

# LNMS EVALUATION REPORT

## M4/M5 Almondsbury Interchange Phase 2A M5 Southbound & Northbound to M4 Eastbound



**March 2006**

# M4/M5 Almondsbury Interchange – Phase 2A M5 Southbound & Northbound to M4 Eastbound

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# 1. Introduction

## BACKGROUND

- 1.1 The project forms one of several phases intended to upgrade the Almondsbury Interchange. The interchange was constructed during the 1960s to the standards prevailing at the time. Project Appraisal Report (PAR) stated that increasing traffic levels during the intervening period resulted in regular and prolonged incidents of congestion leading to queues and delays.
- 1.2 The primary problem identified within the PAR was that the existing layout did not conform to any current design standard leading to driver confusion and late lane changes. It also stated that large tailbacks formed during peak periods, which included holiday periods as well as daily peak periods at this location. A poor accident record existed with 14 injury accidents in a five year study period, including one fatal and one serious.
- 1.3 The full program of improvements was expected to upgrade the interchange to current standards, where possible and parallel initiatives to improve the environmental aspects of the junction.

### *Original PAR Document*

- 1.4 The PAR was produced by Atkins, Bristol office and was last updated in January 2004. The journey time benefits were estimated by Atkins, Cardiff office, before being incorporated in the original PAR.

### *The Scheme*

- 1.5 The scheme opened on 31<sup>st</sup> March 2004. It has provided dedicated lanes from the M5 Southbound diverging nose; a parallel merge for M5 connector road traffic and a ghost island merge with the M4 Eastbound. These measures are aimed at allowing a more orderly passage through the connector roads for traffic joining the M4 Eastbound.
- 1.6 Figure 1.1 shows the location of Almondsbury interchange and the scheme.

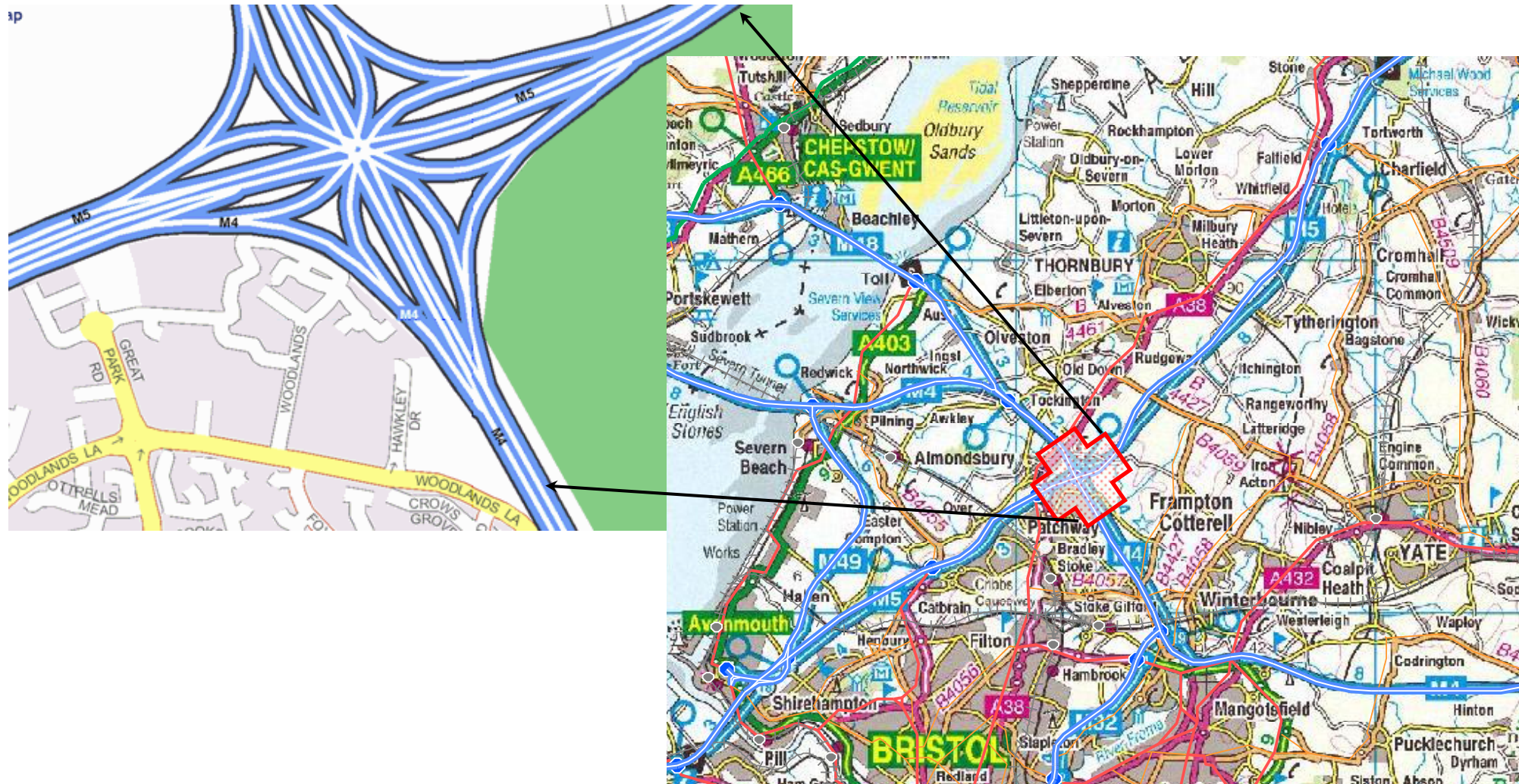


Figure 1.1– Almondsbury Interchange

### 1.7 Other elements of the scheme were as follows:

- ◆ Permanent signs for lane gains and lane drops in accordance with TA 58/92 have been provided with additional signs provided due to the compact nature of the interchange and the close proximity of merging manoeuvres. Ghost island and nose/chevron road markings have been overlapped at the merge of the M5 Motorway connector roads to prevent weaving on approach to the M4 Motorway merge, since this length appears to have sustained a number of personal injury accidents. Figure 1.2 shows the dedicated left-turn lane Permanent Advance Sign;



**Figure 1.2 – Dedicated left-turn lane Permanent Advance Sign**

- ◆ A ghost island and an auxiliary lane have been provided. The existing carriageway has been widened over the length of the auxiliary lane, along with relocation of drainage, safety barriers and street lighting;
- ◆ Improved gantry and Variable Messaging Signs (VMS) signing proposals are also being developed for the area, which will complement the scheme; and
- ◆ An additional drainage measure, the construction of Sustainable Urban Drainage System (SUDS) – SWALES, is required by the Environment Agency as a result of the carriageway widening.

### 1.8 The pre-opening junction arrangement is shown in Figure 1.3 and the post-opening junction arrangement is shown in Figure 1.4. It should be noted that these figures are pictorial representations only and are not drawn to scale.

