longer 'read' well.<br>The ES stated that the roundabouts would provide potential locations for public art. However, apart from the timber sculpture at Alexandra Dock no other sculptures have been located along the route. Although the idea was mentioned in the ES the actual provision of sculptures was not part of the scheme. If it had been then this would have provided a series of focal points along the route and an opportunity to create a distinctive and high quality gateway to Hull.<br>New railings had been installed at various locations along the route to resist impact from traffic but they also add to the sense of place and provide continuity of design. |
| **Landmark bridges** | A63 Selby Bypass<br>  | The A63 crosses over the River Ouse which is navigable and to allow movement of river traffic, the new bridge over the river was designed and constructed to swing through ninety degrees. The new bridge is a distinctive feature along the bypass. |

| | | |
|---|---|---|
| | A21 Lamberhurst Bypass<br>  | Along the A21 a 'Land bridge' has been incorporated into the scheme to maintain access to Scotney Castle National Trust property and estate along its original line. The NT considers 'the type of bridge with the new bush and tree growth means that it is not as distracting as a typical bridge would be, and therefore softens the impact and blends into the surrounding landscape'. The Countryside Agency considered the land bridge to be 'excellent'.<br>The POPE evaluation noted that the land bridge vegetation had established well and provides a landscape framework to the Scotney Castle access drive as well as visually linking the retained existing woodland on either side of the bypass cutting. |
| | A249 Iwade to Queenborough Improvement<br>  | English Heritage stated that the new bridge is a striking addition to the landscape, visible from a few more places than anticipated and also offering a panoramic view of the surrounding area from it.<br><br>The POPE report notes that the design of the long shallow curve of the Sheppey Crossing deck helps to unify the disparate elements of the industrial landscape and reduce the impacts of the other elements such as the Kingsferry Bridge, pylons, the refinery and Ridham docks. When viewed from the Queenborough junction the Sheppey Crossing is another vertical element in a flat and open landscape dominated by vertical industrial infrastructure. |
| | A2 Bean Cobham Phase 2 Widening<br>  | The local authority stated that ideally it would have been desirable to have a more elegant design for the footbridges along the scheme, but through negotiation it was agreed that they would be widened and the hare motif added to the parapet to make them distinctive. The hare design was inspired by a Roman brooch found by HS1 works at Ebbsfleet. |

**Use of Locally Appropriate Materials -** During the POPE consultation process a number of standard and scheme relevant question are posed to consultees. One of these questions is 'in your opinion has the use of materials and finishes to structures been appropriate'. Specific responses to this question are not always provided but, where responses have been received and also based on POPE site visit observations, 20 schemes are noted to have had positive feedback on use of materials. For 8 of these 20 schemes consultees considered the general use of materials and finishes have been appropriate. Further details are shown in Table 7-9 for the remaining 12 schemes where a specific use of particular materials or applications was mentioned in the evaluations.

**Table 7-9 Schemes where specific materials/applications were considered appropriate**

| Theme | Scheme | Consultation Comment / POPE Observation |
|---|---|---|
| **Dry Stone Walls** | A1 Bramham Wetherby upgrade to motorway | Consultee: where dry stone walls have been built these are of good quality. |
| | A66 Temple Sowerby Bypass | Observation: Considerable lengths of locally characteristic dry stone walls have been constructed and restored. |
| | A590 High and Low Newton Bypass | Consultee: The use of materials is seen to be in keeping with the local landscape and better than expected for the use of dry stone walling. |
| | A69 Haydon Bridge Bypass | Consultee: Considered the new dry stone walls to be particularly good |
| **Retaining Walls** | M25 J28 Brook St Junction | Consultee: The use of materials and finishes on new retaining walls is very appropriate. |
| | A650 Bingley Bypass | Observation: Landscape planting is establishing, providing a good framework to the road and a balance to the stone faced retaining walls which reflect local character. |
| | M25 J12 -15 Widening | Observation: Retaining walls have been used to widen existing embankments within the highway boundary, using exposed aggregate pre-cast panels designed to 'blend' into the local landscape. |
| **Structures** | A1 Stannington Junction Improvement | Observation: The use of traditional materials, particularly for the visible structures of the underpass was expected in the ES and the bridge abutment walls have been faced with stone. |
| | M1 J25 to 28 Widening | Observation: The widened bridge has been clad in grey brick and the appearance and finish of this structure is considered an improvement on those existing along the scheme corridor. |
| | A1(M) Ferrybridge to Hook Moor upgrade to motorway. | Observation: Materials and finishes to structures were chosen to be sympathetic to their setting. The design of the reinforced concrete piers at the Holmfield Interchange was agreed with the Commission for Architecture and the Built Environment and they are shaped to imitate the cooling towers of the Ferrybridge Power Station. The bright yellow footbridge provides a link for Holmfield Lane but is visually prominent. |
| | M60 J5-8 Widening | Observation: As expected in the ES where pedestrians have access to structures, e.g. along the tow path of the Bridgewater Canal, main concrete faces have been clad in brick |

| | | |
|---|---|---|
| **Urban walls and railings** | A1033 Hedon Road Improvement | Consultee: considered that the visual/landscape design aspects of the scheme were particularly good and had significantly enhanced a previously run-down part of the city – important as it is the gateway to the city and region for visitors from abroad. Particularly impressed by the quality of the design and construction of the walling and wrought iron fencing at the western end (see below)<br>  |

**Use of Materials with Differing Responses** - In addition to the positive feedback received / observed, 3 schemes received differing views on the use of materials, both positive and negative, from consultees commenting on the same scheme – evidence that to a certain extent this is a subjective area of design. An evaluation overview is also included in Table 7-10 for context, the specific consultee comments have not been responded to with no specific reference to materials and finishes.

**Table 7-10 Schemes where differing views have been received**

| Scheme | Consultation Comments | Evaluation Observations |
|---|---|---|
| **A5 Weeford Fazeley Bypass** | At OYA the District Council commented that 'generally the finishes and materials are considered appropriate / acceptable. However it is considered that the materials of the central reservation could have been improved and there is a visual/litter issue that needs to be addressed through maintenance.' | Finishes and materials were not specifically commented on; litter was noted along some boundaries and in drainage ditches. |
| | At FYA the County Council considered that the appropriate use of materials and finishes was worse than expected. "The bridges are of a standard design with concrete finish, which tends to detract from the overall visual quality of the road and more appropriate finishes could have been utilised". | |
| **A419 Blunsdon Bypass** | At OYA the Parish Council considered material finishes to be visually appropriate. | Mitigation generally implemented as expected but too soon to evaluate the success of the new landscape planting in screening traffic and integration of the scheme into the local landscape – materials not specifically mentioned. |
| | Also at OYA the Borough Council commented that there did not appear to have been any real effort to reduce the visual impact of the structures, though they are as expected. They noted that the structures are slightly unusual in that they use weathering steel and consequently will always look rusty and as if they need re-painting. | |
| **A14 Rookery Crossroads Grade Separated Junction** | At OYA the District Council considered the use of materials and finishes to structures reasonable as the structures are not particularly intrusive or have a major landscape impact. | The realignment of the A14 has had little impact on the landscape character and views from properties or public areas as expected. Materials not specifically mentioned. |
| | Also at OYA the County Council considered the bridge finish to be bland and the signs very intrusive. | |

**Materials Considered Inappropriate** - Analysis of the data has also identified that scheme materials are not always well received by consultees and for 10 schemes material choices have been considered unsuitable by consultees and these are identified in Table 7-11. For another two schemes the evaluation reports noted that some of the vernacular boundary treatments proposed in the ES were not taken forward into the final design/construction phase:

- A595 Parton to Lillyhall Bypass - Stone walling was included in the ES design as it is a characteristic boundary treatment in the local area and to replace stone walls lost to the scheme. At the southern end of the scheme it has been replaced by timber post and rail fencing; and

A30 Whiddon Down Junction Improvement: The proposed Devon hedge bank was planted as an ordinary hedge on the earthworks to the over-bridge.

These two examples are relatively small changes but do illustrate that traditional detailing can be lost between ES proposals and the final design.

