

# Evaluation Insight Paper

## Post Opening Project Evaluation of Major Schemes



The **POPE** (Post Opening Project Evaluation) evidence base shows that major road investments have delivered benefits for our customers, by:

- Reducing the number of collisions;
- Delivering journey time savings and improving journey time reliability;
- Producing high value for money, as on average every £1 spent delivers approximately £3 of benefits over the life of the scheme; and,
- Achieving their objectives, with 90% of scheme objectives met.

## About this Insight Paper

Evaluation has an important role in assuring the investment in major road schemes<sup>1</sup> in order to assess whether the expected costs and benefits have been achieved. POPE was established to provide a systematic approach for major schemes.

This demonstrates our commitment to transparency with our stakeholders and ensures we have the evidence to help us to continually learn and improve as an organisation. The evidence base generated by these evaluations is important in improving our approach to forecasting the impacts and costs for future schemes.

15 years of post opening evaluation of major schemes using the POPE method. This has generated a standardised evidence base which has been commended by the Institute for Government:

“Evaluation of roads now follows a standardised procedure which feeds back into pre-project appraisal in a transparent way”.<sup>2</sup>

85 POPE scheme evaluations are included in the sample that underpins this analysis, relating to all major schemes opening between 2002-2014.

This Insight Paper provides a programme-level overview of the POPE evaluation evidence which covers schemes delivered before the first Roads Investment Strategy.

We would like to acknowledge the work of Atkins in generating the evidence base for this summary.

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## POPE methodology

POPE studies have been undertaken for all of Highways England's major schemes since 2002, and form the mechanism whereby Highways England has:

- Assessed whether schemes have delivered the anticipated value for money;
- Validated the accuracy of the estimated scheme costs, impacts and benefits which were agreed as part of the business case for investment, and used this to improve future scheme appraisals; and,
- Promoted transparency and accountability to our stakeholders.

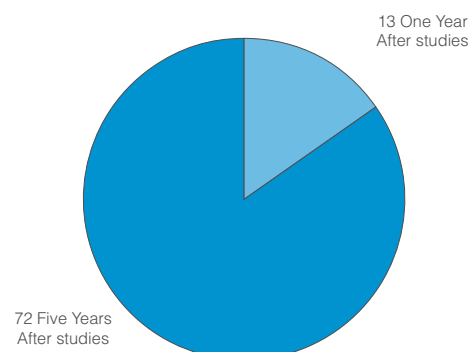
Baseline data and the forecasts used to inform the investment decision were collected prior to construction. Each scheme has been revisited at one and five years after opening and an evaluation undertaken, which covered all the impacts assessed during the scheme appraisal. The evidence observed at the time of the evaluation has then been used to re-forecast the likely benefits of the scheme over its lifetime.

Periodically a 'meta-analysis' is undertaken of all evaluations to date, to take an overview of trends across the programme as a whole. This 'Insight Paper' has drawn on the 2017 meta-analysis, focusing on programme-level findings.

Since these evaluations have been undertaken, Highways England has established an in-house [Evaluation Group](#) which will lead the generation of future insights from evaluation.

They will also be exploring ways to continue to develop the methods for evaluating schemes, in order to further enhance the evidence base.

Figure 1. Profile of evaluation evidence used in 2017 meta-analysis



Source: 2017 POPE Meta-analysis, sample 85 schemes

<sup>1</sup>Major schemes covers improvements to the strategic road network costing more than £10m.

<sup>2</sup>The Institute for Government, 2017 What's wrong with Infrastructure Decision Making?

# Scheme objectives

All Highways England major schemes have specific objectives which were defined early on in the appraisal, when scheme options were being identified.

