

Post Opening Project Evaluation

A421 Scheme M1 J13 to Bedford - Five Years After



August 2017

Although this report was commissioned by Highways England, the findings and recommendations are those of the authors and do not necessarily represent the views of the Highways England. While Highways England has made every effort to ensure the information in this document is accurate, Highways England does not guarantee the accuracy, completeness or usefulness of that information; and it cannot accept liability for any loss or damages of any kind resulting from reliance on the information or guidance this document contains.

Table of contents

Chapter	Pages
Executive summary	4
Scheme description	4
Objectives	4
Key findings	4
Summary of scheme impacts	4
Summary of scheme economic performance	6
1. Introduction	7
Scheme context	7
Description of Scheme	8
Problems prior to the scheme	10
Scheme Objectives	10
Scheme History	11
Overview of post opening project evaluation	14
Contents of this report	15
2. Traffic Analysis	16
Introduction	16
Background changes in traffic	16
Traffic volume analysis	20
Forecast traffic flows	25
Heavy Goods Vehicles	28
Journey times	28
Reliability	31
3. Safety	35
Introduction	35
Data collection	35
Background changes	35
Evaluation approach	36
Observed collisions	37
Collision rates	44
Statistical significance	45
Comparison to forecasts	45
Security	46
4. Economy	49
Introduction	49
Sources	49
Present value benefits (PVB)	49
Vehicle hour benefits	51
Safety benefits	52
Indirect tax	52
Summary of present value benefits (PVB)	53
Scheme costs	54
Present value costs (PVC)	54
Benefit cost ratio (BCR)	55
Wider economic impacts	56
5. Environment	58

Introduction	58
Data collection	58
Site inspections	58
Consultations	59
Animal mortality	60
Traffic forecasts and evaluation	60
Noise	61
Local air quality	64
Greenhouse gases	66
Landscape and townscape	68
Cultural heritage and archaeology	73
Biodiversity	75
Water quality and drainage	83
Physical fitness	86
Journey ambience	89
6. Accessibility and Integration	91
Option values	92
Severance	92
Access to the transport system	94
Transport interchange	95
Land use policy and other government policies	95
7. Conclusions	97
Appendices	98
Appendix A. Appraisal Summary Table (AST) and Evaluation Summary Table (EST)	99
Appendix B. Environment	104
B.1. Sources	104
Appendix C. Glossary	106
Appendix D. Tables and Figures in this Report	111

Executive summary

Scheme description

The A421 Bedford to M1 junction 13 scheme opened in December 2010. The scheme included an upgraded A421 dual 2-lane carriageway, offline from the existing A421 carriageway (except for an online section east of the A421 / A5134 Marsh Leys Junction) between the M1 at junction 13 and Bedford. The key features of the scheme are:

- A new 8 mile (13km) dual two-lane A421 carriageway (three-lane between Marsh Leys and the A6), and detrunking of the former A421 route.
- Improvements to M1 junction 13.
- A grade-separated junction at Beancroft Road, Marston Moretaine and Marsh Leys.
- Removal of the A421/ B530 interchange retail park roundabout, with junction improvements at Cowbridge.

Objectives

Scheme objectives <i>Source: Public Inquiry Inspector's Report (April 2008)</i>	Objective achieved?
To deliver one of the trunk road improvements identified in the London to South Midlands Multi Modal Study (LSMMMS)	✓
To improve journey time reliability	✓
To improve safety	Partial
To achieve the above without causing significant adverse environmental impacts	✓

Key findings

- Traffic flows in the corridor (the old and new road), have increased by around 80% following the scheme opening. This is primarily a result of traffic reassigning along the new A421 as the scheme has become recognised as a key strategic route.
- In the area used for the modelling of the scheme's appraisal, the severity index (the proportion of serious and fatal collisions to slight collisions) has reduced.
- Journey times savings are between 6 and 11 minutes which is similar to the level of savings expected.
- Journey time reliability has substantially improved across the day.

Summary of scheme impacts

Traffic

- Traffic flows on the old A421 are around 80% lower than before the scheme opened as vehicles have rerouted onto the new A421.
- The scheme has resulted in a substantial reduction in the proportion and number of Heavy Goods Vehicles (HGVs) on the old A421 from around 4,000 – 6,000 HGVs to 200 following the scheme opening.
- Flows on the old and new road combined, have increased by around 80% following the scheme opening. This is primarily a result of traffic reassigning along the new A421 as the scheme has become recognised as a key strategic route.
- The modelling overestimated the use of the parallel routes (A6 and A422) before the scheme opened.

- Following scheme opening, observed flows on the new A421 were in line with forecasts. Observed flows on the old A421 were lower than forecast by between 2-15%.
- At the five years after, forecast and observed traffic volume changes on the A421 are relatively in line at 154% (35,500 vehicle increase) and 146% (34,500 vehicle increase) respectively.
- Observed journey times savings are between 6 and 11 minutes on the scheme section, compared with the 9 minutes forecast during peak periods.
- Journey time reliability has substantially improved across the day. Reliability has, however, slightly worsened at five years after compared to one year after. This is likely to be due to increased traffic volumes at the five year after opening stage.

Safety

- For the area directly impacted by the scheme (the 'scheme section'), there has been a negligible reduction in collision numbers (0.7 collisions per annum). The severity index has also reduced meaning that there are proportionally fewer fatal and serious collisions following the scheme opening. This saving has been shown not to be statistically significant and is therefore likely to have occurred without the opening of the scheme.
- In the wider area used for the modelling of the scheme's appraisal, there has been an increase of 30.1 collisions per annum following the scheme opening. In conjunction with this, the number of casualties has also increased, by 20.1 per annum. The severity index has however reduced for both collisions and casualties.

Environment

- Traffic flows on the A421 have increased post opening, as forecast, but they are within the expected ranges. This has resulted in an 'as expected' assessment for the impact on air and noise at five years after opening, with some locations potentially 'better than expected' for air quality.
- Planting five years after scheme opening is showing good continued growth, although there are isolated pockets where some failures are noted. Overall, planting is expected to reach design year (15 years after opening) expectations for growth and thus screening, integration and habitat creation.
- Mammal tunnels are not showing signs of use, with access for badgers obstructed by ditches or overgrown vegetation. Bats and Great Crested Newts (GCNs) were recorded within monitoring reports, with GCNs showing successful colonisation of habitat features. Plant growth within the Brogborough County Wildlife site is slow. Plant growth within the extension to Brogborough Spinney is good, with localised plant failure replacement undertaken. Permanent GCN fencing is not being maintained allowing for access breeches.
- Drainage ponds appear to be working as expected, although drainage ditches are showing little sign of maintenance including no free flow of water.

Accessibility

- The scheme has provided some relief from existing severance within and between the villages on the south-eastern side of the new A421 including Brogborough, Lidlington, Marston Moretaine, Stewartby and Kempston Hardwick, with the reduced volume of traffic (just 20% of previous levels) on the former A421.
- Despite several diversions to public rights of way as part of the scheme, it is considered that the diversions have contributed to a safer, improved public right of way network.
- The scheme has improved access to the trunk road network through the junction improvements made at various points along the scheme. Due to the reduced traffic along the former route, local access to the road network has also been made easier.

Integration

- The scheme aligns with local, regional and national policy by providing suitable crossing points across the scheme for non-motorised users. The scheme also reduces the number of collisions and improves journey times for trunk road traffic, hence contributing to a more efficient transport network and catering for future growth in the region.

Summary of scheme economic performance

All monetary figures in 2002 prices and values	Forecast (£m)	Outturn re-forecast (£m)
Present value costs (PVC)	£163.0m	£154.6m
Present value benefits (PVB)	£1,605.7m	£948.2m
Indirect Tax	£7.4m	£7.4m
Benefit Cost Ratio (with indirect tax in costs)	9.4	5.9
Benefit Cost Ratio (with indirect tax in benefits)	9.9	6.2

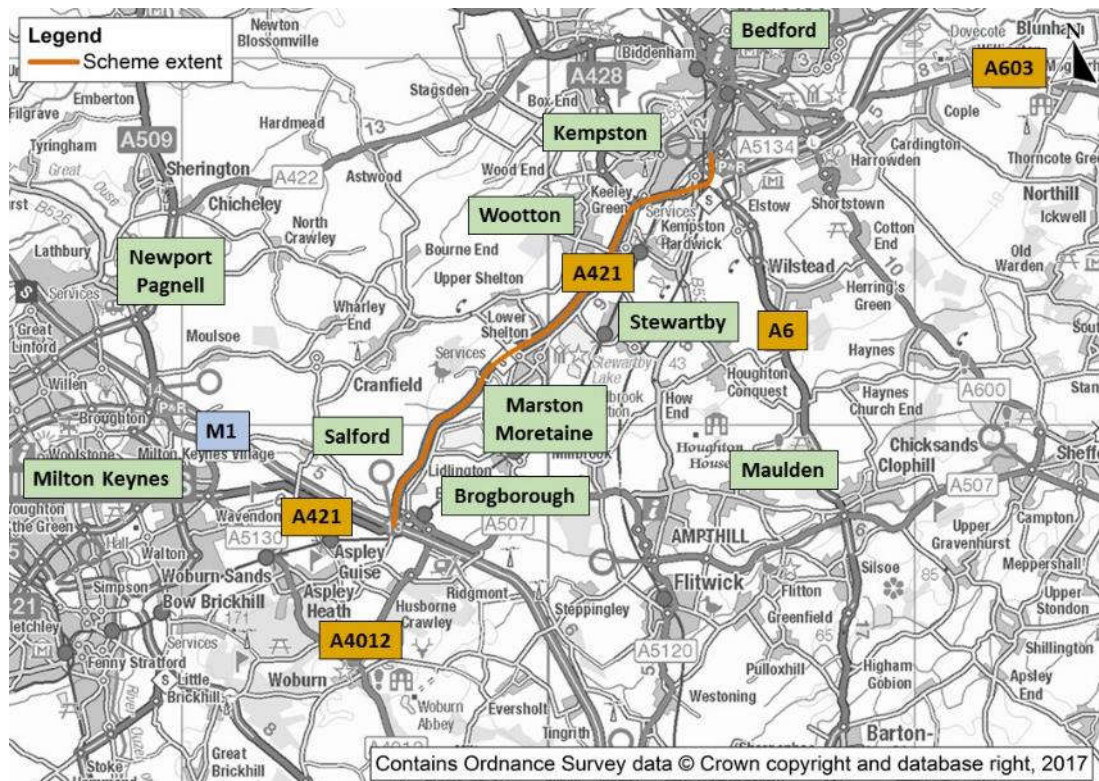
- The total reforecast benefits are £955 million, which is lower (40%) than the £1,612 million expected. This is due to the reforecast journey time benefits being lower than forecast and safety savings not being monetised as they were not shown to be statistically significant. This is a conservative estimate of the total benefits.
- The investment cost (2002 prices, not discounted) of the scheme was 5% lower than expected at £162.1 million compared to £170.5 million.
- The reforecast BCR for the scheme is 6.2, which is lower than the forecast BCR of 9.7. Despite this, the reforecast BCR is still considered by the Department for Transport to be very high value for money.

1. Introduction

Scheme context

- 1.1. The A421 Bedford to M1 junction 13 is a major Highways England scheme that comprises an upgraded A421 dual 2-lane carriageway, offline from the existing A421 carriageway (except for an online section east of the A421 / A5134 Marsh Leys Junction). The scheme opened on 1st December 2010. This report is a five year after (FYA) evaluation of the impacts of the scheme.

Figure 1-1 Location of scheme

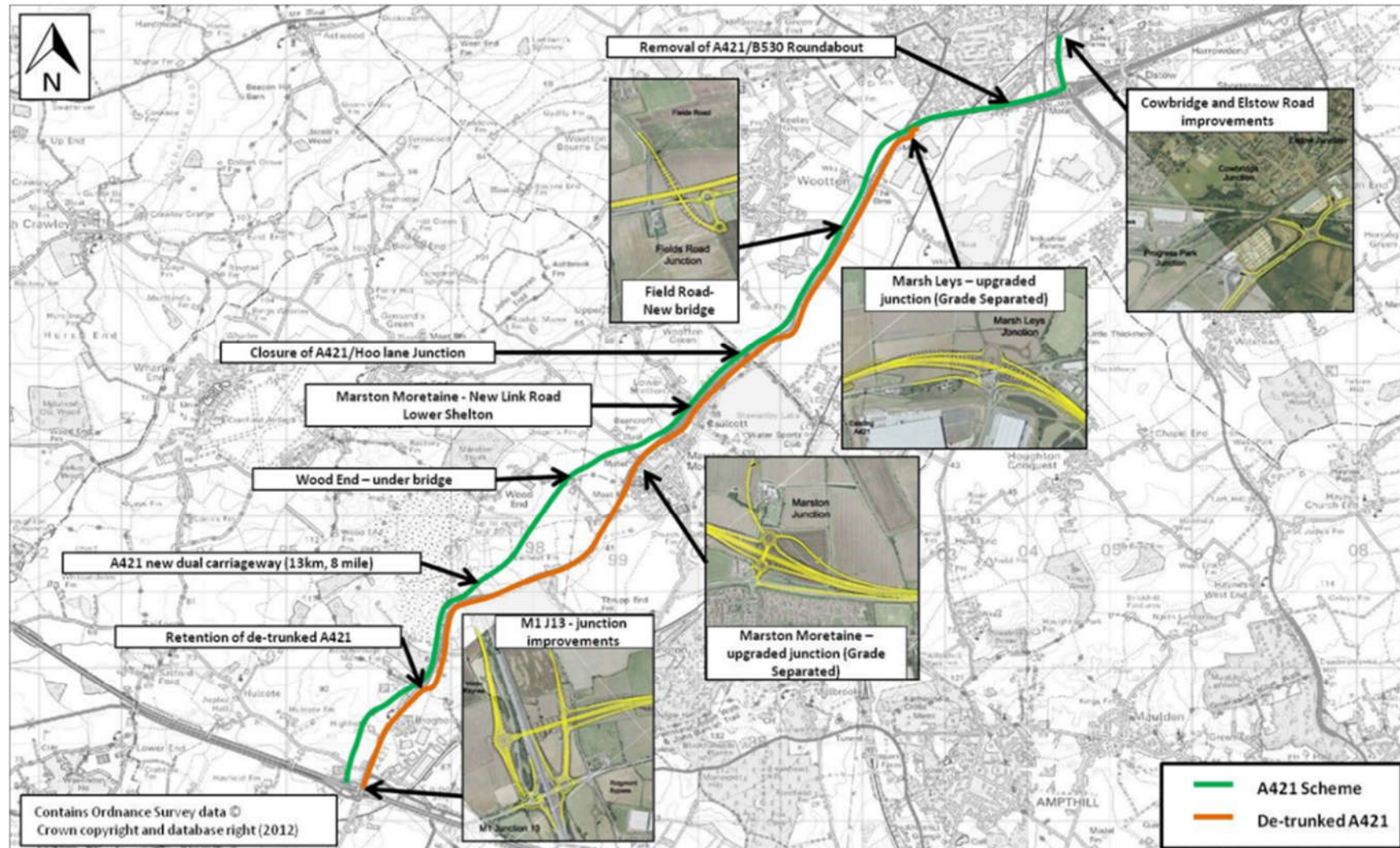


- 1.2. The scheme highlighted in Figure 1-1 is 8 miles (13km) in length and lies south west of the town of Bedford, and falls within the unitary authorities of Bedford Borough Council and Central Bedfordshire Council.
- 1.3. The scheme is within Highways England Area 8, which forms a major link from Milton Keynes to Cambridge and the East of England.
- 1.4. To the south west of the scheme is the M1 motorway, which connects with the A421 at junction 13, and to the east of the scheme lies the A6. The main settlements near the A421 scheme, between the M1 and Bedford include Brogborough, Marston Moretaine and Stewartby to the south and Wootton and Kempston to the north.
- 1.5. The A421 is a popular commuter route, providing an east-west link between the A1 and M1 via Bedford continuing to Milton Keynes and London. Routes include Bedford to Milton Keynes and London, Luton to Milton Keynes and Cambridge, and Peterborough to Milton Keynes.
- 1.6. To the west of Bedford, the land is predominantly agricultural with areas of woodland, hedgerows and trees, with the scheme passing through four landscape character areas (LCAs).

Description of Scheme

- 1.7. The A421 improvements M1 junction 13 to Bedford scheme included the following key features, as mapped in Figure 1-2.
- An upgraded A421 dual two-lane carriageway (three-lane between Marsh Leys and A6).
 - Improvements to the M1 junction 13.
 - A grade-separated junction at Beancroft Road, Marston Moretaine and at the Marsh Leys junction.
 - Vehicle access/egress to and from the new upgraded A421, limited to the upgraded M1 junction 13 and the upgraded junctions at Marston Moretaine and Marsh Leys.
 - Retention of the de-trunked A421 for local access.
 - The westbound carriageway of the existing A421 Marston Moretaine Bypass converted into a two-way single carriageway road running alongside the A421 dual carriageway, thus maintaining the village bypass.
 - A connection at Wood End to cross the A421 via an underbridge.
 - A link road parallel to the new dual carriageway to connect Lower Shelton with Marston Moretaine via the junction at Beancroft Road.
 - Closure of the existing A421/ Hoo Lane junction.
 - A bridge to cross the A421 and connect Field Road to the existing A421 via a new roundabout junction.
 - Removal of the A421/ B530 interchange retail park roundabout.
 - Junction improvements at Cowbridge (roundabout to signalised junctions).

Figure 1-2 Figure 1-2 Scheme Detail



Problems prior to the scheme

- 1.8. In terms of issues pre-scheme, the scheme's Appraisal Summary Table (AST), dated June 2008, states that: *'Existing A421 is largely single carriageway, with substandard geometry, frequent junctions and poor safety record with serious congestion'*
- 1.9. The Report to the Secretary of State from the Public Inquiry (April 2008) stated that some lengths of the existing A421 are below current standards for forward visibility as well as horizontal and vertical alignment. It also describes the existing route and the need for the improvement as follows:
- 'Whilst the width of the existing carriageway is approximately 7.3m, the verges in some locations are narrow. High traffic volumes result in over capacity for long periods leading to severe congestion at certain times of the day on the single carriageway sections and at junctions. Limited overtaking opportunities and high volumes of heavy goods vehicle traffic contribute to congestion, causing rat-running, which has a detrimental effect on adjacent villages.'*
- 1.10. The same document also states that:
- 'The existing A421 has an accident record higher than the national average. Between 1996 and 2005 there were 311 personal injury collisions, of which 7 were fatal.'*
- 1.11. The safety issues described arose from high traffic flows, which varied per location between 26,000 and 35,000 annual average daily traffic (AADT). Collisions were predominantly at priority junctions along the route, mainly turns on the A421 from the many side roads and private/commercial properties. The high traffic volume had an adverse impact on non-motorised users (NMUs) using the route and caused community severance.
- 1.12. The Report to the Secretary of State' from the Public Inquiry (April 2008) also states:
- 'The existing M1 Junction 13 consists of a bridge over the M1 motorway and to the west of the bridge a roundabout that serves traffic from the M1 north-bound off-slip, the A507, the A421 to Milton Keynes and the M1 north-bound on-slip. To the east of the bridge are the existing A421 and the M1 south-bound off and on-slip roads, which are controlled by traffic signals. The junction has insufficient capacity for the conflicting A421 and M1 related traffic movements and results in heavy congestion, which can be severe during peak hours. Approximately 40% of the traffic using this junction passes through it, rather than accessing the M1'.*
- 1.13. In summary, the main issues pre-scheme were considered to be:
- High traffic flows and congestion
 - Limited overtaking opportunities
 - 'Rat-running' which had a detrimental effect on adjacent villages
 - Poor collision record, predominantly at priority junctions
 - High levels of driver stress
 - Community severance

Scheme Objectives

- 1.14. There are two reports that discuss the objectives of the scheme. These are the Report on Public Consultation (October 2004) and Public Inquiry Inspector's Report (April 2008). The objectives included in these documents are discussed below.
- 1.15. The Report on Public Consultation (October 2004) outlined the route improvement objectives as being:

- **Integration** - ensuring that all decisions are taken in the context of the integrated transport policy.
- **Safety** - to improve safety for all road users.
- **Economy** - supporting sustainable economic activity in appropriate locations and getting good value for money.
- **Environmental** - protecting the built and natural environment.
- **Accessibility** - improving access to everyday facilities for non-motorised users and reducing community severance.

1.16. Within the same document, the following measures were identified as fundamental to delivering the route improvement objectives above:

- A scheme which would reduce conflict between through traffic and motorway traffic.
- Grade-separated junctions to provide safe access to the new A421 with minimal disruption to the trunk road flows.
- Minimised number of junctions on the A421 dual carriageway to reduce disruption to the trunk road flow and moderate "rat-running" by reducing access to the local road network.
- Separation of A421 trunk road traffic from local traffic movements by maintaining a local road network and utilising the existing A421 wherever possible.
- Reduction of unavoidable environmental impacts through mitigating measures.
- Creating the opportunity to make better use of the existing A421 and local road network for non-motorised users.

1.17. A later document, the Public Inquiry Inspector's Report (April 2008), specified the following scheme objectives:

- To deliver one of the trunk road improvements identified in the (London to South Midlands Multi Modal Study (LSMMMS)).
- To improve journey time reliability.
- To improve safety.
- To achieve the above without causing significant adverse environmental impacts.

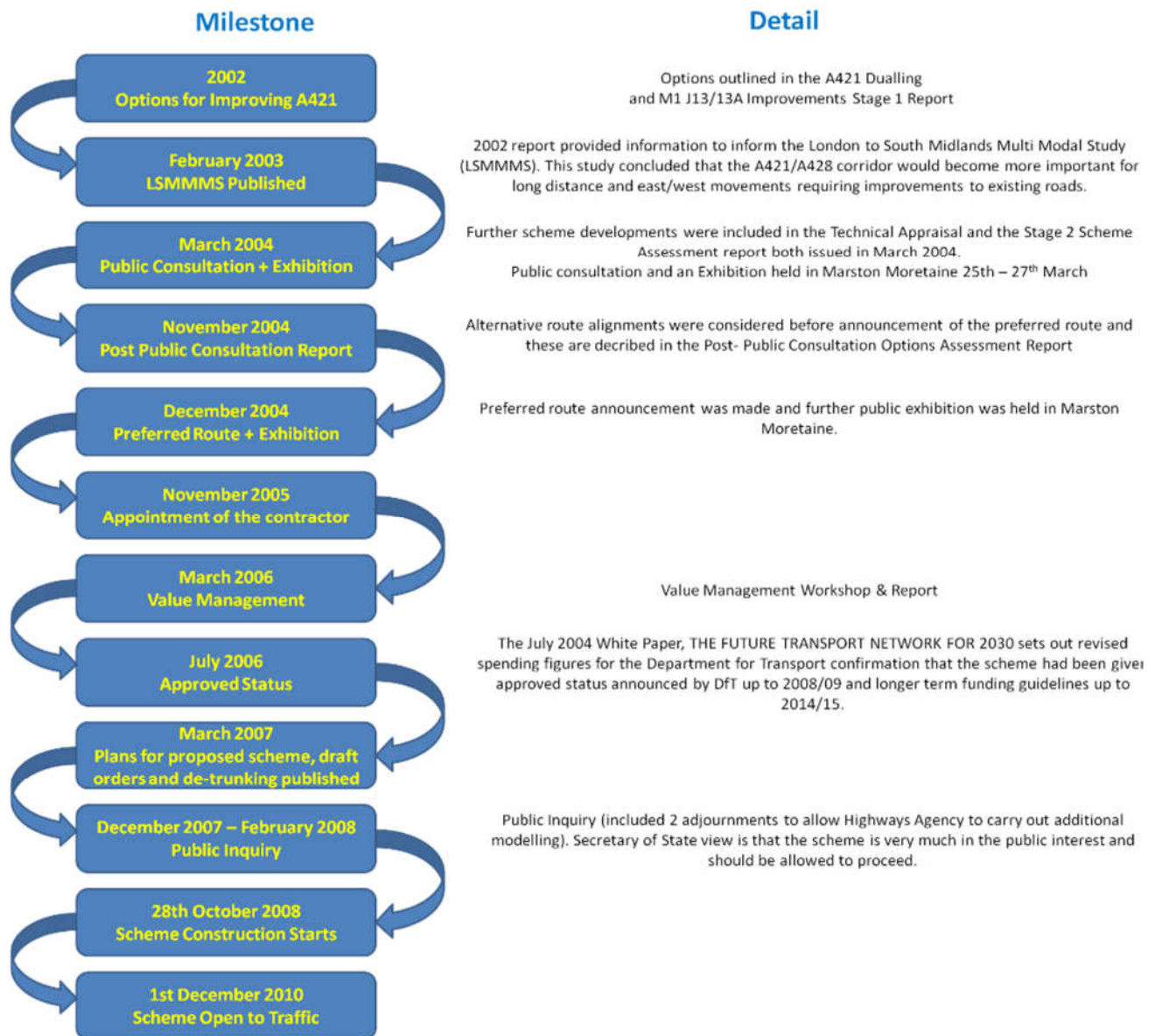
1.18. As the objectives above were specified by the Secretary of State and formally published in the Public Inquiry Inspector's Report, the objectives from the Public Inquiry's Inspector's Report will be used to assess the scheme against in this POPE FYA evaluation.