**Table 7-11 Locally vernacular style or materials considered unsuitable/not appropriate**

| Scheme | Consultation Comment | POPE Observation |
|---|---|---|
| **A1 Peterborough to Blyth Grade Separated Junctions**<br><br>**Carpenters Lodge junction** | The local authority considered the bridge had no sense of locality – so not appropriate but as expected because local character is not embedded very far in road schemes. New planting will shortly hide views of the Burghley estate stone wall a feature of local significance, with resultant loss to the local character of the road. | The opportunity to include some local distinctiveness into the scheme has been lost through choice of bridge materials, and the locally significant stone boundary wall will be screened by new planting; the scheme seems to have failed to create a sense of place, one of the landscape objectives.as it links it to failure of a scheme objective |
| **M6 Toll**<br><br>**Motorway** | The turquoise colour of the toll booth canopies was felt to stand out too much by the County Council, who considered that a darker green colour would have blended into the landscape more effectively and that further offsite planting could be undertaken in mitigation. | The evaluation does not specifically address the impact of the toll booths. Colour is a subjective issue but it should be noted that one of the ES objectives was to blend the road into the existing landscape as far as possible. |
| **A120 Stanstead to Braintree**<br><br>**Bypass** | The District Council considered that the new road layout detracts from the setting of the listed gatehouse at High Wood which has 'lost its sense of place'. The satellite roundabout adjacent to the gatehouse has been 'landscaped' with artificial turf which is considered entirely inappropriate in this context.<br><br>The County Council stated that generally the materials and finishes to structures are considered to be appropriate with the exception of the 'engineering' facing brick applied to the abutments of the over bridge at the GSJ which is insensitive to the character of the area. A more elegant engineering solution may well have been warranted given the proximity to the historic town of Great Dunmow. The limited opportunities for planting in this location does not help in ameliorating the visual impact of this structure. | The evaluation did not specifically mention the impacts on the listed gatehouse.<br><br>With regard to the bridge at the Dunmow South junction the evaluation site visit found the bridge at the Dunmow South junction looked satisfactory and reflected the style of the bridges in the vicinity of Panners Interchange. |
| **A2 Bean Cobham Phase 2**<br><br>**Widening** | The Borough Council considers with regard to the use of materials and finishes to structures that the design and materials are “standard” – and do not match those of HS1[31]. | The evaluation does not specifically mention materials and finishes, it notes that the new transport corridor with associated lighting and sign gantries located close to the HS1 line has adversely impacted on the local landscape character and although new |

[31] HS1= High Speed 1

| Scheme | Consultation Comment | POPE Observation |
|---|---|---|
| | | landscape planting is in place it will take time to mitigate the effects. |
| **M40 J15 (Longbridge)**<br><br>**Junction** | Parish Council commented on materials that "the final appearance of the concrete structures is raw and brutal with no attempt made to dampen down this inappropriate end result in a rural area".<br>  | The evaluation notes that the green wall helps to soften the appearance of the bypass flyover, but the structure and its embankments introduce a strong vertical element to the landscape that is visible from receptors to the north, east and west of the scheme. The concrete finish of the flyover and other structures implemented across the scheme are as expected in the ES. |
| **A38 Dobwalls Bypass** | With regard to finishes the local authority considered that: 'Generally landscape detailing and finishing is poor'.<br>  | The lack of greening on the slopes along the length of the bypass due to the use of low nutrient 'shillet[32]' makes the route feel somewhat barren, drawing the eye to the hard engineering, several areas of which appear to have been poorly finished, as opposed to showcasing the more vernacular features within the design such as the Cornish Hedges – see adjacent illustration. |
| **A63 Melton Grade Separated Junction** | Parish Council considers the design of the footbridge to be 'poor' and a blot on the landscape.<br>  | It was expected that the most significant landscape impacts would be as a result of the visual intrusion of the large prominent junction and the footbridge at Gibson Lane. |
| **A421 Improvements M1 J13 to Bedford – Bypass** | The District Council commented with regard to use of materials in the construction of the new bridges – 'brick making is a historic feature of the area and use of this material for the new bridges would have been more in keeping with the local character of the area'. It also noted that 'the central safety barrier has introduced a bright "spine" which is very dominant feature visually and one which had not been anticipated'.<br><br>The Regeneration Trust said that 'the bridleway over-bridge structure is particularly visually intrusive owing to the metal construction and paint colouring. Whilst appreciative of the engineering considerations, it would have been much more compatible with the environmental regeneration vision for the area if a timber or | New overbridges will remain visible in the landscape until the planting scheme surrounding it matures<br><br>As mentioned in the consultation received from the district council, the use of a concrete central median barrier is highly visible to the surrounding areas and will remain so until planting matures and the initial brightness of the barrier fades. |

[32] Shillet - Coarse soil with pieces of slate – a locally available quarry by product in Cornwall.

| Scheme | Consultation Comment | POPE Observation |
|---|---|---|
| | combined steel/timber unit had been used instead. | |
| **M4 J18 Widening** | The Council commented that the small plant building alongside the roundabout at Junction 18 was not detailed in the manner they would have expected for a new building in the AONB. | The POPE report noted that this building did not form part of this scheme design and was constructed as part of a communications infrastructure upgrade. |
| **A500 City Road and Stoke Junction** | The City Council's Urban Design and Conservation Team are of the opinion that an opportunity has been missed to visually improve the environment of people using the A500 because of the utilitarian design of the highway structures. The materials and design details do not create a sense of "local distinctiveness". The whole project looks to be of a much lower standard than that of the nearby A50 with its acres of red and cream brickwork, distinctive bridges and metalwork.  | The POPE evaluation says -the concrete retaining walls adjacent to the A500 below Glebe Street have been enhanced with a terracotta render and the use of a silver ribbon mural as proposed in the ES. This enhancement was not proposed for either the Stoke Road or City Road junctions. It has improved the appearance of the underpass for both pedestrians and vehicle travellers and is as expected in the ES. |

It would appear that adverse comments tend to be scheme-specific and do not necessarily represent a particular trend. They do, however, demonstrate that the opportunity to include some local distinctiveness into schemes can be lost through choice of materials and that these issues are important locally. The evaluations do not always respond to specific issues raised by consultee with regard to materials and do not necessarily agree with the consultation opinions expressed (A120, A500 and M4 J18).

*Conclusions*

Based on the considerations of schemes for this Meta-analysis where specific references are included regarding materials there are more schemes where materials are considered to have been locally appropriate by consultees or site visit observations than not, and it is evident that the use of appropriate materials makes a positive contribution to scheme design and is generally welcomed by consultees. It is however, a subjective area of design and opinions do differ on the detail.

Vernacular design incorporating locally appropriate materials compliments existing features whilst providing distinctive and high quality elements to the overall design, often using traditional construction detailing which helps to integrate schemes into the landscape and reflect local character The inclusion of 'gateway' features also creates a 'sense of place' often with local significance.

### 7.4.4 How accurately are impacts forecast for designated landscapes?

Forty five (**56%** of 81 schemes) schemes assessed for this Meta-analysis are located within or adjacent to designated landscapes[33] which have included national designations such as National Parks or Areas of Outstanding Natural Beauty (AONB), greenbelt, historic parks and gardens or historic landscapes, as well as areas designated at a local level such as Areas of Great Landscape Value. This is compared

[33] Some schemes have more than one designated landscape.

with the 2010 Meta-analysis[34] report where 33 (**56%** of 59 schemes) schemes were listed as being located within or near designated landscapes.

POPE revisited the OYA assessed schemes from the 2010 Meta-analysis and found original predictions to still be relevant and as such have not influenced the 2010 assessment of designated landscapes identified at that stage.

As can be seen from Table 7-12 below, most impacts on designated landscapes have been considered to be 'as expected'. However, this assumes that the landscape planting will continue to establish satisfactorily to screen and integrate the scheme into the local landscape.

**Table 7-12 Predicted vs. Outturn Impacts in Relation to Designated Landscapes**

| POPE evaluation result | AONB | National Parks | Local Authority Designation | Greenbelt | Historic Park or Landscape |
|---|---|---|---|---|---|
| **Better than expected** | 0 | 1 (1%) | 1 (1%) | 0 | 0 |
| **As expected** | 8 (10%) | 1 (1%) | 20 (25%) | 9 (11%) | 7 (9%) |
| **Worse than expected** | 5 (6%) | 1 (1%) | 3 (4%) | 2 (3%) | 2 (3%) |

Two schemes were considered better than expected; A590 High and Low Newton due to the care and attention to detail in the design as well as close working with the National Park authority to deliver the agreed scheme and M25 Brook Street although the local authority did not expand on its reasons.

Schemes were considered worse than expected for a variety of reasons including:

*Meta-analysis 2010 findings (and still considered relevant for 2015 Meta-analysis)*

- AONBs - adverse effect on the natural beauty and character of the AONBs, including the pattern of the landscape and loss of tranquillity (A34 Newbury, A27 Southerham to Beddingham Improvement), scheme intrusive in the AONB and impact underestimated (A41 Aston Clinton). sign gantry being more visible and a plant building not being detailed in the manner expected in the AONB (M4 junction 18);
- National Park – landscape impact on newly designated National Park greater than expected particularly the raising of the road on embankment (A27 Southerham to Beddingham Improvement);
- Local designations -planting had not matured as quickly as expected (A428 Caxton Common to Hardwick Improvement), impact underestimated in AST due to full lighting and over-bridges (Newark);
- Greenbelt – worse than expected at OYA although may improve as planting establishes (A428 Caxton Common to Hardwick Improvement); and
- Historic Parks and Landscapes - Significant changes made to the landscape character of a historic landscape (A10 Wadesmill to Colliers End Bypass) and the scheme not respecting open views to an ancient field system as expected in the ES (A30 Bodmin to Indian Queens Improvement).

*Meta-analysis 2015 (OYA schemes not assessed for the 2010 Meta-analysis)*

- AONBs - the widening being online had a slight negative impact, particularly the erosion of a narrow corridor of trees (A2 Bean-Cobham, phase 2 Pepperhill – Cobham)
- Local Designations - impact of the scheme on local landscape character was worse than expected in the vicinity of the grade separated junction (A14 Haughley New Street – Stowmarket Improvement); and

[34] This question was not included as part of the 2013 Meta-analysis.