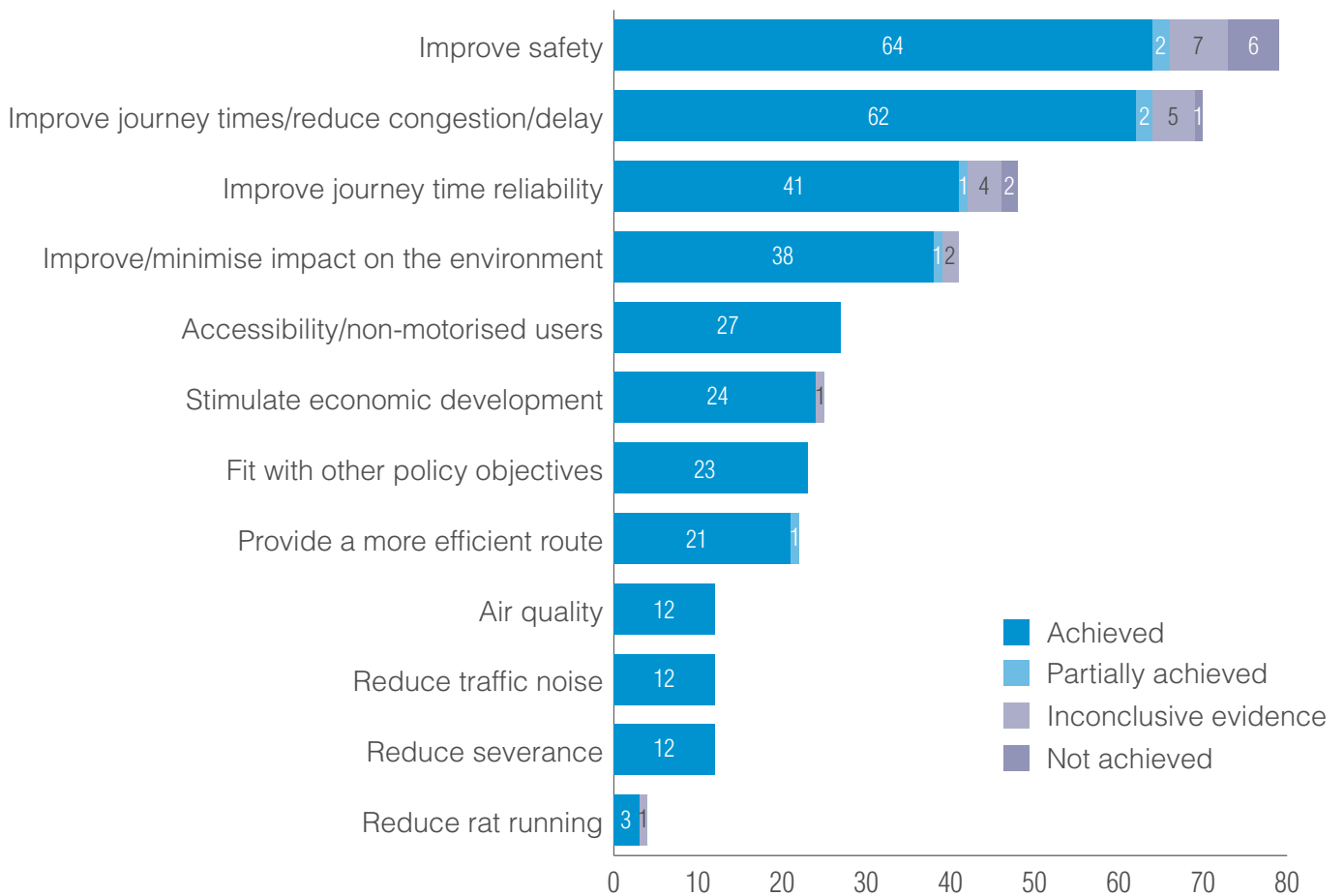
Looking across the programme, 90% of all scheme objectives have been achieved, with only 2% of these not observed to have been achieved.

The most common objective set for a scheme was to 'improve safety' (93% of schemes) and 81% of these schemes achieved this objective.

The second most common objective was to 'improve journey times/reduce congestion and/or delay' (82% of schemes) and 89% of these schemes achieved this objective.

Both of these themes (safety and journey times) are considered in more detail in this paper.

**Figure 2. The extent to which scheme objectives had been achieved (by number of schemes)**



Source: All schemes evaluated between 2002-2014. Most schemes will have multiple objectives (chart presents number of schemes against each objective)

# Accuracy of traffic volume forecasts

## Changes in background traffic levels

POPE evaluations assessed changes in traffic volumes and journey times before and at one and five years after a scheme opened. This analysis needs to be viewed in the context of changes in the national, regional and local background traffic volumes.