Scheme History

1.19. Options for improving the A421 were outlined in 2002 in the A421 Dualling and M1 J13/13A Improvements Stage 1 Report. This report provided information to inform the LSMMMS, which was published in February 2003. The study concluded that the A421/A428 corridor would become more important for long-distance, east-west movements requiring improvement to existing roads.

1.20. The history and key milestones in the scheme's development are summarised in Figure 1-3.

Figure 1-3 Key events in the scheme's development



1.21. At the scheme's Public Inquiry in February 2008 the Highways Agency (at the time) was required to identify potential improvements to the A6, north of the A6/A421 interchange and through the Cowbridge roundabout. This was to confirm the suitability of the A6 as a 'reasonably convenient alternative route' following the removal of a roundabout on the A421 and the closure of a section of the A5134 leading to Bedford and the interchange retail park which was necessary as part of the published scheme proposals.

1.22. Bedfordshire County Council (BCC), as the highway authority for the A6 in this area at the time, and the Highways Agency signed a 'memorandum of understanding' to work together on the development of the improvement proposals. Works to upgrade the A6 roundabouts were completed in December 2009.

Scheme achievements

1.23. In 2010, the A421 improvement scheme was awarded a Gold Considerate Constructors Award. It was commended for several achievements including:

- Great environmental care of the scheme.
- Exceptionally high level of management by the site team.

- Staff welfare and strong safety standards.
- High levels of cleanliness and presentation ensuring the site was one of the UK's top performers.

1.24. In the 2011/2012 Institute of Civil Engineers (ICE) Yearbook, the scheme was awarded a merit for technical excellence and innovation. The award was for the following aspects of the scheme:

- Care paid to operative welfare, site safety and planning.
- Helping to contribute towards a £1-2m saving for the client from using recycled materials.

Nearby schemes

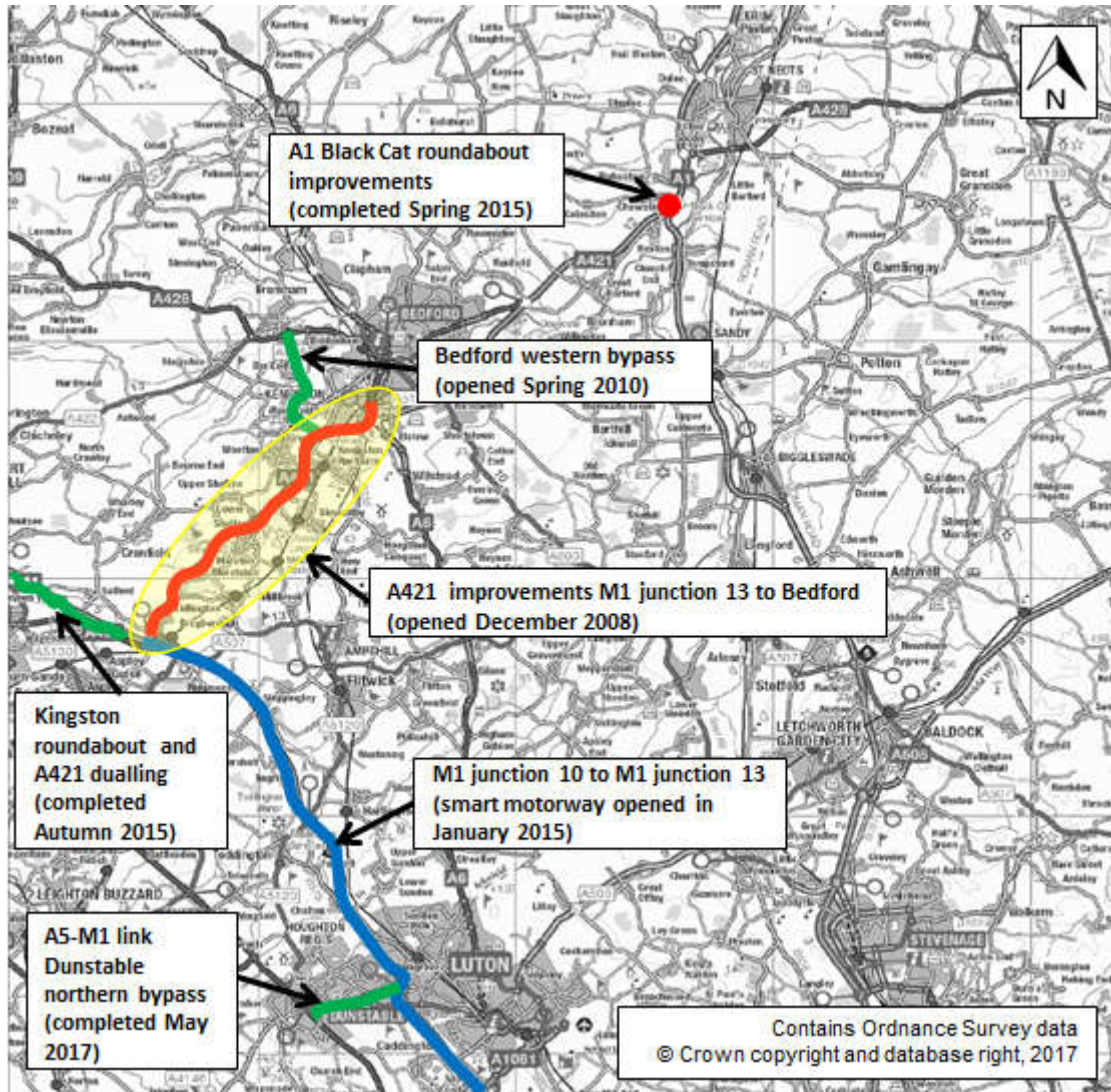
1.25. Several Highways England and Local Authority schemes opened near to the scheme after construction started in October 2008. For context, details of schemes in proximity to the A421 (including opening dates) are presented in Table 1-2 and are mapped in Figure 1-4.

1.26. The impact of these, and other schemes are considered in more detail in the traffic chapter of this report where relevant.

Table 1-1 Nearby schemes

Scheme	Scheme dates	Scheme detail
Bedford Western Bypass	Phase 1 opened in December 2009, Phase 2 opened April 2016	The bypass connects the A421 Marsh Leys with the A428 at Bromham to the west of Bedford. The first section of the bypass from the A421 to the A428 opened in December 2009, and phase 2 linking the A428 with the A6 to the north of Bedford, opened in April 2016.
M1 Junctions 10-13 Smart Motorway (and associated additional works)	Smart Motorway opened December 2012 June 2013- January 2015 – additional works	Located on the M1 in the county of Bedfordshire between junction 10 and junction 13, the scheme implemented hard shoulder running, junction capacity improvements and variable mandatory speed limits, which opened in December 2012. Further works took place at junction 12 and junction 11, involving CCTV installation, environmental barriers, landscaping and resurfacing.
A1 Black Cat roundabout improvements	June 2014 - Spring 2015	Works carried out on the A1/A421 Black Cat Roundabout Gyrotory and approaches/exits to the roundabout
Kingston roundabout improvements and A421 dualling	July 2014 - Mid-2015	Dualling the A421 corridor between M1 Junction 13 and Central Milton Keynes, along with improvements to Kingston Roundabout which serves as a prominent gateway to Milton Keynes.
A5-M1 link (Dunstable Northern Bypass)	February 2015 - May 2017	The scheme involves the construction of a two-lane dual carriageway running east from the A5 north of Dunstable to join the M1 including construction of a new junction (11a) south of Chalton.

Figure 1-4 Nearby completed schemes



Overview of post opening project evaluation

- 1.27. POPE studies are undertaken for all major schemes. During the planning process, scheme effects are based on well informed predictions. However, it is vital to identify the strengths and weaknesses in the techniques used for appraising schemes so that improvements can be made in the future. For POPE, this is achieved by comparing information collected before and after a scheme opens to traffic, with predictions made during the planning process.

Summary of A421 Bedford to M1 J13 to Bedford OYA Opening Study

- 1.28. Traffic volumes using the new road in the first year of opening were lower than forecast. This was partly because the impacts of the recession were not accounted for in the forecasting. Also, the improvements to the M1 junction 10 to 13 section were not completed at the time of the OYA study.
- 1.29. Construction works associated with the M1 junction 10 to 13 Smart Motorway scheme influenced routing patterns in the area, and may have resulted in fewer vehicles using the A421 to access the M1 at junction 13, in addition to reduced flows which were linked to the economic downturn.
- 1.30. Collision savings due to the scheme were substantially higher than forecast, with a saving of 20 collisions per year along the new and old road.

- 1.31. The scheme resulted in significant journey time savings for strategic road traffic, including a saving of up to 13 minutes in the peak periods. Journey time reliability has also improved, most noticeably in the northbound AM peak. Even at less busy times of the day (inter-peak period), journey times using the new route were 6 to 7 minutes faster than they were using the former A421 route.
- 1.32. Overall, the environmental impacts of the scheme were as predicted. Traffic flows were generally lower than expected, and so it is likely that the scheme's impact on air quality and noise were slightly better than expected along the new route.
- 1.33. It was expected that a comprehensive planting scheme both within and beyond the highway boundary would successfully mitigate the impact on landscape and biodiversity by the design year. Integration of the existing public right of way network into the scheme, and the improvement of some access routes had a positive impact on the area.

Contents of this report

- 1.34. Following on from this introduction, this report includes:
 - **Section 2 – Traffic Analysis** - This section presents analysis of the traffic impacts of the scheme and includes a comparison of the 'before' and 'after' traffic on the new A421 and former route, as well as other strategic and local routes. Outturn and forecast traffic flows are compared and journey time analysis completed for the new A421.
 - **Section 3 – Safety** - This section discusses changes in collision patterns and security because of the scheme.
 - **Section 4 – Economy** - This section presents an evaluation of the scheme's economic costs and benefits.
 - **Section 5 – Environment** - A review of the environmental impacts of the scheme is given, supported by an evaluation of the mitigation measures described within the scheme's Environmental Statement (ES).
 - **Section 6 – Accessibility and Integration** - A review of how the scheme has affected accessibility for non-motorised users and public transport users is presented. Furthermore, a review of how the scheme links with wider policy objectives is also given.
 - **Section 7 – Appraisal and Evaluation Summary Tables** - This section contains an overview of the actual scheme impacts through an evaluation summary table (EST), compared to those predicted in the original Appraisal Summary Table (AST).
 - **Section 8 – Conclusions** - This section assesses the scheme's success against its specific objectives.
- 1.35. A glossary of key terms and abbreviations used throughout this document and list of figures and tables are provided in the appendices.

2. Traffic Analysis

Introduction

- 2.1. This section examines traffic information from several sources to provide a comparison of traffic flows and journey times along the scheme extent before and five years after scheme opening. The purpose of this evaluation is to understand whether changes in traffic flows and journey times may be attributable to the scheme.
- 2.2. This chapter comprises of the following:
- An overview of national, regional and local background trends.
 - A detailed comparison of pre-scheme, OYA and FYA traffic flows on the scheme section and routes around the A421 that are likely to be affected by the scheme.
 - A comparison of journey times for before scheme opening and FYA stages.
 - An evaluation of key differences between forecast and outturn impacts of the scheme in terms of traffic flows and journey times.
- 2.3. The following data sources have been used in the traffic evaluation:
- Highways England¹ traffic count information;
 - Commissioned Automatic Traffic Counts (ATCs);
 - Commissioned Manual Classified Counts (MCCs); and
 - Journey times obtained from Satellite Navigation devices.

Background changes in traffic

- 2.4. The Department for Transport (DfT) produces observed annual statistics for all motor vehicles by local authority². At present, data is available until the end of 2016. Background changes in traffic flows, obtained from these statistics, can be used to understand wider trends and potential reasons for discrepancies between forecast and observed traffic flows and journey times.
- 2.5. Table 2-1 and Figure 2-1 show the net differences in million vehicle kilometres (mvkm) travelled since 2004 (the base year of the modelling) for Bedfordshire³ and the East of England.

¹ Information has been obtained from a combination of Highways England data sources; TRADS, TRIS, and WebTRIS, which now supersedes TRADS and TRIS.

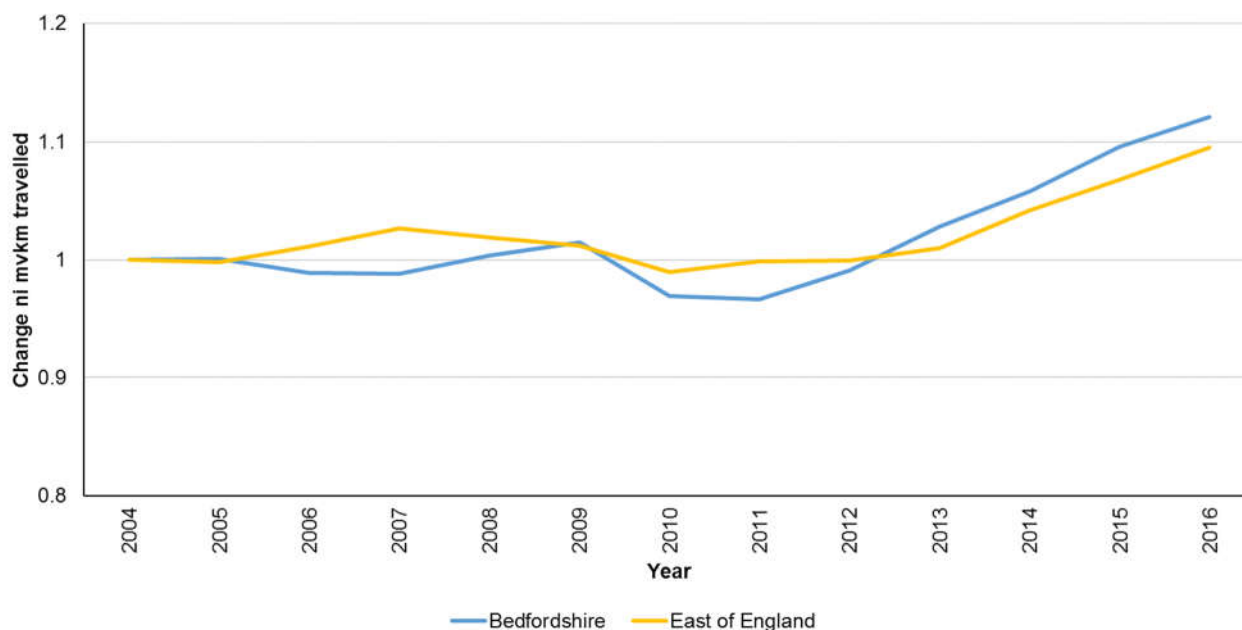
² Road Traffic and Speeds (<http://www.dft.gov.uk/pgr/statistics/datatablespublications/roads/traffic>) Tables TRA8904

³ In 2009, Bedfordshire County Council was abolished to become Bedford Borough Council and Central Bedfordshire Council. Therefore, while 2004 to 2008 represent Bedfordshire County Council, 2009 onwards are figures for Bedford Borough Council and Central Bedfordshire Council combined.

Table 2-1 Change in million vehicle kilometres (mvkm)

Year	Bedfordshire		East of England	
	mvkm	Factor of change on 2004	mvkm	Factor of change on 2004
2004	4,137	-	54,804	-
2005	4,142	1.00	54,686	1.00
2006	4,092	0.99	55,444	1.01
2007	4,090	0.99	56,281	1.03
2008	4,154	1.00	55,846	1.02
2009	4,198	1.01	55,471	1.01
2010	4,010	0.97	54,250	0.99
2011	4,101	0.99	54,729	1.00
2012	4,254	1.03	54,800	1.00
2013	4,254	1.03	55,369	1.01
2014	4,383	1.06	57,143	1.04
2015	4,534	1.10	58,514	1.07
2016	4,638	1.12	60,027	1.10

Figure 2-1 Local and regional trends in million vehicle kilometres (mvkm)



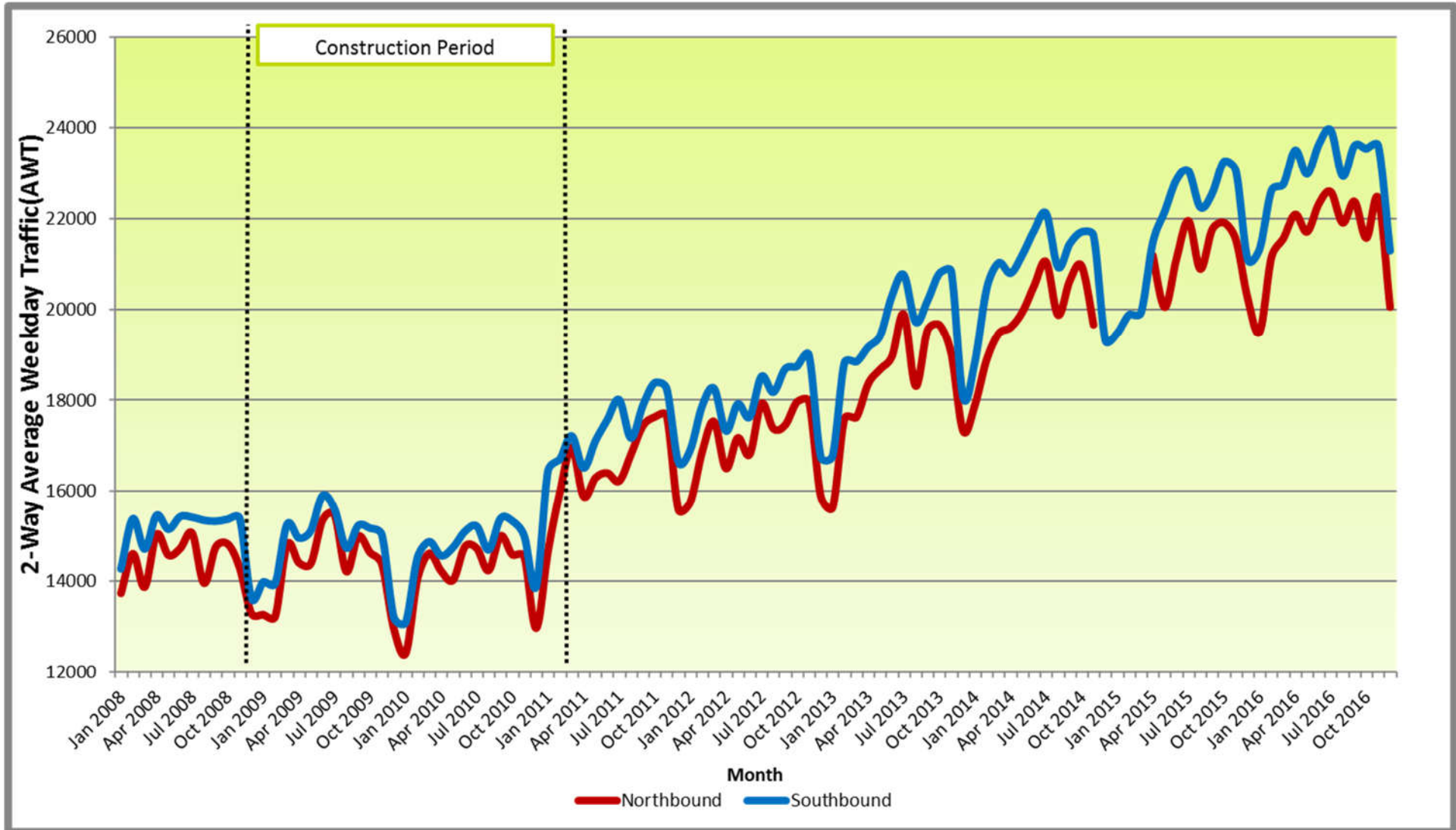
2.6. It can be seen from Table 2-1 and Figure 2-1 that vehicle kilometres in Bedfordshire in 2016 were 12% higher than they were in 2004. There was a general downturn during the economic downturn, however the number of vehicles in Bedfordshire has risen as the economy has improved. A similar trend can be seen in the East of England where there has been a 10% increase in vehicle kilometres between 2004 and 2016.

Long term trends near the scheme

- 2.7. In addition to the local, regional and national trends, long term trends closer to the scheme have also been considered. Traffic flow data for an average 24-hour period was obtained for each month to provide extra context for the analysis later in this section. Figure 2-2 shows the long-term average weekday traffic (AWT) trends in the northbound and southbound direction on the A421 Bedford bypass, south of Bedford. The site is the closest Highway England count site to the scheme, located north east of the scheme, for which long term count data is available.

- 2.8. Figure 2-2 shows that traffic on the A421 Bedford Bypass in the northbound and southbound direction follows a similar pattern in terms of monthly fluctuations. Immediately after scheme opening, an increase in traffic is noted, which continues over the post opening period.

Figure 2-2 Long term trends northbound and southbound on A421, north of the scheme



Conclusions on background changes in traffic

- 2.9. From the analysis of background traffic flow changes, there has been a considerable increase in the number of vehicles kilometres travelled in Bedfordshire since the scheme opened, and a similar increase has been seen in the East of England. Therefore, it is necessary to consider background traffic growth changes when comparing observed and forecast before and after scheme opening traffic flows.