- Greenbelt - the scheme had not given due regard to designations including conservation areas, SLAs or Green Belt had ruined the open, rural feel of the landscape and that many of the local landscape features of individual and grouped trees, mature hedgerows, meadowland and part of the riverine tree belt had been destroyed (M40 junction 15)

### 7.4.5 How often do suggested townscape/streetscape improvements identified in the ES get provided?

From the AST and EST entries, the removal of traffic is seen as the main benefit for bypassed settlements and specific streetscape improvements are not often considered to be necessary, particularly where the fabric of the townscape would not be adversely affected by the proposed works. However, improvements are welcomed by local communities who see the removal of trunk road paraphernalia as an important aspect of reclaiming their local townscape environment.

This question has been answered with reference to townscape/streetscape improvements highlighted in POPE scheme reports – original source documents have not been revisited. Townscape /streetscape deliverables are not always detailed in the ES and might only be highlighted in evaluations if commented on by consultees.

Of the 9 schemes where specific reference has been made to streetscape improvements in the ES, 7 of these (5 Bypass, 1 upgrade to Motorway and 1 Junction) would appear to have generally provided the enhancements as expected, although for 3 of these, certain elements have not been taken forward.

For two schemes the enhancements were not taken forward, further details are shown below;

- **A69 Haydon Bridge Bypass** – The AST specifically referred to the planting of 6 trees along the de-trunked section of road would bring benefits and ES mitigation plans also indicated that six heavy standard trees would be planted at key town centre locations for traffic calming and townscape enhancements. At OYA these had not been provided; and
- **M40 A404 Handy Cross Junction** - The ES noted that the junction improvements would provide the opportunity to create a sense of arrival at Handy Cross that might help restore a sense of local distinctiveness. The scheme included a location for a possible sign/sculpture on the verge in between Marlow Road and Marlow Hill. This was identified as ‘non-essential’ in the ES and was not taken forward which is seen as an opportunity lost.

The 7 schemes where townscape/streetscape proposals formed part of the ES scheme design are summarised below.

**A3 Hindhead Improvement – Bypass:** The ES expected that streetscape improvements would be implemented along the closed section of London Road (formerly the A3) following the completion of the main scheme. These have been provided including reduction in width and resurfacing of London Road between the Hindhead Crossroads and the National Trust Car Park, installation of a traffic calming raised table and turning head at the National Trust Gateway, widened footways, parking bays, seating street furniture and landscaping. The former traffic signals at the crossroads were replaced with a double mini-roundabout incorporating signalised pedestrian crossings which appears to be causing some localised confusion.

**A590 High and Low Newton Bypass:** Townscape along the old A590 has become less urban in character. The removal of significant volumes of traffic from the villages has improved the visual amenity and in turn local landscape character with measures undertaken to ‘downgrade’ the road including widened verges to reduce carriageway width in High Newton (see Figure 7-7). This caused more issues regarding maintenance than had been expected by the local community and by FYA some of the verges had been adopted by households via a stopping up order and others were maintained by a working party of volunteers.

**Figure 7-7 Widened verges along old A590 at High Newton reduce the visual appearance of the old carriageway in keeping with the village setting**

**A1(M) Ferrybridge to Hook Moor upgrade to motorway:** The POPE evaluation considered that the ES commitments to downgrade the existing A1 from Brotherton to Selby Fork had been delivered, with additional features provided by the DBFO Co and Fairburn Parish Council.

It confirmed that along the 'old' A1 through Fairburn, the more formal landscape treatment creates a sense of place on entering the village as expected. New semi-mature tree planting has been undertaken, stone walls retained / repaired and a small community garden has been planted by the DBFO Company (as an additional facility not part of the ES design). The removal of the old A1 overbridge has enabled a small skateboard park to be provided; this was designed and built at the instigation of Fairburn Parish Council with grant aid (Figure 7-8).

**Figure 7-8 Avenue street tree planting and widened verge area within Fairburn which the ES expected would provide open areas similar to a village green with the aim to reconnect the two sides of the village (left). Fairburn Community Garden at OYA (right)**

**A38 Dobwalls Bypass:** The scheme included proposals to amend the geometry of the approaches to Dobwalls to increase footpath widths (Figure 7-9). Following opening, the former A38 through Dobwalls has been de-trunked and a number of improvements were made by the local authority to the old road (although partly funded by Highways England which was included in the predicted cost of the scheme). Improvements included narrowing the road with lining, introducing double mini roundabouts at the crossroads in Dobwalls and the removal of the signalised pedestrian crossing outside the pub in the village. These elements have combined to improve visual amenity and create a road more suited to village character.

**Figure 7-9 Example of changes to townscape delivered by A38 Dobwalls Bypass**

**A500 City Road and Stoke Junction Improvement:** POPE found that in general the improvements and mitigation had been carried out as proposed in the ES with the exception of the raised-bed planting within St Peter's Churchyard Conservation Area and the landscaping aspects of Fowlea Brook (re-grading and softening of banks) due to EA access requirements. The canal side wall elevations at all junctions have been clad with brick to integrate with the retaining walls on the opposite side of the canal in keeping with the character of the Trent and Mersey Canal Conservation Area. The new environmental barrier at the Cornwallis Street/Maclagan Street area is a concrete wall with a blue wave pattern façade. Figure 7-10 shows that the concrete retaining wall adjacent to the A500 below Glebe Street has been enhanced with a terracotta render and the use of a silver ribbon as proposed in the ES. It has improved the appearance of the underpass for both pedestrians and vehicle travellers.

**Figure 7-10 Concrete retaining wall cladding**

**A6 Alvaston Bypass:** Two areas of environmental enhancement were identified in the ES as an Archaeological Interpretation Area/nature area intended to deliver a 'travel through time' educational experience as a resource for local primary schools and a wetland/wildflower area. The site visit confirmed they had been implemented and were well used for informal recreation; there was no interpretative information or evidence that were used as an educational resource (Figure 7-12). There was however, evidence of anti-social activities including vandalism, fly-tipping and littering (Figure 7-11) partly due to the areas being somewhat secluded and screened by planting from adjacent properties.

**Figure 7-11 Fly-tipping and littering at the Archaeology Interpretation Site and Nature Area**

**Figure 7-12 Entrance and sculptural features within the Archaeology Interpretation Site and Nature Area. In the absence of any on site interpretative material, it was considered difficult for an uninformed visitor to appreciate the original intentions.**

**A1033 Hedon Road Improvement – widening:** The ES included comprehensive landscape and streetscape proposals which have generally been provided including extensive areas of planting and mounding, feature walling, new railings at various locations along the route to resist impact from traffic and add to the sense of place and provide continuity of design (Figure 7-13 left), provision of a community amenity area to allow relocation of the Marfleet Memorial – although there were some issues relating to maintenance of planting (Figure 7-13 right) and retention of the existing York stone paving and mature street trees in the area in front of H.M prison and Hedon Road Cemetery.

Some features have either been amended since the ES, not taken forward or retro-fitted;

- The Newtown Court to Ferries Street proposals changed as a result of a post Public Inquiry decision. The pocket park is not a semi-enclosed predominantly soft landscape area as originally envisaged;
- Streetscape improvements outside the shops at Marfleet Avenue were not as extensive as in the ES; underground services limited the number of new trees planted. Paving in front of the shops did not form part of the Scheme, however, if it had been possible to extend the new paving right up to the building façades this would have helped the overall streetscape appearance;
- Although the idea of sites for possible public art along the route was mentioned in the ES the actual provision of sculptures was not part of the scheme. If it had been then this would have provided a series of focal points along the route and an opportunity to create a distinctive and high quality gateway to Hull.

Despite a paved 'splash strip' along the road edge being indicated on mitigation figures included in the ES they were not initially installed. They were eventually retrofitted along most of the route to overcome the problem of spray damage of verges and planted areas (Figure 7-14).

**Figure 7-13 Feature railings (right) and boundary treatment and poor planting maintenance at the Marfleet community amenity area (left)**

**Figure 7-14 Examples where a splash strip was or was not provided at edge of kerb**

*Conclusions*

Based on the examples considered for this Meta-analysis, and as would be expected, townscape/streetscape improvements include a mix of hard and soft design and are very much scheme-specific depending upon the scale of the road proposals and individual locations. Designs have generally been successful in reflecting local character and helping to restore a sense of place, although scheme-specific issues are sometimes raised by consultees or site observations. It is, however, important that enhancements are fully embedded in the ES design as commitments, to ensure that they are delivered as part of the final scheme.

It is also important that the full extent of any additional responsibilities falling to local communities as a result of downgrading or de-trunking roads is fully explored with the communities concerned.

### Schemes where the local authority has implemented enhancements

In addition to streetscape improvements included within schemes, there are schemes where de-trunking has allowed the local authority to provide enhancements (10 schemes). The removal of traffic from the 'old route' provides an opportunity to introduce minor local improvements such as traffic calming and greater priority for pedestrians and cyclists (noted in 4 schemes).

Six schemes where more extensive streetscape improvements have been provided as part of the de-trunking process are included in **Table 7-13**.