The national picture (Figure 3) showed that between 2000 and 2007 there was an 8% increase in the motor vehicle kilometres travelled across Great Britain. The economic downturn in 2008 saw a fall in vehicle kilometres travelled; a trend which started to reverse in 2013.

## Traffic volume forecasts

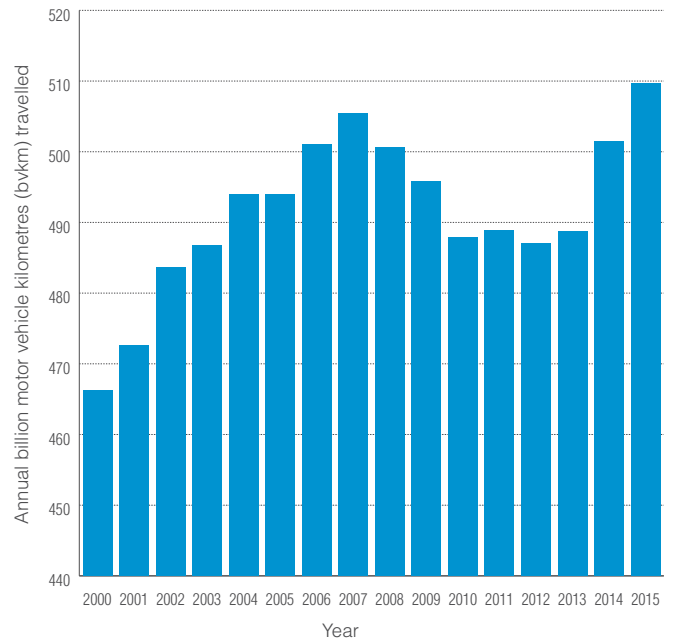
It is important to understand the accuracy of forecast traffic volumes because they are intrinsically linked with economic and environmental impacts.

Across all schemes in the analysis, the results (Figure 4) showed that:

- 78% accurately forecast pre-scheme traffic volumes;
- 59% accurately forecast post-scheme traffic volumes;
- Pre-scheme and post-scheme traffic volumes were more frequently over-predicted than under-predicted.

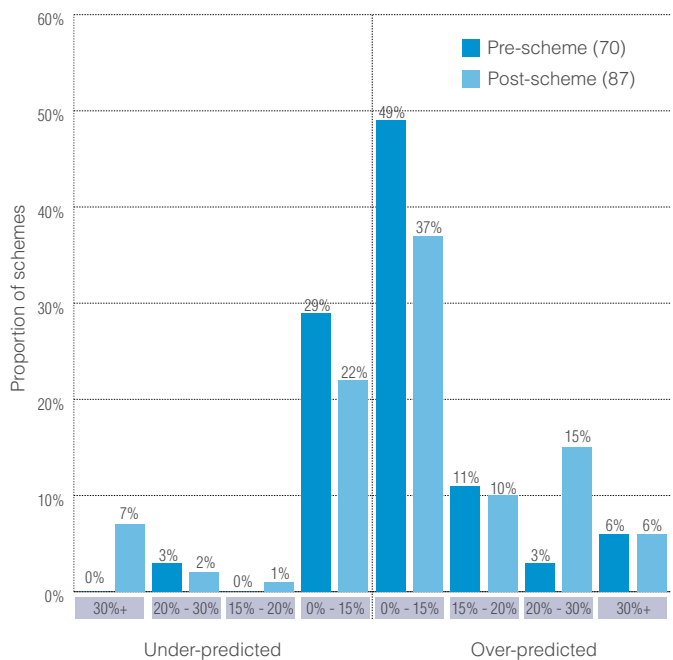
The most common reason for overestimated forecasts was due to the traffic growth assumptions not being realised (affecting 21 schemes), often for schemes appraised before the economic downturn. More recent schemes have accounted for this within their traffic growth assumptions.

Figure 3. The annual number of billion motor vehicle kilometres (BVKM) travelled from 2000 to 2015 (GB)



Source: Department for Transport, TRA0202 (Motor vehicle traffic (vehicle kilometres) by road class in Great Britain, annual from 1993)

Figure 4. Variation between forecast and observed pre-scheme and post-scheme traffic volumes



Source: All schemes evaluated between 2002-2014

The Department for Transport's WebTAG guidance notes that a  $\pm 15\%$  difference between forecast and observed flows is considered accurate.