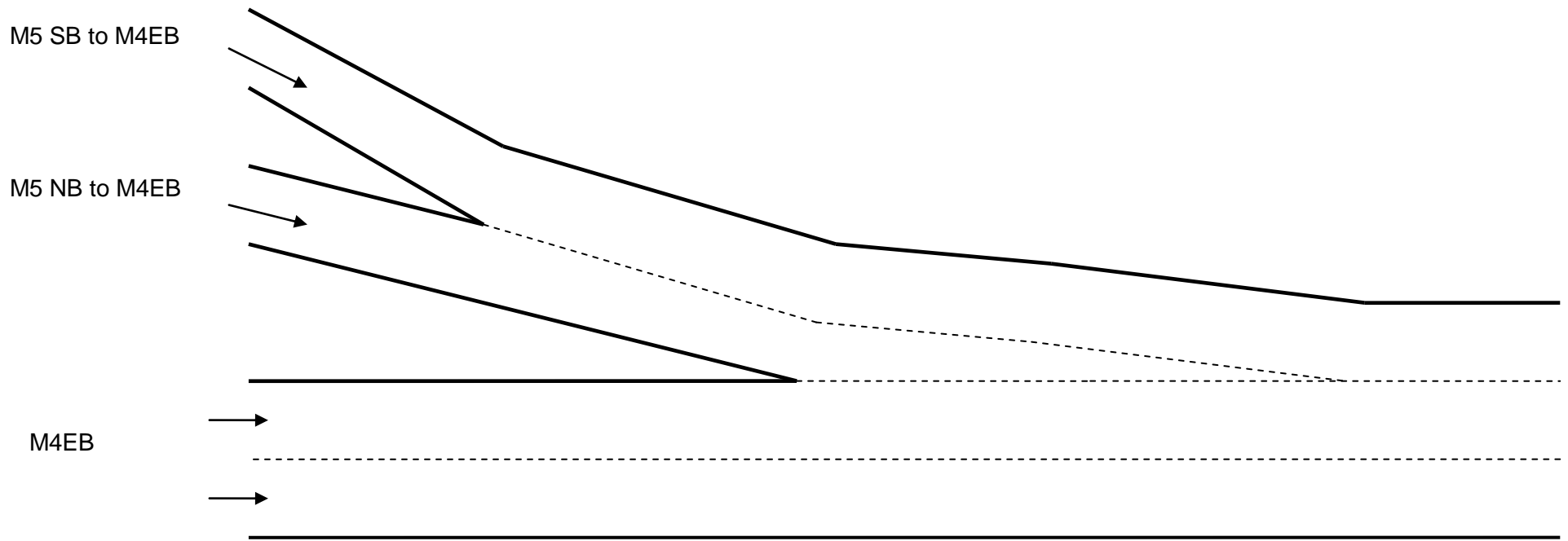


Figure 1.3 – Pre-Opening Junction Arrangements

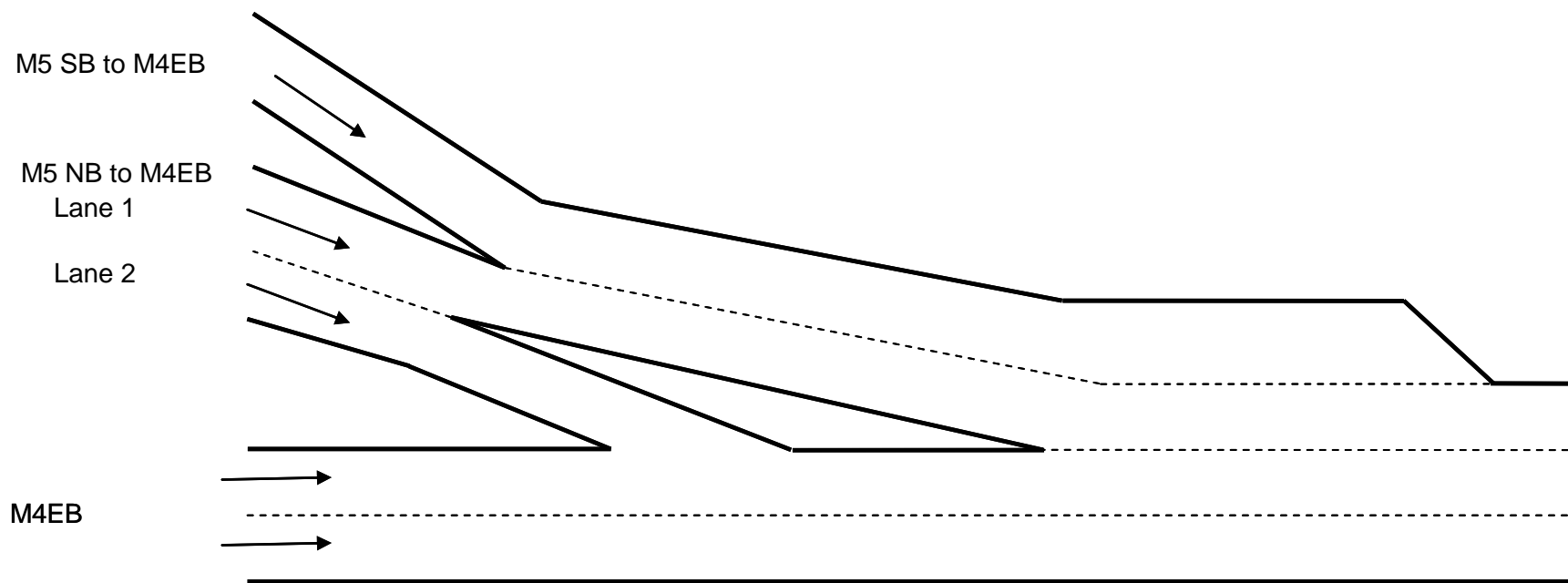


Figure 1.4 – Post-Opening Junction Arrangements

### SCHEME OBJECTIVES

- 1.9 The primary scheme objective as detailed in the PAR was to improve economy by reducing queues and delays at peak times.
- 1.10 The secondary objective of the project was to improve safety by providing clear and ordered series of manoeuvres with an associated reduction in the accident rate.
- 1.11 All of this was to be complimentary to parallel proposals for the interchange, and was aimed to be accomplished within the existing highway boundary without major structural changes.

### PURPOSE OF THIS REPORT

- 1.12 The Highways Agency has a requirement to carry out re-evaluations of trunk road schemes recently implemented by the Department for Transport. The purpose of these re-evaluations is to provide a back check of the levels of benefit accruing from new schemes and to determine how far the department achieves the objectives and benefits it claims from its road programme.
- 1.13 This report will initially undertake an assessment of the 'physical' impact of the scheme, namely:
  - ◆ A comparison of the 'Before' and 'After' traffic volumes on the route to illustrate how traffic volumes have changed since the opening of the scheme;
  - ◆ A comparison of the changes in accidents on the route since the scheme has been implemented;
  - ◆ A comparison of the 'Before' and 'After' journey times on the route to illustrate how the journey times have changed since the opening of the scheme; and
  - ◆ It will also identify the changes in the environmental issues, including landscape, biodiversity and journey ambience, since the scheme has been implemented and establish whether they differ from those changes that were predicted.
- 1.14 This is in turn, followed by the assessment of the scheme in accordance with the Post Opening Project Evaluation (POPE) methodology', which is being followed for the purpose of this study. This methodology aims to provide a process by which the forecast and outturn effects of a scheme can be evaluated on a common basis. This process ultimately presents two appraisals:
  - ◆ Appraisal 1: The original PAR assessment (including the original Appraisal Summary Table (AST)). This is a forecast of the cost/benefits of the scheme, calculated in accordance with full PAR version 3.2 July 2003 Guidance (1998 prices discounted at 3.5.0%).
  - ◆ Appraisal 2: An Evaluation Summary Table (EST) based on outturn effects, but evaluated on precisely the same terms (version of the PAR document,

present value year and discount rate) of the original assessment. The calculation is usually a simple pro-rata of the original assessment based on the outturn impact with regard to user benefits and scheme costs. The advantage of this assessment is that it is an outturn assessment that is directly comparable with the original PAR AST.

- 1.15 Following this introduction the report has been divided into five further sections as follows:
- ◆ Section 2 outlines existing data collation and new data collection;
  - ◆ Section 3 outlines the scheme's impact and reports on traffic volume, accident and journey time changes attributable to the scheme;
  - ◆ Section 4 presents an assessment of predicted and outturn economic benefits using the POPE methodology;
  - ◆ Section 5 presents the original AST for the M4/M5 Almondsbury Interchange-Phase 2A scheme and then re-evaluates these predictions with an EST; and
  - ◆ Section 6 summarises the main conclusions from the evaluations and the limitations of use.
- 1.16 It is intended that the findings of this report will feed into a wider summary of the outcomes of the POPE process.

## 2. Data Collection

### 'BEFORE' SURVEYS

- 2.1 The original PAR document submitted in support of the scheme was based upon the following data:
- ◆ Accident data for the years 1998 - 2002;
  - ◆ Traffic Count Information from Highways Agency permanent count site locations;
  - ◆ Journey time surveys on M5 southbound to M4 Eastbound slip;
  - ◆ A Cost Benefit Analysis (COBA) model of the proposed scheme; and,
  - ◆ A Landscape Assessment Desk Study / Environmental Assessment Preliminary Scoping Study.

### 'AFTER' SURVEYS

- 2.2 In the course of undertaking the Local Network Management (LNM) evaluation of the scheme, the following data was utilised.

#### *Automatic Traffic Counts*

- 2.3 Traffic count data from the following Highways Agency permanent count sites was obtained:
- ◆ 2/4151 - SB, M4/M5, M5 Slip to M4 Eastbound;
  - ◆ 2/4161 - NB, M4/M5, M5 Slip to M4 Eastbound; and
  - ◆ 2/4126 - EB, M4/M5 Junction 20 Main C way before on-slip.

#### *Accident Data*

- 2.4 Accident data was obtained from the Highways Agency area team for 01/01/1999 to 31/12/2004.

#### *Journey Times*

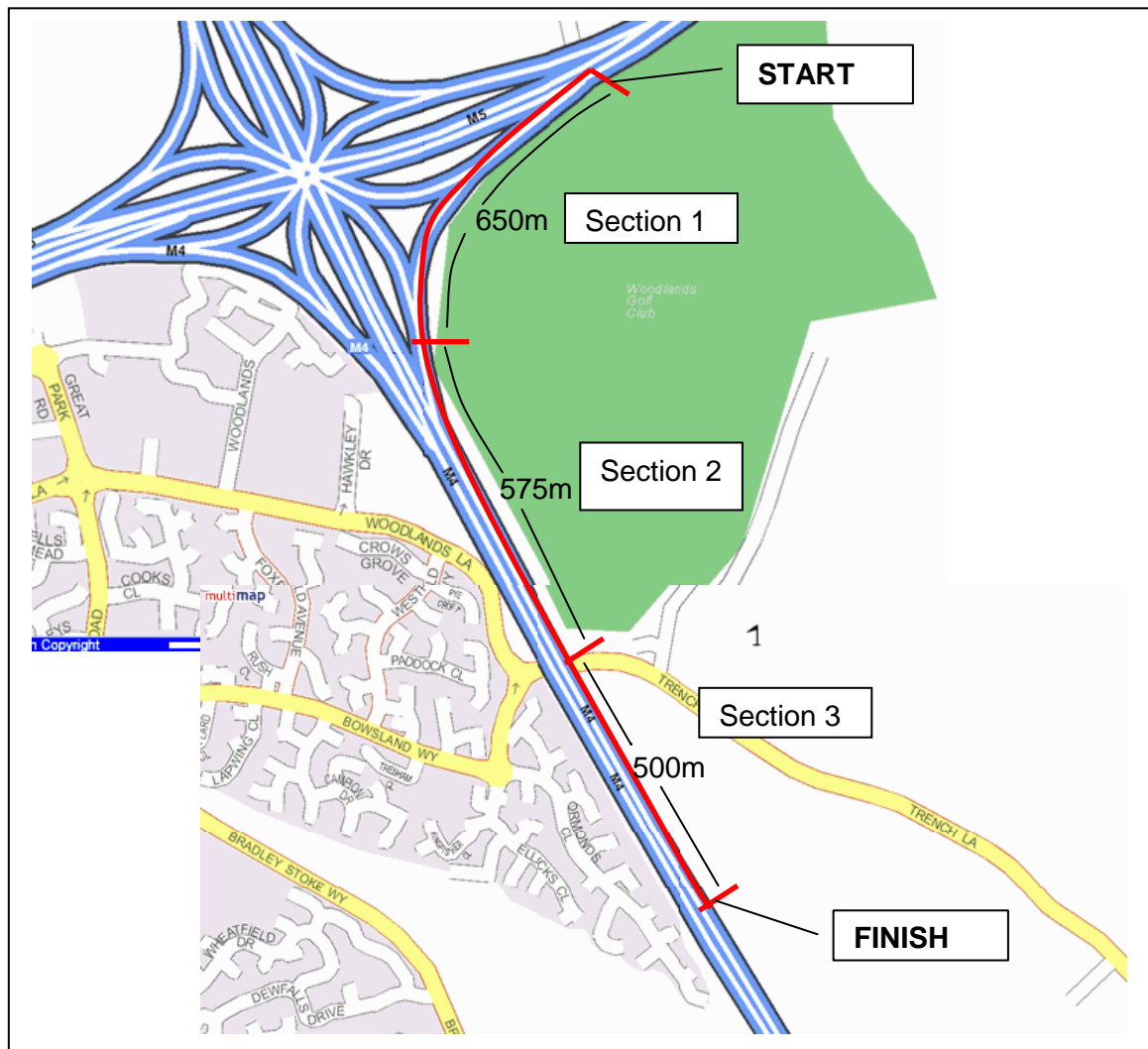
- 2.5 Journey time surveys were undertaken using the moving observer method along the M5 Southbound to M4 Eastbound slip and the subsequent merge on the M4 Eastbound main carriageway. Figure 2.1 depicts the timing points along the survey route including the start and end points. It may be noted that section 2 as illustrated in Figure 2.1 has journey time data prior to scheme implementation (1999). The journey times on this section were used to draw a comparison between the COBA modelled results and the observed journey times.

**COBA**

2.6 The original COBA files were used by Atkins, Cardiff office, to undertake additional COBA runs as appropriate for the present evaluation.

**Environmental Data**

2.6 From site visit and information obtained from the managing agent.



**Figure 2.1: Timing points for Journey Time Surveys - September 2005**

### 3. Scheme Impact

#### OVERVIEW

- 3.1 This section provides details of the outturn safety and traffic impacts of the scheme.

#### SAFETY

- 3.2 The original PAR assessment of the scheme forecast an opening year accident saving of 2.1 accidents which capitalised over the 30-year evaluation period would provide a saving of 75 and 85 accidents at low and high growth forecasts respectively.
- 3.3 For the present evaluation, the accident analysis done at the time of original appraisal was revisited and as part of this the pre-opening accidents were re-analysed using data for the period 1998 to 2002. This provided a total of 60 months pre-opening accident data. The re-analysis resulted in a predicted accident saving of 1.8 accidents in the opening year which capitalised over the 30-year evaluation period would provide a saving of 64 and 73 accidents at low and high growth forecasts respectively. Differences between the original PAR prediction and the re-analysis carried out could be attributed to the inclusion of accidents which were not directly related to the scheme in the accident analysis in the original PAR. These accidents not directly related to the scheme were excluded for the re-analysis and have been referred to as “PAR Predicted Corrected” for the purpose of the present report. Therefore, the present evaluation, wherever appropriate, would be compared both with the “PAR Predicted Corrected” and the “Original PAR” forecasts.
- 3.4 The analysis in Table 3.1, which is based on the above mentioned pre-opening accident data and 9 months post-opening accident data, shows that there were 2.4 accidents per year pre-opening and 1.33 accidents per year post-opening, resulting in an outturn accident saving of 1.07 accidents per year. This capitalised over the 30 year evaluation period results in a saving of 38 and 43 accidents at low and high growth forecasts respectively.
- 3.5 In summary, the observed accident reduction of 1.07 accidents per annum is below the PAR forecast accident reduction of 2.1 accidents per annum. The observed accident savings are also lower than the PAR Predicted Corrected accident analysis, which are 1.80 accidents per annum. However, it should be noted that the analysis was based on only 9 months of post-opening data and a further assessment should be completed when more data is available.
- 3.6 Further detail of the analysis of accident data is presented in Appendix A.