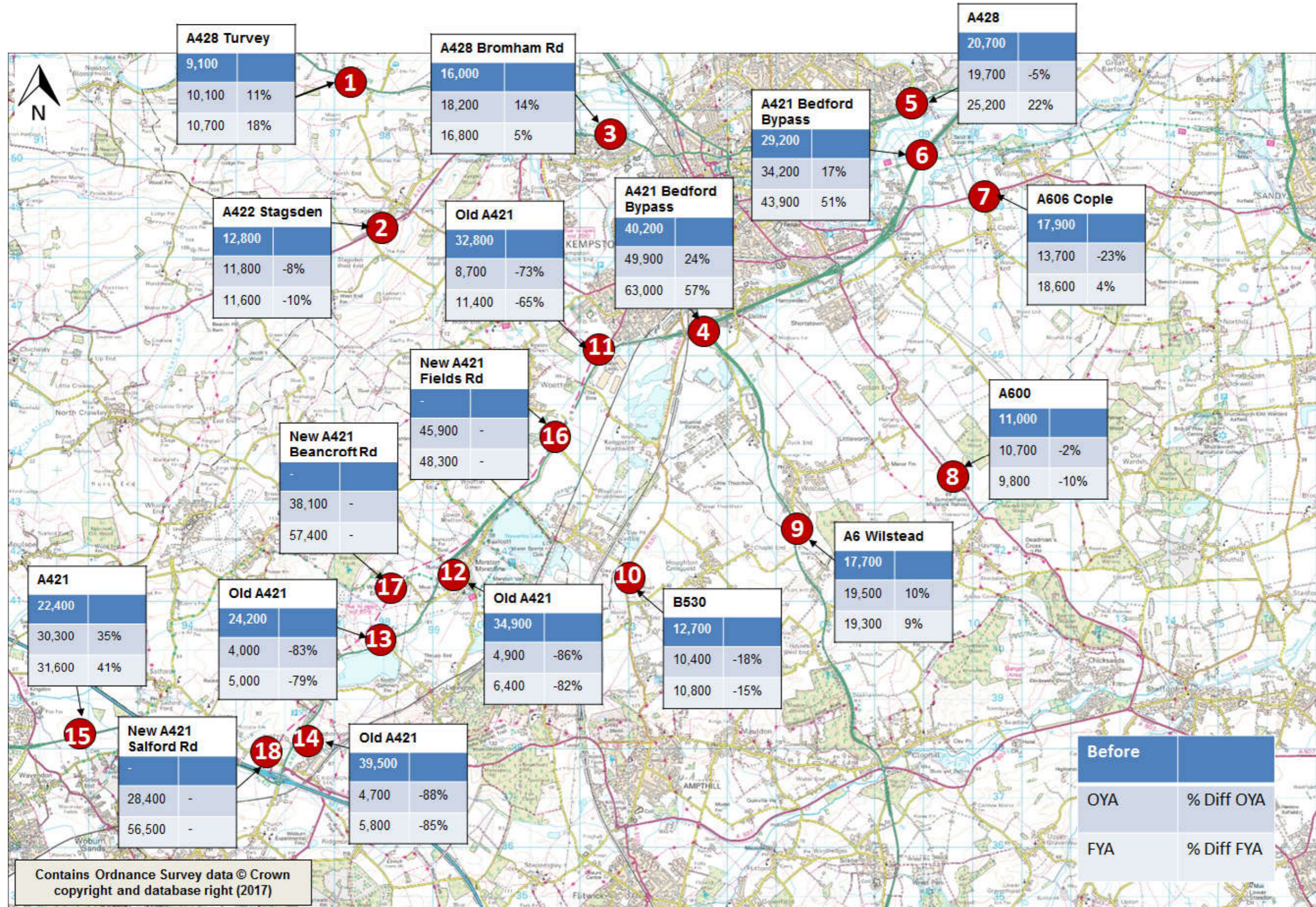
Traffic volume analysis

- 2.10. Traffic flow data has been collected for 18 locations. Two-way Average Weekday Traffic (AWT) flows and Average Daily Traffic (ADT) flows at each of the count sites for before and five years after the scheme opening are presented in Table 2-1. Figure 2-3 presents the before, one year after and five year after opening flows on a map for additional context. Sites 11-18 are directly located on the A421 prior to junction 13 northbound, representing the new A421 and the old A421.

Table 2-2 Change in two-way traffic volumes

Site no.	Location	AWT				ADT			
		Before	FYA	Diff FYA	% Diff FYA	Before	FYA	Diff FYA	% Diff FYA
1	A428 Turvey	9,100	10,700	1,600	18%	8,200	9,500	1,300	16%
2	A422 Stagsden	12,800	11,600	-1,200	-9%	11,500	10,500	-1,000	-9%
3	A428 Bromham Road	16,000	16,800	800	5%	14,600	16,400	1,800	12%
4	A421 Bedford Bypass south of Bedford	40,200	63,000	22,800	57%	36,400	57,400	21,000	58%
5	A428 west of A421	20,700	25,200	4,500	22%	18,600	23,200	4,600	25%
6	A421 Bedford Bypass (west of A428)	29,200	43,900	14,700	50%	26,500	42,600	16,100	61%
7	A603 Cople	17,900	18,600	700	4%	16,400	17,100	700	4%
8	A600	11,000	9,800	-1,200	-11%	9,900	8,800	-1,100	-11%
9	A6 Wilstead	17,700	19,300	1,600	9%	16,400	17,800	1,400	9%
10	B530	12,700	10,800	-1,900	-15%	11,400	10,500	-900	-8%
11	Old A421 Marsh Leys	32,800	11,400	-21,400	-65%	31,700	10,600	-21,100	-67%
12	Old A421 at Beancroft junction	34,900	6,400	-28,500	-82%	33,600	5,700	-27,900	-83%
13	Old A421 Brogborough	24,200	5,000	-19,200	-79%	23,600	4,600	-19,000	-81%
14	Old A421 Salford Road	39,500	5,800	-33,700	-85%	-	-	-	-
15	A421 North of Lower End, Wavendon	22,400	31,600	9,200	41%	21,600	30,400	8,800	41%
16	New A421 Fields Road	-	48,300	-	-	-	43,800	-	-
17	New A421 Beancroft Road	-	57,400	-	-	-	53,500	-	-
18	New A421 Salford Road	-	56,500	-	-	-	52,800	-	-

Figure 2-3 Average weekday traffic (AWT)



2.11. Table 2-2 and Figure 2-3 show:

- Traffic volumes along the former A421 are around 80% less than pre-scheme as vehicles are now presumably using the A421 instead of the de-trunked road. Traffic volumes at three traffic sites on the old A421 have experienced a reduction in flows since the scheme opened. Traffic flows have reduced by 28,500 vehicles (82%), 19,200 (82%) and 33,700 (85%) at sites 12, 13 and 14 respectively.
- There has been a large increase in traffic flows along the A421. Combining traffic volumes on the former A421 and the new A421 at Marston Moretaine (sites 12 and 17) shows that there has been an increase of approximately 83% compared to pre-scheme levels. This is well above regional and national growth trends. It is considered that at five years after opening traffic has reassigned to the A421 as the route has become more established as a strategic route.
- On the new A421 near Salford Road (site 18), traffic flows have increased by 28,100 vehicles between one year and five years after opening. However, these numbers should be treated with caution due to the different data collection sources used.
- There has been a 41% increase in traffic at site 15 on the A421 south of the scheme and prior to M1 junction 13. Flows have increased slightly since OYA where traffic had reassigned to the A421 corridor from other routes such as the A509 and A422.
- Traffic on the A6 has remained steady with an increase of around 9%. At OYA, the development at Wixams⁴ was underway and at the FYA stage the area now has multiple residential sites and amenities, with further development taking place over the next construction phase. Due to the location of Wixams, situated between the A421 and A6, it is likely that traffic will continue to increase in this area, using either the A6 or the A421.
- Traffic has increased on the Bedford Bypass south of Bedford (site 4) by 59% FYA. This is likely to have increased by a large percentage as traffic on the A421 has continued to increase since the scheme opened, traffic on the A6 has also increased from pre-scheme levels.
- The B530 (site 10) has not returned to pre-scheme levels with a 15% decrease in traffic flows. The B530 runs parallel to the east of the A421 and joins Bedford to the A507, A5120 and the M1 junction 12, traffic has most likely reassigned on to the A421.
- Traffic on the A422 (site 2) has experienced a 10% reduction in traffic. The A422 links Bedford to Milton Keynes and the M1 junction 14, again indicating continued traffic reassignment.
- The A603 (site 7) has shown an increase of 4% compared to levels before the scheme opened. At OYA, there was a 23% decrease in traffic flows and therefore there has been a considerable increase five years on with the potential reason being that traffic could now be re-routing back on to the A603 which runs parallel to the A421.

Screenline analysis

2.12. The traffic count sites have also been grouped into 'screenlines'. A screenline can be described as an imaginary line intersecting routes on a map to allow easier analysis of vehicular movement across a wider corridor. Two screenlines have been identified to help establish

⁴ Wixams is a new town located just to the south of Bedford, under construction since 2007, for more information about the settlement please refer to the weblink masterplan, www.centralbedfordshire.gov.uk/Images/wixam-master-plan_tcm3-6809.pdf.

whether traffic is likely to have re-routed. The screenlines used in this study are shown in Figure 2-4. The results of the screenline analysis are presented in the tables below.

Figure 2-4 Traffic screenlines

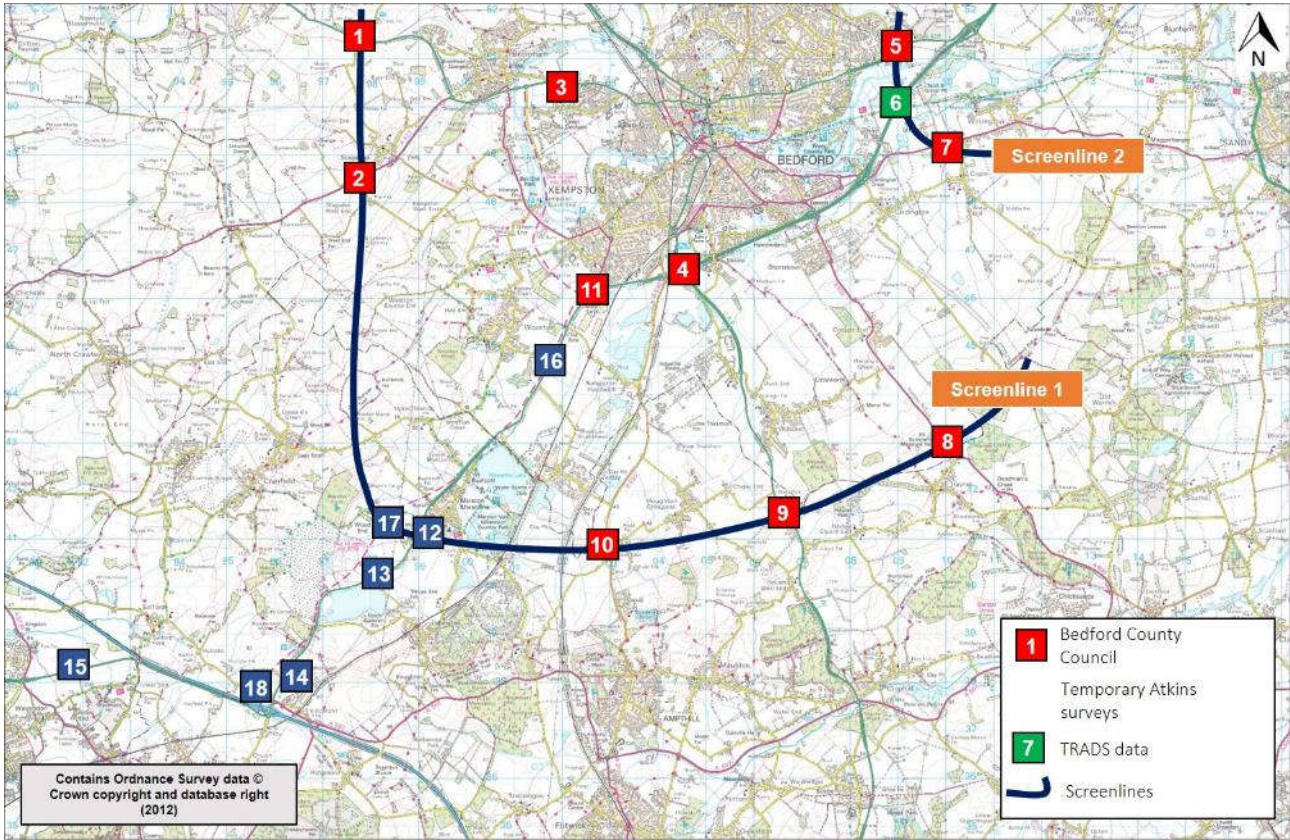


Table 2-3 Screenline 1 AWT

Site reference	Location	Before	FYA	% Diff
1	A428 Turvey	9,100	10,700	18%
2	A422 Stagsden	12,800	11,600	-9%
17	New A421 Fields Road	N/A	48,300	-
12	Old A421 at Beancroft junction	34,900	6,400	-82%
10	B530	12,700	11,400	-10%
9	A6 Wilstead	17,700	10,800	-39%
8	A600	11,000	9,800	-11%
Total		98,200	109,000	11%

Table 2-4 Screenline 2 AWT

Site reference	Location	Before	FYA	% Diff
5	A428 west of A421	20,700	25,200	22%
6	A421 Bedford Bypass (west of A428)	29,200	43,900	50%
7	A603 Cople	17,900	18,600	4%
Total		67,800	87,700	29%

2.13. The main findings for Screenline 1 is that there is evidence of reassignment of traffic to the A421 from some of the other smaller local roads. This indicates that the additional capacity

provided on the dualled A421 has enabled drivers to travel on a more suitable route. Some level of growth is also seen though on this screenline.

- 2.14. The main findings from Screenline 2 is that there has been a higher increase across all sites which indicates that this is mostly traffic growth rather than reassignment. It is possible that accessing Bedford from the A1 may be more appealing following improvements made to the A1/A421 junction in 2015.

Forecast traffic flows

- 2.15. The scheme was justified based on an appraisal of impacts carried out prior to construction. This section compares these forecasts with observed traffic volumes to ascertain the accuracy of predictions.
- 2.16. The forecast model developed for the scheme were derived from the A421 Stage 3 SATURN highway model. Traffic flow forecasts in this section have been taken from the Environmental Statement (ES), Volume 1 (March 2007) which provides detailed information.
- 2.17. Table 2-5 shows a comparison of the Do-Minimum⁵ central growth Annual Average Daily Traffic (ADDT) forecasts with observed Average Daily Traffic (ADT) flows in 2008 before the scheme was constructed, which is the most comparable information available. Table 2-6 shows the Do-Something⁶ forecasts for 2017 compared to observed FYA opening traffic volumes.

Table 2-5 Accuracy of Do Minimum forecasts

Site	Location	Forecast 2008	Observed 2008	Diff to forecast	% Diff
2	A422 Stagsden	16,700	11,500	-3,900	-23%
4	A421 east of A6 junction	42,700	36,400	-2,500	-6%
9	A6 Wilstead	19,800	16,400	-2,100	-11%
10	B530 Kempston Hardwick	12,900	11,400	-500	-4%
13	(Old) A421 Brogborough	23,100	23,600	500	2%

Table 2-6 Accuracy of Do Something forecasts

Site	Location	Forecast (2017)	Observed FYA (2017)	Diff to forecast	% Diff
2	A422 Stagsden	16,500	10,500	-6,000	-36%
4	A421 east of A6 junction	63,200	57,400	-5,800	-9%
9	A6 Wilstead	21,300	17,800	-3,500	-16%
10	B530 Kempston Hardwick	13,100	10,500	-2,600	-20%
11	(Old) A421 south of Marsh Leys	10,800	10,600	-200	-2%
13	(Old) A421 Brogborough	5,400	4,600	-800	-15%
15	A421 North of Lower end, Wavendon	30,800	52,800	22,000	71%
17	(New) A421 Beancroft Road	53,200	53,500	300	1%

⁵ This is the scenario which comprises the existing road network plus improvement schemes that have already been committed.

⁶ This is the scenario detailing the planned scheme.

- 2.18. It can be seen from Table 2-5 that for the sites considered, the accuracy of Do Minimum forecasts varies. On the A422 and A6, parallel routes to the A421, observed flows are lower than forecast by 23% (3,900 vehicles) and 11% (2,100 vehicles) respectively. These results suggest that the modelling overestimated the use of the parallel strategic routes into Bedford (A422 and A6). The accuracy of the forecasts for the old A421 (site 13) are considered to be accurate as observed flows are within 2% of forecast.
- 2.19. Table 2-6 shows that the Do Something forecasts were largely overestimated as observed traffic volumes are lower than forecast for the majority of sites. The most substantial differences between forecast and observed flows is on the parallel A routes into Bedford (A422, B530 and A6) with differences ranging from -16% to -36%. Traffic flows on the new A421 were in line with forecast (only 1% difference between forecast and observed), whereas flows on the A421 near to Wavendon were 71% higher than forecast.
- 2.20. Whilst it is important to understand the accuracy of Do Minimum and Do Something flows in isolation, it is also useful to consider the accuracy of forecast changes in flows. Table 2-7 shows the observed and forecast percentage change. These percentages have been calculated by comparing observed pre-scheme and five years after opening flows to generate a percentage change and completing the same for the forecast flows.

Table 2-7 Forecast and observed changes in volumes

Site No	Site description	Observed volume change	Observed % change	Forecast volume change	Forecast % change
2	A422 Stagsden	-1,000	-9%	-200	-1%
4	A421 east of A6 junction	21,000	58%	20,500	48%
9	A6 Wilstead	1,400	9%	1,500	8%
10	B530 Kempston Hardwick	-900	-8%	200	2%
13	(Old) A421 Brogborough	-19,000	-81%	-17,700	-77%
13/17	New road + old road at Brogborough (A421 Corridor)	34,500	146%	35,500	154%

- 2.21. Table 2-7 shows that:
- Percentage changes in traffic flows on the old A421 are slightly greater than expected at 81% compared to the forecast 77%.
 - In terms of overall traffic volume changes on the A421 corridor (new road, site 17 and old road, site 13), forecast and observed changes are relatively in line at 154% (35,500 vehicle increase) and 146% (34,500 vehicle increase) respectively.
 - Changes on the parallel routes, A422 (site 2) and B530 (site 10) were forecast and observed to have $\pm 10\%$ change in traffic volumes, which is within the range for discrepancies that can be associated with traffic count accuracy. These observed changes are therefore generally considered to be in line with the forecast changes.

Reasons for difference between forecast and observed traffic volumes

- 2.22. Other road schemes and developments can contribute to discrepancies between observed and forecast traffic volumes. Several other road schemes were included in the original forecasts based on expected construction timescales at the time of appraisal. POPE has undertaken desktop research to identify other road schemes in the scheme vicinity, and has identified their status in the traffic forecasting and status at the time of this five year after evaluation. Table 2-8 provides the outcome of the desktop research.

Table 2-8 Road schemes

Scheme	Included in forecast?	Actual opening
M1 Junctions 6a-10 Widening	Yes	December 2008
M1 Junctions 10a-13 Smart Motorway	Included as a widening scheme (as opposed to a smart motorway scheme)	January 2015
M1 Junction 19 Improvements	Yes	December 2016
M25 Junctions 27-31 Smart Motorway	Included as a widening scheme (as opposed to a smart motorway scheme)	November 2014
A5-M1 link (Dunstable Northern Bypass)	Yes	May 2017
A47 Thorney Bypass	Yes	December 2005
Great Barford Bypass	Yes	August 2006
Dualling of A421 from the west of M1 junction 13 – Milton Keynes	Yes	October 2015
A428 Caxton Common to Hardwick Dualling	Yes	May 2007
M1 Junctions 25-28 Smart Motorway	M1 Junction 27-30 Widening scheme included	May 2010
M1 Junctions 28-31 Smart Motorway	M1 junction 27-30 Widening scheme included	March 2016
M25 Junctions 16-23 Widening	Yes	March 2014
M25 Junctions 23-27 Widening	Yes	November 2014
A13 Sadler's Farm Junction improvements	Yes	2013
A1 Black Cat (A1/A421 junction) improvement Pinch Point scheme	No	2015

2.23. The desktop research undertaken has shown that there are no additional highway schemes in the area that could affect the scheme which were not included in the forecasting schemes with the exception of the Black Cat junction scheme. However, there are some smart motorway schemes (for example, at the M1 junctions 10-13 and the M25 junctions 23-27) which were assumed to be widening schemes in the forecasting. Additionally, while the forecasting included a widening scheme on the M1 between junctions 27 and 30, what materialised were two smart motorways on the M1 between junctions 25 and 28 and between junctions 28 and

31. It is also noted that while the forecasting assumed that some schemes would be constructed by 2011, they actually opened after this date. This is the case for the schemes at the M1 between junctions 10 and 13, the M1 junction 19, at the M25 between junctions 27 and 31, the A5-M1 link (Dunstable northern bypass) and the dualling of the A421 from the west of the M1 junction 13 to Milton Keynes.

2.24. The transport schemes that have opened since the introduction of this scheme, could be contributing to the substantial increase in flows on the scheme observed at FYA, particularly traffic at M1 junction 13 and traffic from Milton Keynes.

Heavy Goods Vehicles

2.25. At locations where classified ATC data⁷ is available, it is possible to assess the proportion and number of Heavy Goods Vehicles (HGVs). By looking at this information for 2008 and 2017, it is possible to determine if there has been a change in the number and proportion of HGVs and assess whether the change may be attributed to the scheme. Table 2-9 presents the number of HGVs and proportions on a typical weekday for before and five years after the scheme opening.

Table 2-9 Volume and proportion of HGVs on a typical weekday

Site No	Site description	Before		FYA	
		% of vehicles that are HGVs	Number of HGVs	% of vehicles that are HGVs	Number of HGVs
12	(Old) A421 at Beancroft junction	16%	5,600	4%	250
13	(Old) A421 Brogborough	16%	3,900	3%	150
14	(Old) A421 Salford Road	15%	5,900	3%	160
15	A421 North of Lower End, Wavendon	10%	2,200	6%	1,970
18	(New) A421 Salford Road	-	-	13%	7,390

2.26. Comparison of the number and proportion of HGVs on the new A421 between the before and after opening period is not possible due to new road not being built. However, it can be seen from Table 2-9 that there has been a reduction in HGV traffic along the old A421 following the scheme opening. This in conjunction with the overall substantially reduced flows on the A421 as shown earlier in Table 2-6, indicates that the reduced HGV volumes are likely to be due to rerouting to the new A421.

2.27. Brogborough Parish Council commented that the A421 eastbound exit at Marston Moretaine to access Marston and Stewartby involves a tight turn around a small roundabout making it difficult for HGVs, suggesting that some HGV traffic re-route along the old road. Interrogation of the information in Table 2-9 suggests that HGVs represent an overall low proportion of traffic on the old A421 at the five year after opening stage.

Journey times

2.28. To understand the impact of the scheme on journey times, data has been collected for before and five years after scheme opening. Journey times along the along the new A421 between

⁷ For the purpose of this evaluation, HGVs have been classified as any vehicle with three, four, five and six axles articulated vehicle or rigid vehicle and trailer. Or a B-double or heavy truck and trailer, double or triple road train or heavy truck and two (or more) trailers.

Bedford and M1 junction 13 were obtained for this study using satellite navigation data⁸. The route is shown in Figure 2-5.

2.29. The journey times were obtained for the following date periods, with school holidays excluded:

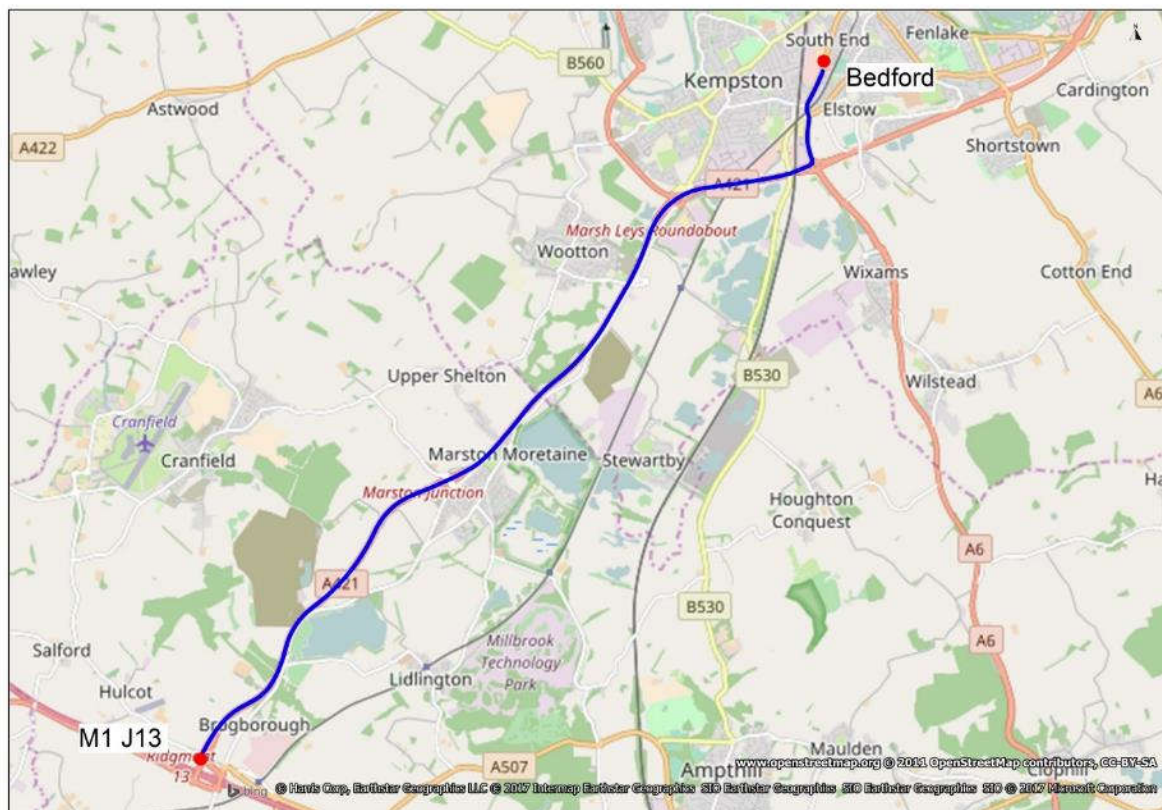
- **Before scheme opening:** October 2008
- **One year after scheme opening:** October 2011
- **Five years after scheme opening:** October 2016

2.30. The journey time analysis has been undertaken for the below time periods for Tuesday to Thursday:

- **AM peak:** 07:00-10:00
- **Inter-peak:** 11:00-16:00
- **PM peak:** 16:00-19:00

2.31. Table 2-10 provides a summary of the journey times savings presented as the difference between the old A421 (before scheme opening) and the new A421 at five years after opening.