## Do schemes result in additional journeys?

The implementation of a major scheme can have widespread geographical impacts on traffic volumes and travel behaviours. These include:

- Changes in background traffic growth
- Reassigned traffic (route choice)
- Mode shift (between public transport and private motor vehicle)
- Time of travel change
- Trip frequency increase
- New trips (due to causes such as land use changes).

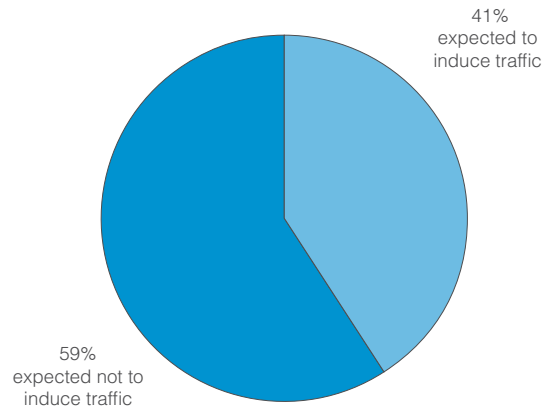
The evaluations were able to distinguish changes in background growth and reassigned traffic using observed information; however it has not been possible to differentiate between the other reasons for traffic growth (mode shift, time of travel and new trips). Additional traffic due to changes in mode, destination, time and frequency, as well as new car trips were considered to be 'induced traffic' for this analysis.

From a review of appraisal documentation (Figure 5), it appears that approximately **59% of schemes were not expected to induce traffic.**

POPE evaluation assesses changes in traffic at one and five year(s) after opening and considers the cause of change.

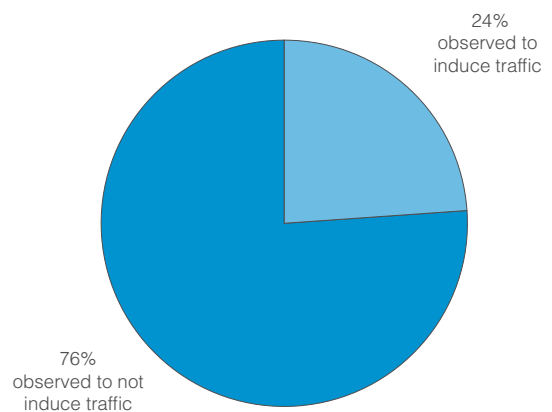
For **76% of schemes, increases in traffic volumes have been attributed to either changes in background growth or reassignment of journeys from alternative routes** (Figure 6).

Figure 5. Induced traffic predicted in appraisal by scheme type



Source: 2017 POPE meta-analysis, sample 76 scheme appraisals

Figure 6. Induced traffic observed in evaluation by scheme type



Source: 2017 POPE meta-analysis, sample 71 schemes evaluated at one or five year(s) after opening

# Evaluating the accuracy of journey time and reliability forecasting

## Journey times

There are three key time periods considered when evaluating journey times: the impact during the AM peak, interpeak (IP) and the PM peak.

Based on small samples where sufficiently detailed forecast information was available (ranging from 21-29 schemes), the meta-analysis has indicated that:

- The average forecast time saving of **around 3 minutes per journey during the AM and PM peaks**, has been achieved;
- **43%** delivered journey time savings **in excess** of their forecast saving in the **AM peak**;
- This was higher for the **PM peak with 67% of schemes delivering greater journey time savings** than expected.
- During the interpeak period, the average expected time savings were forecast to be lower at just under **2 minutes per journey and the majority of schemes achieved this**.