**Table 3.1 - Accident Savings**

Scenario	Number of Months	Observed Number of Accidents:	
		Over Observed Period	Per Year
Pre-Opening (1998 to 2002)	60	12	2.4
Post Opening (April 2004 to Dec 2004)	9	1	1.33
<b>Observed Accident Savings in the opening year (Post Opening Assessment)</b>			<b>1.07</b>
<b>Original PAR Predicted Accident Savings in the opening year (Pre-Opening)</b>			<b>2.10</b>
<b>PAR Predicted Corrected Accident Savings in the opening year (Pre-Opening)</b>			<b>1.80</b>

**TRAFFIC FLOW**

- 3.7 Information on traffic flows for the scheme area was collated from three HA permanent monitoring sites located on the M5 Southbound to M4 Eastbound slip (TRADS site 2/4151), the M5 Northbound to M4 Eastbound slip (TRADS site 2/4161) and the M4 Eastbound main carriageway (TRADS site 2/4126).

*Traffic Volume Changes*

- 3.8 Examination of traffic flow information for the period 1999 to 2005 from the above named sites reveals that:
- ◆ Traffic growth along this section of M4 Eastbound main carriageway, before the scheme opening was around 2.3% per annum, with the increase in AADT from 50,100 vehicles per day (vpd) in 1999 to 56,200 vpd in 2003 (Scheme opened on 31<sup>st</sup> March 2004).
  - ◆ The traffic growth post scheme opening from 2004 to 2005 shows an increase in traffic by 1.75% per annum (an increase from 56,800 vpd to 57,800 vpd). This level of growth is slightly lower to the pre-opening scenario indicating that the scheme has had no significant impact on traffic flows. The actual growth is also in line with the National Road Traffic Forecasts (NRTF) growth which is around 1.7% per annum.
- 3.9 Further detail of the analysis of traffic data is presented in Appendix B.

**ACCIDENT RATE**

- 3.10 Further analysis of the accident data in the region of the scheme illustrated that the accident rate pre-opening was 0.071 Personal Injury Accidents (PIA) per Million Vehicle Kilometres (MVKM). Post-opening accident rate is 0.037 PIA per MVKM, which means that although the accident rate was already lower than the COBA accident rate for motorways (0.098 PIA/MVKM for the link and

junction combined), the implementation of the scheme has enabled it to decrease further (Table 3.2).

**Table 3.2 –Accident Rate (Personal Injury Accidents per million vehicle kilometres)**

Scenario	Personal Injury Accidents per million vehicle kilometres
Pre Scheme Opening Accident Rate	0.071
Post Scheme Opening Accident Rate	0.037

### JOURNEY TIMES

- 3.11 The original aim of the scheme was focused on the objective of improving the economy; therefore a key element of the original PAR assessment was the predicted journey time savings. The original PAR stated in the AST that there would be a reduction in journey times in peak periods along the section of the interchange affected by the scheme, although no predicted journey times were actually provided in the main section of the original PAR document.
- 3.12 On revisiting the journey time analysis, it was established that for the present evaluation information on journey times could be obtained from:
- ◆ The analysis of the COBA model’s detailed link wise outputs that was used to predict the monetised journey time benefits in the original PAR; and
  - ◆ Information on journey times that was available for the 575 metre section of the scheme (refer Figure 2.1 on page9) before the scheme was implemented.
- 3.13 For the present evaluation, it was considered important to compare the observed journey times with the COBA estimated link transit times for the same section. It was considered important to do this comparison both for the pre and the post scheme opening journey times. For this reason, post-opening journey time data was also collected for the same section in 2005.
- 3.14 The following subsection discusses the results of the COBA journey time estimation, followed by details of the observed journey times, before comparing the two to draw inferences on how close are the COBA predictions to the observed impacts on ground.

#### *COBA Estimated Journey times*

- 3.15 To ensure comparison on a like by like basis a few additional COBA runs had to be undertaken using the original COBA decks used for the original PAR. The following COBA runs were undertaken to obtain information on COBA estimated link transit times which were considered comparable to the observed journey times for section 2 as illustrated in Figure 2.1. The COBA scenarios were:
- ◆ Do Minimum Scenario - 1999 flows (the flows used for the original PAR analysis); with the first and last scheme year being 1999, to be compared to

the pre-scheme opening observed journey times used to validate the COBA results for the original PAR; and

- 3.16 Do Something Scenario - 1999 flows; with the first and last scheme year being 2005, to be compared to the post-scheme opening observed journey times collected in 2005. Table 3.3 summarises the COBA estimated link transit times for section 2 of the scheme. From the table it is evident that:
- ◆ The average link transit times to traverse this 575 meter section of the scheme as predicted by COBA for the Do Minimum 1999 scenario (Comparable to the pre-opening observed journey times) are around 22.55 and 21.50 seconds during the peak and the inter-peak periods in 1999;
  - ◆ The estimated average link transit times to traverse the same 575 meter section of the scheme, based on the same COBA model for the Do-Something scenario in 2005 (Comparable to the post-opening observed journey times) are around 19.15 and 18.70 seconds during the peak and the inter-peak period respectively; and
  - ◆ Comparing the COBA estimated pre scheme opening (1999) and post scheme opening (2005) journey times shows a reduction in the journey times of around 3.40 and 2.80 seconds during the peak and the inter-peak periods.

**Table 3.3: COBA estimated link transit times (section 2 only)**

Period	COBA estimated Journey Times over the common section of 575 meters (in seconds)		
	Pre-Opening Do Minimum (1999) (a)	Post –Opening Do Something (2005) (b)	Difference (a-b)
Peak (A)	22.90	19.40	3.50
Shoulder peak (B)	22.20	18.90	3.30
Average (A+B)/2	22.55	19.15	3.40
Inter-peak (C)	21.50	18.70	2.80

#### *Observed Journey times*

- 3.17 In order to compare the prediction made by the COBA model with the observed impacts, post-opening journey time data was also collected. To ensure comparison of likes the post scheme implementation journey time surveys were based on the same methodology as that used to conduct pre-opening journey time surveys. The moving observer method was used along the same section of highway during the same periods and on the same day of the week. Detail of the collection, collation and analysis of journey time data is presented in Appendix C.

- 3.18 Table 3.4 presents a summary of both the observed before and after journey times for the 575 meters section of the scheme, (section common to the before and after journey time surveys).

**Table 3.4 – Observed Before and After Average Journey Time Information**

Period	Observed Average Journey Times over the common section of 575 meters (in seconds)		
	Pre-Opening (1999) (a)	Post –Opening (2005) (b)	Difference (a-b)
AM Peak (A)	23.33	22.75	0.58
PM Peak (B)	22.33	22.83	-0.50
Average Peak (A+B)/2	22.83	22.79	0.04
Inter-peak (C)	22.00	22.17	-0.17

- 3.19 Unfortunately, no journey times were actually predicted by the PAR so a comparison can not been made between the PAR predicted journey time savings and the actual observed journey time savings to assess whether the benefits were as expected. However, in comparing the observed pre scheme opening (1999) and post scheme opening (2005) journey times it is evident that:
- ◆ In the peak period, there has been an insignificant change in the observed journey times, under one second decrease and increase for the AM and the PM peak respectively ; and
  - ◆ In the Off-peak period, there has been a marginal increase in journey times.
- 3.20 It may be noted that it would be inappropriate to draw any definitive conclusions about the actual changes in the journey times from this comparison because:
- ◆ There has been a considerable growth in traffic from 1999 to 2005 it being 15.4% (from 50,100vpd to 57,800vpd) indicating that even though the post scheme opening journey times appear to have remained more or less unchanged or shown a marginal change, in actuality had the scheme not been implemented, these journey times would have further increased resulting in greater delays; and
  - ◆ These marginal differences could be a result of marginal differences in the before and the after surveys like a slight difference in the timing points and such like factors which are beyond control.

*COBA versus Observed Journey times*

3.21 Table 3.5 shows the comparison between the COBA estimated link transit times and the observed journey times during the peak and the inter-peak period for the 575 meters common section of the scheme.

**Table 3.5: Comparison of COBA estimated and observed Journey Times**

Scenario	Average Journey Times over the common section of 575 meters (in seconds)	
	Peak	Inter-peak
<b>COBA Results</b>		
COBA Do Minimum (1999) {A}	22.55	21.50
COBA Do Minimum (2005) {B}	23.20	21.70
COBA Do Something (2005) {C}	19.15	18.70
<b>Observed</b>		
Before Scheme Opening (1999) {D}	22.83	22.0
After Scheme Opening (2005) {E}	22.79	22.17
<b>Journey Time Benefits per vehicle (In Seconds)</b>		
COBA predicted benefits in 2005 {B}-{C}	4.05	3.0
*Actual benefits / disbenefits in 2005 {B}-{E}	0.41	-0.47

\* The COBA Do Minimum (1999) {A} estimated journey times are comparable to the Observed Before Scheme Opening journey times {D}, therefore COBA results were considered to represent the Do minimum 2005 journey times to estimate the actual benefits

3.22 From the table it can be observed that:

- ◆ The observed journey times before the scheme opening are significantly close to the COBA estimated link transit times (COBA Do Minimum, 1999) during both the peak and the inter-peak period;
- ◆ The observed journey times during both the peak and the inter-peak period after the scheme opening are over three seconds higher than the COBA estimated link transit times for the high growth traffic scenario (COBA Do Something, 2005). This shows that the COBA modelled link transit times are around 16% lower than the observed journey times, indicating that COBA may be overestimating the travel times benefits;
- ◆ COBA estimated Journey time benefits in 2005 resulting from the difference between the COBA Do minimum and Do something scenarios for 2005 are around 4.05 and 3.0 seconds per vehicle for the peak and the

inter-peak periods respectively. However, actual benefits as estimated from the difference between the COBA Do minimum 2005 and the observed journey times (2005) are only around 0.41 seconds for the peak. Contrary to this for the inter-peak there is a disbenefit of 0.47 seconds per vehicle.

- 3.23 In summary, though the COBA modelled results show journey time benefits, in actuality, the journey times does not seem to have changed significantly to result in considerable journey time benefits.