Figure 2-5 Journey Time Route



⁸ Satellite navigation data is collected anonymously from vehicles using the route and provides a greater sample size than the moving observer. In this study it has only been used for the post opening period because the before construction period is too early for suitable satellite navigation data to be available.

Table 2-10 Journey times and savings (mm:ss) by time period and direction

Direction	Date period: road	AM	IP	PM
Northbound	Before scheme opening: old A421	22:17	15:47	17:04
	FYA opening: new A421	11:23	10:17	11:33
	Saving (new route compared to old route)	10:54	05:30	05:31
Southbound	Before scheme opening: old A421	18:49	15:14	16:14
	FYA opening: new A421	11:36	09:01	09:09
	Saving (new route compared to old route)	07:13	06:13	07:05

2.32. From Table 2-10, the following can be observed:

- Journey times on the new A421 are between 9 and 11 minutes across the day, with the lowest journey times experienced in the interpeak.
- Journey time savings are between approximately 5 and 11 minutes. The most substantial time savings (~11 minutes) are in the AM peak in the northbound direction, however on this section, journey times before the scheme opened were the greatest (~22 minutes).
- In the southbound direction, time savings are more balanced between the AM and PM peak at around 7 minutes, however journey times before the scheme opened were similar in both time periods.
- In the inter-peak period, there are journey time savings of around 6 minutes which demonstrates that even at less congested times of the day the scheme still offers journey time savings compared to the former route.

2.33. While the AST for the scheme does not quantify journey time benefits, it states the following:

'The proposed improvement scheme is anticipated to bring significant travel time and vehicle operating cost benefits to consumers and business users'.

2.34. The Traffic Forecasting Report (dated January 2007) shows journey time savings for the scheme but these are presented over the whole model network and are therefore not comparable to the data presented above. The same report also provides a list of average delay times at junctions along the scheme, however this is for a Do-Minimum scenario in the design year (2026) and therefore also not comparable to the observed data where the scheme has taken place.

2.35. The ES (dated March 2007) is the only source available which quantifies predicted journey time savings on the new A421, which states:

'At the year of opening, 2011, the journey time along the section being improved would reduce from about 19 minutes in the AM Peak and 15 minutes in the PM Peak along the existing A421 to less than 9 minutes along the new A421 during a typical peak period'

- 2.36. This statement suggests a predicted journey time saving of 10 minutes in the AM peak and 6 minutes in the PM peak.
- 2.37. As shown in Table 2-10, observed journey times in the AM and PM peak are generally in line with the forecast at around 19 – 22 minutes in the AM peak and 16 – 17 minutes in the PM peak. Thus, it can be considered that these forecasts were relatively accurate.
- 2.38. In relation to the post-scheme journey times, they are between 9 and 11.5 minutes which are slightly higher than the forecast post-scheme journey time of 9 minutes during a typical peak period. However, savings are between 6 and 11 minutes, which are similar to the predicted savings for the time periods.

Reliability

- 2.39. Journey time reliability can offer a significant source of economic benefit to transport schemes. In recognition of its growing importance as an indicator of network performance, WebTAG has now been updated to provide guidance on how reliability benefits can be monetised using the Incident Cost-benefit Assessment (INCA) program, and research is ongoing to develop new and better ways of evaluating reliability impacts. At the time of the appraisal for this scheme, INCA was not available.
- 2.40. In relation to the scheme's forecast impact on reliability, the AST states:
- 'The scheme is predicted to improve journey time reliability for journeys along the upgraded A421. Two sections were assessed to be 'large beneficial' with the third section showing 'moderate beneficial' impact in terms of reliability'.*
- 2.41. No quantitative measure was given, with an overall assessment of moderate to large beneficial.
- 2.42. Figure 2-6 and Figure 2-7 show the changes in journey time reliability between the old A421 in the pre-scheme period and the new A421 at one year and five years after on the northbound and southbound sections, respectively. This information has also been sourced from the satellite navigation data.

Figure 2-6 Journey time reliability, northbound

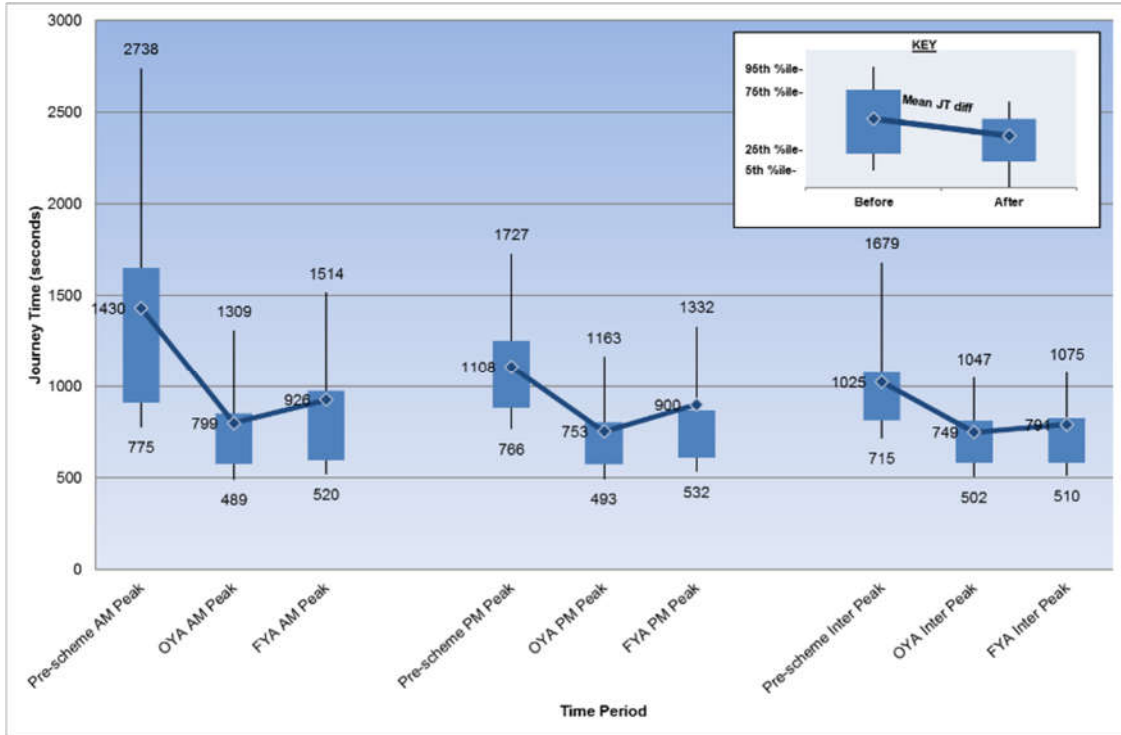
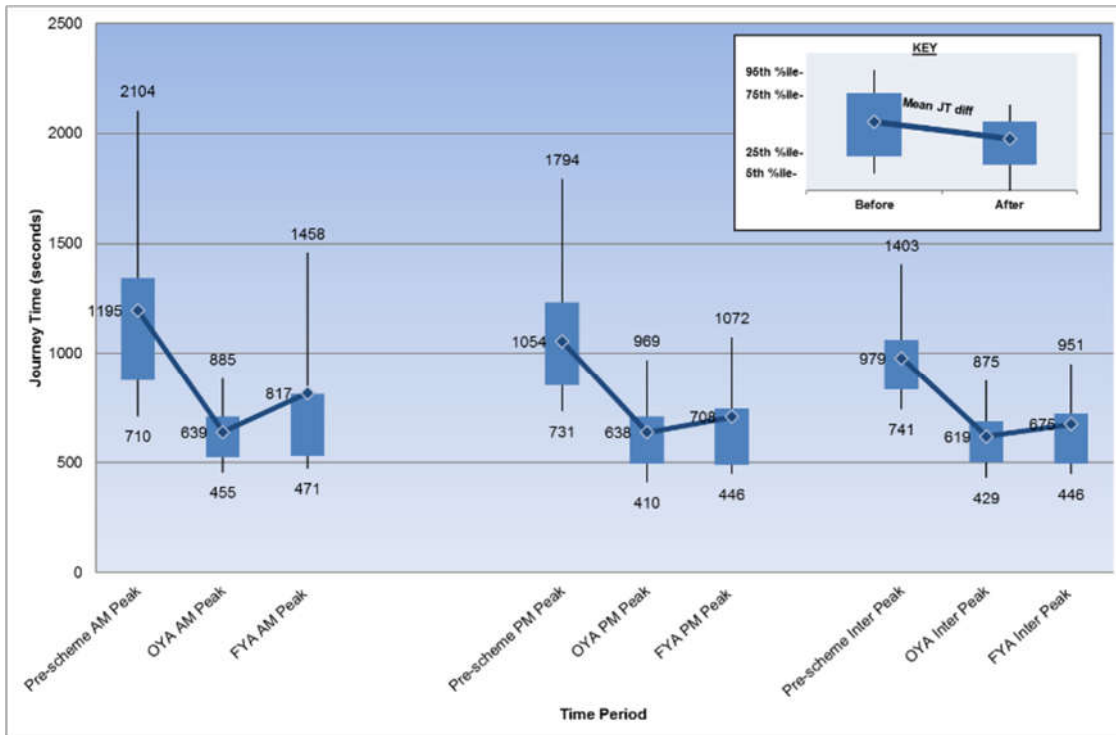


Figure 2-7 Journey time reliability, southbound



2.43. Figure 2-6 and Figure 2-7 show that in the northbound and southbound direction, reliability has substantially improved following the opening of the scheme in all three time periods. The interquartile range is considerably smaller; however, it is noted that reliability has slightly worsened at FYA compared to OYA, with the most pronounced change in the AM peak. The 5th and 95th percentile have also increased in all time periods in both directions indicating that the fastest and slowest journey times have also increased since the one year after opening

stage. The overall worsening of reliability is likely to be due to increased traffic volumes on the new A421 and subsequent increases in journey times.

Key points from traffic evaluation

Traffic volumes

- Following the scheme opening, traffic volumes on the old A421 are around 80% lower as vehicles have rerouted onto the new A421.
- Combining traffic flows on the old A421 and new A421 to calculate flows using the corridor demonstrates that flows have increased by around 83% following the scheme opening. This is expected to be a result of traffic reassigning along the new A421 as the scheme has become recognised as a key strategic route.
- Flows on the two parallel routes, the A6 and A422, have reduced by between 15% and 10% respectively, which is likely to be due to traffic rerouting to the A421.
- The scheme has resulted in a substantial reduction in the proportion and number of HGVs on the former A421 since scheme opening. HGVs previously constituted approximately 15% of the total flow (between 4,000 and 6,000 vehicles) to 4% (less than 200 vehicles) of the total flow FYA.
- Observed traffic volumes before the scheme opened on the parallel routes into Bedford, the A422 and A6, were lower than forecast by between 2,100 and 3,900 vehicles. These results suggest that the modelling overestimated use of the parallel routes.
- The post-scheme flows were largely overestimated as observed traffic volumes are lower than forecast for many of the sites. The most substantial differences between the forecast and observed flows is on the parallel strategic routes into Bedford, with differences ranging from -16% to -36%.
- Despite some of the discrepancies between the before and after scheme opening observed and forecast flows, in terms of overall traffic volume changes on the A421 corridor (new road, site 17 and old road, site 13), forecast and observed changes are relatively in line at 154% (35,500 vehicle increase) and 146% (34,500 vehicle increase) respectively.

Journey times

- Observed journey times in the AM and PM peak are generally in line with the forecasts for before the scheme opened.
- In relation to the post-scheme journey times, observed journey times slightly higher than expected at between 9 and 11.5 minutes compared to a forecast of 9 minutes.
- Journey time savings are between 6 and 11 minutes, which is similar to the predicted savings for the time periods.

Reliability

- Reliability has substantially improved in all three time periods following the scheme opening. However, as a result of increased volumes on the A421 and increased journey times, reliability has slightly worsened at FYA compared to OYA, albeit the improvement in reliability is still considerable following the scheme opening.

3. Safety

Introduction

- 3.1. This section considers the impact of the scheme in terms of the level of success in addressing the objective of reducing collisions.
- 3.2. To assess the impact of the scheme on collisions, this section of the report analyses changes in personal injury collisions (PICs) occurring in the five year period prior to scheme construction and the five year post-opening period. Evaluation of the scheme's impact on personal security has also been undertaken using observations made during a site visit.

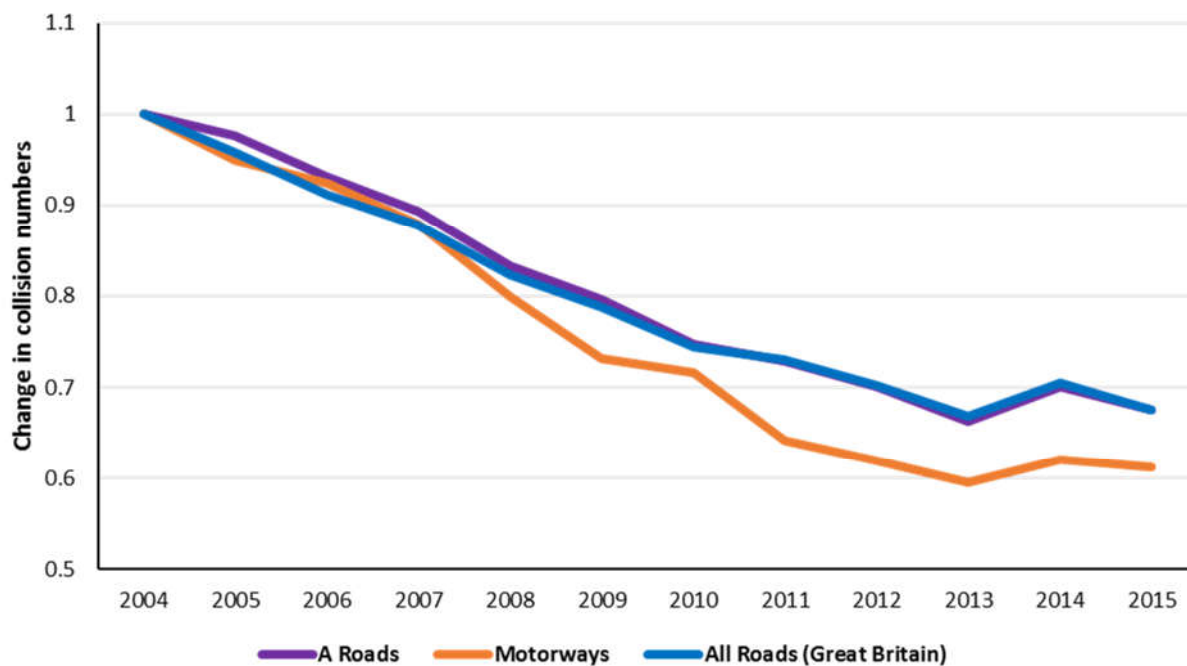
Data collection

- 3.3. For this study, collision data has been obtained from Central Bedfordshire Council for the period between November 2005 to December 2015. The collision data is based on the records of PICs recorded in the STATS19 data, which has been collected by police when attending collisions. Damage only collisions are not included in the analysis. The collision data referred to in this report has not necessarily been derived from the national validated collision statistics produced by the DfT. The requirement for up-to-date information and site specific data was a consideration in the decision to use invalidated data and, as it is sourced from local processing units, it is considered sufficiently robust for use in this report.

Background changes

- 3.4. It is widely recognised that for much of the last decade and early part of this decade there has been a year-on-year reduction in the numbers of personal injury collisions on roads, even against a trend of increasing traffic volumes during much of the same period. The reasons for the reduction are multi-factorial and include improved safety measures in vehicles and reduced numbers of younger drivers. Similar to the background traffic growth, background trends in collisions needs to be considered when examining the changes in collision numbers. If the scheme had not been built, collision numbers in the area may still have been influenced by wider trends and therefore reduced.
- 3.5. The national change in the number of collisions between 2005 and 2015 (the years of collisions data considered in this evaluation) for A roads and motorways is shown in Figure 3-1.
- 3.6. Figure 3-1 shows that between 2004 and 2015, annual collision numbers reduced by around 30 – 35% on A roads, motorways and all roads in Great Britain. When comparing the number of collisions and casualties before and after the scheme was built and the associated net change with the scheme, it is important to take account of these background reductions.
- 3.7. To apply the background trends, it is assumed that if the scheme had not been built, the number of collisions and resulting casualties on the roads in the modelled area used for forecasting (Figure 3-2) would have dropped at the same rate as they did nationally during the same period. This gives a counterfactual 'without scheme' scenario on a like-for-like basis with the observed post opening data, which is the 'with scheme' scenario. The difference between the number of collisions in these two scenarios can then be attributed to the scheme rather than the wider national trends. This result will inform the calculation of monetised safety benefits achieved by the scheme, which is discussed in the Section 4 of this report.

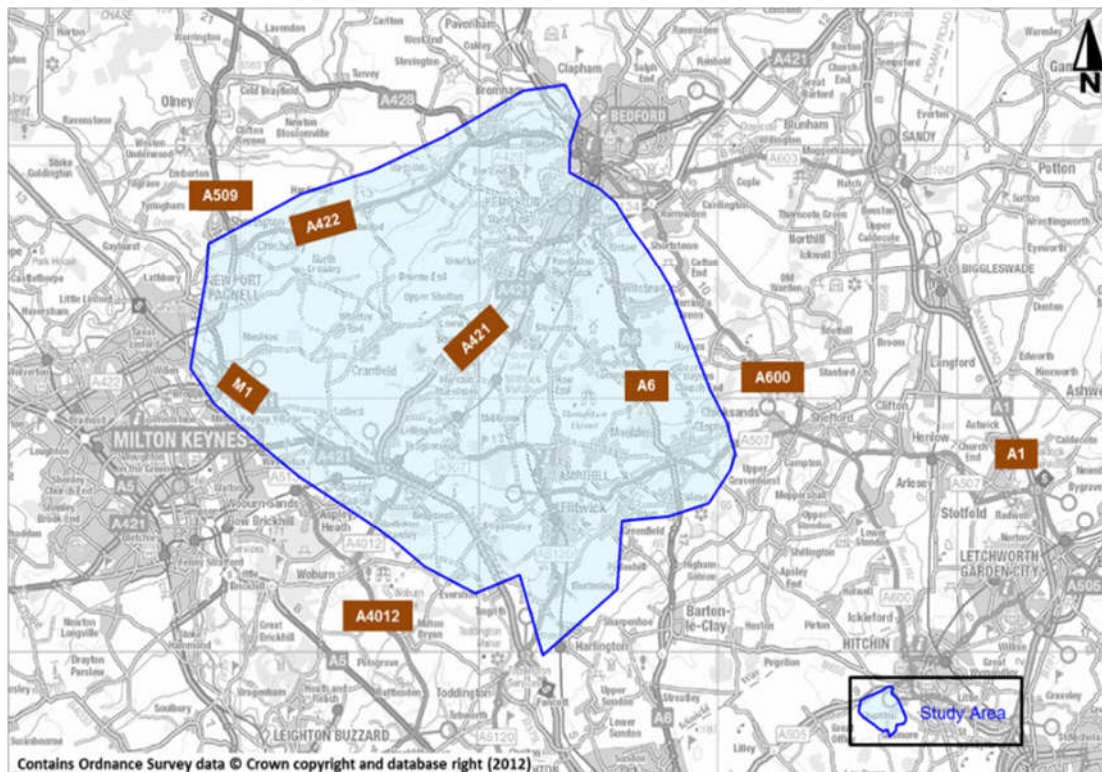
Figure 3-1 Background trends in collision numbers



Evaluation approach

- 3.8. In most scheme appraisals, the forecast safety benefits of the scheme are derived from a COBA model which gives predicted collision savings for the opening year and over the appraisal period. Wherever possible, to evaluate the safety benefits after scheme opening, the same geographical area is studied to make like-for-like comparisons. Before the A421 scheme was built, a COBA (cost benefit analysis area) was derived to forecast collision savings across both the new road, old road and surrounding area. The COBA area is shown in Figure 3-2.
- 3.9. The COBA model area, presented in the Economic Assessment Report (dated February 2007), has been used to provide a like-for-like comparison of the forecast and observed impacts of the scheme on collisions. This section of the report presents data on the number of collisions and casualties in the before scheme period and after scheme opening period and discusses changes which may have occurred due to the scheme.
- 3.10. Collision data has been obtained for three years prior to the start of construction, in November 2008, and all subsequent years up to December 2015 to cover the five year after opening period.

Figure 3-2 Study area (COBA) for collision analysis



Observed collisions

3.11. Table 3-1 compares the observed number of collisions (without scheme counterfactual) before the scheme was implemented, with the observed number of collisions during and after scheme construction. Table 3-2 presents the casualties that occurred in conjunction with these collisions. The latter figures are based on a counterfactual scenario to ensure background changes in the number of collisions are considered. The table also gives a figure for severity index which is the percentage of fatal and severe collisions.

Table 3-1 Observed collision numbers in COBA area

Date period	Date		Number of collisions				Annual average				Severity index
	From	To	Fatal	Serious	Slight	Total	Fatal	Serious	Slight	All	
Before scheme opening	Nov-05	Oct-06	10	43	229	282	10.0	45.3	253.3	308.7	18%
	Nov-06	Oct-07	14	56	273	343					
	Nov-07	Oct-08	6	37	258	301					
Without scheme counterfactual (0.83⁹)										255.1	-
Construction period	Dec-08	Nov-09	4	41	237	282	4.0	41.1	235.3	280.4	16%
	Dec-09	Nov-10	4	41	233	278					
After scheme opening	Dec-10	Nov-11	4	29	209	242	3.2	35.0	246.5	285.2	13%
	Dec-11	Nov-12	2	43	267	312					
	Dec-12	Nov-13	1	27	225	253					
	Dec-13	Nov-14	4	36	266	306					
	Dec-14	Nov-15	5	40	265	310					
Annual collision saving										-30.1	-

⁹ RAS10002, Reported accidents and accident rates by road class and severity, Great Britain

3.12. The results presented in Table 3-1 show:

- Comparison of the pre-scheme annual number of collisions without the counterfactual applied and the post-scheme annual number of collisions indicates that collisions have reduced by an average of 23.5 per annum. When applying the counterfactual to assume that some of the collision savings would have occurred without the scheme being built, the average annual number of collisions has increased by 30.1 from 255.1 to 285.2.
- The severity index has reduced from 18% to 13%, demonstrating that there are proportionally fewer fatal and serious collisions following the scheme opening.

Table 3-2 Observed casualties in COBA area

Date period	Date		Number of casualties				Annual average				Severity index
	From	To	Fatal	Serious	Slight	Total	Fatal	Serious	Slight	All	
Before scheme opening	Nov-05	Oct-06	13	54	350	417	11.7	57.0	393.7	462.3	15%
	Nov-06	Oct-07	14	72	430	516					
	Nov-07	Oct-08	8	45	401	454					
Without scheme counterfactual (0.81¹⁰)										374.5	-
Construction period	Dec-08	Nov-09	5	47	355	407	4.5	46.6	345.0	396.1	13%
	Dec-09	Nov-10	4	46	334	384					
After scheme opening	Dec-10	Nov-11	4	35	307	346	4.0	29.6	361.0	394.6	11%
	Dec-11	Nov-12	2	32	371	405					
	Dec-12	Nov-13	1	22	336	359					
	Dec-13	Nov-14	4	31	383	418					
	Dec-14	Nov-15	9	28	407	444					
Annual casualty saving										-20.1	-

Note: Casualty numbers may be higher than collision numbers due to some collisions involving multiple casualties.