**Table 7-13 Examples of streetscape improvements undertaken as part of the de-trunking process.**

| Scheme | Enhancement |
|---|---|
| **A10 Wadesmill Bypass** | The removal of traffic from the villages enabled the local authority to undertake improvements including reducing the carriageway width, gateway features (village signs-illustrated), replacement street lighting and traffic calming which has enhanced the local street scene with a style more sympathetic to a village environment.      |
| **A21 Lamberhurst Bypass** | As a result of the bypass construction it was possible for the local authority to implement traffic calming measures together with other streetscape enhancements which have benefitted the amenity of the village including improvements at the village green and replacement of locally distinctive white picket garden boundary fence. Properties in close proximity to the old A21 have benefitted by significant reduction in through traffic, widening footpaths and providing more generous pedestrian areas adjacent to buildings.   |
| **A1 Stannington Grade Separated Junction** | The C364 through the village has undergone some environmental improvements carried out by the County Council in agreement with the Parish Council including a paved central reserve and occasional planters which reduces the dominance of the carriageway and provides a village feel to the main through route.  |

| | |
|---|---|
| **A63 Selby Bypass** | The bypass has enabled the local authorities to implement a programme of improvements to the town centre as part of an Urban Renaissance Programme which have improved the setting of Selby Abbey and the character and amenity of the Conservation Area. This has included repaving the area in front of the Abbey and the introduction of new street furniture, reducing the width of the carriageway on Gowthorpe and introducing speed reduction measures.<br>   <br>  |
| **A650 Bingley Relief Road** | The town centre has benefited with traffic, particularly heavy goods vehicles, being transferred to the north of the town, which has also allowed the local authority to undertake various improvements to streetscape e.g. provision of a new town square next to the historic Butter Cross which provides an attractive focal point off Main Street, carriageway narrowing to allow on-street parking, pedestrian crossing points, introduction of a 20mph zone and provision of new street furniture and lighting columns.<br>   |

| | |
|---|---|
| **A66 Temple Sowerby Bypass & Improvements at Winderwath** | De-trunking measures on the existing A66, including reducing the width of the road by extending the grass verges, removing the red central surface treatment and reducing the speed limit to 30mph, have reduced the impact of the road on the townscape and on the setting of the conservation area and listed buildings as expected.<br>  |

*Conclusions*

Based on the examples considered for this Meta-analysis, for schemes where no environmental enhancements were proposed in the ES, some form of townscape/streetscape improvement has been provided by others, usually by the local authority as part of de-trunking works (9 bypasses and 1 junction), The downgrading of former trunk roads by Highways England has therefore facilitated these improvements improving visual amenity and creating a road more suited to local town or village character.

It is worth pointing out, however, that it has been suggested by consultees for bypass schemes that small scale improvements along the former trunk road should, as a matter of course, be included in Highways England scheme design e.g. the removal of street furniture, signs and lighting which is no longer appropriate would help restore a more local town/village character and remove visual clutter from the street scene.

Overall, where townscape/streetscape initiatives were included in the ES design they have generally been implemented as expected and are well received locally.

## 7.5 Is Highways England improving document provision to support POPE studies?

The POPE environmental evaluations are predominantly based on the information that is made available. No new environmental surveys are undertaken for the purposes of POPE and hence the validity/depth of conclusions made about the likely effectiveness of scheme mitigation is strongly dependent on the information provided.

### Collection and Scrutiny of Baseline Data

As a baseline for each scheme, environmental evaluations use the scheme's Environmental Statement (ES) or latest Scheme Assessment Report (SAR) and Appraisal Summary Table (AST). Scheme-specific background data is requested from the Highways England scheme Project Manager which is based on a standard list of information which has evolved over time. Post construction information such as 'As Built' scheme drawings for the environmental design and monitoring of landscape and biodiversity features are critical in allowing an accurate assessment of the impacts of schemes against those predicted in the ES.

Information relating to ongoing maintenance and monitoring, lately in the form of a Handover Environmental Management Plan (HEMP), greatly improves the quality of the evaluation process. Further information such as archaeological reports (popular and academic) and post opening non-motorised user (NMU) audits when received allow for greater clarity on scheme performance against ES environment objectives.

### How does data availability affect the ability to evaluate the schemes?

Document and data availability has an impact on environmental aspects of evaluation as it determines the degree of certainty over which conclusions can be made. As no new environmental surveys are carried out for the specific purposes of POPE, confirming that scheme proposals have been provided as expected and ascertaining the effectiveness of some mitigation measures relies on scheme post opening information being available to POPE. Generally it has been possible to evaluate (at least to a limited extent) the majority of sub-objectives from data available. However, the robustness of reporting is greatly influenced by the quality and content of information received.

Non- availability of some documentation does not necessarily represent a non-compliance as not all documents listed will necessarily be a requirement of the individual scheme contracts and it this analysis does not take account of this.

### To what extent has Highways England been able to provide the standard documentation requested?

The most commonly requested information for POPE evaluations is included in this evaluation. Data provided to support POPE evaluations for the **81** schemes being considered in this Meta-analysis has been variable between schemes for a variety of reasons. Where data was not provided this was typically due to:

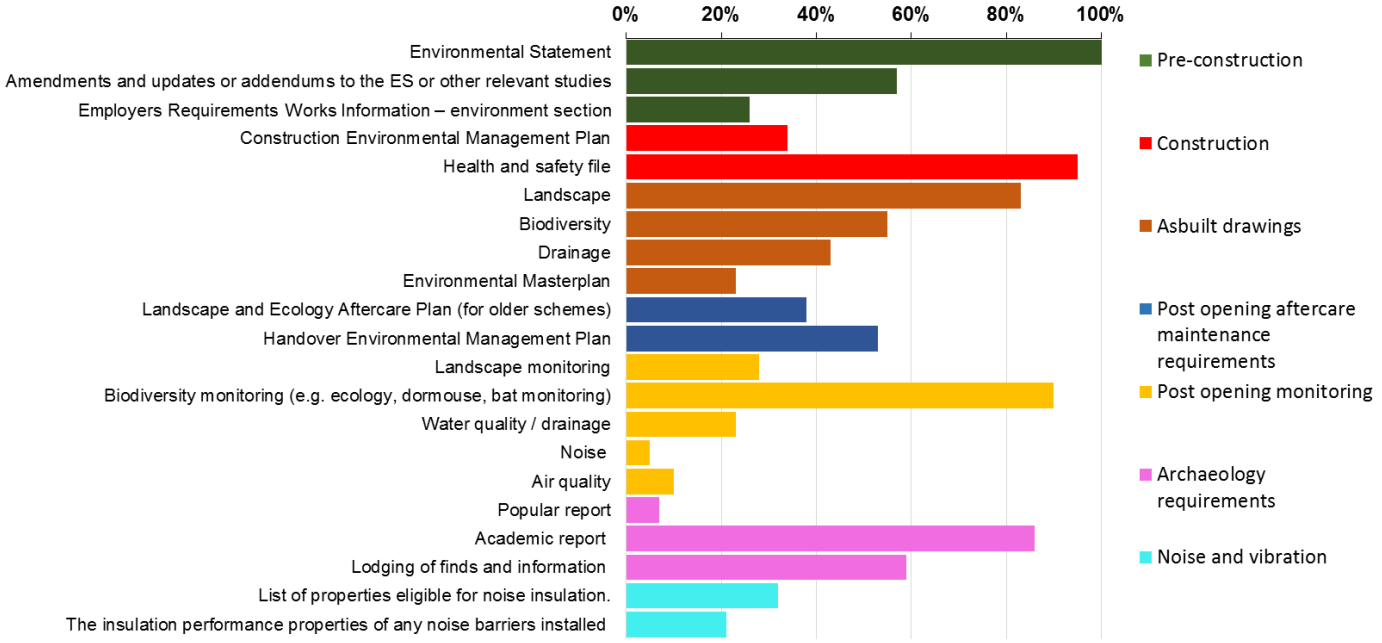
- Difficulties in retrieving requested documentation from Highways England's file archiving systems;
- Staff changes following scheme opening;
- Post construction surveys or monitoring not undertaken; and
- Data unavailable at time of request due to timing of evaluations compared with expected timescales for publishing key documents.

Due to changes in scheme appraisal and environmental requirements over time, in some instances it would not be expected that all documentation requested as part of POPE would be available. This aside the following trends have been identified with respect to data collection:

- Overall **33%** of information requested was received,
- Seventy two (**89%**) scheme reports received less than 50% of information requested.

It is noted that this Meta-analysis includes all schemes assessed within POPE, including 24 FYA schemes assessed in 2010. At this time, although there was a mostly comparable POPE document request list, items such as the Health and Safety file and the Employers Requirements (works information) were not included in this list. However, a comparison excluding 2010 data collection figures undertaken demonstrates that overall trends remain similar with only a slight improvement noted post 2010.