### SUMMARY

- 3.24 **The evaluation of safety impacts of the scheme show that for the first nine months post opening of the scheme, there has been a reduction of around 1.07 accidents per annum which is below the Original PAR predicted accident savings of 2.1 accidents per annum. The scheme has therefore resulted in lower than predicted accident benefits.**
- 3.25 **The evaluation of impact of the scheme on the traffic flows shows that as the level of traffic growth post-scheme opening (1.75% per annum) is only slightly lower to the pre-opening annual average traffic growth (2.3% per annum), it is indicative that the scheme has had no significant impact on traffic flows.**
- 3.26 **The evaluation of journey time impacts shows that:**
- ◆ **COBA estimated link transit times for the comparable 575 meter section of the scheme show an improvement in the journey times as a consequence of the scheme;**
  - ◆ **The post scheme opening observed journey times (2005) for the same section appear to have remained more or less unchanged as compared to the observed journey times before the scheme opening (1999) for the same section. This could be attributable to the high traffic growth between 1999 to 2005 of around 15.4% and marginal differences due to any uncontrolled variables ;**
  - ◆ **COBA modelled link transit times for the Do something scenario (2005) for this compared section of the scheme are around 16% lower than the observed journey times (2005) both for the peak and the inter-peak period; and**
  - ◆ **COBA estimated Journey time benefits in 2005 (COBA Do minimum – COBA Do something for 2005) though are around 4.05 and 3.0 seconds per vehicle for the peak and the inter-peak periods respectively, however, actual benefits as estimated (COBA Do minimum 2005 - observed journey times,2005) are only around 0.41 and - 0.47 (disbenefit) seconds per vehicle for the peak and inter-peak respectively. This shows that in actuality, the journey times does not seem to have changed significantly, indicating little journey time benefits due to the scheme.**

## 4. Economic Evaluation

### INTRODUCTION

- 4.1 This section assesses the level of economic benefits predicted for the scheme and compares these predictions with actual benefits accrued. The scheme even though is defined as an economy scheme it was predicted to accrue benefits from both accident and travel time savings. The POPE methodology uses observed accident and journey time savings to provide an economic assessment of the performance of the scheme. This result is presented in the scheme EST and is expressed in same terms as the original evaluation (present value year of 1998, and discount rate of 3.5 per cent).

### ACCIDENTS

- 4.2 The original PAR predicted an accident saving of 2.1 accidents in the opening year. This capitalised over the 30 year assessment period resulted in an accident saving of 75 and 85 accidents for the low and the high traffic growth respectively This equates to an accident saving, in 1998 prices and discounted to 1998, of £126,027 in the opening year and £3,226,294 and £3,629,580, over the 30 year assessment period, for the low and high traffic growth respectively.
- 4.3 On revisiting the accident analysis for the purpose of present evaluation, it appeared that the opening year accident savings as stated in the original PAR was based on all accidents, including the ones not directly related to the scheme. Therefore the original PAR accident analysis was repeated to exclude the accidents not directly related to the scheme. For the present report it is called as the “PAR Predicted Corrected” analysis and would be discussed along side the “Original PAR Predicted” results, when they are being compared with the present POPE evaluation results.
- 4.4 The “PAR Predicted Corrected” accident analysis estimated an accident saving of 1.8 accidents in the opening year. This capitalised over the 30 year assessment period resulted in an accident saving of 64 and 73 accidents for the low and the high traffic growth respectively This equates to an accident saving, in 1998 prices and discounted to 1998, of £108,023 in the opening year and £2,765,394 and £3,111,069, over the 30 year assessment period, for the low and high traffic growth respectively.
- 4.5 Section 3 presented Atkins analysis of the observed post-opening accident saving of 1.07 accidents per annum. These observed accident savings have in turn been used to forecast monetised accident benefits from the scheme, as given in Table 4.1. This table also presents the original PAR predicted and the PAR predicted-corrected assessment of the scheme accident benefits.

**Table 4.1: POPE Comparison: Accident Savings and Benefits**

Traffic Growth Forecast	Opening Year Accident Saving	Opening Year Accident Benefits	30 Year Accident Saving	30 Year Accident Benefits
<b>Pre-Opening (Original PAR Predicted) Assessment</b>				
Low Growth	2.1	£0.127m	75	£3.226m
High Growth	2.1	£0.127m	85	£3.629m
<b>Pre-Opening (PAR Predicted-Corrected) Assessment</b>				
Low Growth	1.8	£0.108m	64	£2.765m
High Growth	1.8	£0.108m	73	£3.111m
<b>Post Opening Assessment</b>				
Low Growth	1.07	£0.064m	38	£1.638m
High Growth	1.07	£0.064m	43	£1.843m

All costs and benefits are 1998 prices discounted to 1998 at 3.5%.

- 4.6 Table 4.1 illustrates that the POPE assessment of the scheme accident benefits, in 1998 prices and discounted to 1998, is in the range of £1.638m to £1.843m for the low and high traffic growth respectively. Although the scheme has produced some outturn accident benefits the table shows that they are lower than those estimated in the “Original PAR Predicted” assessment and the “PAR Predicted Corrected” assessment.

#### JOURNEY TIME BENEFITS

- 4.7 Within the assessment, journey time benefits were evaluated using a COBA model of the study area. This forecast journey time benefits resulting in monetary savings, at 1998 prices discounted to 1998, of £162,000 in the opening year. This capitalised over the 30 year assessment period, at 1998 prices and discounted to 1998, results in a monetary saving of £4,329,000 and £5,661,000 for the low and the high traffic growth respectively. For the scheme, based on a 60:40 weighted average, PAR predicted journey time savings £4,682,000 over the 30 year assessment period, at 1998 prices and discounted to 1998.
- 4.8 In the absence of before observed journey time information for the entire length of the scheme, for the present evaluation an attempt to estimate the actual journey time benefits accrued from the scheme has been made by using the below methodology:

#### *Re-run of COBA model for the high growth scenario*

- 4.9 As a starting point, COBA model was rerun. The observed traffic growth between 1999 (the year of PAR appraisal) and 2005 of 15.4% was comparable to the NRTF high traffic growth scenario between the same years (14.3%). Hence for the evaluation, it was considered appropriate to undertake the COBA runs for the high traffic growth scenario only. It appeared to be more realistic estimation of the actual benefits.

### Factoring of the COBA results

- 4.10 Based on the comparison of the COBA predicted journey times and the observed journey times as discussed in section 3.21, the COBA re-run results were factored to estimate the monetised journey time benefits that would represent the actual benefits more realistically. The comparisons drawn in Table 3.5 show that whilst the COBA predicted link transit time during the peak and the inter-peak periods for the Do minimum scenario (1999) are comparable to the before scheme opening observed journey times, for the Do-something scenario (2005) both for the peak and the inter-peak period, they are around 16% lower than the after scheme opening observed journey times.
- 4.11 Therefore for the present evaluation, it was considered reasonable to factor the COBA predicted results using the following basis:
- ◆ As the COBA predicted results for the Do minimum 1999 scenario were comparable to the before scheme opening observed journey times (1999), the COBA predicted Do minimum monetised travel times for the scheme were expected to represent the actual monetised travel times;
  - ◆ However, the COBA predicted results for the Do something 2005 scenario were around 16% lower than the after scheme opening observed journey times (2005), the COBA predicted Do something monetised travel times for the affected sections of the scheme (sections with the additional merge lane) were uplifted by 16% to estimate the actual monetised travel times for the Do something scenario;
  - ◆ Finally, these difference of the COBA predicted Do nothing monetised travel times and the factored COBA predicted Do something monetised travel times was expected to be the best estimated journey time savings due to the scheme.
- 4.12 Based on the aforementioned methodology, the comparison of the journey time benefits/disbenefits as estimated for POPE with those predicted in the original PAR assessment is as summarised in Table 4.2 . It is evident that in the opening year the scheme seems to have had slight disbenefits of around £18,000, at 1998 prices discounted to 1998, as against the predicted benefits of around £162,000. Over the 30 year assessment period, at 1998 prices discounted to 1998, the estimated journey time benefits are around £417,000 which is under 10% of the journey time benefits as predicted in the original PAR.

**Table 4.2 - POPE Comparison: Journey Time Benefits**

Traffic Growth Forecast	Opening Year Journey Time Monetary Benefits (£)	30 Year Journey Time Monetary Benefits (£)
<b>Pre-Opening (Original PAR Predicted) Assessment</b>		
Low Growth	-	£4.329m
High Growth	-	£5.661m
60:40 Average for the Scheme	<b>£0.162m</b>	£4.558m
<b>Post Opening Assessment</b>		
High Growth	<b>-£0.18m</b>	£0.417m

All costs and benefits/disbenefits are at 1998 prices discounted to 1998 at 3.5%.

- 4.13 This could be attributed to insignificant reduction in journey times in the peak period and a slight increase in journey times in the inter-peak period. However, based on the comparison of the COBA predicted results as against the observed journey times as detailed in section 3.21 and Table 3.5, it would be reasonable to expect that the journey times after the scheme opening have remain unchanged indicating insignificant or no journey time benefits due to the scheme.

#### **VEHICLE OPERATING COSTS (VOC) BENEFITS/DISBENEFITS**

- 4.14 Within the assessment, VOC disbenefits were evaluated using a COBA model of the study area. This forecast VOC disbenefits resulting in monetary disbenefits, at 1998 prices discounted to 1998, of £10,000 in the opening year. This capitalised over the 30 year assessment period, at 1998 prices and discounted to 1998, results in a monetary disbenefits of £304,000. This was perhaps due to the predicted increase in speeds over the optimal speeds due to the interchange improvements as a part of the scheme. Research indicates that increase in speeds above the optimal threshold speeds may result in the slight increase in the VOC.
- 4.15 However, based on the comparison of the COBA predicted results as against the observed journey times as detailed in section 3.21 and Table 3.5, it would be reasonable to expect that the journey times and hence the average speeds after the scheme opening have remain unchanged indicating that the scheme has had no impact on the VOC. For the present evaluation, it was therefore considered reasonable to consider that there have been no changes to the VOC.

#### **SCHEME COST**

- 4.16 The original PAR predicted the total Present Value Cost (PVC) of the scheme, at 1998 market prices, discounted to 1998, to be £2.62m with the estimate year as 2002 quarter 3 (The original PAR document erroneously states the estimate year as 2003, Quarter 4). It maybe noted that this cost includes the annual maintenance costs of £1,000 per annum, capitalised over 30 year assessment period, at 1998 prices discounted to 1998. To ensure comparison of predicted costs with the outturn costs, which being for the opening year, does not include the maintenance costs, it was considered reasonable to exclude the maintenance costs from the predicted costs in the original PAR document. Thus the original PAR predicted Works, land and other PVC costs, at 1998 market prices and discounted to 1998 of £2,605,106.04 was used for comparing it to the outturn costs.
- 4.17 The outturn cost of the scheme as provided by the project sponsor for the scheme of March 2004 was £2,42,5658 (including preparation and site supervision). In the absence of more detailed information it was assumed that the value excluded VAT.
- 4.18 Table 4.3 presents the conversion of the outturn cost to the present value year of 1998.

**Table 4.3 - Conversion of Outturn Cost to Present Value Cost**

	Total Current Project Cost (1)	Latest RPI (2)	Latest RPF (3)	RPI (1998) (4)	Discount Factor (5)	Present Value Cost $((4*3*1)/2)*5$
Actual Outturn	£2,42,5657.75	(P)183.8	(P)1.00	162.8	0.81	<b>£2,104,019.39</b>

All Present Value Costs are in 1998 prices discounted to 1998 at 3.5%, RPI for Q1- 2004 & RPF for Q4- 2003(P).