3.13. The results in Table 3-2 show:

- The without scheme counterfactual casualty rate (accounting for the background reduction in collisions over time) is calculated as 374.5 casualties per annum. When compared to the post-scheme annual number of casualties, there has been an increase of 20.1 casualties following the scheme opening.
- The severity index has decreased from 15% to 11% post opening. This suggests that while the annual average number of fatal and serious casualties have reduced post-opening, slight casualties have slightly increased.

3.14. The location of collisions in the pre-scheme and post-scheme period are shown in Figure 3-3 and Figure 3-4. The information shows that both pre- and post-scheme there is a concentration of collisions at M1 junction 13 at the southern end of the route, and Marsh Leys roundabout at the northern end of the route below Bedford. Post opening there is also a concentration of collisions at the Marston Moretaine/Lower Shelton junction.

¹⁰ RAS30009, Reported casualties by gender, built-up and non-built up roads, road class and severity, Great Britain

Figure 3-3 Location of collisions – pre-scheme

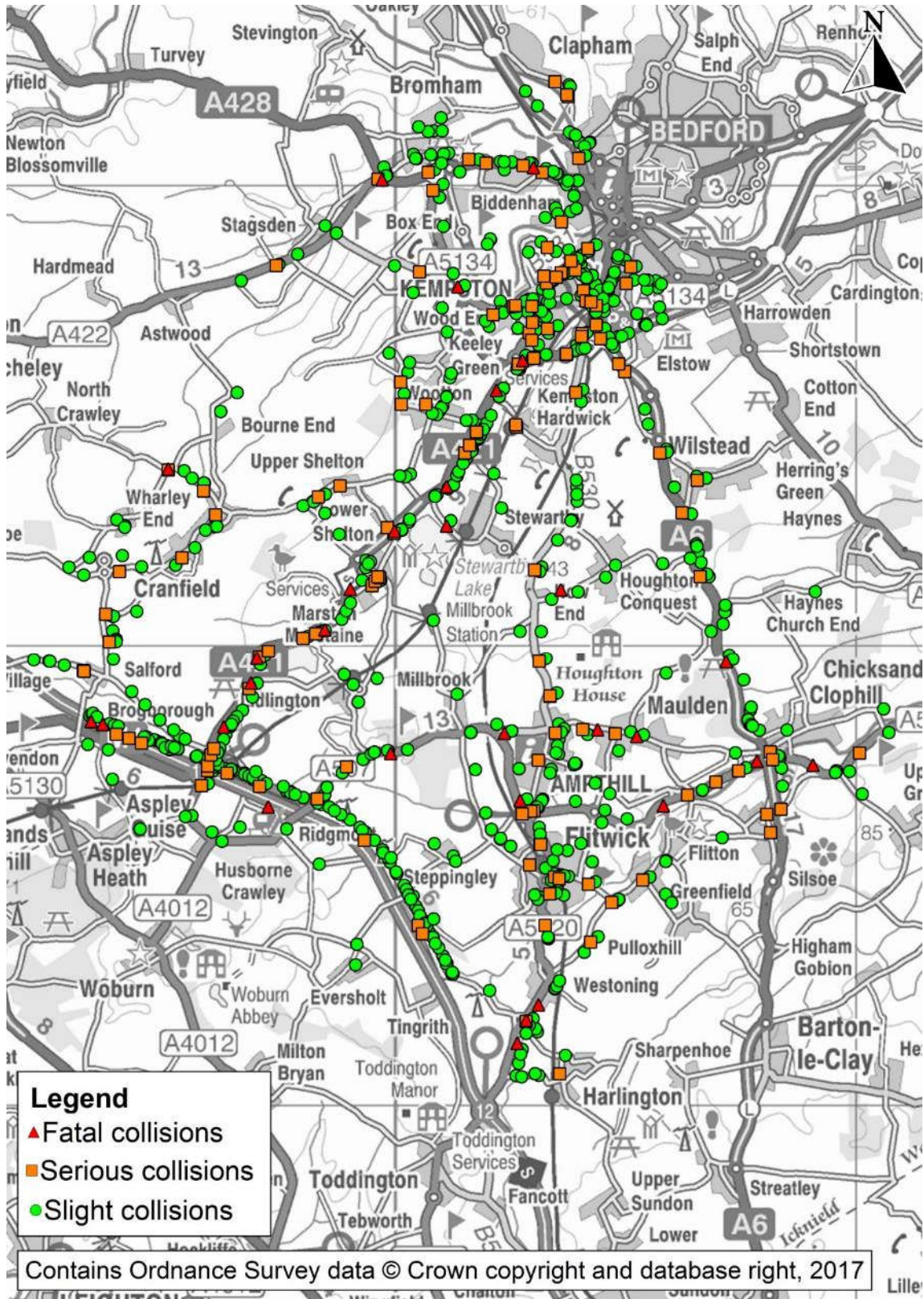
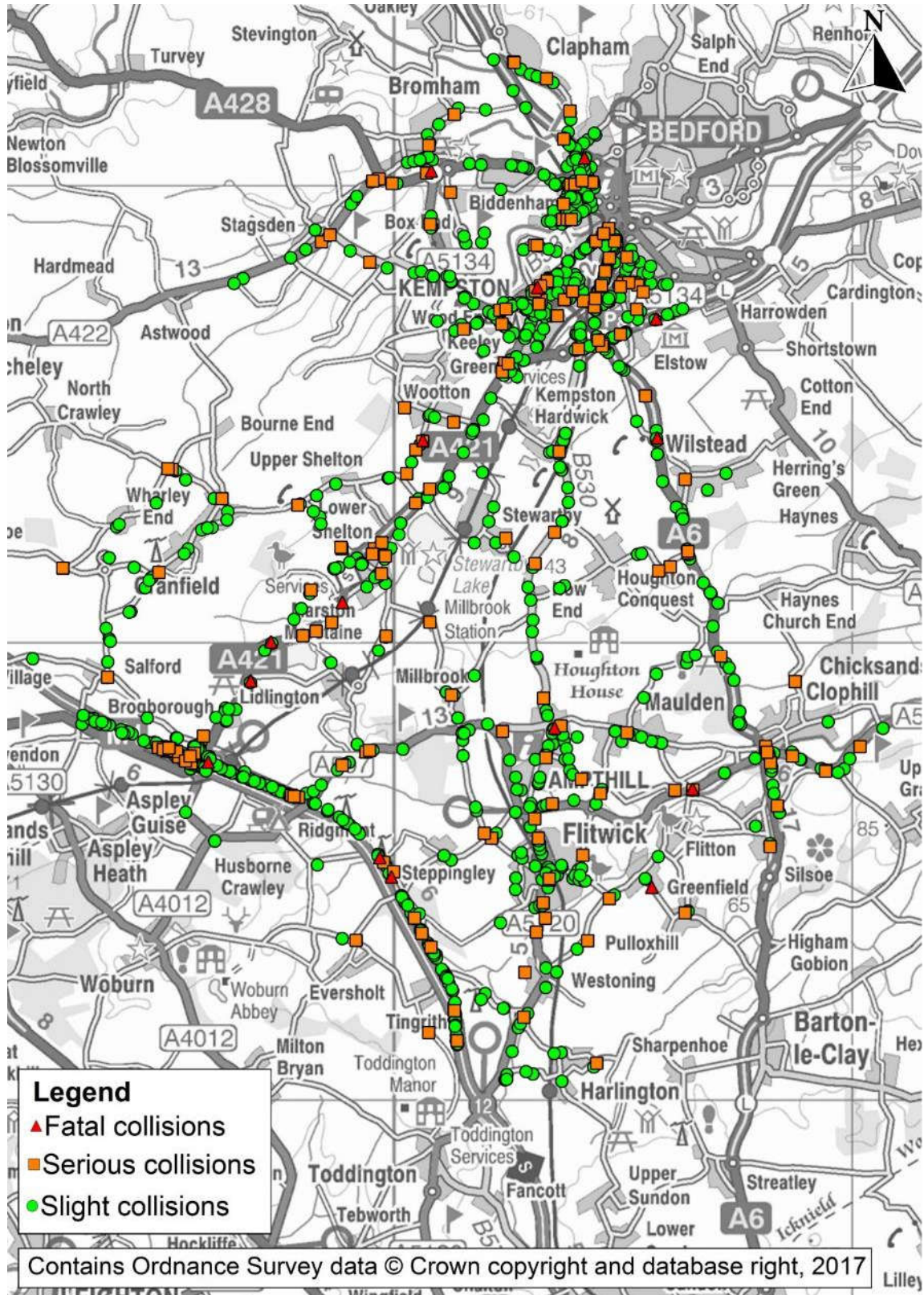


Figure 3-4 Location of collisions – post-scheme



Scheme section

3.15. Collision and casualty numbers have also been evaluated on the scheme vicinity, which is shown in Figure 3-5. The results are presented in Table 3-3 and Table 3-4.

Figure 3-5 Scheme section

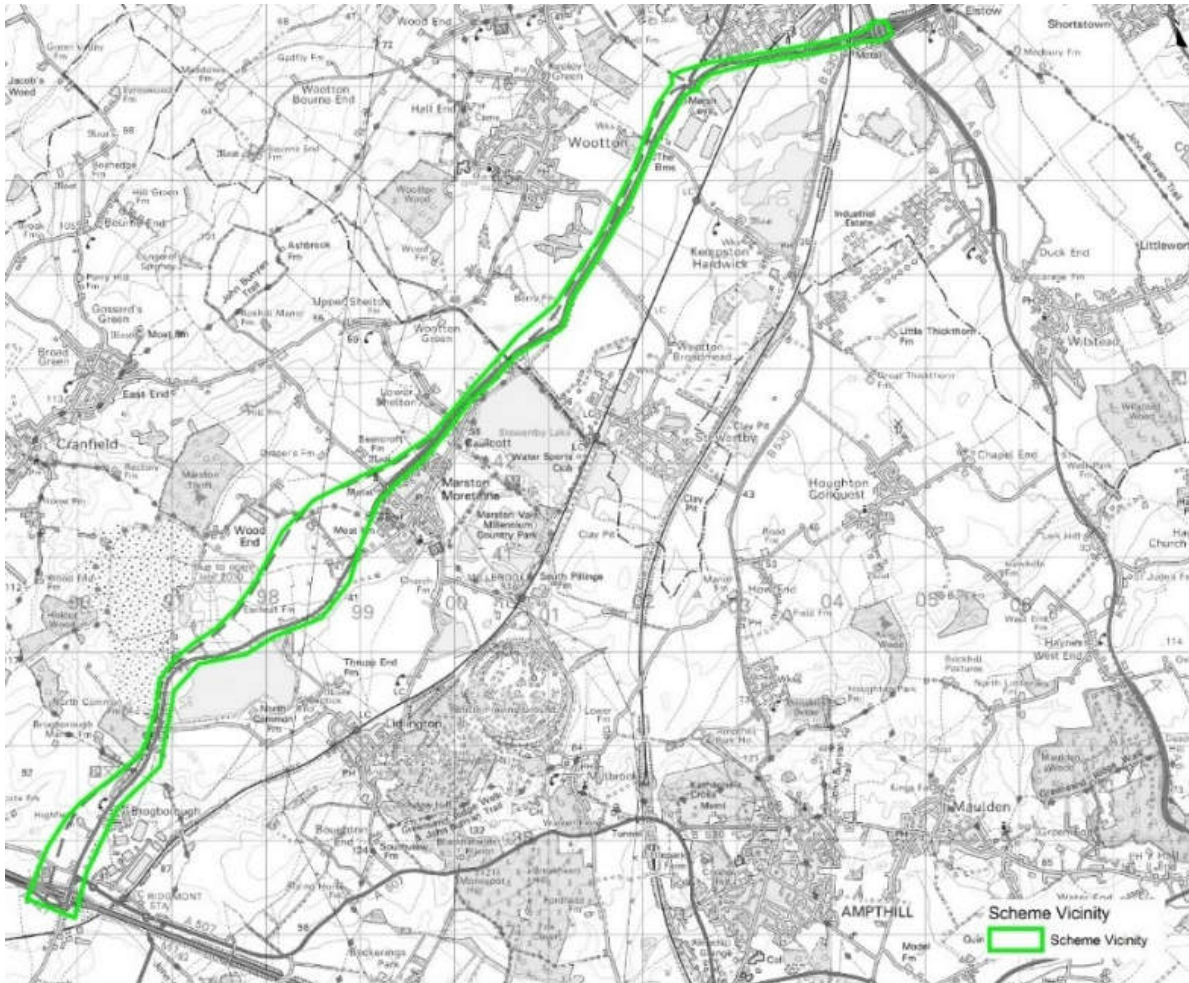


Table 3-3 Observed collisions in scheme section

Date period	Date		Number of collisions				Annual average				Severity index
	From	To	Fatal	Serious	Slight	Total	Fatal	Serious	Slight	All	
Before scheme opening	Nov-05	Oct-06	2	8	39	49	3.0	7.0	44.3	54.3	18%
	Nov-06	Oct-07	4	10	42	56					
	Nov-07	Oct-08	3	3	52	58					
Without scheme counterfactual (0.83)										44.9	-
Construction period	Dec-08	Nov-09	2	6	35	43	1.0	4.5	31.0	36.6	15%
	Dec-09	Nov-10	0	3	27	30					
After scheme opening	Dec-10	Nov-11	1	3	38	42	1.0	4.0	39.2	44.2	11%
	Dec-11	Nov-12	1	6	43	50					
	Dec-12	Nov-13	1	2	34	37					
	Dec-13	Nov-14	1	4	38	43					
	Dec-14	Nov-15	1	5	43	49					
Annual collision saving										0.7	-

3.16. The results presented in Table 3-3 show:

- The without scheme counterfactual collision rate (accounting for background reduction in collisions over time) is calculated as 44.9 collisions per annum, resulting in a saving of 0.7 collisions following the scheme opening.
- The severity index has decreased from 18% to 11% post opening.

Table 3-4 Observed casualties in scheme section

Date period	Date		Number of casualties				Annual average				Severity index
	From	To	Fatal	Serious	Slight	Total	Fatal	Serious	Slight	All	
Before scheme opening	Nov-05	Oct-06	4	15	61	80	4.3	12.7	72.3	89.3	19%
	Nov-06	Oct-07	4	14	67	85					
	Nov-07	Oct-08	5	9	89	103					
Without scheme counterfactual (0.81)										72.3	-
Construction period	Dec-08	Nov-09	2	7	60	69	1.0	5.5	49.6	56.1	12%
	Dec-09	Nov-10	0	4	39	43					
After scheme opening	Dec-10	Nov-11	1	4	48	53	1.4	3.2	55.8	60.4	8%
	Dec-11	Nov-12	1	4	54	59					
	Dec-12	Nov-13	1	2	52	55					
	Dec-13	Nov-14	1	4	54	59					
	Dec-14	Nov-15	3	2	71	76					
Annual casualty saving										11.9	-

3.17. The results presented in Table 3-4 show that the number of casualties occurring per year has reduced from an annual average of 72.3 when adjusted for the counterfactual to 60.4 following

the scheme opening. This represents an annual average saving of 11.9. The severity index has also reduced from 19% to 8%.

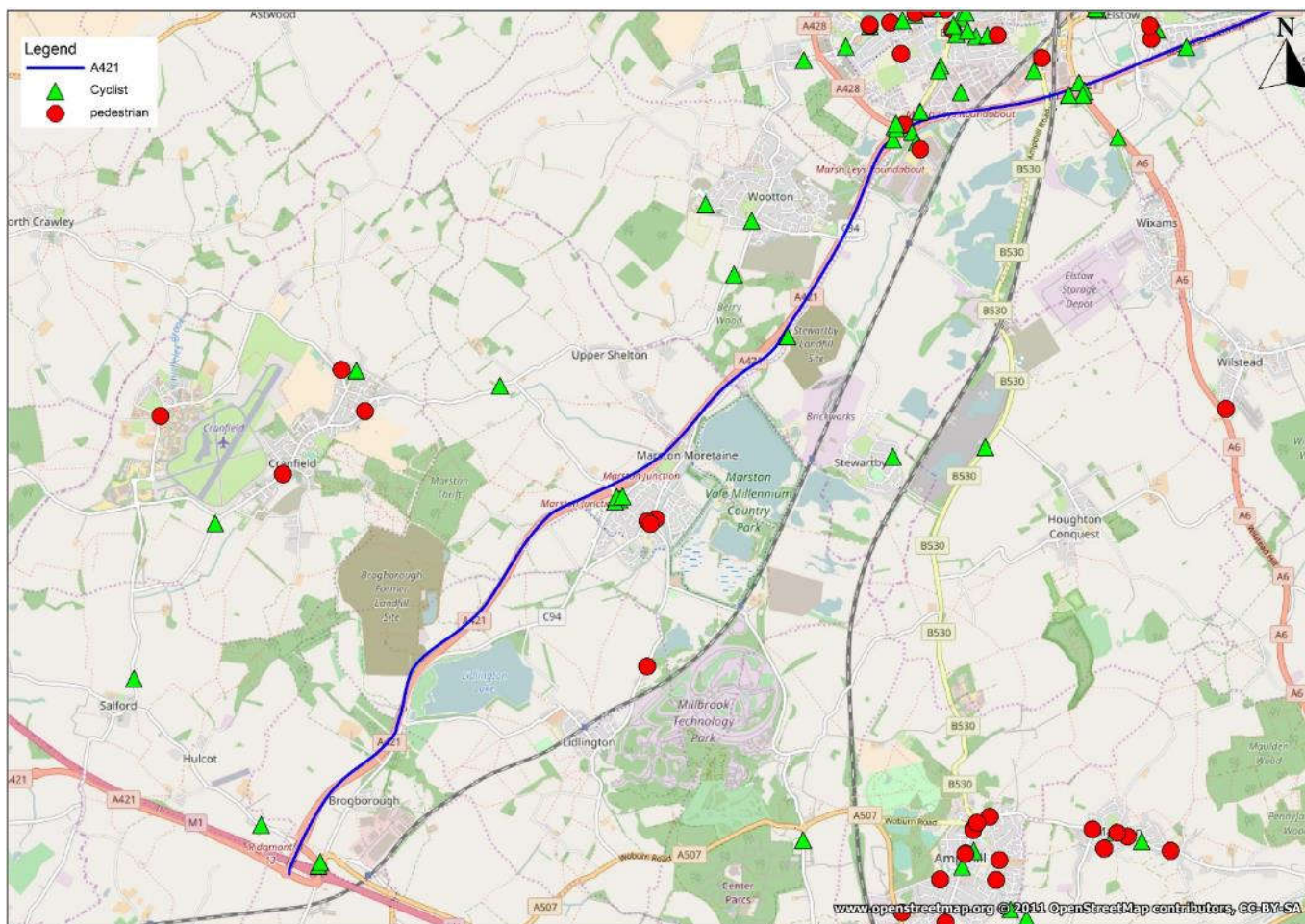
- 3.18. The collision data used to inform the previous analysis of the COBA modelled area contained information regarding collisions that have involved non-motorised users (NMUs), namely pedestrians, cyclists and equestrians. Collisions have been broken down into yearly periods and summarised in Table 3-5.

Table 3-5 Collisions involving NMUs within the COBA modelled area

Date period		Number of collisions	Annual average
Before scheme opening	Nov 2005 - Oct 2006	42	47.3
	Nov 2006 - Oct 2007	59	
	Nov 2007 - Oct 2008	41	
After scheme opening	Dec 2010 - Nov 2011	46	62.2
	Dec 2011 - Nov 2012	72	
	Dec 2012 - Nov 2013	50	
	Dec 2013 - Nov 2014	66	
	Dec 2014 - Nov 2015	77	
Saving			-14.9

- 3.19. Table 3-5 indicates that the number of collisions occurring per year involving NMUs has increased from an average of 47.3 before the scheme opened to an average of 62.2 following the scheme opening. This represents an annual average increase of 14.9 collisions over the whole study area representing an increase of 32%. However, Figure 3-6 overleaf shows that only a small number of these NMU collisions are located within the scheme vicinity, including the old and new A421.

Figure 3-6 NMU collision locations by casualty type



Collision rates

3.20. The number of collisions along the length of road together with its AADT (annual average daily traffic) can be used to calculate a collision rate, in PIC/mvkm (personal injury collisions per million vehicle kilometre). Table 3-6 shows the collision rate calculated for the former A421 prior to the scheme opening and for the new A421 five years after opening. These collision rates have been compared to the national average to establish whether the collision rates on the scheme section are in line with expected rates.

Table 3-6 Collision rate before and after compared to the national average

Date period	Section	Route length (km)	Total collisions	Collision rate (PIC/mvkm)	National average (PIC/mvkm)
Before	Old road	13.6	68 (over 3 years)	0.464	0.332
After	New road	13.0	76 (over 5 years)	0.320	0.122

3.21. The key points to note from Table 3-6 are:

- Prior to scheme, the former A421 had a collision rate which was higher than the national average for a road of that type.

- On the scheme at FYA opening, the collision rate has reduced when compared with the collision rate on the old A421 prior to scheme opening. However, this is higher than the national average for a carriageway of this type.

Statistical significance

- 3.22. In order to determine whether the changes in collision numbers observed before and after the scheme opened are statistically significant, chi-square tests have been undertaken on the collision numbers for the scheme and for the COBA area. This test uses the before and after numbers of collisions to establish whether the changes are significant or likely to have occurred by chance.
- 3.23. A chi-square value greater than the critical value of 3.840 would suggest that we can be 95% confident that a change in the number of collisions is not a result of chance alone. The chi-square results for the scheme and COBA modelled area are presented in Table 3.7.

Table 3-7 Chi-square tests for the scheme

Analysis area	Chi-square result	Conclusion
Scheme	0.019	Not significant
COBA area	6.195	Statistically significant

- 3.24. Table 3-7 shows that the increase in collision numbers is significant for the COBA area but the negligible saving for the scheme area is not significant. In line with POPE methodology, as the savings for the scheme section have been shown to not be significant, the savings will not be included in the reforecast value for money assessment. This is covered in more detail in the economy chapter.

Comparison to forecasts

- 3.25. The AST gives a 60-year forecast saving for the scheme of 1,731 collisions (comprising of 47 fatal, 331 serious and 2,131 slight casualties).
- 3.26. To establish if the observed collision savings are in line with the forecast for the scheme, forecast collision savings for the opening year have been taken from the COBA model. The COBA model is documented in the Economic Assessment Report (February 2007). As this POPE analysis of collisions has used a study area that best matches the COBA network used in the original appraisal, it is possible to make a like-for-like comparison. Table 3-8 shows the collision numbers and savings from COBA and observed five years after opening.

Table 3-8 Forecast vs. observed collision savings

	COBA forecast collisions			Observed collisions		
	DM	DS	Saving	Before	After	Saving
COBA area	403	371	31	255.1 ¹¹	285.2	-30.1
New A421	0	31	-31	44.9	44.2	0.7
Old A421	49	13	35			
New/old A421 combined	49	44	5			

- 3.27. Table 3-8 indicates:

- There has not been any annual collision savings in the COBA modelled area, which is contrary to the 31 collisions expected to be saved.

¹¹ *counterfactual rate

- COBA forecasts predicted a saving of 5 collisions in the opening year on the old and new A421. However, the observed information demonstrates a saving of 0.7 collisions, noticeably lower to that predicted.