**Figure 7-15 Breakdown of the overall reports and drawings received for the purposes of POPE**



# 8. Further Analysis

**Scheme Photo: A1 Bramham to Wetherby Improvement, One Year After**

# 8. Further Analysis

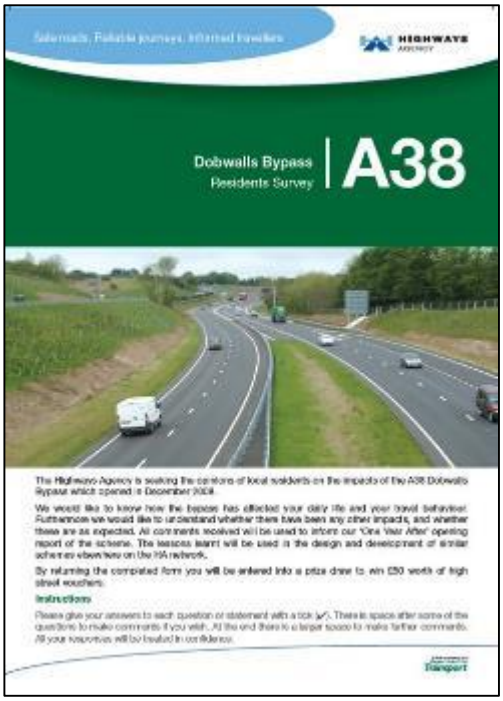
This section considers the remaining line of inquiry included in this Meta-analysis, many of which do not easily sit within a specific DfT objective for transport.

## 8.1 Are local communities satisfied with Major Schemes?

**Local communities are generally satisfied with Major Schemes with 65% of questionnaire respondents (across 15 schemes) either agreeing or strongly agreeing that the scheme had made their community a better place to live.**

Resident surveys' have been undertaken for 15 schemes to collate the opinion of those people directly impacted by each scheme. Whilst based on a relatively small number of schemes, these surveys have been undertaken as part of the POPE process in recognition that Major Schemes often have impacts on the community that cannot easily be evaluated fully through use of appraisal methods prescribed at the time of a scheme's appraisal. It should be noted therefore, that this section represents findings from a small number of schemes only and in no way aims to represent trends regarding all Major Schemes at a national level.

**Residents Survey Example: A38 Dobwalls Bypass**




Each survey asked respondents how much they agreed with the statement that the scheme consulted on had made their community a better place to live[35]. Results of this, split by scheme, are presented in Figure 8-1.

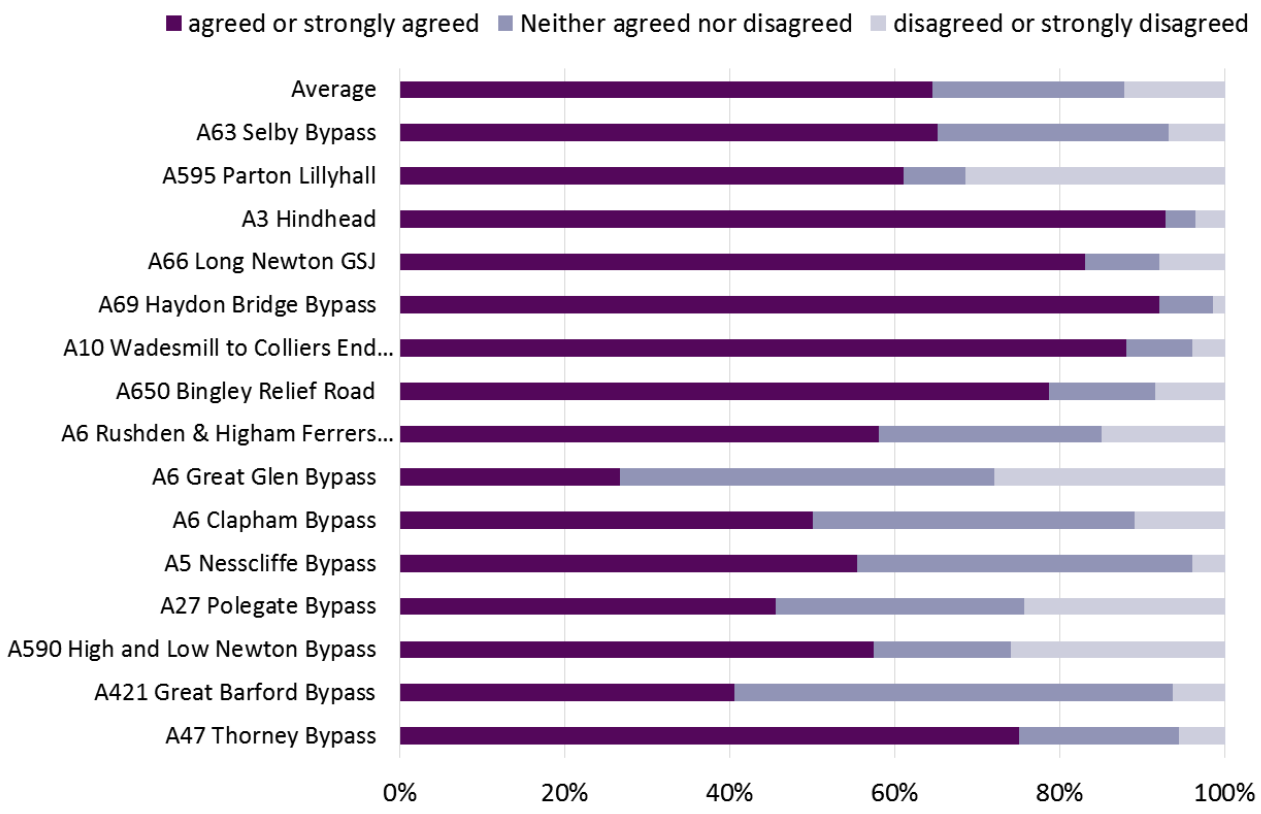
Across the 15 schemes, a significant majority (65%) of respondents either agreed or strongly agreed with the statement that the scheme consulted on had made their community a better place to live, as a reflection of satisfaction with scheme. This level of agreement ranged from 27% for the A6 Great Glen Bypass to 92% for the A3 Hindhead and A69 Haydon Bridge Bypass schemes.

Across the 15 schemes, 7% of respondents either disagreed or strongly disagreed that that the scheme consulted on had made their community a better place to live. For four of the schemes, levels of dissatisfaction exceeded a quarter of respondents (A590 High and Low Newton Bypass, A27 Polegate Bypass, A6 Great Glen Bypass and A595 Parton Lillyhall).

Whilst the sample is biased towards bypass schemes, in many instances lessons learnt from these surveys will be of value to any appraiser of a trunk road project with anticipated traffic reduction effects on built up areas and also prompt Highways England thinking about the wider community implications of its proposed schemes.

[35] For the A3 Hindhead and A595 Parton Lillyhall schemes, residents were instead asked how satisfied with the scheme they were.

**Figure 8-1 Satisfaction levels in local communities based on residents' survey findings***




*Based on questions worded 'has it made … a better place to live' or 'how satisfied are you with …'

## 8.2 How long does Highways England Major Scheme appraisal take?

**The average duration of Highways England Major Scheme appraisal is just over four years (for schemes with a construction start date between 2004 and 2009), although there is a wide variety between individual schemes.**

**There has been little change in the duration of scheme appraisal between 2004 and 2009.**

Broadly speaking, transport scheme appraisal is the process Highways England undertakes (using the DfT's WebTAG guidance) to:

- Identify the problem to be solved;
- Identify a scheme;
- Develop the business case to ensure that the scheme is value for money and adequately mitigates any adverse impacts against the DfT's objectives for transport; and
- Secure the necessary funding approval for the scheme to allow construction works to commence.

Scheme appraisal can take differing lengths of time depending on many factors including the complexity of the scheme, size of the scheme, and whether a Public Inquiry is required. To determine how long scheme appraisal takes, this analysis assumes the following:

- Start of appraisal – Date of scheme entry into Highways England's Programme of Major Schemes.
- End of appraisal – Date of start of construction works on site.

The results of this analysis for schemes with a start of construction from 2004 onwards is shown in Figure 8-2. The older schemes have been omitted from this analysis because many schemes were already being appraised before they entered the Major Schemes Programme. It would therefore be inaccurate to include these schemes in the analysis.