- 4.19 Table 4.4 compares the predicted cost and the outturn costs for the scheme. It shows that the outturn scheme cost was around 19% below the predicted value as given in the original PAR for the scheme.

**Table 4.4 – Comparison of predicted and outturn costs**

Present Value Costs		Percentage Difference
Original PAR Predicted(1)	Outturn(2)	Outturn vs. Original PAR Predicted $(2-1)/1$
£2,605,106	£2,104,019	<b>19.2% lower</b>

**SUMMARY**

- 4.20 Table 4.5 presents a summary of the original PAR, PAR corrected and POPE economic evaluation of the scheme. The assessment is expressed in terms of 1998 prices, discounted to 1998 at 3.5 per cent, with the methodology used being in accordance with Full PAR guidance version 3.2.July 2003.

**Table 4.5 - POPE Comparison: Summary**

Scenario	Original PAR Worksheets	Corrected PAR Worksheets	***POPE Assessment	
			With Journey Time, VOC & Accident Benefits/ Disbenefits	Assumes No Journey Time & VOC Benefits/ Disbenefits
<i>Number of accidents saved</i>				
Opening Year	2.1	1.8	<b>1.07</b>	<b>1.07</b>
30 Year Assessment period	Low forecast:75	Low forecast:64	<b>43</b>	<b>43</b>
	High Forecast:85	High Forecast:73		
<i>Accident Benefits</i>				
Opening Year	£0.126m	£0.108m	<b>£0.064m</b>	<b>£0.064m</b>
30 Year Assessment period (Present Value Benefits {PVB} 1)	*£3.409m	*£2.412m	<b>£1.843m</b>	<b>£1.843m</b>

Scenario	Original PAR Worksheets	Corrected PAR Worksheets	***POPE Assessment	
			With Journey Time, VOC & Accident Benefits/ Disbenefits	Assumes No Journey Time & VOC Benefits/ Disbenefits
<b>Travel Time Benefits</b>				
Opening Year	£0.162m	£0.156m	-£0.018m	-
30 Year Assessment period (PVB 2)	*£4.862m	*£4.862m	£0.417m	-
<b>VOC Benefits/Disbenefits</b>				
Opening Year	-£0.010m	-£0.010m	-	-
30 Year Assessment period (PVB 3)	*-£0.304m	*-£0.304m	-	-
<b>Scheme Costs &amp; Value</b>				
PVC	**£2.627m	***£2.605m	£2.104m	£2.104m
Net Present Value {NPV}= {(PVB-1+2+3) - (PVC)}	£5.340m	£4.365m	£0.156m	-£0.261m
<b>*First Year Rate of Return (FYRR) and Cost Benefit Ratio</b>				
First Year Rate of Return (FYRR)	10.58%	9.75%	2.2%	3.04%
Benefit Cost Ratio (BCR)	3.03	2.67	1.07	0.87

All costs and benefits are 1998 prices discounted to 1998 at 3.5%.

\* These benefits are based on the weighted average of the low and the high forecast scenario by 60:40.

\*\* Includes the maintenance costs of £1000 per annum capitalised over assessment period.

\*\*\* Only the works, land and other PVC costs excluding the maintenance costs of £1000 per annum.

\*\*\*As High traffic growth was observed from 1999 to 2005, the POPE assessment summarises the evaluation results for high growth scenario only.

' - ' Expected to have had no benefits due to unchanged journey times.

#### 4.21 The main points to note are:

- ◆ The evaluated accident benefits in the first year post scheme opening are around 49% and 40% lower than the forecasted accident benefits in the original PAR and the corrected PAR respectively. Over the 30 year assessment period the forecasted accident benefits based on observed accidents are around 46% lower than the predicted accident benefits in the original PAR and around 24% lower when compared with the corrected PAR benefits;
- ◆ The evaluated travel time benefits/disbenefits in the first year post scheme opening, based on the COBA results factored in the light of comparison of observed and the COBA predicted journey times, shows a slight dis-benefit as against the predicted travel time benefits in the original PAR. Based on the same methodology, over the 30 year assessment period the forecasted travel time benefits are less than 10% of the original PAR predicted travel

time benefits. However, the analysis of observed journey time data and its comparison with the COBA results indicates that the journey times have not changed significantly post scheme opening. Thus it would be reasonable to state that the scheme seems to have had little travel time and VOC benefits/disbenefits;

- ◆ The outturn scheme cost was around 19% lower than the original PAR forecast;
- ◆ The FYRR of the scheme, based on the COBA results factored in the light of comparison of observed and the COBA predicted journey times, is around 2.2%, which is significantly lower than the original PAR predicted and PAR predicted corrected FYRR of 11.72% and 9.75% respectively. However as it seems that journey times have remained unchanged post scheme opening, the FYRR of the scheme was also estimated with only accident benefits. Based on this, the FYRR of the scheme is around 3.04 % which is a quarter of the original PAR predicted FYRR and a third of the PAR predicted corrected FYRR; and
- ◆ The BCR, based on the COBA results factored in the light of comparison of observed and the COBA predicted journey times, is approximately 1.07, which is around 65% and 60% lower than the original PAR predicted and the PAR predicted corrected estimates respectively. The BCR based on the scheme having only accident benefits, is around 0.87 which indicates, that the scheme has not been a good value for money.

4.22 **Overall the scheme does not seem to represent a good value for money, with significantly lower than predicted benefits even with a lower than forecast scheme cost.**

## 5. Summary of Appraisal and Evaluation Summary Tables

### INTRODUCTION

- 5.1 In order to fully evaluate the effects of this phase of the interchange improvement scheme, Atkins has undertaken a review of the original PAR document which was also prepared by Atkins. The AST from this document, which summarises the predicted impact of the scheme under the five objectives of environment, safety, economy, accessibility and integration, is presented as Appendix D in this report.
- 5.2 The Atkins review focused on:
- ◆ The main body of the PAR document itself; and,
  - ◆ The AST from the PAR.
- 5.3 Each of these is dealt with in turn below.

### PAR DOCUMENT

- 5.4 The main points to note from the PAR document of the M4/M5 Almondsbury Interchange – Phase 2A M5 Southbound and Northbound to M4 Eastbound are as follows.

#### *Environment*

- 5.5 The PAR includes an assessment of the environmental impacts of the scheme, including landscape, biodiversity and journey ambience. In addition, a separate environmental statement was published prior to the PAR in question which also identified the potential environmental impacts likely to occur from construction and operation of the section of road associated with the M4/M5 Almondsbury Interchange Improvements Phase 2A.
- 5.6 The following points were noted:
- ◆ With regard to landscape, the PAR identified that the proposed scheme would result in the loss of vegetation and increases in tarmac surface with additional sign gantry and associated lighting. Overall, it was stated that this would only have a slight adverse impact on the existing landscape character as the species mix are able to be replaced and additional mitigation will provide the opportunity for some local landscape benefits with appropriate planting on the motorway verge or on additional land.
  - ◆ In terms of biodiversity, the scheme will result in the loss of verge habitats and loss/displacement of associated fauna. The PAR stated that this would have a minor adverse impact on the biodiversity of the area as existing verge habitats of only low biodiversity value will be lost. It has suggested that there is potential for creation of further habitats in mitigation and

careful relocation of reptiles and other protected species to ensure minimal adverse impacts.

- ◆ The PAR states that improved information and lane discipline will reduce uncertainty for drivers and will hence lead to a reduction in accidents. This will therefore have a significant beneficial impact on the journey ambience along the route.

### *Safety*

- 5.7 The PAR identified that between 1998 and 2002, there has been 14 PIAs recorded at the site. Of the 14 accidents, one was fatal, one was of serious severity and the remaining 12 were slight. This approximates to 2.8 PIAs per year.
- 5.8 The PAR predicts that the scheme will save 2.1 personal injury accidents in its opening year.

### *Economy*

- 5.9 The proposed interchange improvements were forecast to cause a reduction in journey times at peak periods resulting in:
- ◆ beneficial impact on the economy, with the forecast user travel time benefits of £4.862m;
  - ◆ slight adverse impact on economy with the forecasts VOC disbenefits of around £0.304m; and
  - ◆ The Net consumer benefits of +£4.558.

### *Accessibility*

- 5.10 The scheme does not impact the overall accessibility and is thus neutral towards this objective

### *Integration*

- 5.11 The PAR predicts that the scheme even though is a stand alone improvement, it forms a part of the series of measures planned to upgrade the interchange at Almondsbury, thus resulting in a neutral impact on integration in terms of land-use policy.

## **AST**

- 5.12 The main points to note from the AST of the M4/M5 Almondsbury Interchange Improvement – Phase 2A are:

### *Environment*

- ◆ *Noise:* PAR predicted no adverse effects of the scheme on the noise levels. However, some temporary noise impacts during construction were predicted. No properties were predicted to have experienced any changes in the noise levels.

- ◆ *Local Air Quality:* Similarly, AST predicted that air quality will not be affected during the operational stage; however, there may be a temporary impact on air quality during the construction of the improvements. No properties were predicted to have experienced any changes in the air quality.
- ◆ *Greenhouse Gases:* AST predicted that greenhouse gases will not be affected and states the impact of the scheme to be neutral on greenhouse gases.
- ◆ *Landscape:* An assessment made of the landscape concluded that there will be no significant loss of planting. The role of the junction in the landscape will not be affected but there will be a slight adverse impact on the existing landscape character. Resultantly, the scheme will have a minor adverse effect on the landscape overall.
- ◆ *Townscape:* The impact on townscape has not been assessed, as it was not applicable.
- ◆ *Heritage of Historic Resources:* The AST predicted a neutral impact of the scheme on the heritage of the historic resources as the scheme does not impact any historic resources.
- ◆ *Biodiversity:* The AST predicted minor adverse impact of the scheme on biodiversity of the area, although no significant loss of habitats is predicted.
- ◆ *Water Environment:* AST assessed that the scheme would have a neutral impact on the water environment.
- ◆ *Physical Fitness:* The impact has not been assessed, as it was not applicable.
- ◆ *Journey Ambience:* The AST predicts that the journey ambience along the route will get better with journey time and driver stress being improved. The scheme was predicted to have minor benefits. However, in the main PAR document it was predicted that the effect of the scheme on journey ambience would be significantly beneficial.

### Safety

- ◆ The AST predicts a saving of 2.1 PIAs per year resulting in an average accident benefits (PVB) of around £3.409m million over a 30 year assessment period (£3.18m and £3.62m for the low and the high traffic growth respectively).
- ◆ The AST states that between 1998 and 2002, there has been 14 PIAs recorded at the site. Of the 14 accidents, one was fatal, one was serious and the remaining 12 were of slight severity.
- ◆ However before the onset of the evaluation, these accident savings were recalculated considering the accidents which were only related to the scheme. (Please refer section 4.3 and 4.4 for further details). The revised estimates result in saving of 1.8 PIAs per year resulting in an average accident benefits (PVB) over a 30 year assessment period of around £2.76m and £3.11m for the low and the high traffic growth respectively.

### *Economy*

- ◆ The AST states that there would be a reduction in journey times at peak periods along the route. A PVB of £4.558m is stated.
- ◆ The AST also states that a limited improvement in journey time reliability will occur.