Security

- 3.28. The scheme's predicted impact on security was described in the scheme's AST as:
- 'Lay-bys located with clear sight lines to minimise security risks. No additional security measures proposed',* and the overall assessment was given as 'neutral'.
- 3.29. The neutral assessment is further supported in the Environmental Statement Volume 1, which regarding the scheme's impact on security states *'Limited substantial change, but lay-bys built with clear sight lines to minimise security'*.
- 3.30. For this POPE study, desktop analysis has been conducted to assess the scheme's outturn impact on security five years after opening.
- 3.31. For highway schemes, security issues may arise from the following:
- On the road itself (for example, being attacked whilst broken down).
 - In service areas, car parks, and so on (for example, vehicle damage while parked at a service station, being attacked while walking to a parked car).
 - At signals or junctions (for example, smash and grab incident while queuing at lights).
- 3.32. The removal of congestion and the potential for queuing conditions along the trunk road and former A421 route has led to traffic which is more free-flowing. This means that the conditions on the A421 are less conducive to the possibility of smash and grab incidents, although this is considered low risk.
- 3.33. The new route is away from the urban areas reducing access to local facilities. Lay-bys installed along the road are still well used at FYA, as highlighted in Figure 3-7, although these do not have CCTV, emergency telephones or lighting.
- 3.34. There are sections of the old A421 where footways, cycleways and bridleways have been provided away from the main road. The footways near the junctions along the old A421 and at Marsh Leys upgraded roundabout scheme are open and exposed, therefore giving users good visibility of their surroundings. Footpath examples are included in Figure 3-8 and Figure 3-9, overleaf.
- 3.35. The overall assessment of the scheme on security is neutral, as expected.

Figure 3-7 A lay-by in use on the A421 © 2017 Google (September 2016 image)



Figure 3-8 Footpath alongside the old road © 2017 Google (September 2010 image)



Figure 3-9 Footpath at Woburn Road junction © 2017 Google (September 2016 image)



Key points from safety evaluation

Collisions

- In the area used for the modelling of the scheme's appraisal, there has been an increase of 30.1 collisions per annum following the scheme opening. In conjunction with this, the number of casualties has also increased, by 20.1 per annum. The severity index has however reduced for both collisions and casualties.
- For the scheme section, there has been a negligible reduction in collision numbers (0.7 collisions per annum). The severity index has also reduced meaning that there are proportionally fewer fatal and serious collisions following the scheme opening. This saving has been shown to not be statistically significant and is therefore likely to have occurred without the opening of the scheme.
- Collision rates on the old road have increased following the road being de-trunked with collision rates above the national average before and after the scheme opened.
- In relation to forecast safety impacts, the increase in collisions in the modelled area was not expected. Instead, a saving of 31 collisions in the opening year was forecast which is contrary to 20.1 increase in collisions.

Non-motorised users

- The number of collisions involving non-motorised users in the modelled area has increased from an average of 47.3 before the scheme opened to 62.2 following the scheme opening, representing a 32% increase. Further interrogation of the location of collisions involving non-motorised users demonstrates that only a small number are located within the scheme vicinity.

Personal Security

- The overall assessment of the scheme on security is neutral, as expected.

4. Economy

Introduction

- 4.1. This section of the report evaluates the costs and economic benefits of the A421 Bedford to M1 junction 13 scheme based on observed 'before' and 'after' data and a comparison with the forecast economic impact.
- 4.2. The scheme appraisal in 2007 predicted economic benefits of the scheme based on the forecast stream of monetised impacts over the 60 years following opening. This section evaluates the outturn benefits, based on the observations on traffic and safety as noted earlier in this report. Information provided on costs to date enables us to compare forecast costs with outturn costs of the scheme at the five years after opening stage.

Sources

- 4.3. The economic forecasts presented in this section are based upon:
 - A421 Bedford to M1 junction 13 Economic Assessment Report (February 2007).
 - A421 Bedford to M1 junction 13 to Economic Assessment Report Addendum (November 2007)
 - AST (June 2008).
- 4.4. Forecasts presented in the Economic Assessment Report (EAR) used the results of modelling using the Transport User Benefit Appraisal (TUBA) program, Cost Benefit Analysis (COBA) program and Queues and Delays at Roadworks (QUADRO) software, although model outputs were not available.
- 4.5. The outturn results are based on the following sources:
 - Outturn costs from the Regional Finance Manager in 2017.
 - Benefits are based on the observed findings of the impacts on traffic and collisions as detailed in the preceding traffic and safety sections of this report which have been monetised to create re-forecasts of the long-term impacts.
 - Project Appraisal Report (PAR) 5.0 guidance.
- 4.6. The EAR provided forecasts of the benefits for a 60-year appraisal period. All costs presented in the EAR and this chapter are in 2002 prices discounted to 2002, unless otherwise stated. This is in line with the price base as used in the EAR.

Present value benefits (PVB)

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

Table 4-1 Economic benefits of scheme (2002 prices and values)

Benefit stream	Forecast¹²	Evaluate?	Evaluation approach/comments
Journey time (business and consumer users)	£1447.8m	Yes	Outturn journey time impacts can be calculated from observed data.
Vehicle operating costs (VOC)	£43.4m	No	EAR addendum states that sector analysis showed that the majority of these benefits were for the wider area including M1. Recalculation of this is beyond the scope of this report. Assumed as forecast.
Delay during construction and future maintenance	£7.2m	No	Not evaluated in POPE studies. Assumed as forecast.
Safety benefits	£106.2m	No	Collision savings on the scheme are not statistically significant and have therefore not been monetised.
Carbon benefits	£1.1m	No	As per indirect tax below. Assumed as forecast.
Indirect tax revenue impact	£7.4m	No	It would not be appropriate to evaluate, as the profile of the predicted indirect tax impact switches from a positive to a negative during the scheme life, and the impact observed FYA is not indicative of that over the whole scheme life. Assumed as forecast.

- 4.8. These elements are used to calculate monetised benefits to business users and consumers over a wide area network and provide the forecasts for the transport economic efficiency (TEE) component of the TUBA model.
- 4.9. Forecast costs incurred by road users during road construction and maintenance relating to the scheme were assessed using the DfT computer program QUADRO. The majority of the scheme is off-line and therefore construction impacts on traffic were forecast to occur at the tie-in points only.
- 4.10. The QUADRO assessment showed a forecast user delay cost of £3.5m during construction, however, during maintenance, the user delay costs in the Do-Something scenario were forecast to be £8.6m less than in the Do-Minimum scenario. These impacts have not been evaluated in this study, however, it is appropriate to assume that the scheme would offer future maintenance delay savings, as works on a dual carriageway would cause less disruption and delays to users than on the existing single carriageway if the scheme was not built.
- 4.11. TUBA undertakes a matrix-based approach rather than a link-based approach, and the geographical area over which the scheme was assessed covers a large area extending northwards to the north of Bedford, westwards to the south west of Milton Keynes, towards the outskirts of Stevenage in the east, and Northampton in the north west. For these reasons, it is not possible to replicate the forecast assessment using observed data collected for this study.
- 4.12. The POPE evaluation methodology is based on monetising the observed post-opening vehicle hour benefits. The outturn 60-year vehicle hour benefits for this scheme is based on the observed journey times at OYA and FYA and monetised using a PAR approach, typically adopted by the Highways England for the appraisal of smaller schemes. It is accepted that this

¹² Using forecast benefits from the Addendum to EAR (November 2007)

is only an approximate methodology of obtaining economic benefits, which is not ideal for use on such a scheme as this. Therefore, it is being used merely to provide a benchmark of economic benefits.

- 4.13. As observed journey times are only available for the scheme length on the new and former A421, benefits on other routes have not been considered in this evaluation. The A421 corridor is where the clear majority of the benefits will have occurred, and whilst some parallel routes have witnessed reassignment, this is not considered likely to have resulted in journey time benefits of a magnitude that is significant to this evaluation. However, it should be kept in mind that this evaluation of vehicle hour benefits is likely to represent a conservative approach. This is further discussed later in this section.
- 4.14. To provide a possible range of benefits evaluated at this FYA stage, a 55-year capitalisation factor based on NRTF '07¹³ growth has been applied.

Vehicle hour benefits

- 4.15. Based on the above methodology and assumptions, an estimate of the scheme's vehicle hour benefits has been calculated, and is summarised in Table 4-2.

Table 4-2 Vehicle hour savings at FYA and calculation of vehicle hour benefits

Outturn vehicle hour benefits	Value and calculations
Vehicle hours saved at OYA	1,589,460
Vehicle hours saved in 2016 (a)	1,585,708
Total vehicle hours saved in first 5 years (b)	7,939,795
Value of time for opening year of 2011 (c)	£13.02
Value of first 5 years (d) = (b) * (c)	£103.4m
Value of 2016 saving (e) = (a) * (c)	£20.6m
Capitalisation factor (55 years) (f)	52.21 ¹⁴
Value of 60 years (g) = (d) + (e) * (f)	£1,181m
60 years vehicle hour benefits (2002 prices, discounted to 2002)	£896.5m

- 4.16. The outturn vehicle hour benefits at FYA using a PAR methodology is calculated to be £896.5m. This is notably lower than the £1,447.8m estimated in the scheme's appraisal¹⁵.
- 4.17. It should be noted that the result calculated here at FYA is likely to be a conservative one for the following reasons:
- Only the scheme sections of road (A421 between M1 and A6 to Cowbridge junction) have been included in the analysis, which means that possible benefits experienced elsewhere on nearby or parallel routes are not captured in the evaluate.

¹³ NRTF is the national road traffic forecast, which is a document defining the latest forecasts produced by the Department of the Environment, Transport and Regions of the growth in the volume of motor traffic. NRTF'07 is the most recent document version.

¹⁴ Based on PAR method, NRTF% growth.

¹⁵ Addendum to Economic Assessment Report, November 2007, Table 2.2.

- Considerable benefits are likely to have arisen from a reduction in junction delays. The EAR states: *'The improvement scheme will also relieve congestion compared to the present road, thus reducing time spent in queues approaching junctions'*.
- The scheme will have reduced junction delays at the at-grade junctions for traffic accessing the old road from the side roads along the route, which has not been captured in this evaluation. In addition, the EAR states that:

'a number of junctions were noted as having long delays associated with some movements in 2026 in both the AM and PM peaks'....'this was perceived to be a realistic reflection of existing permanent queuing conditions in the base year if improvement works are not undertaken to alleviate the problem'. The EAR lists several movements at M1 junction 13 and junction 14, and the A421 westbound approach to Marsh Leys junction, as examples of where large delays were expected to occur in the Do-Minimum scenario.

4.18. Taking the above into account, the scheme is still considered to have improved journey times and the lower than forecast benefits could be a result of the conservative approach to reforecasting.

Safety benefits

- 4.19. In scheme appraisal, the economic impact of changes in safety are calculated by assigning monetary benefits to the predicted reduction in the number and severity of PICs over the appraisal period.
- 4.20. As mentioned in the previous section, the forecast safety benefits of this scheme were derived from a COBA model, which gives predicted collision savings for the 60-year appraisal period. The COBA model network, over which safety benefits were forecast, is shown in Section 3.
- 4.21. As noted earlier, the observed savings for the scheme section were shown as not statistically significant and therefore in line with POPE methodology, the savings are not monetised and included as part of the reforecast BCR.
- 4.22. Normally, the POPE methodology for evaluating the outturn of economic value of benefits arising from safety benefits is based on a comparison between the forecast and observed collision changes at the POPE evaluation stage (in this case five years after opening, and using the pre-scheme counterfactual scenario to take background decline in collisions into account). It is then assumed that the observed safety impact for the five-year period after the scheme opened is indicative of what will be achieved over the remainder of the 60-year appraisal period. The ratio between the number of collisions saved in the first five years to the forecast 60 year benefits is then used to generate a re-forecast economic benefits.
- 4.23. If the savings were to be monetised and included as part of the reforecast BCR, the benefits would be approximately £91 million over the 60-year scheme appraisal period (2002 prices, discounted to 2002). However, as stated earlier, these benefits are not included in the final reforecast BCR and as such the final reforecast BCR can be considered to be a conservative reforecast.

Indirect tax

- 4.24. In addition to the scheme costs, the total forecast PVC (present value costs) for a scheme includes an amount of indirect tax which relates to the value of VAT (value added tax) and fuel duty that the government is expected to gain or lose as a result of the scheme.
- 4.25. Many major improvement schemes result in an increase in indirect tax revenue to the government which is expressed as a negative cost within the PVC. This is because the scheme has often resulted in more vehicles traveling at faster speeds.

- 4.26. For this scheme the forecast impact was less indirect tax revenues in the Do-Something than in the Do-Minimum scenario over the 60-year appraisal period.
- 4.27. The EAR (economic assessment report) states:
- 'This is a result of reduction in overall fuel consumption, and hence reduces the fuel duty and VAT received by the Government. This reduction in Government revenue has therefore contributed to the positive value of PVC.'*
- 4.28. The EAR gives no further information regarding the basis for this predicted impact on indirect tax. Closer inspection of one of the TUBA output files indicates that:
- The first three years after opening of the scheme were forecast to result in an increase in indirect tax revenues per year.
 - Years 4 to 60 were forecast to result in a reduction in indirect tax, resulting in an overall 60-year reduction in indirect tax revenues.
- 4.29. Overall the scheme was predicted to result in a reduction of indirect tax revenues to the value of £7.4m (in 2002 prices, discounted to 2002) over 60 years. It was assumed that in the Do-Minimum scenario congestion would increase over time to such an extent that vehicles would have slowed to a point where the fuel efficiency was lower than that of the faster speeds experienced with the scheme (Do-Something). In addition, the new road is slightly shorter than the old road, and this will also have contributed to this result.
- 4.30. Usually in POPE methodology, the evaluation of indirect tax impacts is based upon comparing observed and forecast change in fuel consumption at the POPE evaluation stage, combined with the assumption that the observed change in fuel consumption at the FYA stage can be taken as indicative of that over the whole 60-year appraisal period. The ratio of observed to forecast change in fuel consumption would then be applied to the forecast 60-year indirect tax monetary figure.
- 4.31. In this instance, however, it would not be appropriate to adopt this approach, as the profile of the predicted indirect tax impact switches from a positive to a negative during the scheme life, and the impact observed in the opening year is not indicative of that over the whole scheme life.
- 4.32. For this reason, the outturn indirect tax impact for this scheme has not been evaluated at this FYA stage, and an assumption shall be made that the forecast impact was accurate.

Summary of present value benefits (PVB)

- 4.33. The re-forecast PVB for the scheme is shown in Table 4.3. The forecast benefits for the scheme are taken from the scheme's 'Addendum to Economic Assessment Report'¹⁶. The reforecast values are based on the assessment of journey times, traffic volumes and safety impacts at five years after the scheme opening, which were discussed in previous sections.

¹⁶ Table 2.2 (vehicle hour benefits), and Table 3.3 (safety benefits).

Table 4-3 Present value benefits £m, in 2002 prices and values

Benefit stream	Forecast	Reforecast
Journey times	1,447.8	896.5
Vehicle operating costs	43.4	43.4
Delay during construction and future maintenance	7.2	7.2
Safety	106.2	n/a
Carbon	1.1	1.1
PVB sub total	1,605.7	955.6
Indirect tax revenue	7.4	7.4
PVB Total (including indirect tax in benefits)	1,613.1	955.6

4.34. It can be seen from Table 4.3 that the scheme's PVB is lower than forecast. This is due to the reforecast journey times being lower than forecast and the exclusion of safety benefits because the savings were not statistically significant.

Scheme costs

4.35. In addition to reassessing the level of benefits accrued by the scheme, a review of predicted and actual costs has also been undertaken. The outturn investment costs for building the scheme were obtained from the Regional Finance Manager at Highways England in July 2017 for the purposes of this study. The forecast costs for the scheme were provided by the Highways England Scheme Project Manager and are the Ministerial Approved Budget (MAB) from October 2008.

4.36. These outturn costs and forecast costs, which are not discounted, are shown in 2002 prices in Table 4-4. Of the figure provided for the outturn expenditure on lands, 11% was in relation to Part 1 claims for which the spend profile is not available.

Table 4-4 Costs in 2002 prices, £million

Forecast	Outturn
£170.5m	£162.1m

4.37. The outturn costs for the scheme at the OYA stage were 5% below the forecast cost. It is understood that the lower than forecast outturn costs are partly attributable to construction savings made using recycled materials.

Present value costs (PVC)

4.38. The scheme costs converted into present value are shown in Table 4-5. These figures are in 2002 prices, have been discounted to 2002 at 3.5% and converted to market prices. It should be noted that to present the forecast costs discounted to 2002, an assumption had to be made about the years in which the costs were forecast to be spent. To do this, it was assumed that the costs were forecast to be spent in the same years that they were spent. The PVC excluding the indirect tax impact is also shown.

Table 4-5 PVC for A421 improvements M1 junction 13 to Bedford scheme

Item	Forecast	Outturn
Works, prep & supervision	£163.0m	£154.5m
Land		
PVC (no indirect tax)	£163.0m	£154.5m
Indirect tax	£7.4m	£7.4m ¹⁷
Total PVC (as per appraisal, with indirect tax in costs)	£170.4m	£161.9m

4.39. With these costs expressed in present value on the same basis as the benefits (PVB), the benefit cost ratio can be calculated.

Benefit cost ratio (BCR)

4.40. The Benefit Cost Ratio (BCR) for a scheme is the ratio between the monetised benefits (PVB) and costs (PVC) and is used as a measure of value for money in economic terms.

4.41. At the time of scheme appraisal, Treasury guidance was to include indirect tax impact as part of the cost. However, the most recent guidance on indirect tax impacts recommends that it is included as part of the benefit.

4.42. The benefits and costs of the scheme expressed in present value are listed in Table 4-6, with the indirect tax being treated as part of the costs and benefits, and the calculated BCR at the FYA stage alongside the forecast BCR.

Table 4-6 Benefit Cost Ratio

	Forecast	Outturn
Present value costs (PVC)	£163.0m	£154.6m
Present value benefits (PVB)	£1,605.7m	£948.2m
Indirect Tax	£7.4m	£7.4m
BCR (with indirect tax in costs)	9.4	5.9
BCR (with indirect tax in benefits)	9.9	6.2

4.43. It can be seen from Table 4.6 that although the scheme has produced a BCR lower than forecast it is still above 4, which is the level deemed to be very high value for money. As demonstrated earlier, the reason for the lower present value benefits is due to the safety and journey time benefits being lower than expected. As no safety benefits are included, hence this is likely to be a conservative estimate of the benefits.

4.44. The BCR ignores non-monetised impacts. In scheme appraisals, the impact of the scheme on wider objectives must be considered but not monetised. The evaluation of the environmental, accessibility and integration objectives are covered in the following sections.

¹⁷ As explained earlier in this section, outturn indirect tax has not been evaluated and an assumption made that forecast indirect tax was valid.

Wider economic impacts

- 4.45. The scheme's forecast impact on the wider economy impacts sub-objective was assessed as 'neutral' in the Appraisal Summary Table (AST), as the scheme does not affect a regeneration area.
- 4.46. The Economic Assessment Report (EAR) states that:
- 'the proposed dualling of the A421 should contribute to the overall government objectives of regenerating the Bedfordshire area'.*
- 4.47. The Regional Transport Strategy for the East of England (2008) set the strategy transport policy in the region from 2008 to 2011. The strategy identified the A421 as part of the strategic road network for the region.
- 4.48. As part of the Regional Transport Strategy (2008), policy T1 places an importance on enabling:
- 'the provision of the infrastructure and transport services necessary to support existing communities and development proposed in the strategy'.*
- 4.49. This recognises the importance of a strong transport infrastructure in driving economic development and in improving communities.
- 4.50. Policy T6 states that *'the strategic and regional road networks identified on the key diagram should be improved, managed and maintained'*. The A421 scheme supports this policy by improving a strategic transport corridor within the region. The policy goes on to state that priority outcomes include:
- Improved journey reliability as a result of tackling congestion.
 - Improved safety and efficiency of the network.
- 4.51. The Bedford Council Core Strategy and Rural Issues Plan (2008) outlines the local transport strategy. The Plan states that *'east-west communications will be much improved with the completion of the Great Barford bypass and improvements to the A421 west of Bedford'*.
- 4.52. As previously discussed in this report, the A421 Bedford to M1 junction 13 scheme has improved the variability of journey times in all three time periods, which is in line with expectations in the Regional Transport Strategy. Further to this, average journey times have reduced in the AM peak, the PM peak, and the inter-peak period.
- 4.53. The scheme, with improved journey reliability, reduced journey times and improved safety, is likely to have improved communications across this strategic corridor. Furthermore, the Great Barford Bypass scheme has also improved conditions elsewhere on the A421 route. Taken together, it is likely that these schemes have made the whole A421 route more attractive, and a corridor for economic growth.
- 4.54. Differences between forecast and outturn traffic flows also shows evidence to suggest that despite the economic downturn, economic growth in terms of employment and housing has been strong in the Borough.
- 4.55. While it is difficult to state that an increase in economic activity is directly attributable to the scheme, it can be concluded that the scheme will have helped to facilitate economic opportunities.
- 4.56.** Taking the above into account, it is likely the scheme has had a 'slight beneficial' impact on the wider economics sub-objective which is higher than the 'neutral' impact expected in the AST.

Key points from economy evaluation

Benefits

- Journey time benefits for the scheme are lower than forecast, although still considerable at £896.5m. This is likely to be a conservative estimate due to the evaluation not capturing all roads included in the appraisal.
- The Present Value Benefits for the scheme are £956 million, which is £661 million (~40%) lower than forecast which is primarily due to the journey time benefits being lower than forecast. However, although it is noted that the reforecast has adopted a conservative approach, and the safety benefits are not statistically significant, they have not been included in the reforecast.

Costs

- The present value cost of the scheme was £162 million, which is 5% lower than the forecast cost of £170 million.

Benefit Cost Ratio

- The scheme's reforecast BCR has been calculated to be 6.2, which although lower than forecast is still considered very high Value for Money according to the DfT criteria.

Wider economic impacts

- Taken together with the A421 Great Barford Bypass, it is likely that these schemes have made the whole A421 route more attractive, and a corridor for economic growth. It is difficult however to be able to state that an increase in economic activity is directly attributable to the scheme, rather, it is likely that these schemes will have helped facilitate economic opportunities.

5. Environment

Introduction

- 5.1. This section documents the evaluation of the impacts of the scheme on the environmental sub-objectives.
- 5.2. The Non-Technical Summary of the Environmental Statement stated that the scheme would include:
- Extensive planting to help the road blend in with the landscape and contribute to the aims of the Forest of Marston Vale.
 - Ponds and habitat for the protected great crested newt and other wildlife.
 - Re-use of as much excavated material as possible from within the site.
 - Pollution and drainage control measures.
 - Low noise surfacing throughout, and noise barriers where needed.
 - Construction of bridges and underpasses to allow pedestrians, cyclists and horse riders to cross the road in safety.

Data collection

- 5.3. The following documents have been used in the environmental evaluation part of this study:
- Appraisal Summary Table (AST), June 2008.
 - Environmental Statement (ES) Volumes 1 (main text), 2a (detailed assessment), 2b (detailed assessment) and 3 (figures).
 - As built drawings (2011).
 - Construction Environmental Management Plan (CEMP) (November 2010).
 - Works information.
 - Traffic Forecasting Report (TFR) (January 2009).
 - Addendum to Traffic Forecasting Report (November 2007).
 - Noise Insulation Regulations Report – Salford Road property (December 2008).
 - Sound absorption properties of noise barriers.
 - Acoustic Report prepared for POPE report (March 2012).
 - Road surface influence (RSI) value of low noise surfacing.
 - The Woodland Vibration and Noise Survey (February 2012).
 - Scheme layout drawings.
 - Series 3000 specification appendices.
 - Ecology surveys 2015 – Great Crested Newts (GCN) and Bats, Brogborough County wildlife site (CWS).
 - Landscape and Ecology Aftercare Programme (LEAP).
 - Landscape audit reports (2016 used for this report).
 - Written scheme of investigation for: archaeological field evaluation and mitigation.
 - Archaeological Evaluation Report (November 2008).
 - Archaeological post excavation assessment (June 2009).
 - Non-Motorised User (NMU) Audit reports (August 2009 and September 2011).
- 5.4. A full list of the background information requested and received to help with the compilation of this report is included in the Appendix.