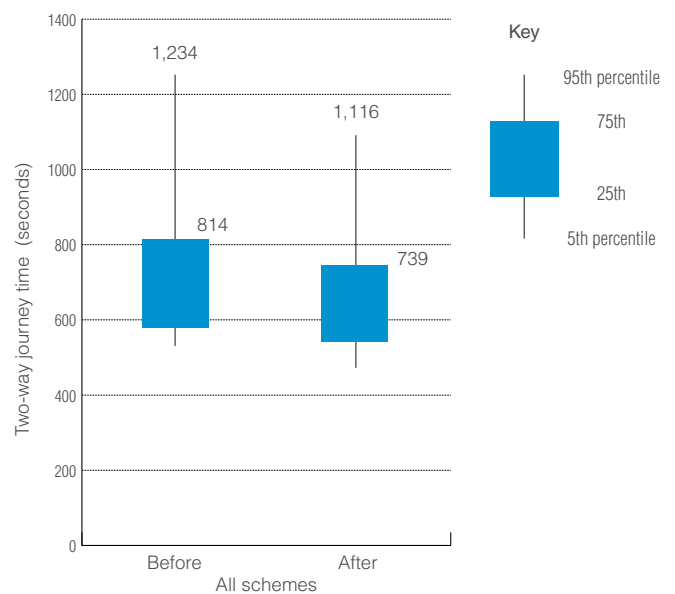
A larger sample is required to enable us to draw any firm conclusions about changes in forecasting accuracy over time.

## Methods for evaluating journey time reliability

A new method has been introduced, using data from SatNav devices to measure journey times before and after scheme construction. This data allowed analysis of the range of journey times to be undertaken, to assess the impact of the scheme on journey time reliability. Only 9 scheme evaluations within the meta-analysis have been undertaken using this data so far.

While it is hard to put an overall figure on the benefit being accrued from reliability, early indications have shown that these schemes provided reliability benefits in the AM and PM peaks. Figure 7 shows that on average, journey times generally became shorter following the opening of the schemes and more consistent, as shown by the reduction in the range between the shortest and longest journey times. These improvements would have helped road users to plan for their journeys by making journey times more predictable.

Figure 7. Journey time reliability percentiles



Source: 2017 POPE meta-analysis, sample 9 schemes



# Evaluating safety impacts of major schemes

## Methods for evaluating safety impacts

It is Highways England's ambition that no one should be harmed when travelling or working on our highways.

All major schemes included an assessment of the impact on safety, even for those schemes which didn't forecast a change in collisions, as it is important for the evaluation to verify whether this has been the case.

For the purposes of appraisal and evaluation, collision analysis focused on changes to personal injury collisions (PICs) before and after the scheme opened (the evaluations undertaken have not covered the construction period).

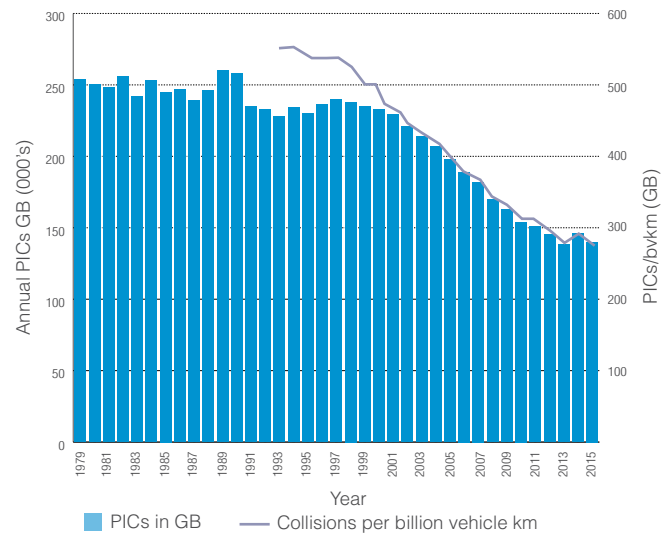
## National trends in the number of road collisions over time

It has been important to understand the national trends for how PICs have changed over time when assessing safety impacts. Figure 8 shows that trends in PICs across Great Britain have been reducing fairly consistently since around 1996. There has been a number of factors influencing this trend, including vehicles being designed to be safer, safer driving policies and road improvement schemes.

## Isolating the scheme effects on reducing collisions

POPE has recently developed a more robust method for isolating and evaluating the safety impacts of schemes. This has been through the production of a counterfactual estimate which applied an adjustment for the background trends in PICs to the scheme baseline, in order to compare the change in safety impacts observed to that which might have occurred had the scheme not been put in place.

Figure 8. Trends in personal injury collisions and collisions per billion vehicle kilometres (GB)



Sources: Department for Transport - RAS10013 (Reported personal injury road accidents, by severity, Great Britain, 1979-2016) & TRA0202 (Motor vehicle traffic (vehicle kilometres) by road class in Great Britain, annual from 1993).