### *Accessibility*

- ◆ No impacts were identified in terms of accessibility and therefore the schemes overall impact on accessibility was predicted to be neutral.

### *Integration*

- ◆ The AST predicts that the scheme even though is a stand alone improvement, forms a part of the series of measures planned to upgrade the interchange at Almondsbury, thus resulting in a neutral impact on integration in terms of land-use policy.

## **OUTTURN EFFECTS**

- 5.13 In order to assess the actual or outturn effects of the opening of the scheme, we have produced an EST, which mirrors the appearance of the AST, and includes details of the actual sub objectives that have been evaluated. The EST is presented in Appendix E.
- 5.14 Section 4 discussed the economy and safety impacts of the scheme. The scheme was an economy scheme and focused on the impacts on economy and safety. The impacts on accessibility and integration were not identified. This section thus concentrates on the Environmental impacts such as noise, local air quality, landscape, biodiversity, heritage and water.
- 5.15 The assessments that follow are all subjective assessments from members of the evaluation team.
- 5.16 The following reiterates the statements that accompanied these impacts before providing relevant evidence/ a logical case to evaluate the scheme in light of the predicted impacts and the proposed mitigation measures.

## **Environment**

### ***Noise - No operational impact but temporary construction impacts. No properties to experience higher noise levels.***

- 5.17 The evaluation being post scheme opening the impacts during the construction could not be assessed for this evaluation. Although the traffic flow data suggests a high growth in traffic from 1999 to 2005 (15.4%); nevertheless with an annual average growth of around 1.75% post scheme opening, the scheme does not seem to have generated any extra traffic. Therefore it is expected that the predictions made in the PAR and AST for the operational stage hold true. Hence the scheme is expected to have had no impact on the noise levels.

**Local Air Quality – No operational impact but temporary construction impacts.**

- 5.18 The evaluation being post scheme opening the impacts during the construction could not be assessed for this evaluation. As stated earlier, the scheme does not seem to have generated any extra traffic. The journey times and hence the speeds seem to have remained unchanged. Therefore it is expected that the predictions made in the PAR and AST for the operational stage hold true. Hence the scheme is expected to have had no impact on the local air quality.

***Landscape – No significant loss of planting and wherever, the proposals involve any loss of vegetation on the existing highway verge, it is the species mix that is capable of being replaced on completion of engineering works. The role of the junction in the landscape not affected but a slight adverse impact on existing landscape character to that of the immediate study area, which is already dominated by the existing motorway corridor. Additional mitigation will provide opportunity for some local landscape benefits with appropriate planting within the motorway verge or on additional land acquired for mitigation. On this basis, the PAR and AST predicts that there will be a slight adverse impact on the landscape.***

- 5.19 From site observations and as can be seen from Figure 5.1, it is apparent that extensive planting has occurred which, based on details given in the PAR, has replaced previously existing vegetation with species of a higher visual quality. It was also apparent that there had been negligible change to the existing local landscape and the immediate study area as it was already dominated by the motorway corridor. Therefore, the scheme seems to have had a slight beneficial impact on the landscape.



**Figure 5.1: Evidence of Extensive Planting**

***Biodiversity – No significant loss of existing verge habitats. Overall a minor adverse impact predicted.***

- 5.20 In the absence of a full biodiversity assessment of the scheme impacts it is assumed that the predictions made in the PAR and AST are correct.

***Journey Ambience – Proposal involves improved information and lane discipline reducing journey time and driver stress, resulting in a minor benefit to journey ambience.***

- 5.21 From site observations it was apparent that driver information has been improved through the erection of permanent signs indicating the dedicated lanes, as illustrated in Figure 5.2. These appear to have reduced uncertainty for drivers which in turn, have lead to a reduction in accidents. Data shows that the scheme has saved 1.07 accidents in the opening year. Therefore, the scheme has had a slight beneficial impact as predicted by the PAR and AST.



**Figure 5.2: Dedicated left turn signs**

***Accessibility - The proposals will have no impact on any aspect of accessibility in the area affected by the scheme. Therefore, the schemes overall impact on accessibility will be neutral.***

- 5.22 In the absence of a full assessment of the accessibility impacts of the scheme it is assumed that the predictions made in the PAR and AST hold true.

***Integration - Land-Use Policy - The project is a stand alone improvement, but forms part of the series of measures planned to upgrade the entire interchange at Almondsbury. It is predicted that the scheme will have a neutral impact on the land-use policy.***

- 5.23 The project continues to form part of the series of measures planned to upgrade the entire interchange at Almondsbury and therefore, it would appear that the scheme has had a neutral impact on the land-use policy.

***Other Government Policies – The scheme continues to contribute to two of the five objectives in the Government’s 10-year transport plan, including economy and safety.***

- 5.24 From this evaluation it appears that the scheme has positively contributed to safety. However, no definitive conclusions can be drawn about schemes contribution to the economy as discussed in section four of the report.

## 6. Conclusions

- 6.1 The main points to note from this evaluation of the M4/M5 Almondsbury Interchange Phase 2A Improvement Scheme are:

### *Safety*

- 6.2 The scheme has delivered a saving of 1.07 accidents per year in comparison to a predicted saving of 2.1 accidents per year. However, it should be noted that this is based on just 9 months of post-opening accident data and hence the accident savings could be different from the evaluated savings if a longer post opening period was considered.
- 6.3 Pre opening there was an accident rate of 0.071 personal injury accidents per million vehicle kilometres whilst post opening this fell to 0.037 personal injury accidents per million vehicle kilometres. Therefore, although the accident rate on the stretch of road in question was already low the implementation of the scheme has further reduced it.

### *Traffic Volumes*

- 6.4 Even though a high traffic growth of 15.4% has been observed from 1999 to 2005, but the annual average growth rate of 1.75% per annum, post scheme opening indicates that the scheme does not seem to have attracted any additional traffic onto the main route.

### *Journey Times*

- 6.5 According to the POPE assessment based on the COBA results factored in the light of comparison of observed and the COBA predicted journey times, in the opening year the scheme seems to have had slight disbenefits of around £18,000 as against the predicted benefits of around £162,000, at 1998 market prices and discounted to 1998. Over the 30 year assessment period the estimated journey time benefits are around £417,000 which is less than 10% of the journey time benefits as predicted in the original PAR.
- 6.6 However, based on the comparison of the COBA predicted results as against the observed journey times (section 3.21 and Table 3.5), it appears that the journey times after the scheme opening have remain unchanged indicating insignificant journey time benefits.

### *VOC*

- 6.7 VOC analysis using COBA model shows VOC disbenefits resulting in monetary disbenefits, at 1998 prices discounted to 1998, of £10,000 and £304,000 in the opening year and over the 30year assessment period respectively.
- 6.8 However, based on the comparison of the COBA predicted results as against the observed journey times (section 3.21 and Table 3.5), it would be reasonable to state that the journey times and hence the average speeds after the scheme opening have remain unchanged indicating that the scheme has had no impact on the VOC.

### *Scheme Costs*

- 6.9 The scheme was built at 19% less cost than predicted.

### *Economic Evaluation – POPE Method*

- 6.10 The POPE economic evaluation of the observed benefits demonstrates that the scheme has provided lower than predicted accident benefits and insignificant journey time benefits, if not slight disbenefits as predicted by COBA model factored in the light of comparison of observed and the COBA predicted journey times. In spite of the PVC being 19% less than predicted, the NPV was still around 97% less than predicted as well as the BCR being around 65% and 60% lower than the original PAR predicted and the PAR predicted corrected estimates respectively.

### *Overall*

- 6.11 The scheme appears to have delivered significantly lower level of benefits than predicted (as a result of lower than predicted accident savings and insignificant journey time savings).
- 6.12 The post opening accident benefits are estimated based on accident information for only nine months. Actual estimation based on more data could result in different accident benefits.
- 6.13 The scheme should be re-evaluated in future years with additional post opening data and journey time data to enable more robust conclusions to be drawn.

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## **Appendix A – Analysis of Accident Data**

## **Introduction**

The original Atkins PAR and AST forecast that the scheme would provide significant accident savings. In order to evaluate whether these forecast savings have occurred or will occur, Atkins has undertaken an initial evaluation of accident savings accrued post opening.

It is usual for accident savings to be evaluated at least three years after opening in order to get a fair reflection of the changes in accidents in the vicinity of the scheme. Therefore this evaluation should be considered to be an initial view based upon nine months of available data.

## **Accident Prediction & Evaluation**

The PAR examined accidents between 1998 and 2002. During this period of 5 years, the PAR stated that 14 PIAs occurred, of which 1 was fatal, 1 was serious and 12 were slight. This resulted in an accident rate of 2.8 PIAs per year and based on the assumption that the project could save 75% of accidents per year at this location, the predicted PIA saving in the opening year was 2.1 accidents per year.

For the purpose of this evaluation the accident assessment was revisited to assess the pre and post opening accident record for 7 years from 01/01/1998 to 31/12/2004. STATS19 observed accident data for these 7 years for the slip in question was acquired. Generally, accidents which are beyond the scheme and not directly related to the scheme are excluded from the analysis. However, it was unclear if these criteria had been used to select the accidents stated in the PAR. Therefore, the pre-opening accidents were re-analysed on the same basis as that used for the post-opening accident data so that a 'like' for 'like' assessment of the 'before' and 'after' accident data could be undertaken.

For the original PAR, the then available accident data upto the year 2002 was used for the before scheme opening accident analysis. To ensure that a true comparison can be made between the predicted accident benefits and the outturn accident benefits data for 2003 and the first 3 months of 2004 has not been included in the prediction of the before scheme opening accident analysis for the present POPE assessment. Accident data from April 2004 (scheme was opened end of March) to the last available information, December 2004, was used to estimate the post-opening accidents per year.

Accident data showed that between 1998 and 2002 there were 12 relevant PIAs, of which 10 were slight, 1 was serious and 1 was of fatal severity. This resulted in an accident rate of 2.4 accidents per year which when using the same methodology as the PAR (saving of 75% of accidents per year), results in a predicted accident saving of 1.8 accidents per year.

Figure A1 provides an indicative plan of the location of the relevant accidents on the M5 southbound to M4 eastbound slip road for the period 1<sup>st</sup> January 1998 to 31<sup>st</sup> December 2004 (excluding the accidents that occurred during the period between the writing of the PAR and the opening of the scheme), while Table A1 summarises this data.