**Figure 8-2 Duration of Highways England's Major Scheme appraisal for schemes constructed from 2004 onwards**

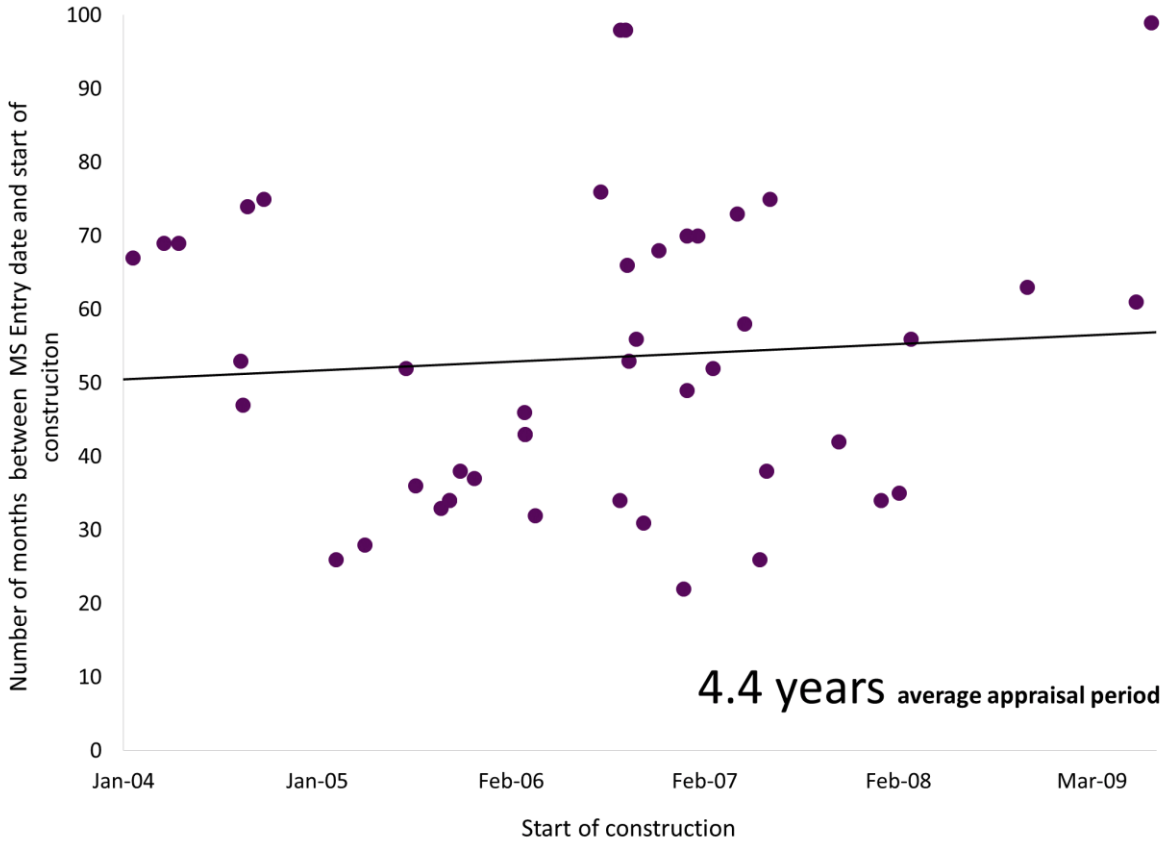



Figure 8-2 shows:

- There has been little change in the length of Highways England Major Scheme appraisal for schemes which commenced constriction between 2004 and 2009.
- There is a wide variation in the length of appraisal for individual schemes, with the range from approximately 20 months to 100 months. This is likely to be because Major Schemes can vary significantly in size and complexity, with many schemes subject to a Public Inquiry which also adds time to the process.
- The average appraisal period is just over four years.

## 8.3 How accurate are the forecasts for the accessibility objective?

**Accessibility is concerned with increasing the ability with which people in different locations and with differing availability of transport can reach different types of amenities such as places of education, worship, leisure, healthcare and employment.**

**90% of schemes were evaluated 'as expected' for accessibility.**

**A5 Nesscliffe Bypass:**
New Footbridge over A5

Accessibility was previously one of the five government objectives for transport which the majority of the schemes within this Meta-analysis were appraised against. In general terms, the DfT accessibility objectives (now called the 'Social' objective) is concerned with increasing the ability with which people in different locations, and with differing availability of transport, can reach different types of facility such as schools, places of worship, leisure facilities, hospitals and employment. The three sub-objectives with the accessibility objective are as follows:

- **Option Values** – The value that an individual places on having the option to use a new form of infrastructure, irrespective of whether they use it or now.
- **Severance** – The level of hindrance to pedestrians, equestrians, and cyclist movements caused by a specific barrier e.g. a dangerous road. Degree of severance is usually a function of suitable crossing facilities for different user groups.
- **Access to the transport system** – Relates to the proportion of non-car households within 250m of an hourly bus service.

An analysis of the accuracy of accessibility impact forecasts has been undertaken by comparing the AST and EST (Evaluation Summary Table) scores for each environmental sub-objective. The predicted impacts are assesed based on a seven point scale ranging from 'large beneficial' to 'large adverse'. This analysis makes a comparison between predicted and outturn impacts and identifies whether each sub-objective scored 'better than expected','as expected' or 'worse than expected' (based on a change of at least one point on the 7 point scale). The results are summarised in Table 8-1 which shows that the outturn impact of Major Schemes are predominantly 'as expected'.

**Table 8-1 Outturn Evaluation of Accessibility sub-objectives**

| | Outturn score | | | | Comparison with prediction | | |
|---|---|---|---|---|---|---|---|
| Sub-objective | Neutral | Adverse | Benefit | Not assessed | Impact Better than Expected | As Expected | Impact Worse than Expected |
| Option Values | 49% | 0% | 11% | 40% | 8% | 92% | 0% |
| Severance | 30% | 4% | 63% | 4% | 5% | 86% | 9% |
| Access to the Transport System | 55% | 1% | 17% | 27% | 6% | 94% | 0% |
| All sub-objectives | | | | | 6% | 90% | 4% |

Other key points from Table 8-1 are as follows:

- The forecasts for option values and access to the transport system are mainly 'as expected'. For option values, the schemes which are 'better than expected' are due to the appraisal not forecasting a benefit from improved walking and cycling facilities being implemented as part of schemes.
- For the small number of schemes where severance impacts were worse than expected, this was primarily due to low numbers of users of NMU facilities being observed (based mainly on site visit observations). The assessment contained in the scheme appraisal may have assumed a greater number of users, so the impact observed after opening is deemed to have been less or 'worse than expected', because fewer people have been affected.

## 8.4 How accurate are the forecasts for the integration objective?

**Integration is concerned with ensuring that all decisions are taken in the context of the Government's transport policy at the time of the scheme appraisal.**

**89% of schemes were evaluated 'as expected' for integration.**

**M40 Junction 15 Longbridge:**
Improved bus facilities on the A46 southbound

Integration was previously one of the five government objectives for transport which the majority of the schemes within this Meta-analysis were appraised against. The purpose of this objective was to ensure that transport intervention decision making is made within the context of national, regional and local policies. More specifically, this means:

- Integration within and between different types of transport, so that each contributes its full potential and that people can easily move between them.
- Integration with the environment, so that transport choices available support a better environment;
- Integration with land-use planning, at national regional and local level, so that transport and planning work together to support more sustainable travel choices and reduce the need for travel.
- Integration with policies for education, health and wealth creation, so that transport helps make a fairer, more inclusive society.

The integration objective had three sub-objectives:

- **Transport Interchange** – Consists of an assessment of the proposed intervention's impact upon freight and/or passenger interchange facilities.
- **Land Use Policy** – Relates to the extent to which the scheme is integrated with; and supported by land use policies and with proposals and policies concerning transport (all modes).
- **Other Government Policy** – This involves a review to identify whether the strategy or plan as a whole either (a) contributes to and is consistent with, (b) has no overall contribution or (c) is inconsistent with other Government policies beyond transport.

An analysis of the accuracy of integration impact forecasts has been undertaken by comparing the AST and EST (Evaluation Summary Table) scores for each environmental sub-objective. The predicted impacts are assesed based on a seven point scale ranging from 'large beneficial' to 'large adverse'. This analysis makes a comparison between predicted and outturn impacts and identifies whether each sub-objective scored 'better than expected','as expected' or 'worse than expected' (based on a change of at least one point on the 7 point scale). The results are summarised in Table 8-2.

**Table 8-2 Outturn Evaluation of Integration sub-objectives**

| Sub-objective | Outturn score | | | | Comparison with prediction | | |
|---|---|---|---|---|---|---|---|
| | Neutral | Adverse | Benefit | Not assessed | Impact Better than Expected | As Expected | Impact Worse than Expected |
| Transport Interchange | 57% | 1% | 12% | 30% | 5% | 95% | 0% |
| Land Use Policy | 31% | 4% | 47% | 18% | 5% | 83% | 12% |
| Other Government Policy | 31% | 2% | 36% | 30% | 4% | 90% | 6% |
| All sub-objectives | | | | | 5% | 89% | 7% |

As demonstrated in the previous analysis of forecast and outturn accessibility impacts, the majority of schemes were evaluated as ‘as expected’, as shown in Table 8-2. A number of the schemes were not assessed. This is because they were not considered in the appraisal (usually in line with the guidance available at the time).