This new method has only been applied to a small sample of schemes in the evaluation programme. Therefore, it is too early to draw conclusions from this sample.

Over time, building a larger sample will give more confidence that the findings can be generalised across the programme.

## Timeframe for assessing impact

Safety data needs to be monitored over a number of years before statistically valid changes can be observed. Therefore, it is much more likely that analysis over a longer evaluation period will enable more robust conclusions to be generated.

# Average scheme impacts on number of collisions

## Changes in number of collisions

Analysis of the change in collision rates (per million vehicle kilometres (mvkm)) showed that, across the sample of schemes assessed using the counterfactual method, there was an average reduction in collision rates of 35% (Figure 9).

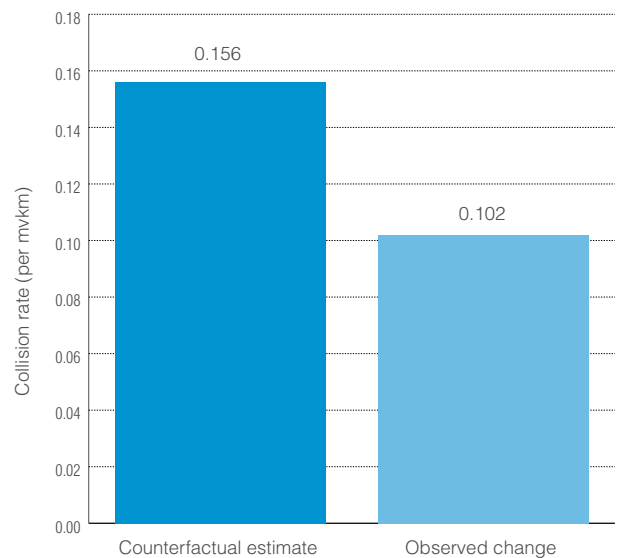
Based on an analysis of a sub-sample of 26 schemes, there was an average saving observed of around 4 personal injury collisions (PICs) per annum on the sections of the road directly changed by the scheme (key links). This was after accounting for the background reduction in collisions (page 7). On average, the schemes reduced PICs by 11% compared to the counterfactual.

The expectation has been that improvements in the Strategic Road Network would deliver safety benefits across a wider geographical area, including the local road network (the study area). Analysis based on a sample of 31 schemes has indicated an average reduction in PICs of 4%. This equated to around 4 PICs per annum and indicates that major schemes have delivered benefits to the surrounding road network.

## Impact on the severity of collisions

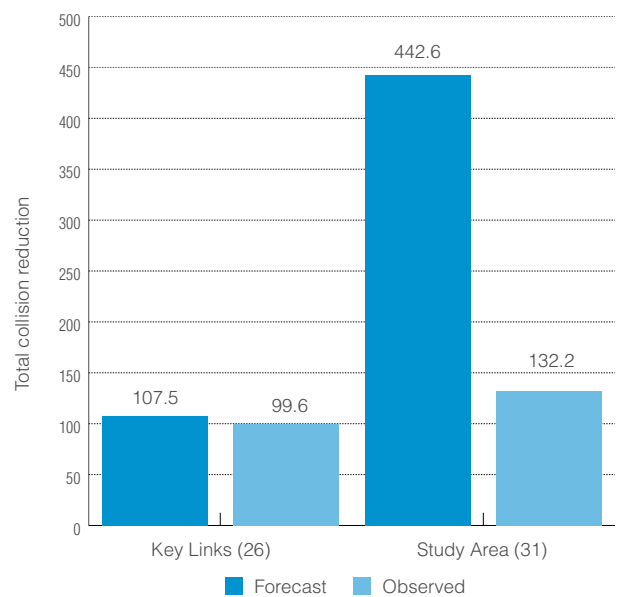
The evaluation evidence indicated that there has been a reduction in the severity of collisions when comparing the levels before and after scheme opening. This implies that schemes have potentially generated a beneficial impact for the strategic and local road networks. However, this analysis has not been assessed against a counterfactual estimate, therefore it is not possible to confidently conclude that the changes observed had been directly caused by the investment rather than generated as a result of other factors.