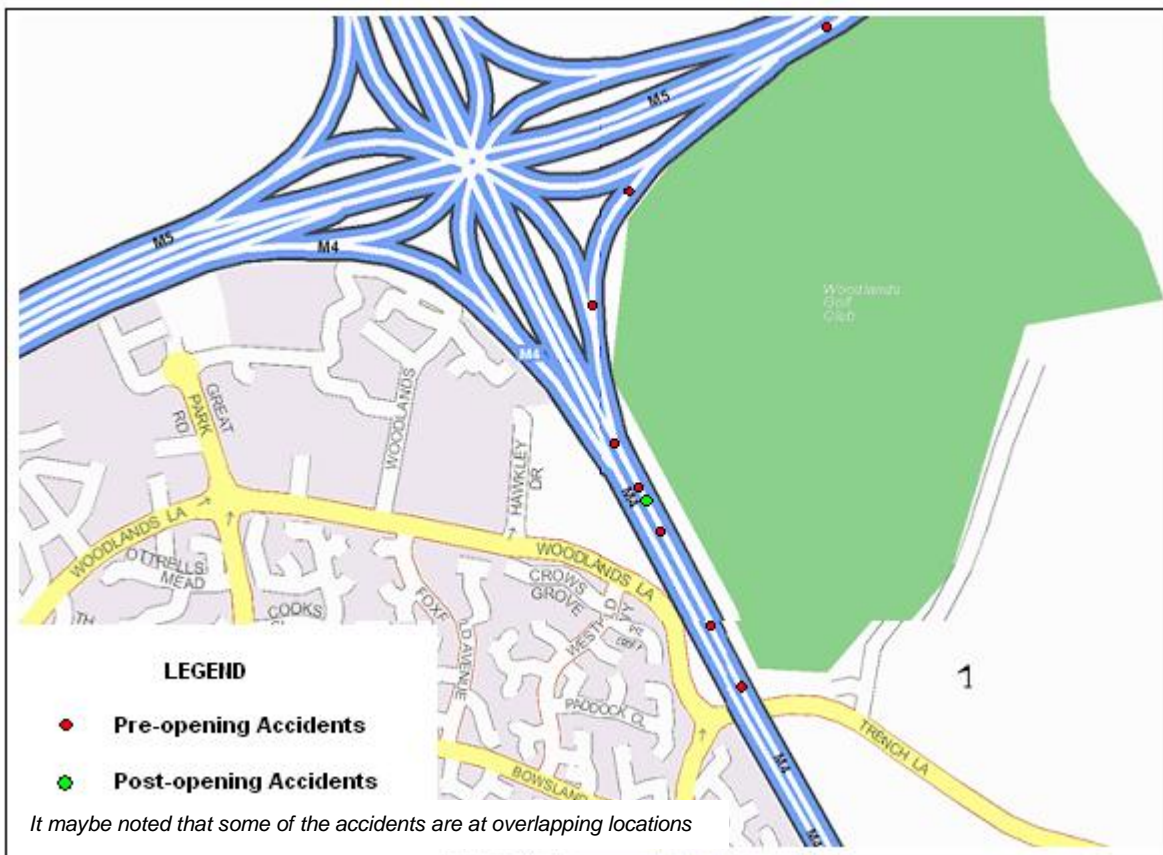
**Table A1 – Relevant Accidents on the M5 SB to M4 EB Slip Road**

Year	Slight	Serious	Fatal	Total
1998	3	-	-	3
1999	-	-	-	-
2000	2	-	1	3
2001	3	1	-	4
2002	2	-	-	2
<b>Pre-opening (60 Months)</b>	<b>10</b>	<b>1</b>	<b>1</b>	<b>12</b>
<b>Pre-opening accidents per year</b>				<b>2.4</b>
April 2004 – Dec 2004	1	-	-	1
<b>Post Opening (9 months)</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>1</b>
<b>Post-Opening accidents per year</b>				<b>1.33</b>

From Table A1 it can be seen that the number of accidents varied between years. The scheme opening date was 31<sup>st</sup> March 2004, therefore only the last 9 months of 2004, in which 1 accident occurred, constitutes the post-opening scenario. When examining the number of accidents per year, there were on average, 2.4 accidents per year pre opening and 1.33 accidents per year post opening. Therefore, it may be concluded that the scheme has provided an accident saving of 1.07 Pea's per year in the opening year. The post-opening accident analysis is based on nine months worth accident data, indicating that with more data more conclusive results could be drawn in future.

POPE accident saving of 1.07 Pea's per year in the opening year is lower than the annual accident saving predicted by the original PAR (2.1 accidents per year). It is also lower than the annual accident figure calculated during the pre-opening accident re-analysis (1.8 accidents per year), which used the same accident selection criteria as that used in the post-opening accident analysis. Thus, suggesting that the scheme has not improved safety as much as expected.

Figure A1 shows that pre opening, the accidents were generally evenly spread out over the length of the scheme. No significant clusters highlighting accident black spots were apparent, although the majority of accidents did occur along the length of the merge area on the M4. The single accident that occurred post-opening also occurred at this point. However, it must be noted that location data for 1999 accidents is unavailable; therefore these accidents are not on the map and can not be included in the analysis.



**Figure A1 – Accidents within the vicinity of the scheme**

STATS19 data shows that there are two main reasons for the majority of the PIAs recorded pre-opening. The majority were attributable to vehicles changing lanes at the merge and most of the remainder were due to stationary traffic near the merge and thus, shunt type accidents occurred as vehicles came upon the queuing traffic.

**Accident Severity (KSI)**

Pre opening there were only two accidents of a severity greater than slight in the vicinity of the scheme (1 serious and 1 fatal), whilst post opening there were no accidents of a severity of greater than slight. Therefore it could be argued that the scheme has reduced the severity of accidents, although it must be noted that the post-opening scenario is based on only nine month worth of accident data and estimation based on more data could result in different results.

**Accident Rate**

PIA rates are visually expressed in terms of million vehicle kilometres. In order to undertake accident rate calculations 24 hour annual average daily traffic (AADT) were obtained for this section of the M4/M5 Interchange from the Highways Agency permanent count sites 2/4151, 2/4161 and 2/4126. Site 2/4151 is located on the M5 Southbound to M4 Eastbound slip road, Site 2/4161 is located on the M5 Northbound to M4 Eastbound slip road.

Table A2 shows the accident rate per million vehicle kilometres.

**Table A2 – Accident Rate**

Year	Length of road (km)	Average Flow (AADT)	Average No. of accidents per year	Accident Rate (PIA/MVKM)
Average Pre Opening (1998 – 2002)	1.725	53,550	2.4	0.071
Average Post Opening (2004)	1.725	56,800	1.33	0.037

From Table A2 it can be seen that the accident rate has dropped post opening when compared with pre opening values. Pre Opening there was an average accident rate of 0.071 PIA/MVKM, compared with 0.037 PIA/MVKM post-opening.

The main points to note from the safety section are:

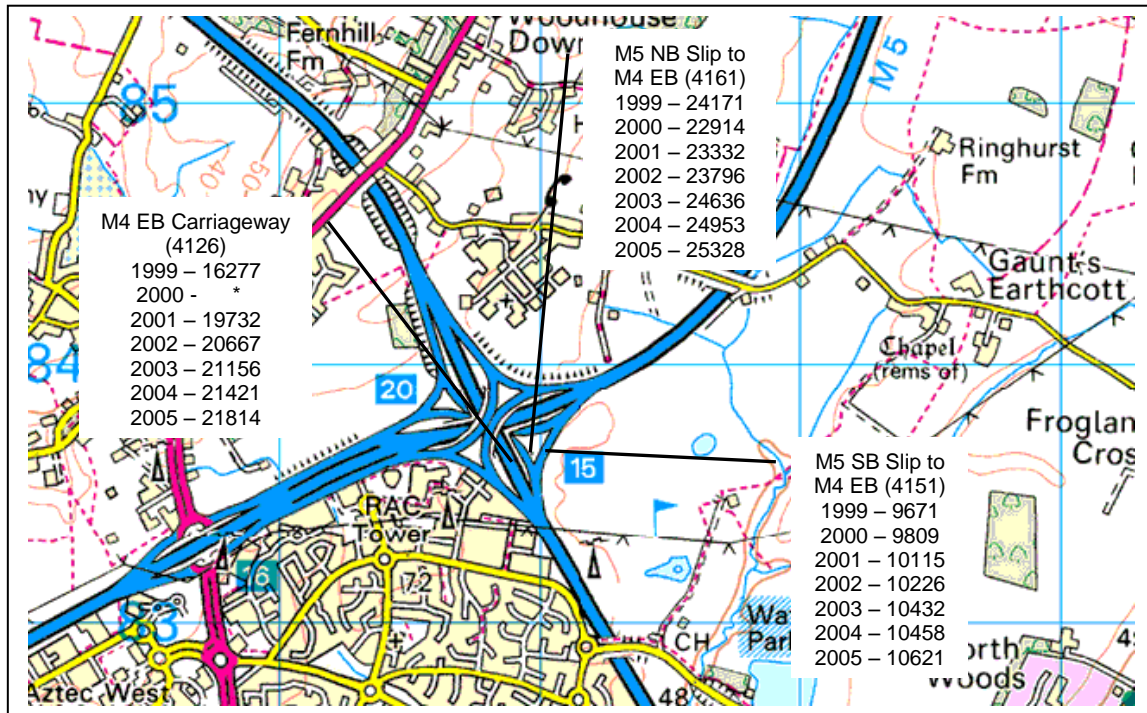
- ◆ Average pre-opening accidents of 2.4 PIAs per year which equates to an accident rate of 0.076 PIA/MVKM over the scheme length of 1.725 kilometres;
- ◆ In the first 9 months after opening there has been just 1 accident which equates to an accident rate of 0.037 PIA/MVKM over the scheme length of 1.725; and
- ◆ It can be concluded that the scheme saves 1.07 PIAs per year as assessed for the opening year.

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## **Annex B –Analysis of Traffic Flow Data**

**Analysis of Traffic Flow**

Figure B1 shows the changes in annual average daily traffic volumes on the M4/M5 Interchange in the immediate vicinity of the merge in question.



**Figure B1 - Traffic Volume Changes in the proximity of the M5 SB & NB merge with M4 EB**

From Figure B1 it is apparent that in 2004 the M4 Eastbound carriageway carried an annual average daily traffic flow of 56832 vehicles per day (vpd). In total there were 35411 vpd merging (10458 from the M5 Southbound and 24953 from the M5 Northbound).

**Traffic Growth**

Annual average traffic growth between 1999 and 2003 (pre-opening) at sites 4151, 4161 and 4126 stands at 1.3%, 0.3% and 4.5% respectively. For the M4 Eastbound carriageway in total (i.e. after the merge) annual average traffic growth between 1999 and 2003 (pre-opening) was 2.3% and from 2004 to 2005 (post-opening) traffic growth stands at 1.75%. This appears to indicate that the scheme has not resulted in any significant changes in traffic flow along the section of highway covered by the scheme. In summary, the main point to note from the traffic flow section is that the scheme has not significantly affected traffic growth on the trunk road.

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## **Annex C- Analysis of Journey Times**

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## Journey Times

The original aim of the scheme was focused on the objective of improving the economy; therefore a key element of the original PAR assessment was the predicted journey time savings. The original PAR stated in the AST that there would be a reduction in journey times in peak periods along the section of the interchange affected by the scheme, although no predicted journey times were actually provided in the main section of the original PAR document. This prediction was based on the output from a COBA model that was developed for this scheme but no quantitative predictions (i.e. journey times) were provided.

For the present evaluation, Atkins, Birmingham liaised with Atkins, Cardiff, which was involved with the original PAR to understand the methodology adopted to assess the journey time benefits in further details. It was established that information on journey times was collected before the scheme was implemented for the 575 metre section of the scheme, where an additional merging lane was added as a part of the scheme (section 2 in Figure 2.1 on page 9 of the main report). These surveys were undertaken on Thursday 10<sup>th</sup> August 2000 using the moving observer method.