Site inspections

- 5.5. A site visit was undertaken in June 2017, and photo comparison views between OYA and FYA are included.

Consultations

5.6. Table 5.1 lists the organisations contacted on their views of the impacts they perceive the scheme has had on the environment, and whether they feel that the mitigation measures implemented have been effective. The table includes information on responses received, which are drawn on through this chapter.

Table 5-1 Summary of environmental consultation responses

Organisation	Field of interest	OYA comments	FYA comments
Environment Agency (EA)	Water	The EA reported that they had no issues relating to the scheme.	Responded that they have no comments.
Natural England	Biodiversity	Responded that the request for consultation did not appear to fall within the scope of the consultations that Natural England would routinely provide detailed comments on.	Not approached at FYA.
English Heritage	Archaeology	No response received.	Not approached at FYA.
Internal Drainage Board	Water	Responded positively to the scheme.	No response received.
Central Bedfordshire Council	General	Physical fitness, heritage and landscape.	No response received.
Bedford Borough Council	General	Public rights of way (PROW) with Central Bedfordshire Council.	Commented on water.
Apley Guise Parish Council	General	Comments received (included in journey ambience section).	No response received.
Brogborough Parish Council	General	No response received.	No response received.
Cranfield Parish Council	General	No response received.	No response received.
Hulcote and Salford Parish Council	General	No response received.	No response received.
Marston Moretaine Parish Council	General	No response received.	No response received.
Wootton Parish Council	General	Comments received (included in physical fitness section).	Commented on scheme lighting.
Lidlington Parish Council	General	No response received.	Response received for noise and air quality. Traffic concerns

			forwarded for reference in the rest of the report.
Forest of Marston Vale	Landscape	Commented on the sub-objectives noise, air, landscape, biodiversity and water.	No response received.

Animal mortality

- 5.7. The Asset Support Contractor (ASC) has been consulted regarding animal mortality figures. It was confirmed that no figures are available for this report.

Traffic forecasts and evaluation

- 5.8. Three of the environmental sub-objectives (noise, local air quality and greenhouse gases) are directly related to traffic flows. No new environmental surveys are undertaken for POPE and an assumption is made that if the observed level of traffic is in line with forecasts, then it is likely that local noise and air quality are as expected.
- 5.9. The traffic forecasts from the ES (interpolated to 2017) are used for comparison, in the noise and local air quality appraisals, with the observed flows are summarised in Table 5.2.
- 5.10. The ES noted that flows along the existing A421 varied along its length, with flows being at their lowest in the section between Brogborough and Marston Moretaine (in the region of 21,000 vehicles AADT), and with the higher flows occurring between Wootton and the Marsh Leys Junction (in excess of 28,000 vehicles AADT).
- 5.11. The ES stated that the existing A421 (without the scheme) was predicted to have 24-hour traffic flows (AADT) in the region of 26,000 to 41,000, at various locations along the route in 2011, whilst flows might increase to between 30,000 and 45,000 by 2026. With the scheme, traffic figures would increase by 2026 resulting in traffic flow numbers to increase to between 60,000 and 68,000. Under the 'Do-Something' scenario, flows on the existing A421, which would be detrunked, would fall substantially. A comparison of Do-Minimum and Do-Something flows on the existing A421 between M1 junction 13 and Marston Moretaine shows that by 2026 the AADT would be reduced to around 30% of the do-minimum AADT.
- 5.12. The general effect of the scheme on the local road network was expected to be a reduction in flows, although there would be localised increases where traffic would be directed to new/improved junctions and over/underbridges.
- 5.13. No traffic speeds or percentage HGVs were included for comparison in the ES.
- 5.14. Table 5-2 present the forecast and observed flows at five years after opening.

Table 5-2 Traffic flows: FYA observed versus forecast

	Location/ link	AADT			
		Forecast 2017	Observed (FYA 2017)	Difference	Percentage difference
13	Old A421 - Brogborough	5,780	4,600	-1,180	-20%
12	Old A421 – near Lidlington	5,400	5,700	-120	-2%
12	Old A421 – near Marston Moretaine	6,420	5,700	-720	-11%
17	A421 Near Vale Farm overpass bridge	53,200	53,500	-440	-1%
18	A421 Near Berry Farm underpass	62,580	52,800	-9,780	-16%

Noise

- 5.15. The 2008 AST stated that there would be a negligible increase in the overall number of people annoyed. Areas that would experience an overall improvement in noise climate included Brogborough, parts of Marston Moretaine and parts of Lower Shelton. It further stated that there would be significant effects from redistributed traffic on existing roads outside the Scheme corridor.
- 5.16. In the long term it was estimated that with the scheme there would be an increase of 168 people within the study area annoyed by traffic noise in the design year (2026). This would change the percentage of people annoyed by traffic noise in the study area from 9.1% to 9.2% and was considered to be a negligible effect. The AST noted that the scheme would have an impact on traffic levels over a particularly large area. With the scheme, there would be a decrease of 258 in the number of people exposed to traffic noise levels above 69 dB LA10,18h¹⁸.

Environmental statement

- 5.17. It was estimated that there would be a short-term increase of 4,120 in the number of people annoyed by traffic noise over the future baseline in total. This would change the percentage of people in the study area annoyed by traffic noise from 8.8% to 12.2% and was considered to be moderate adverse.
- 5.18. In the long-term it was estimated that with the scheme there would be a decrease of 251 in the number of people annoyed by traffic noise over the future baseline, in a total population of 121,315. This would change the percentage of people annoyed by traffic noise from 9.3% to 9.1% and is considered to be a negligible effect.
- 5.19. In the long term, it was estimated that, with the scheme, there would be a decrease of 246 in the number of people annoyed by traffic vibration over the future baseline. This would change the percentage of people in the study area annoyed by traffic vibration from 3.2% to 3.0% and was considered to be a negligible effect.
- 5.20. The assessment was considered to be a worst case as based upon DMRB (design manual for roads and bridges) guidance. In particular, the assessment assumed a low-noise road surface for the existing A421 in the future 2025/26 baseline. Different properties at these locations would experience both increases and decreases in noise as a result of the scheme. With regard to ground-borne vibration, the ES considered that no properties were sufficiently close to the scheme for significant ground-borne vibration impacts to occur.

¹⁸ UK Traffic Noise Index

- 5.21. The key objectives of the scheme regarding noise are:
- To minimise traffic noise at residential properties affected as a result of the scheme.
 - To minimise the impact of traffic noise on public rights of way and amenity areas affected as a result of the scheme.

Consultation

- 5.22. Lidlington Parish council commented that “*Lidlington has not really been affected by noise levels, except [by] 'racing vehicles' at night*”.

OYA evaluation

- 5.23. The OYA report noted that there were lower than expected flows (less than 20% of predictions) for the new A421 and although higher than expected traffic flows were observed on the old A421 near Lidlington, they had reduced significantly from the before scheme flows.
- 5.24. The OYA report also confirmed that proposed developments in Kempston West and to the north and south of Fields Road, Wootton, would provide an additional 925 residential properties within the study area for 2010/11. A worst case estimate was that an additional 267 people would be bothered by traffic noise, out of a total population of 2,220 in these three developments. This was taken into account in the final ES assessments for noise.
- 5.25. Noise mitigation measures included the use of low-noise surfacing (high speed Road Surface Index (RSIH) 5.5dB(A), which is below that of a standard hot rolled asphalt surface) throughout the scheme.
- 5.26. Noise mitigation in the form of carriageway-edge noise barriers were installed where calculations indicated that road traffic noise levels at properties along the route of the scheme would be increased to exceed 68 dB LA10,18h. Additionally, bunding was included where estimated noise increases as a result of the scheme were shown to be significant, although expected to be below 68 dB LA10,18h.
- 5.27. The OYA observed traffic flows on the new A421 were more than 20% below forecast, and therefore it was predicted that noise was likely to be better than forecast at this location. Traffic flows were roughly as expected at Brogborough and Marston Moretaine on the former A421. Therefore noise at these locations was predicted to be as expected. However, due to the higher (by 32%) than expected traffic volumes near Lidlington on the old A421 noise may be worse than expected at that location. Noise impacts of the scheme are summarised together with a summary of the other sub-objectives at the end of this section.

FYA evaluation

- 5.28. Noise from the flow of road traffic is generated by both vehicles' engines and the interaction of tyres with the road surface. The traffic noise level at a receptor, such as an observer at the roadside or residents within a property, is influenced by a number of factors including traffic flow, speed, composition (% HGVs), gradient, type of road surface, distance from the road and the presence of any obstructions between the road and the receptor. An assumption is made by POPE methodology that noise levels will be as expected if observed traffic flows are within 25% more or 20% less than predicted; average speed is different by at least 10kph; or % HGVs is different by at least 20%.
- 5.29. During the POPE site visit it was noted that preliminary construction works of new developments at OYA are mostly complete, bringing in extra vehicular traffic as predicted in the ES (see Figure 5-1). In addition to this, new developments were noted to the east of the A421 although still at an early stage of construction. These developments will impact on both the old and new A421, adding additional traffic volumes and thus contributing to the overall noise experienced by existing receptors.

Figure 5-1 Development east of Fields Road overbridge – under construction (OYA view) and nearing completion (FYA view)



- 5.30. During the POPE site visit, the noise barrier east of Marston junction was accessed (see Figure 5-2 below). The barrier appeared generally in good condition and functioning as expected apart from the gap in the barrier detailed below.

Figure 5-2 Noise barrier east of Marston Junction



- 5.31. During both the June and July site visits, the gap in the noise barrier east of Marston junction shown in Figure 5-3 below was noted. It is concerning that the gap had remained for this duration although it is unknown how long it has remained prior to the site visits. Barrier panels matching those missing were seen on the verge of the southbound on slip at Marston junction – POPE is unsure if these were the missing panels. It is noted that no damage to safety barriers on either side of the noise barrier (i.e. old and new A421) indicating a collision was seen during the POPE site visits. The panels were cleanly cut indicating intentional programmed removal.

Figure 5-3 Gap in noise barrier east of Marston junction



5.32. Based on traffic figures shown in Table 5-2, observed traffic flows on the new A421 are 1% lower than predicted near Vale Farm overbridge and 16% less than predicted near Berry Farm underpass and therefore it is predicted that noise is likely to be as expected along the new A421. Traffic flows on the former A421 are between 2 and 20% lower than forecast and therefore noise prediction is as expected at Brogborough and Marston Moretaine on the former A421.

Table 5-3 Evaluation summary: noise

Sub-Objective	AST	FYA
Noise	Increase in 168 people annoyed in 2026. NPV £2.49m.	As expected

Local air quality

Forecast

AST

5.33. The 2008 AST stated that there would be a net beneficial impact to the community as a whole. A total of 35,389 properties were located within 200m of the existing A421 and/or Scheme and/or surrounding roads. 61.7% would experience an improvement in PM₁₀ and 38.3% would experience a worsening. It further stated that 62.4% would experience an improvement in NO₂ and 37.6% would experience a worsening.

5.34. No exceedances of the air quality objectives were predicted at any affected property with or without the scheme. There would be no negative effect on any Air Quality Management Areas (AQMAs).

Environmental statement

5.35. The ES concluded that:

- Overall, the scheme would have a minor beneficial impact on community exposure to road traffic pollution.
- The total quantity of road traffic pollutants and the greenhouse gas CO₂ had been predicted with and without the scheme in operation. The increase in total vehicle

kilometres travelled in the traffic model study area and the increase in average speed on the A421 with the scheme in place would result in a moderate increase in total emissions from road traffic.

- The impact of road traffic emissions on the Marston Thrift site of special scientific interest (SSSI) had been assessed. As the only SSSI site within the study area was located more than 200m from any road affected by the scheme it was concluded that the operation of the scheme would have no significant impact on nature conservation sites due to changes in road traffic emissions.
- The air quality impact assessment concluded that the scheme would not result in any significant air quality problems due to changes in road traffic emissions. As the DMRB procedures used were designed to over predict traffic emissions, it could be assumed with confidence that no such problems would occur.

5.36. A key air quality objective of the scheme was to minimise traffic derived air pollution levels close to residential properties affected as a result of the scheme.

Consultation

5.37. Lidlington Parish Council commented '*There has not been any change to pollution levels*'.

OYA evaluation summary

5.38. Average traffic flows on the scheme were lower (by more than 10%) than predicted across all links, indicating air quality was better than expected along the new road and generally as expected along the old A421, while pollutant concentrations were likely to be lower than expected along the new route.

FYA evaluation

5.39. An assumption is made by POPE methodology that if traffic flows vary by more than +/- 10% AADT, or by +/- 200 HGV AADT, or daily speed by 10kph, or peak hour speeds by 20kph from those predicted in the ES, it is assumed that local air quality is likely to be either 'worse than' or 'better than' expected.

5.40. At FYA, traffic flows on the new A421 are within the 10% range at Vale Farm, whilst at Brogborough there are 16% lower than predicted traffic flows resulting in a better than expected evaluation. On the old A421, traffic flows are within the range near Marston Moretaine, and may be better than expected at Brogborough. Overall it is expected that air quality at FYA is likely to be as expected, with some areas likely to be better than expected.

Table 5-4 Evaluation summary: local air quality

Sub-objective	AST	FYA
Air quality	No. of properties where PM ₁₀ concentrations would improve in 2011 due to the scheme: 21,820	As expected
	No. of properties where PM ₁₀ concentrations would worsen in 2011 due to the scheme: 13,569	
	No. of properties where NO ₂ concentrations would improve in 2011 due to the scheme: 22,079	
	No. of properties where NO ₂ concentrations would worsen in 2011 due to the scheme: 13,310	

Greenhouse gases

- 5.41. The assessment of the impacts of transport schemes on emissions of greenhouse gases is one of the environment sub-objectives. WebTAG notes that Carbon Dioxide (CO₂) is considered the most important greenhouse gas, therefore is used as the key indicator for the purposes of assessing the impacts of transport options on climate change. Changes in CO₂ levels are considered in terms of equivalent tonnes of carbon released due to the scheme. Carbon emissions are forecast for the Do-Something (with scheme) and Do-Minimum (without scheme) scenarios for the opening year.

Forecast greenhouse gases

- 5.42. The latest AST for the scheme stated that *'total emissions of carbon from traffic in the Traffic Model Study Area were predicted (based on total 12 hour weekday flows) to increase by 1% in 2011 with the introduction of the scheme. This is due to reduced emissions per vehicle kilometre with the scheme in place, which partially offsets a 2.4% increase in total vehicle kilometres'*.
- 5.43. In quantitative terms, the estimated emissions in the opening year with the scheme were 187,528 tonnes of carbon, compared to 185,446 without the scheme, an increase of 2,082 tonnes. Over 60 years however, annual tonnes of carbon were estimated to reduce with the scheme, which is consistent with findings presented earlier in relation to indirect tax. This is because in the Do-Minimum scenario, over time, congestion would increase to such a point where fuel consumption would be higher (i.e. less fuel efficient) than with the scheme.

FYA evaluation

- 5.44. Using current guidance on air quality assessment provided in DMRB¹⁹, it has been possible to calculate outturn changes in carbon emissions (tonnes per annum) using observed data to determine if the forecast impact five years after scheme opening has been in line with predictions. These calculations have been based on traffic volumes, HGV percentages and average speeds taken from the journey time data presented earlier in Section 2 of this report.
- 5.45. A proxy for the Do-Minimum scenario has been created by taking the traffic flows for the 'before' period and interpolating to 2016 levels as an approximate indication of any background changes in traffic levels that may have occurred without the scheme in place.
- 5.46. Only the sections of the new and old A421, the A421 between Marsh Leys junction and the A6. The results of this exercise are shown in Table 5.5.
- 5.47. Therefore, in order to provide a like-for-like comparison of forecast and observed impacts using the same methodology and covering the same geographical area, a forecast has been produced using forecast traffic flows from the ES. As HGV percentages and forecast speeds are not provided in the scheme's ES, forecast HGVs have been taken from the traffic forecasting report as it is assumed these would have been used for the environmental assessment work, and the forecast speeds were assumed to be the same as observed. Given that the journey time savings presented in Section 2 were roughly in line with the time savings stated elsewhere in the ES, this is considered a reasonable assumption and approach to take.
- 5.48. The results of this exercise are presented alongside the outturn in Table 5.5.

¹⁹ Volume 11 Section 3 Part 1

Table 5.5 Revised forecast and outturn impact on annual emissions (tonnes of carbon) at OYA and FYA

	Year	Without scheme (proxy Do-Minimum)	With scheme	Change
Forecast	2011	4,550	24,401	19,851
OYA	2011	10,662	15,422	4,761
FYA	2016	11,816	16,264	4,448

5.49. Table 5.5 shows that the scheme has resulted in a smaller increase in carbon than forecast when considering only those roads directly affected by the scheme. The reasons for these findings are explored below:

- The revised forecast increase in carbon is much higher than the 1% increase predicted in the AST, which is because the original carbon assessment included a large modelled area which included several other routes where traffic was expected to reassign to the A421 corridor as a result of the scheme. Therefore, the relatively small predicted increase in the modelled area compared to the large increase along the scheme extent merely reflects this, and supports the need for producing the revised forecast so that a like-for-like comparison can be made.
- HGV proportions in the forecasts have been taken from the Traffic Forecasting Report as the ES did not present them. Based on this information, the HGV proportions were significantly underestimated in the Do-Minimum within the forecasts. As the assessment of carbon is highly sensitive to the proportion of HGVs, this is considered to be the main reason that the outturn 'proxy Do-Minimum' carbon emissions are higher than forecast, and subsequently resulted in a smaller increase in the Do-Something.
- The other key factor is that traffic volumes using the scheme have been significantly lower than forecast in the Do-Something. The increase in traffic has also been less than forecast, partly explained by less reassignment from other routes than anticipated. This has resulted in a much smaller increase in tonnes of carbon in the opening year than forecast.
- FYA emissions on the scheme section of the A421 are higher than OYA due to the increased traffic, although the net difference in carbon emissions is lower than at OYA. This is due to the increased speeds with the scheme being lower at FYA than at OYA.

5.50. To conclude, the scheme's impact on carbon emissions has been less than forecast over the area immediately affected by the scheme.

5.51. It should be borne in mind, that this scheme was predicted to bring about an overall reduction in carbon emissions over the 60 year appraisal period, because the Do-Minimum scenario was predicted to deteriorate to such a point where fuel consumption and therefore emission became higher than in the Do-Something. Therefore, as with the findings regarding indirect tax, the results presented here should not necessarily be taken as indicative of the scheme's impact over 60 years.

Landscape and townscape

Forecast

AST

- 5.52. AST stated that whilst the scheme would introduce an artificial element into an already damaged landscape, extensive woodland, tree and shrub planting had been incorporated into the design to mitigate this. It was predicted therefore, that the scheme would be better integrated into the landscape, while assisting in meeting the objectives of the Forest of Marston Vale in increasing woodland cover and promoting recreation.
- 5.53. Additionally, the AST stated that the scheme would enhance the landscape quality through the introduction of new landscape features which would be visible from within the Area of Great Landscape Value (AGLV) which lies to the south of the scheme. This visibility was not considered of enough significance to lead to conflict with the policies in the Bedfordshire Structure Plan.
- 5.54. The AST scored a slight adverse effect for landscape.

Environmental Statement

- 5.55. The ES stated that the A421 was a well-established east-west route between the M1 close to Milton Keynes and Bedford. With the existing route rising high over the Greensand Ridge at Brogborough before dropping down into the Marston Vale towards Bedford with the scheme passing through four distinct Landscape Character Areas (LCA). Vegetation had established naturally along much of the existing route and under the stewardship of local farmers. Some sections of more recent improvement to the road included landscape planting designed as mitigation.
- 5.56. The scheme's key landscape objectives were:
- To minimise impacts on the character and quality of the local landscape.
 - To fit into plans for the Forest of Marston Vale strategy area.
 - To minimise the visual impact of the scheme from residential and recreational properties.
 - To minimise the visual impact of the scheme from Public Rights of Way and amenity areas.
 - To minimise the impact of the scheme on agricultural holdings and farming practices.
- 5.57. The ES confirmed that the design of the landscape mitigation would aim to integrate the scheme into the landscape through appropriate use and grading of earthworks in addition to planting. The proposals aimed to not only replace the landscape features lost to the scheme but also to increase planting where opportunities allowed and to conserve, restore and diversify the landscape character. The scheme would be particularly beneficial in furthering the aims and objectives of the Forest of Marston Vale. The landscape proposals were also designed to mitigate the visual effects of the scheme from visual receptors, especially local residents. A number of earth bunds had been incorporated into the scheme to provide screening of the road from the surrounding landscape. In the location of Wood End, this would take the form of a false cutting where the road would be on embankment. Wherever possible, existing landscape features would be incorporated into the landscape proposals to improve the structure of the landscape and provide visual screening at an early stage. However, the size of the cutting at Brogborough, and the introduction of Marston junction and a number of overbridges would have a significant impact on the character of the landscape.

- 5.58. The ES noted that the construction process would give rise to adverse landscape effects of at least moderate significance on all four of the LCAs directly affected by the scheme. However, landscape mitigation would alleviate the effects and by year 15 only LCA 3 would suffer adverse effects, of at least moderate significance.
- 5.59. The effect of the scheme on sensitive visual receptors would reduce over time from construction through to operation. By year 15 of operation (2025/26), the planting carried out as part of the environmental mitigation for the scheme would have matured sufficiently to screen the road in many areas, and would provide a beneficial effect to the majority of visual receptors. Some 69% of receptors would suffer adverse effects at year 1. The impact of the proposed landscape planting would reduce this number to 10% at year 15.
- 5.60. As well as bringing benefits to some visual receptors, the scheme would contribute to the character of the landscape through which it passed. The scheme included significant amounts of tree, shrub, woodland and hedgerow planting which would assist in repairing what was in many cases a degraded landscape. The landscape proposals would also further the aims and objectives of the Forest of Marston Vale in terms of woodland cover, landscape benefits, ecological benefits and benefits to the community as a whole. Despite the inevitable adverse effects on landscape and views, the landscape proposals were considered to provide a benefit to the landscape in many areas.

Effects of lighting at year 15 (ES)

- 5.61. The ES expected that by year 15 of operation, the planting proposed as part of the mitigation for the scheme would have matured sufficiently to provide landscape integration and visual screening. This planting would also have an effect of reducing the amount of light spill created by the scheme by diffusing and containing light from overhead lamp columns and vehicles moving along the road.

Consultation

- 5.62. Wootton Parish Council referenced a street light on the A421 adjacent to the overbridge which leads from the A421 into Wootton. It was noted the light has never been illuminated due to its close proximity to the bridge and the fact its height (if lit) could dazzle drivers as they use the bridge whilst entering/leaving the village. Members considered its positioning a design flaw.

OYA Evaluation

- 5.63. The ES stated that to provide visual screening to residents adjacent to the main carriageway, including those located at Highfield Farm and along the existing A421, a block of woodland was established, including an earth-bund, along the southern edge of the road. This would also filter medium distance views from residential properties in Brogborough.
- 5.64. The landscape planting and ecological mitigation measures that were put forward as part of the scheme were developed in consultation with the Forest of Marston Vale and considered to go an appreciable way towards meeting policy objectives for the Marston Vale Community Forest.
- 5.65. The site visit for the OYA evaluation confirmed that planting mitigation had been implemented as expected within the highway boundary, and that offsite planting had been undertaken as required by the ES.
- 5.66. The OYA report confirmed that specific areas within the scheme had not established as expected including the approach walkway slopes to Manor Farm bridleway and areas within the Marston junction. The vegetation surrounding the retaining netting on the slope at Manor Farm bridleway had not established well.
- 5.67. During the OYA site visit, it was noted that planting had been undertaken in phases during scheme construction. Areas where planting was completed early on was showing signs of growth comparative to what could be expected 2 years after completion, while others were

within the six months to one year growth phase. This should be noted for the FYA report, as growth may appear mixed, or assumptions made of possible poor soil conditions limiting growth in some areas which would not be the case for this scheme in general.

- 5.68. The OYA site visit confirmed that seeding of embankment and cutting slopes had generally established satisfactorily and appeared free of noxious weeds although litter appeared to be an issue along the route concentrated mostly at the lay-bys.