Figure 9. Average collision rates (per mvkm)



Source: 2017 POPE meta-analysis, sample 34 schemes

Figure 10. Comparison between forecast and observed collision savings



Source: 2017 POPE meta-analysis, samples: 26 scheme evaluations for key links analysis and 31 scheme evaluations for study area analysis

## Accuracy of Safety forecasts

Collisions are random events and therefore it is inevitable that forecasts will not be precisely accurate. However, schemes tended to achieve lower outturn collision reductions than were predicted. Figure 10 shows that accurate forecasts were much more likely for the scheme key links than the wider study area.

Individual scheme forecasts were more likely to overestimate than underestimate benefits indicating a potential systematic bias at the scheme level.



# Economic impacts of major schemes

## Average investment in major schemes

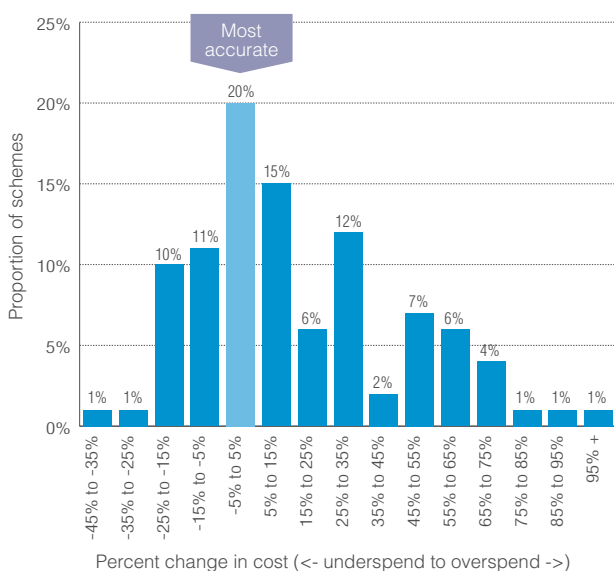
Across the POPE programme the **average (mean) spend per scheme is £124 million** both in the forecast and observed scenarios.

Across the sample of schemes the forecast costs have proven to be relatively accurate. However, when broken down to an individual scheme level, there was more variation (see Figure 11).

**Just under half of all schemes were accurate to within ±15% of their forecast cost and 20% of schemes were within ±5% of their forecast cost.**

Generally, cost forecasts had tended to underestimate the investment required. However, the 2015 POPE Meta Report showed that scheme cost forecasts have improved over time. Looking at the small sample of the most recent schemes, **they have typically come in under the forecast cost**, although a larger sample of schemes will be needed to verify this.

Figure 11. Percentage change between the forecast and observed scheme cost



Source: 2017 POPE Meta-analysis, sample 81 schemes evaluated at one or five years after opening

## Average economic benefits

Scheme costs, and benefits from safety impacts and journey times (see Figure 12) are combined with the other monetised impacts to produce an overall benefit cost ratio (BCR). **Investment in major schemes delivered benefits of approximately £3 for every £1 spent.** This implies they fall in the 'high' value for money category.

There has been a **tendency for the forecast BCR to be overly optimistic** for 60 schemes in the sample, which may have been a consequence of the overestimation of journey time impacts (page 6). **However, the majority of schemes (71%) delivered high value for money.**

# Journey time and safety benefits

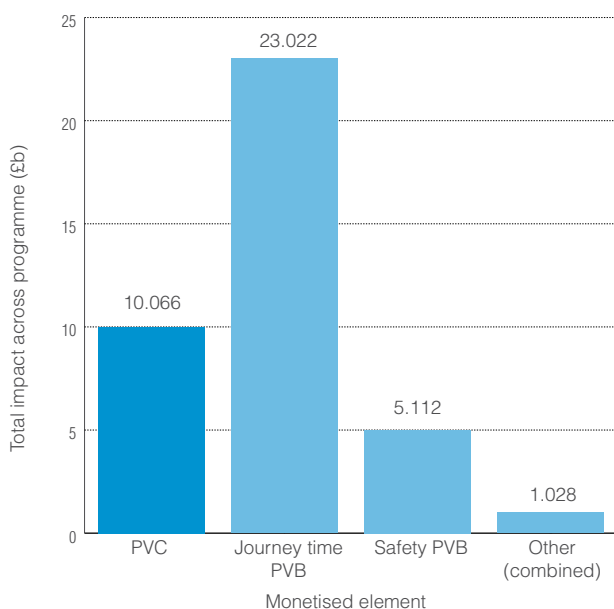
## Journey time benefits observed across the POPE programme

Journey time benefits were the biggest contributor to generating a positive benefit cost ratio (BCR), with journey time benefits equating to around 2.3 times the cost.