In order to determine the actual impact of the scheme on journey times it was considered important to compare the observed journey times with the COBA estimated link transit times. It was considered essential to compare the relevant COBA predictions on journey times with both the pre and the post scheme opening observed journey times. For this reason, post-opening journey time data was also collected in 2005 for the same section for which the pre-scheme opening observed journey time information was available.

The following subsections describe the journey time analysis using the observed journey time information and the COBA predictions separately.

### *Observed Journey Time*

These surveys were based on the same methodology as that used for the pre-opening surveys to ensure a like on like comparison between the two sets of data. As in the before scenario the after surveys were undertaken for the scheme length of 575 metres with the same timing points as that used for the before journey time surveys. The surveys were undertaken on Thursday 15th September 2005, during:

- ◆ AM Peak period between 0800hrs and 1000hrs;
- ◆ PM Peak period between 1600hrs and 1800hrs; and
- ◆ Inter-peak between 1000hrs and 1600hrs.

The moving car method was used wherein the driver drives along the survey route maintaining the speed of other vehicles and without exceeding the speed limit. The journey start and end times are recorded to estimate the journey times. An effort was made to undertake as many runs as possible, six runs was the target minimum number of runs however, given certain circumstances and constraints, such as time, this was not achieved during some periods.

Table C1 presents the average journey times (in seconds) before and after the opening of the scheme for the peak and the inter-peak periods. The comparison of the before and after journey times summarised in Table C1 shows that the post-opening journey time has increased and decreased marginally for the peak and the inter-peak periods respectively. It appears that post scheme opening the journey times have not changed significantly from the pre scheme opening journey times for the same section. These could be contributable to the traffic growth along the scheme and not the scheme itself.

Traffic flow along the section of highway affected by the scheme has shown a growth of around 15.4% from an AADT of 50119vpd in 1999 to 57827vpd in 2005 and this growth is likely to have retained the journey times at a similar level as that recorded before the scheme was implemented.

**Table C1 – Pre- and Post-Opening Journey Times**

Period	Average Journey Times over the common section of 575 meters (in seconds)		
	Pre-Opening (1999) (a)	Post –Opening (2005) (b)	Difference (a-b)
AM Peak (A)	23.33	22.75	0.58
PM Peak (B)	22.33	22.83	-0.50
Average Peak (A+B)/2	22.83	22.79	0.04
Inter-peak (C)	22.00	22.17	-0.17

#### COBA Estimated Journey times

To ensure comparison on a like on like basis a few additional COBA runs had to be undertaken using the original COBA decks used at the time of the original PAR. The following COBA runs were undertaken to obtain information on COBA estimated link transit times which were comparable to the observed journey times for section 2 (575meters). The COBA scenarios were:

- ◆ Do Minimum Scenario - 1999 flows; with the first and last scheme year being 1999, to be compared to the pre-scheme opening observed journey times collected in 2000 (1999 flows and 2000 observed journey times were used for the pre-scheme opening COBA analysis) ; and
- ◆ Do Something Scenario - 1999 flows; with the first and last scheme year being 2005, to be compared to the post-scheme opening observed journey times collected in 2005. Table C2 summarises the COBA estimated link transit times for section 2 of the scheme.

**Table C2: COBA estimated link transit times (section 2 only)**

Period	Average Journey Times over the common section of 575 meters (in seconds)		
	Pre-Opening Do Minimum (1999) (a)	Post –Opening Do Something (2005) (b)	Difference (a-b)
Peak (A)	22.20	18.90	3.50
Shoulder peak (B)	22.90	19.40	3.30
Average (A+B)/2	22.55	19.15	3.40
Inter-peak (C)	21.50	18.70	2.80

From the table it is evident that:

- ◆ The COBA model used to assess the original PAR journey time benefits before the scheme was opened, estimated the average link transit times (to traverse this 575 meter section of the scheme) of around 22.55 and 21.50 seconds during the peak and the inter-peak periods respectively in 1999,;
- ◆ The estimated average link transit times (to traverse the same 575 meter section of the scheme) based on the same COBA model for the Do- Something scenario in 2005 are around 19.15 and 18.70 seconds during the peak and the inter-peak period respectively; and
- ◆ Comparing the COBA estimated pre scheme opening (1999) and post scheme opening (2005) journey times shows a reduction in the journey times of around 3.40 and 2.80 seconds during the peak and the inter-peak periods.

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## **Appendix D - Original Scheme AST**

**Original AST**

Option N/A		Road No. and Project Name M4/M5 Almondsbury Interchange Improvement – Phase 2A. M5 Southbound to M4 Eastbound.	Present Value of Cost £2.627m	
OBJECTIVES	SUB-OBJECTIVE	QUALITATIVE IMPACTS	QUANTITATIVE MEASURE	ASSESSMENT
ENVIRONMENT	Noise	No operational Impact. Temporary Construction Impacts.	No. properties experiencing increase/decrease in noise = 0	Net 0 properties experience <i>higher</i> noise levels
	Local air quality	No operational impact. Temporary Construction Impacts.	Properties experiencing better/worse air quality = 0	+/- 0 PM10 +/- 0 NO <sub>2</sub>
	Greenhouse Gases	No operational impact.	Not Applicable	Neutral
	Landscape	No significant loss of planting. Role of junction in the landscape not affected & slight adverse impact on existing landscape character	Not Applicable	Minor adverse
	Townscape	Not applicable	Not applicable	Not applicable
	Heritage of Historic Resources	No impact on heritage resource.	Not Applicable	Neutral
	Biodiversity	No significant loss of habitats	Not Applicable	Minor adverse
	Water Environment	No operational impact.	Not Applicable	Neutral
	Physical Fitness	Not applicable	Not applicable	Not applicable
	Journey Ambience	Journey time and driver stress improved	Not applicable	Minor benefit
SAFETY	Accidents	A reduction of 2.1 PIA per year is predicted	Fatal = 1 Serious =1 Slight = 12	PVB £3.410M
	Security	Not Applicable	Not Applicable	Not Applicable
ECONOMY	Public Accounts	No Impact	Not Applicable	PVC £2.627m
	Business Users and Providers	Not Applicable	Central Govt PVC, Local Govt PVC	Not applicable
	Consumer Users	Reduction in journey times at peak periods	Users PVB, Providers PVB, Other PVB	PVB £4.558
	Reliability	Limited improvement in journey time reliability (Quantitative measure of stress usually measured on links and junctions)	Not applicable	Not applicable
	Wider economic Impacts	No impact	Not applicable	Neutral
ACCESSIBILITY	Option Values	No impact	Not applicable	Neutral
	Severance	No impact	Not applicable	Neutral
	Access to the Transport System	No impact	Not applicable	Neutral
INTEGRATION	Transport Interchange	No impact	Not applicable	Neutral
	Land-use policy	The project is a stand alone improvement, but part of a series of measures planned to upgrade the entire interchange at Almondsbury	Not applicable	Neutral
	Other Government Policy	The scheme contributes to two of the five objectives in the Governments 10-year transport plan, including economy and safety.	Not applicable	Not applicable

Note: This Table reproduces the AST of the PAR document, all costs and benefits are in 1998 prices, discounted to 1998 at 3.5%.

## **Appendix E - Atkins EST**

Atkins EST

Option N/A		Road No. and Project Name M4/M5 Almondsbury Interchange Improvement – Phase 2A. M5 Southbound to M4 Eastbound.	Present Value of Cost <b>£2.104m</b>	
OBJECTIVES	SUB-OBJECTIVE	QUALITATIVE IMPACTS	QUANTITATIVE MEASURE	ASSESSMENT
ENVIRONMENT	Noise	No operational Impact. Temporary Construction Impacts. Traffic flow changes do not indicate any additional traffic due to the scheme, so no evidence of changes in noise level. No operational Impact.	No. properties experiencing increase/decrease in noise = 0 Assumed Correct	Net 0 properties experience higher noise levels Assumed Neutral
	Local air quality	No operational impact. Temporary Construction Impacts. Traffic flow changes do not indicate any additional traffic due to the scheme, so no evidence of changes in local air quality. No operational Impact.	Properties experiencing better/worse air quality = 0 Assumed Correct	+/- 0 PM10 +/- 0 NO <sub>2</sub> Assumed Neutral
	Greenhouse Gases	No operational impact.	Not Applicable	Neutral Assumed Neutral
	Landscape	No significant loss of planting. Role of junction in the landscape not affected & slight adverse impact on existing landscape character Slight beneficial impact as the loss of poor visual quality planting in verge has been replaced with extensive planting of more suitable species resulting in visual enhancement of the verge. Loss of screening vegetation to east has been mitigated with further planting therefore a neutral impact on role of junction in the landscape and landscape character. Further planting and seeding also undertaken as part of Sustainable Urban Drainage System (SUDS).	Not Applicable	Minor Adverse Slight beneficial
	Townscape	Not applicable	Not applicable	Not applicable
	Heritage of Historic Resources	No impact of heritage resource. Assumed Correct	Not Applicable	Neutral Assumed Neutral
	Biodiversity	No significant loss of habitats Assumed Correct	Not Applicable	Minor adverse Assumed Minor Adverse
	Water Environment	No Operational Impact Sustainable Urban Drainage System (SUDS) implemented	Not Applicable	Neutral Slight Beneficial
	Physical Fitness	Not applicable	Not applicable	Not applicable
	Journey Ambience	Journey time and Driver Stress improved Driver stress and confusion improved	Not applicable	Minor Benefits Slight beneficial for Driver Stress
SAFETY	Accidents	A reduction of 2.1 PIA per year is predicted A reduction of 1.07 PIA per year has been achieved.	Fatal = 1 Serious =1 Slight = 12 Fatal = 0 Serious =0 Slight = 1 (April 04 to Dec 04) Savings of 1.7 Pea's per year	PVB £3.410M PVB £1.843m
	Security	Not Applicable	Not Applicable	Not Applicable
ECONOMY	Public Accounts	No Impact	Not Applicable	PVC £2.627m PVC £2.104m
	Business Users and Providers	Not Applicable	Central Govt PVC, Local Govt PVC	Not applicable
	Consumer Users	Reduction in journey times at peak periods Journey times seem to have remained unchanged	Users PVB, Providers PVB, Other PVB	PVB £4.558m Assumed Insignificant

				(Based on COBA model estimated £0.417)
	Reliability	Limited improvement in journey time reliability (Quantitative measure of stress usually measured on links and junctions)	Not applicable	Not applicable
	Wider economic Impacts	No impact	Not applicable	Neutral Assumed Neutral
ACCESSIBILITY	Option Values	No impact	Not applicable	Neutral Assumed Neutral
	Severance	No impact	Not applicable	Neutral Assumed Neutral
	Access to the Transport System	No impact	Not applicable	Neutral Assumed Neutral
INTEGRATION	Transport Interchange	No impact	Not applicable	Neutral Assumed Neutral
	Land-use policy	The project is a stand alone improvement, but part of a series of measures planned to upgrade the entire interchange at Almondsbury	Not applicable	Neutral Assumed Neutral
	Other Government Policy	The scheme contributes to two of the five objectives in the Governments 10-year transport plan, including economy and safety. <i>The scheme contributes to one of the five objectives, safety, in the Governments 10-year transport plan.</i>	Not applicable	Not applicable

Note: All costs and benefits are in 1998 prices discounted to 1998 at 3.5%