# 9. Appendices

**Scheme Photo: A66 Long Newton Grade Separated Junction Five Years After**

# Appendix A. Environmental issues

## A.1. Landscape mitigation issues - schemes by Issue Category

| Theme | Scheme | Evaluation Stage (OYA/FYA) |
|---|---|---|
| **Slow establishment of specialised plant material (Species Rich Grassland, plug planting and heather)** | A3 Hindhead Improvement | OYA |
| | A1 Bramham - Wetherby (Including Wetherby BP) | OYA |
| | A30 Bodmin Indian Queens Improvement | FYA |
| **Establishment within the scheme, in some areas is less than expected** | A2 Bean - Cobham Phase 2 Pepperhill - Cobham | OYA |
| | A428 Caxton Common to Hardwick Improvement | FYA |
| | A590 High and Low Newton Bypass | FYA |
| | A1 Stannington Junction | FYA |
| | A1(M) Ferrybridge - Hook Moor | FYA |
| | A11 Roudham Heath -Attleborough Improvement | FYA |
| | A120 Stansted to Braintree Improvement | FYA |
| | A27 Polegate Bypass | FYA |
| | A34 Chieveley-M4 Jct 13 Improvement | FYA |
| | A47 Thorney Bypass | FYA |
| | A595 Parton - Lillyhall Improvement | FYA |
| | A6 Alvaston Improvement | FYA |
| | A6 Great Glen Bypass | FYA |
| | A64 Colton Lane GSJ | FYA |
| | A650 Bingley Relief Road | FYA |
| | M60 J5-8 Widening | FYA |
| | A46 Norton Lenchwick Bypass (10 years after) | FYA |
| | A34 Newbury Bypass | FYA |
| | M6 Toll | FYA |
| **Slow growth and high percentage failures** | A1 Peterborough to Blyth | OYA |
| | M25 Junction 28-A12 Brook Street Junction Improvement | FYA |
| | M27 J11-J12 Climbing Lanes | FYA |
| | A1033 Hedon Road Improvement | FYA |
| | A11 Attleborough Bypass | FYA |
| | A500 Basford, Hough, Shavington Bypass | FYA |
| **Screening through planting not sufficient resulting in areas being more exposed / visible** | A1 Peterborough to Blyth | OYA |
| | A30 Bodmin Indian Queens Improvement | FYA |

| Theme | Scheme | Evaluation Stage (OYA/FYA) |
|---|---|---|
| **Poor ground preparation** | A428 Caxton Common to Hardwick Improvement | FYA |
| | A590 High and Low Newton Bypass | FYA |
| | A1 Stannington Junction | FYA |
| | A34 Chieveley-M4 Jct 13 Improvement | FYA |
| | A47 Thorney Bypass | FYA |
| | A6 Great Glen Bypass | FYA |
| | A34 Newbury Bypass | FYA |
| **High incidence of noxious weeds and other invasive species** | A69 Haydon Bridge Bypass | OYA |
| | A30 Bodmin Indian Queens Improvement | FYA |
| | A66 Greta Bridge to Stephen Bank Improvement | FYA |
| | M27 J11-J12 Climbing Lanes | FYA |
| | A47 Thorney Bypass | FYA |
| | A6 Rushden & Higham Ferrers Bypass | FYA |
| | A64 Colton Lane GSJ | FYA |
| | M60 J5-8 Widening | FYA |
| **Self seeding and colonisation of Gorse** | M27 J11-J12 Climbing Lanes | FYA |
| | A14 Rookery Crossroads GSJ | FYA |
| | A64 Colton Lane GSJ | FYA |
| | A34 Newbury Bypass | FYA |
| **Introduced soil replacement mediums (colliery spoil / shillet) resulting in a large reduction in expected plant growth.** | A38 Dobwalls Bypass | OYA |
| | A64 Colton Lane GSJ | FYA |
| **Not all planting implemented by OYA review** | A419 Blunsdon Bypass | OYA |
| | A421 Bedford to M1 Junction 13 | OYA |
| | A69 Haydon Bridge Bypass | OYA |
| | M27 J3 to J4 Widening | OYA |

## A.2. Schemes with reduced establishment aftercare maintenance period

| Theme | Scheme | Issue | Assessed to reach growth targets by Design Year | Aftercare period (years) | OYA / FYA |
|---|---|---|---|---|---|
| **Handover Issues** | A5117-A550 Deeside Park Junctions Improvement | Decrease of aftercare period by Highways England. Maintenance establishment handed to MAC – unclear whether MAC undertook maintenance in line with ES requirements for growth achievements | Too early to confirm. | Three | OYA |
| | A590 High and Low Newton Bypass | No evidence of weed-free circles around planting stations and some rank weed growth was visible within plots and balancing pond areas. | Yes | Three | FYA |
| | A66 Carkin Moor to Scotch Corner Improvement | Plant shelters remain in place throughout planted areas and along hedgerows, and although not adversely affecting the planting so far, are specified in the HEMP to be removed at the end of the three-year Aftercare Period. The MAC is of the opinion that they should have been removed as part of the original contract and that the MAC should not be expected to remove them (Handover issue). | Yes | Three | FYA |
| | A66 Greta Bridge to Stephen Bank Improvement | | Yes | Three | FYA |
| | A66 Long Newton Junction | The HEMP outlined the need for continued management to maintain planted areas free of weeds until such time as the canopy had closed over completely, and to maintain areas of grassland to an acceptable and safe height as appropriate. Lack of replacement planting appeared to be a continuing issue. | Yes | Three | FYA |
| | A27 Polegate Bypass | Some of the new tree planting may not be establishing as well as others and it would be expected that this issue would be addressed as part of the ongoing landscape aftercare operations | Environment not assessed at OYA. FYA not set to reach targets. | Three | FYA |
| | M27 J11-J12 Climbing Lanes | Some areas subject to planting have a high mortality rate and it is clear that no active maintenance is in place. The landscape strategy for trees and shrubs in the Handover Management Plan notes that control of scrub is required to 'ensure that vigorous species such as gorse and bramble do not become dominant'. | At OYA it was determined that planting was acceptable (i.e. plants in place). At FYA planting was not set to reach targets | Two | FYA |

| Theme | Scheme | Issue | Assessed to reach growth targets by Design Year | Aftercare period (years) | OYA / FYA |
|---|---|---|---|---|---|
| **Gorse establishment with potential to outcompete planting plots** | A14 Rookery Crossroads GSJ | The use of common gorse was identified as a concern at OYA as this species tends to spread easily and can become invasive if not managed, to the detriment of other species within the planting mix. The HEMP quite clearly states that invasive species such as Gorse should be controlled and that plots should be monitored every two years for scrub control requirements. There appears to be no allowance for this in the early handover to the MAC. | At FYA, gorse has reached heights of 2 metres and there is a danger that it will overwhelm other plants, it being twice as high in many instances. | Three | FYA |
| | A64 Colton Lane GSJ | In some locations gorse has self-seeded and begun to establish. Without rigorous control through ongoing management it is likely that given time it will out-compete other more desirable species. | At OYA significant numbers of plants had died. At FYA planting was not set to reach targets | Three | FYA |
| | A34 Newbury Bypass | Gorse would appear to be colonising many plots at the southern end of the scheme at the expense of the designated plot species | At FYA planting was not set to reach targets | Three | FYA |
| | M27 J11-J12 Climbing Lanes | Colonisation of gorse is visible in one of the plots which further indicates a lack of required maintenance. | At OYA it was determined that planting was acceptable. At FYA planting was not set to reach targets | Two | FYA |
| **No effect of reduced aftercare** | A21 Lamberhurst Bypass | No growth related issues identified. | Yes | Three | FYA |
| | A66 Stainburn & Great Clifton Bypass | | Environment not assessed. FYA set to reach targets | Three | FYA |
| **Impact on growth targets** | A500 Basford, Hough, Shavington Bypass | In the first year of the aftercare period, the number of plants lost was approximately 60%. Agreement was reached to use water retention polymer granules within the pit preparation due to free draining sandy soils. Landscape planting is slow to establish in some areas. Slow establishment could affect the long term objectives for landscape screening and integration without ongoing management. | Environment not assessed at OYA. FYA not set to reach targets | Three | FYA |

| Theme | Scheme | Issue | Assessed to reach growth targets by Design Year | Aftercare period (years) | OYA / FYA |
|---|---|---|---|---|---|
| | M60 J5-8 Widening | Expected shrub and tree planting in some locations were struggling to establish, and some failures had occurred, which could be in connection with the ground conditions (topsoil depth and quality and permeability of sub layers).A high presence of weed growth was noted during the FYA visit, this could be an indication that establishment maintenance has not been effective. | At OYA, planting failures and poor establishment were reported in some locations. At FYA planting in some areas was still struggling to reach its growth targets. | Three | FYA |
| | M27 J3 To J4 Widening | Growth of weeds and lack of topsoil in offsite planting areas may impact on growth targets | Yes (OYA only) | Two | OYA |