Aggregating the value of journey time savings across a sub-sample of 81 major schemes, there has been around **£23 billion of journey time benefits** across the life of the schemes, **averaging £300 million of benefits per scheme**.

While these were large scale benefits being recorded, the observed benefits were around 30% lower than the forecast programme benefit of **£32.675 billion**. Where it has been possible to interrogate the forecast figures (see page 6) schemes were generally delivering the time savings expected, so this variation is likely to have been caused by the lower than expected traffic growth.

Figure 12. Total observed costs and benefits aggregated across the POPE programme



Source: 2017 POPE Meta-analysis, sample 81 schemes

A Present Value of Costs (PVC) is a future cost adjusted to a price base at a specific point in time. The PVB is similar, but relates to the Present Value of Benefits.

## Safety benefits observed across the POPE programme

Across the evaluation programme, the observed value of safety benefits was equivalent to around half of the investment made on the schemes.

The evidence indicated that **the observed benefits from reducing collisions across major schemes were higher than forecast**. Around £5.1 billion of benefits were estimated to have been delivered averaging **£63 million of benefits per scheme** (14% higher than forecast).

It is important to note that this analysis has been based on evaluation evidence across all schemes and not just the small sample of evaluations applying the new counterfactual methodology (page 7). Early analysis showed that the new method (applying a counterfactual) was more likely to observe fewer benefits than forecast. A larger sample of schemes applying the new method will be required to verify this.

## Environmental impacts

### Delivery of environmental sub-objectives

Both pre-construction and post-opening, a range of environmental impacts or 'sub-objectives' are considered. Overall, [major schemes have been delivering their environment sub-objectives](#) with 70% of environmental sub-objectives scoring 'as expected' and a further 18% scoring 'better than expected'. This is broadly consistent with the findings from the 2015 POPE Meta Report.

### Carbon impacts

The majority of major schemes resulted in an [increase in carbon emissions in the opening year](#). Changes in carbon emissions were typically due to changes in traffic volumes, journey distances, vehicle composition and/or speed of traffic.

The increase in carbon emissions as a result of major schemes was often forecast as part of the scheme appraisal. [The majority of scheme forecasts overestimated the impact](#), as a consequence of the overestimation of the traffic volumes.

## Noise impacts

Nearly half of schemes contained a Noise Important Area. The vast majority of these schemes have implemented appropriate noise mitigation either through application of low noise surfaces, mounds or noise barriers.

### Biodiversity mitigation

Schemes have invested in measures to mitigate negative impacts on biodiversity. 92% of schemes were likely to meet their expected biodiversity objective.

[Habitats such as grasslands, woodlands and hedgerows](#) are generally being established and maintained. However, some scheme evaluations identified instances where the measures had not been establishing as expected or where maintenance issues / incidents of vandalism had occurred.

Table 1 - Observed evaluation assessment of environment sub-objectives<sup>3</sup>

Sub-objective	Observed score %				Comparison with prediction %		
	Neutral	Adverse	Benefit	Not Assessed	Better than Expected	As Expected	Worse than Expected
Noise	30	16	53	1	34	54	11
Local Air Quality	30	13	56	1	35	56	9
Greenhouse Gases	16	67	6	11	58	11	32
Landscape	16	78	5	1	3	73	23
Townscape	21	8	15	56	0	94	6
Biodiversity	36	56	3	4	9	83	8
Heritage	29	59	10	2	10	79	11
Water	46	30	23	1	12	83	4
Physical Fitness	51	0	37	12	2	95	4
Journey Ambience	14	0	78	8	0	86	14

Source: 2017 POPE Meta-analysis

<sup>3</sup>Please note that not all the percentages add to 100% due to rounding

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For more information about POPE studies please refer to [Post Opening Project Evaluation \(POPE\) of Major Schemes](#)

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Registered office Bridge House, 1 Walnut Tree Close, Guildford GU1 4LZ  
Highways England Company Limited registered in England and Wales number 09346363