# Appendix B. Glossary

| Term | Abbreviation | Description where appropriate |
|---|---|---|
| **Average Annual Daily Traffic** | **AADT** | This traffic flow is derived by averaging a traffic flow 24 hours a day, 365 days a year. |
| **Appraisal Summary Table** | **AST** | 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** |
| **Automatic Traffic Count** | **ATC** | A machine which measures traffic flow at a point in the road. |
| **Benefit Cost Ratio** | **BCR** | This is the ratio of the benefits expressed in terms of present value (**PVB)** divided by the costs also expressed in terms of present value (**PVC)**. |
| **Cost Benefit Analysis** | **COBA** | **CO**st **B**enefit **A**nalysis – a computer program which compares the costs of providing road schemes with the benefits derived by road users (in terms of time, vehicle operating costs and accidents), and expresses the results in terms of a monetary valuation. The **COBA** model uses the fixed trip matrix unless it is being used in Accident-only mode. |
| **-** | **COBALT** | **Cost and Benefit to Accidents – Light Touch**) is a computer programme developed by the DfT to undertake the analysis of the impact on collisions as part of the economic appraisal for a road and supersedes the COBA programme |
| **-** | **D3M, D4M** | **Dual 3 lane Motorway** and **Dual 4 lane Motorway** |
| **Design Built Finance and Operate** | **DBFO** | The private sector assumes responsibility for the operation and maintenance of a length of existing road (where appropriate) and for building specified improvement schemes for the life of the contract. |
| **Design Year** | **-** | A set period after the opening of a scheme for which the scheme is designed to be fit for purpose. This is usually 15 years after the planned opening year. |
| **Department for Transport** | **DfT** | A Government department whose objective is to oversee the delivery of a reliable, safe and secure transport system that responds efficiently to the needs of individuals and business whilst safeguarding our environment. |
| **Design Manual for Roads and Bridges** | **DMRB** | A comprehensive manual system which sets out current standards, Advice Notes and other published documents relating to Trunk Road works. |
| **Design and Build** | **D&B** | A project delivery system used in the construction industry. It is a method to deliver a project in which the design and construction services are contracted by a single entity. |
| **Do-Minimum** | **-** | In scheme modelling, this is the scenario which comprises the existing road network plus any other improvement schemes that have already been committed. |
| **Do-Something** | **-** | In scheme modelling, this is the scenario detailing the planned scheme. |
| **Early Contractor Involvement** | **ECI** | This is a model for contract procurement that is currently being used by various government agencies to deliver major road projects. |
| **Environment Agency** | **EA** | Public body for protecting and improving the environment in England and Wales. |
| **Economic Assessment Report** | **EAR** | A report presenting the economic appraisal of a scheme. |

| Term | Abbreviation | Description where appropriate |
|---|---|---|
| **Elastic Assignment Modelling** | | An elastic assignment model uses an elasticity function to approximate some demand responses, in addition to the change in route response modelled by an assignment. It is assumed that the demand for travel between an origin and destination is purely a function of the change in costs for that mode between the two points. |
| **Environmental Statement** | **ES** | A document produced in accordance with the EIA Directive as transposed into UK law by EIA Regulations. |
| **Evaluation Summary Table** | **EST** | In **POPE** studies, this is a summary of the evaluations of the Government objectives for transport using a similar format to the forecasts in the **AST**. |
| **Five Years After** | **FYA** | Relating to five years after a scheme opened. |
| **Fixed Demand Modelling** | | The assignment of traffic in a model using a fixed trip matrix with no induction or suppression of trips (also referred to as 'fixed trip matrix assignment'). |
| **Grade Separated Junction** | **GSJ** | A GSJ is a junction at more than one level to enable through traffic on the main route to pass through unimpeded. |
| **Great Crested Newt** | **GCN** | |
| **Highways Agency** | **HA** | Formerly an Executive Agency of the Department for Transport. The HA has now become Highways England. |
| **Highways England** | | A Government-owned Strategic Highways Company responsible for the strategic highway network in England. |
| **Handover Environment Management Plan** | **HEMP** | Provides a framework for Highways England to fulfil the environmental commitments made with regard to long-term management associated with schemes. |
| **Incident Cost Benefit Analysis** | **INCA** | A modelling programme used to estimate the monetised benefits of measures affecting journey time variability covering incidents on motorways and dual carriageways. |
| **Journey Time Database** | **JTDB** | Holds information on journey times and traffic flows for links of the strategic network. |
| **Landscape and Ecology Aftercare Plan** | **LEAP** | LEAP aims to provide details of the protection, management, monitoring and maintenance of existing and new planting, seeding and habitat creation areas undertaken by the contractor for five years following the construction and practical completion of the landscape and ecological works. The LEAP may be used to inform or be superseded by, the **HEMP**. |
| **Landscape Management Plan** | **LMP** | The LMP provides details of the maintenance requirements for planting undertaken within a scheme. |
| **Local Model Validation Report** | **LMVR** | A mandatory key element in reporting model reliability. Its purpose is to demonstrate the model reproduces an existing situation; summarise the accuracy of the base from which the forecasts are derived; to present validation procedures, and details of adjustments made during calibration. |
| **Major Schemes programme** | **-** | Highways England and formerly the Highways Agency's programme of investment in improvements to the Trunk road and Motorway road network comprised of a number of Major Schemes each costing more than £10million (formerly £5million). |
| **Managing Agent Contractor** | **MAC** | A MAC is the supplier responsible for the design and delivery of road maintenance in a particular area of England for a fixed period of years |
| **Meta-analysis** | **-** | A quantitative method of combining the results of independent studies and synthesizing summaries and conclusions from which new and improved processes can be developed. |
| **Managed Motorway** | **MM** | See smart motorway |

| Term | Abbreviation | Description where appropriate |
|---|---|---|
| **Motorway Incident Detection and Signalling system** | **MIDAS** | Inductive loops installed in the carriageway monitoring speeds, vehicle types and flows. The prime aim of **MIDAS** is to protect the back of queues, which have formed or are about to form, by automatically setting suitable signals to warn approaching traffic. |
| **National Trust** | **-** | A charity completely independent of Government which works to preserve and protect the buildings, countryside and coastline of England, Wales and Northern Ireland, in a range of ways, through practical conservation, learning and discovery. |
| **Natural England** | **NE** | The Government's advisor on the natural environment, whose remit is to ensure sustainable stewardship of the land and sea so that people and nature can thrive. |
| **Non-Motorised Users** | **NMU** | A generic term covering pedestrians, cyclists and equestrians |
| **National Road Traffic Forecasts** | **NRTF** | This document defines the latest forecasts produced by the **DfT** of the growth in the volume of motor traffic. The most recent one is **NRTF11** and the one previous was **NRTF09**. |
| **Net Present Value** | **NPV** | Net Present Value is the value of the benefit of a scheme and is calculated by subtracting the discounted sum of all future costs from the discounted sum of all future benefits i.e.<br>NPV = PVB - PVC |
| **Net Present Value / Cost Ratio** | **NPV/£** | NPV/£ is a measure of best value for public accounts expenditure, defined as the ratio NPV / PVC.<br>It is an alternative measure of value to the BCR. |
| **One Year After** | **OYA** | Relating to one year after a scheme opened. |
| **Post Opening Project Evaluation** | **POPE** | Before and after monitoring of all major highway schemes in England. |
| **Personal Injury Collision** | **PIC** | A road traffic collision reported to the police and in which at least one person required medical treatment. |
| **Present Value Benefits** | **PVB** | Value of a stream of monetary benefits accruing over the appraisal period of a scheme expressed in the value of a single 'present' year to give a present value based on the concept of discounting.<br>Discounting is a technique used to compare costs and benefits that occur in different time periods. It is based on the principle known as time preference that people prefer goods and services now rather than later. This preference for goods and services now rather than later applies to both individuals and society. |
| **Present Value Costs** | **PVC** | As for **PVB** but for a stream of costs |
| **Public Right of Way** | **PROW** | These are roads, paths or tracks which can run through towns, countryside or private property and are open to everyone to walk on. Some PROWs are also open to horse-riders, cyclists and motorists. |
| **Sites of Specific Scientific Interest** | **SSSI** | The country's very best wildlife and geographical sites. There are over 4,000 **SSSI**s in England, covering around 7% of the country's land area. |
| **Smart Motorway** | **SM** | Smart Motorways (previously called Managed Motorways) help relieve congestion by using technology to control traffic flows, making best use of the existing road space by utilising the hard shoulder, assist in the management of incidents and providing information to road users. They also allow the hard shoulder to be used as a running lane at peak times to create additional capacity. |
| **-** | **STATS19** | A database of injury accident statistics recorded by police officers attending accidents. |

| Term | Abbreviation | Description where appropriate |
|---|---|---|
| **Sustainable Drainage Systems** | **SUDS** | Water management practices and facilities designed to drain surface water in a manner that will provide a more sustainable approach than what has previously been the conventional practice of routing run-off through a pipe to a watercourse |
| **Trip End Model Program** | **TEMPRO** | A program which provides access to the **DfT'**s national Trip End Model projections of growth in travel demand, and the underlying car ownership and planning data projections. |
| **Traffic Forecasting Report** | **TFR** | The TFR details the forecasting approach, in terms of future network and matrix development, as well as assignment methodology and use of VDM. The report shows the impact of the scheme on traffic flows and journey times. |
| **Traffic Data System** | **TRADs** | The Traffic Data System which holds information on traffic flows at sites on Highways England's network. |
| **Transport Users Benefit Analysis** | **TUBA** | A computer system issued and maintained by the DfT. The program calculates the costs and benefits that would accrue to users of a transport system, companies, national and local government as a result of making improvements to a transport network. |
| **Variable Demand Modelling** | **VDM** | VDM predicts and quantifies the change in demand due to a change in transport conditions for a number of demand responses including mode choice, trip frequency, trip distribution and time of day choice. |
| **Vehicle Operating Costs** | **VOC** | The use of the road system by private cars and lorries gives rise to operating costs for the user. These include costs of fuel, oil and tyres, and an element of vehicle maintenance. |
| **Value for Money** | **VfM** | In this study, VfM refers to the DfT guidance on interpretation of BCR ranges for use in the Business Case of a scheme. |
| **WebTAG** | **-** | **DfT**'s website for guidance on the conduct of transport studies. |

# Appendix C. List of Tables and Figures

**List of Tables**



**List of Figures**