Visual impacts

- 5.69. The OYA report confirmed that the visual effects of the scheme on receptors within the visual envelope was considered to be generally adverse, as expected, with some sensitive receptors likely to suffer adverse effects of at least moderate significance. The completed scheme included a number of highly visible new features such as junctions and bridges. Although the landscape mitigation was in place, it was immature and was not effective as a visual screen. This was as expected. At year 15, it was expected that filtered views of the scheme would remain, with the scheme more visible in the winter due to deciduous tree and hedge species losing their leaves.
- 5.70. New lighting within the scheme had been implemented as expected. The site visit confirmed that as stated in the ES, there was no lighting on the mainline but there was significant new lighting located at the new junctions and between the A421 and Lower Shelton.
- 5.71. Overall, it was considered at OYA that impacts were as expected.

FYA evaluation

- 5.72. Wootton Parish council noted lighting near the Fields Road overbridge as a concern, with particular reference to a single lighting column not in use. No further information is available on the lighting design.
- 5.73. Planting at FYA is showing good continued growth with isolated pockets where some failures are noted. Overall it is expected that planting within the scheme will generally meet its screening and integration function by the design year (2026).

Figure 5-4 Woodland planting and species rich grassland showing good growth and establishment



- 5.74. The new A421 still has an impact on the North Marston Vale landscape character area and the Greensand Ridge although planting has matured considerably since completion of construction. Whilst the effect will remain, it is expected that this will soften by the design year.
- 5.75. Townscape was not assessed in the ES. There have been considerable positive effects for the amenity of Brogborough Village, the setting of Marston Moretaine and Shelton and the

approach to Cranfield. Traffic flows have reduced, resulting in a more tranquil atmosphere, most especially during peak hour traffic times.

- 5.76. Consistent aftercare maintenance was noticeable during the POPE site visit including successful colonisation of slopes with species rich grassland where planted.
- 5.77. Notes taken from the 2015 Landscape Monitoring Schedule indicated that most planting plots were well established with only a few notes of concern:
- A planting plot to the east of the A421 near M1 junction 13 and a planting plot near Marsh Leys junction have been affected by ash dieback (*Hymenoscyphus fraxineus*) which was originally identified in 2015 and identified for future monitoring and reporting to the forestry commission in 2016.
 - Ornamental Himalayan Poppies (*Papaver somniferum* – invasive species) near the Manor Farm overbridge have been controlled via strimming twice a year to prevent spread into the species rich grassland in this area.
 - In several species rich grassland (SRG) plots, it is noted that arisings from these plots have been left – these arisings should be removed after strimming.
 - Woodland planting within Brogborough spinney woodland mitigation planting has been extensively grazed by deer with approximately 50% plant losses. Replacement planting was undertaken in 2014.
- 5.78. Bulb planting proposed north of Marston junction is confirmed as planted. Unfortunately, strimming was undertaken of the area prior to the POPE site visit. Figure 5-5 below shows recently cut plants amongst the grassland.

Figure 5-5 Bulb planting north of Marston junction



- 5.79. Figure 5-4 and Figure 5-5 demonstrate good growth in vegetation throughout the scheme.

Figure 5-6 Planting near Fields Road overbridge



Figure 5-7 Comparison views of planting between the old A421 and existing A421 at Fields Road junction (OYA view on the left, FYA view on the right)



Figure 5-8 Southern approach to Manor Road Bridleway (OYA view on left, FYA view on right)



Sub-Objective	AST	FYA
Landscape	While the Scheme introduces an artificial element into an already damaged landscape, extensive woodland, tree and shrub planting has been incorporated into the design. The Scheme is thus better integrated into the landscape, while assisting in meeting the objectives of the Forest of Marston Vale in increasing woodland cover and promoting recreation. It also enhances the landscape quality by the introduction of new landscape features. An Area of Great Landscape Value (AGLV) lies to the south of the Scheme. Whilst the road would not pass through this it would be visible from within the AGLV in the Lidlington/Brogborough area. This is not however considered of enough significance to lead to conflict with the policies in the Bedfordshire Structure Plan.	As expected

Cultural heritage and archaeology

Forecast

AST

- 5.80. The AST predicted that the scheme would have no direct impact on any scheduled ancient monuments (SAMs), historic parks and gardens, historic battlefields or conservation areas. It confirmed that the scheme would have an adverse impact on some identified archaeological sites and that there would be indirect adverse impacts upon three Grade II listed buildings due to noise and visual intrusion.
- 5.81. The AST scored a slight adverse effect for heritage.

Environmental statement

- 5.82. The ES Volume 2 concluded that the off-line sections of the scheme would exert the greatest impact on built heritage resources, introducing new impacts on the setting of previously unaffected built heritage receptors. However, the on-line sections would also result in increased impacts from the road on the setting of some historic buildings.
- 5.83. The scheme's non-technical summary report stated that issues identified as part of the scheme included the loss of the building of local interest at Charity Farm, impacts on 'setting' of a number of local historic or listed Buildings, impacts on five archaeological sites of regional importance and impacts on four archaeological sites of local importance.
- 5.84. The scheme's key heritage objectives were:
- To develop the scheme to be compatible with the historic fabric of the area.
 - To avoid or minimise change to heritage features.
 - To ensure that where proposals affect a feature of historic value, that there is no loss of potentially important historic information.
 - To develop a strategy for cultural heritage surveys, mitigation and consultation.
- 5.85. To minimise impacts on cultural heritage, further archaeological survey work prior to construction was proposed and any significant finds would be preserved on site or investigated

and recorded in detail. Archaeological areas and sites would be protected during scheme construction. Hedgerow, tree and shrub planting would reduce impact on 'settings' of buildings.

- 5.86. Impacts would be realised due to the setting of historic assets caused by the scheme, loss of vegetation and the introduction of motorway furniture including lighting, gantries and environmental barriers, as discussed in the landscape section.

Consultation

- 5.87. No consultation responses were received.

OYA evaluation

Built environment

- 5.88. The building demolished at Charity Farm was subject to a scheme of photographic recording, to English heritage level 2 standard, in advance of its demolition to provide a permanent record of the structure. As the scheme had been implemented as proposed, it was assumed that the effects on the built environment remain as predicted in the ES.

Archaeology

- 5.89. The archaeological evaluation report dated November 2009 comprised a post excavation assessment and project design for the site archive generated by a programme of fieldwork along the route of the A421 Improvements.
- 5.90. The excavations recorded a series of sites of later Iron Age to Roman date, representing evidence for domestic occupation and agricultural activity. The sites were all situated in similar geological and topographical settings within Marston Vale, a south-westerly projection of the Ouse Valley, and so they form a particularly coherent group, both chronologically and geologically, and provided an opportunity to study the functioning and evolution of this landscape during this period.
- 5.91. No conclusions could be presented at OYA as the final archaeology report was not available and it was confirmed that the archaeological aspect of the scheme should be assessed within the FYA report if the final report was made available.

Historic landscape

- 5.92. The OYA report stated that landscape design had been implemented as proposed and it was assumed that the slight adverse effects on the historic landscape affected by the scheme was as expected.

FYA evaluation

- 5.93. The finds, paper record and digital archive are to be deposited with Bedford Museum under accession code BEDFM:2008.313. It has not been possible to confirm this at FYA.
- 5.94. The final archaeology report notes that following a thorough programme of geophysical survey and field evaluation a total of nine sites were selected for further investigation, either as open area excavation or strip, map and sample excavation. Six investigations produced evidence for activity during the Iron Age and Roman period. Useful information was also provided by the geophysical survey and field evaluation of the proposed borrow area at Berry Farm, although the site was ultimately not investigated further because extraction of the proposed borrow pit was deemed unnecessary. The remains recorded at these sites formed a particularly coherent group as a result of their common geographical and topographical settings and their similar chronology and have provided significant evidence for the occupation of the Vale during these periods.
- 5.95. No information has been made available to POPE that might indicate the scheme effects on cultural heritage are anything but as expected.

Sub-Objective	AST	FYA
Heritage of historic resources	The Scheme would have no direct impact on any Scheduled Ancient Monuments, Historic Parks and Gardens, Historic Battlefields or Conservation Areas. The Scheme would have an adverse impact on some identified archaeological sites. There would be indirect adverse impacts upon three Grade II listed buildings due to noise and visual intrusion.	As expected

Biodiversity

Forecast

AST

5.96. The 2007 AST stated that the road passed through a landscape dominated by arable land and improved pastureland, generally of limited value for nature conservation. Planting proposed for the new road corridor would, beyond the short-term, provide new areas of species-rich grassland, scrub and woodland and the realignment of Broughton Brook would enhance its nature conservation potential. Specific adverse ecological effects would be amenable to mitigation with the mitigation proposed for the great crested newt would result in a positive effect on the species overall.

5.97. The AST scored a slight beneficial effect for biodiversity.

Environmental statement

5.98. The ES stated that:

- The proposed scheme would pass through an agricultural landscape that overall may be assessed to have a limited biodiversity value.
- The proposed scheme would have no effect on designated sites of national or international importance. The road passes through the north-western corner of Brogborough Lake County Wildlife Site (CWS), causing permanent land take of 2.5ha (3.4% of the CWS). The grassland that has developed in this part of the CWS is of medium value and its loss would be mitigated by habitat enhancement as a consequence of improved management nearby within the CWS, along with the creation of similar grassland along the new road embankment adjacent to the CWS. Throughout the route, there would be a small gain in neutral grassland to the scheme.
- The route corridor supported a medium population of great crested newts. Although no ponds would be lost, land take to and severance of supporting terrestrial habitat would be mitigated by the enhancement of remaining terrestrial habitat and the provision of six new ponds.
- The existing hedgerow network would be broken by the new road in several locations, although new hedges along the road would ensure that there was a net gain of hedgerow length and quality within the route corridor. This change in the network of hedges would potentially affect the six species of bat that forage within and pass through the route corridor; this would be mitigated by detailed landscaping. Although no bat roosts were found within the area of land take, careful removal of eleven trees and one building with at least moderate potential for supporting bat roosts would be carried out.
- Overall, there would be a significant net increase in native woodland and scrub within the route corridor; the loss of 1.13ha of the semi-natural woodland at Brogborough

Road Spinney would be mitigated by the provision of 2.1ha of contiguous new woodland planting.

- Realignment of Broughton Brook and the extension of the culverts over Broughton and Elstow Brooks would be carried out carefully to avoid adverse effects upon the spined loach and bullhead that are found within the brooks. The nature conservation potential of the realigned section of Broughton Brook would mitigate, to an extent, the effects of the extended culverts.
- Badgers have a number of territories within the Scheme corridor, and construction would cause the loss of areas of foraging habitat. Currently, no setts would be lost to the Scheme. The planting of semi-natural areas of vegetation would reduce the impact overall, and the provision of fencing would reduce the potential mortality of individuals crossing the new road alignment.
- Otters were known to frequent the area and it is believed that they use Elstow Brook as a transitory route. The increase in length of culverted stream in this area would increase the barrier effect to otter movement. However, the installation of a mammal shelf within the culvert and the creation of a habitat corridor alongside the culvert would offset the increase in length.
- The scheme area supports a range of breeding and wintering birds, the majority of which are common species. Two species of note were found breeding in proximity to the scheme: kingfisher and common tern. However, the scheme would not affect the species. The increase in woodland and scrub habitats as a result of landscape and ecological mitigation planting would benefit the majority of the species found within the corridor.
- Overall, there would be a slight beneficial effect on the biodiversity resource of the corridor after mitigation. The amount of hedgerow, scrub and woodland habitat would increase as a result of the scheme, as would the number and quality of great crested newt ponds and associated terrestrial habitat.

5.99. The scheme's key biodiversity objectives were:

- To safeguard protected species and Biodiversity Action Plan (BAP) species.
- To enhance the biodiversity value of species and habitats of nature conservation value.
- To maximise habitats within highway land, with sustainable wildlife value, that link with wildlife habitats in the surrounding landscape.
- To maintain and improve links through and between the territories and ranges of protected animal species.
- To maximise local provenance in planting stock by sourcing from the Community Tree Project administered by the Forest of Marston Vale.

Consultation

5.100. No response to consultation for biodiversity was received.

OYA evaluation

5.101. The OYA report noted that the impacts of the scheme were generally as expected – with no material damage to any habitats – designated or otherwise – outside of that required for the Works (as built scheme boundary).

- 5.102. An area of land north of Brogborough Lake County Wildlife Site (CWS) had been purchased by Highways England and set aside for conservation management. A management plan had been produced which prescribed rotational scrub clearance within the grassland/scrub mosaic and reed bed management. This would provide a positive benefit to the species found within the grassland present on the northern side of the CWS, in particular the grizzled skipper. At the OYA stage, it was too early to assess the benefits of the management. It was confirmed that the implementation of the management plan was not fully investigated at OYA and should be examined at the FYA stage.
- 5.103. Six new great crested newt ponds were created within new terrestrial habitat. The ponds were establishing well at OYA, and during aftercare surveys undertaken in 2011, great crested newts (GCN) were found to be breeding at all six of the ponds. This would indicate that the mitigation has been highly successful in a relatively short time.
- 5.104. Permanent amphibian-proof fencing had been installed on the edge of the scheme to prevent great crested newts from straying into the area of the new road. The fencing was intact at OYA. The success of this fencing in the long-term should be monitored and looked at again at FYA. The fencing would need to be regularly inspected and maintained to remain effective.
- 5.105. New habitat creation (planting and seeding) proposed by the ES had been implemented and was confirmed by the landscape as-built drawings. Planting and seeding had been generally implemented as expected and was well maintained.
- 5.106. Seeding of species rich grassland was carried out within the scheme to create new habitats on the new road embankment. This has resulted in an increased area of neutral grassland than that lost to the scheme. Species rich grassland would provide replacement habitat for reptiles and great crested newts. Areas of species rich grassland were being monitored as part of the aftercare contract and it was noted that monitoring would continue in subsequent years. Future monitoring reports, if available, should be reviewed at FYA.
- 5.107. Native tree species had been planted adjacent to the spinney as expected, as compensation for the permanent loss of woodland at Brogborough Road Spinney. This woodland plot showed good early signs of establishment. New woodland, scrub and hedgerows have all been planted within the scheme, resulting in increased area of all these habitats than that lost to the scheme. This will in time provide replacement habitat for bats and breeding birds.
- 5.108. The replacement watercourse for Broughton Brook has a more natural, ecologically sensitive channel. This realigned section is predicted to increase the length of suitable habitat for wildlife, including spined loach and bullhead.
- 5.109. Bat boxes were proposed as mitigation for the loss of trees with bat roosting potential. These could not be inspected during the OYA site visit, but they are specified in the Appendix 3000 Landscape and Ecology Specification produced by the contractor.
- 5.110. An otter ledge proposed in the ES for the Race Meadow Culvert on Elstow Brook was not located during the OYA site visit. However, the maintenance of habitat links along the side of the railway (a habitat 'bridge') under the new road may be sufficient to provide otters safe passage under the scheme. Alternatively, otters may use the culvert without the need for a ledge. The Highways Agency (at the time) confirmed that the removal of the otter ledge was required by agreement with the Internal Drainage Board (IDB) on the basis that it could cause a restriction in flow in times of flood. It was considered that the route through the adjacent railway bridge would offer a suitable alternative route.
- 5.111. Three badger tunnels are specified in the Appendix 3000 Landscape and Ecology Specification. Two were inspected during the OYA site visit. There were no signs of badger use recorded during the site visit but there was evidence of use by foxes. One active badger sett was closed due to construction of the scheme, and a licence was obtained from NE for the purpose.

FYA evaluation

5.112. POPE site visits were undertaken in June and July 2017. During these site visits, mammal tunnels, GCN ponds and ditches, habitat replacement planting, amphibian and badger proof fencing, bat boxes and hibernacula were located.

Ecology aftercare monitoring reports

5.113. Ecology monitoring reports were provided to POPE for the use in this report. Results from these reports are summarised as follows:

Badgers

- No signs of badger utilising the tunnels were recorded with no signs of other mammals observed. It was noted during the POPE site visit that there is no easy access for badgers to either of the mammal tunnel entrances within the scheme, which should be considered a failure of scheme design.

Figure 5-9 Mammal tunnel entrance south east of North Common Farm underpass (left) and an example of badger proof fencing (right)



Figure 5-10 Badger tunnel near Wootton (OYA view on the left, FYA on the right)



Bats

- The majority of bats recorded during the dusk survey were either common pipistrelle or soprano pipistrelle together with seven incidences of faint calls by noctule.
- Both common pipistrelle and soprano pipistrelle bats were observed foraging along the hedgerow that lies adjacent to the west of the bridleway and either returning along the opposite side of the hedgerow or commuting along the fence line that borders the scheme.

- Bat activity was infrequent during the dawn survey with only one registration of common pipistrelle foraging activity recorded. No bats were observed crossing the scheme during the dawn survey.
- Bat boxes installed near Vale Farm bridleway overbridge.

Figure 5-11 Bat boxes installed near Vale Farm bridleway overbridge



Great Crested Newts (GCN)

- All six of the ponds created under the commitments of the Natural England licence have been shown to be supporting great crested newts. The clearest beneficial effects to date have been achieved where new waterbodies and terrestrial habitat have been provided in close proximity to pre-existing waterbodies. However, in the longer term the benefits of new pond locations could increase through these waterbodies providing 'stepping stones' that will aid the flow of individuals between existing populations.

Figure 5-12 GCN mitigation pond (OYA view below, with FYA view below that)



Brogborough County Wildlife Site

- The base of the embankment consisted of short sown grassland and areas of bare ground previously recorded along the base of the embankment have now become colonised by vegetation;
- To the west, the meshed area of the embankment is slowly becoming colonised by vegetation.
- Approximately 50% of the trees planted along the embankment have started to protrude through their guards.

Figure 5-13 Planting within the Brogborough Lake CWS



- The walkover survey showed that occasional individual hawthorn has been removed from the areas selected for thinning during year 5. The brash from the clear scrub has been stored in small piles across the area subjected to clearance.
- Within areas of grassland where approximately 25% of the colonising scrub has been cleared during years 1-4, the grassland has benefited from an increased level of light. In these same areas, no signs of re-growth of the cut scrub were evident.
- The two discrete areas of plantation woodland within the CWS where trees have been removed along the boundary to encourage greater variation continues into year 5. However, there has been an increase in scrub growth between a narrow corridor that exists between the two blocks, with fast growing Lombardy poplar (*Populus nigra* 'Italica') saplings encroaching.

Brogborough Spinney / North Common Farm

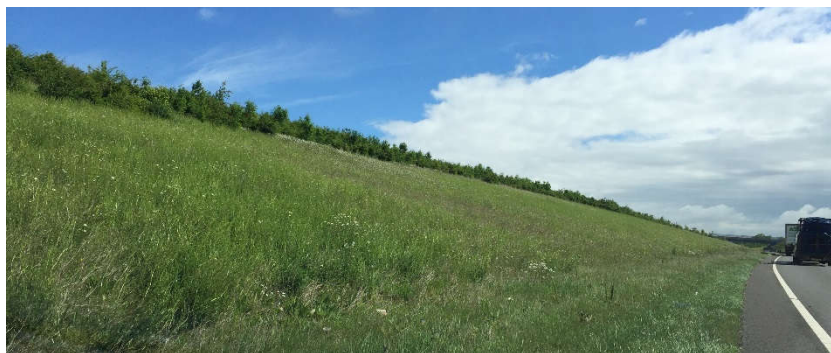
- The mitigation area at North Common Farm lies adjacent to the retained areas of Brogborough Spinney and consists of a former pasture field which has been block planted with a mixture of broadleaved trees. The planted trees remain staked and within protective guards.
- Saplings in the southern, eastern and central section of the planting area are growing particularly well with tall examples of silver birch protruding over the guards together with ash, guelder rose (*Viburnum opulus*), blackthorn (*Prunus spinosa*), hawthorn, hazel, wild privet and field maple also emerging.
- To the north and west approximately 40% of the saplings have failed.
- As trees within the planted area remains relatively immature and small there is at present no canopy or shading of the ground below.
- Areas beneath the planted trees have been treated with herbicide creating circular areas of dead vegetation. Beyond these treated areas semi-improved grassland remains in place.
- In other areas of the planting area, namely to the north and west ruderal species are beginning to dominate the ground flora.

Figure 5-14 Extension of Brogborough Spinney adjacent to North Common Farm



- 5.114. Further to the POPE site visit undertaken, biodiversity features were assessed. Species rich grassland (SRG) was found to be colonising slopes successfully, with maintenance regimes appearing to be correct. See Figure 5-15 below as an example of this success.

Figure 5-15 Species rich grassland along the A421 north of the M1 junction 13



- 5.115. Permanent amphibian-proof fencing along the route to stop movement onto the A421 by GCNs appears to be suffering from a lack of regular maintenance with large gaps and toppled fencing occurring throughout the scheme. This will be reducing the functionality of the fencing and is a concern. See Figure 5-16 below for a length of fencing still present as a part of the scheme.

Figure 5-16 Example of amphibian-proof fencing located along the A421



- 5.116. During the POPE site visit, a log pile was located near Vale Farm brideway overbridge. It is unclear what the purpose of this log pile is, but it will provide a useful additional habitat location for the scheme.

Figure 5-17 Log pile near Vale Farm overbridge



Figure 5-18 GCN hibernaculum near Vale Farm overbridge



- 5.117. The ASC was contacted at FYA for the provision of animal mortality data. Although a confirmation of receipt email was sent, no further information has been made available to POPE.
- 5.118. Overall, the effect of the scheme on biodiversity is considered as expected with although the lack on maintenance for the permanent amphibian fencing is a concern.

Sub-Objective	AST	FYA
Biodiversity	The road passes through a landscape dominated by arable land and improved pastureland, generally of limited value for nature conservation. Landscaping proposed for the new road corridor would, beyond the short-term, provide new areas of species-rich grassland, scrub and woodland; realignment of Broughton Brook would enhance its nature conservation potential. Specific adverse ecological effects would be amenable to mitigation; indeed the mitigation proposed for great crested newt would result in a positive effect on the species overall.	As expected

Water quality and drainage

Forecast

AST

- 5.119. The 2007 AST stated that the diversion of Broughton Brook for 700m using a flood channel and meandering low flow channel would improve the habitat, offsetting the effects of the extra length of culvert. The lengthened culvert for the Elstow Brook and culverting of several of its minor tributaries would be offset by improved strategic control of flood risk. Balancing ponds would be provided to ensure no impact on the brooks from the increased rate of runoff from the scheme and would reduce the risk of pollution from routine highway runoff. Possible adverse pollution impact from this runoff would be offset by improved pollution control systems for the M1, and introduction of these systems for the A421.
- 5.120. The AST scored a neutral effect for water.

Environmental statement

- 5.121. A number of potential impacts on the water environment were identified with the proposed scheme. The magnitude of these impacts would be reduced by mitigation measures incorporated into the scheme design, as well as actions taken during the construction phase. A number of residual effects were identified. The majority were assessed as being neutral, though, two were assessed as being slight adverse and one as slight beneficial.
- 5.122. The assessment showed that the significance of the effects of the impacts from the scheme on the hydrology of both Broughton Brook and Elstow Brook would be neutral. A hydraulic model shows that the impact on Broughton brook would be negligible. In the Elstow Brook catchment, the arrangement whereby the Surface Water Group, through the offices of the Internal Drainage Board (IDB), was planning to manage the impacts of various proposed developments including this scheme, were estimated to lead to negligible impact on the hydrology of the brook.
- 5.123. The assessment showed that assuming the worst case cumulative impact, the effect of routine run-off on water quality could be adverse. It also showed that for Broughton Brook the effect of spillage risk would be beneficial.
- 5.124. The overall assessment of the effect of the scheme on the water environment was that it would have a neutral effect.
- 5.125. Mitigation measures set out in the ES included:
- All runoff from additional hardstanding to be attenuated to existing runoff rates.
 - Spillage containment to be provided at all outfalls identified as being at unacceptable risk by the spillage risk calculations.
 - Pollution control to be provided at the majority of outfalls. Locations to be revised during the development of the drainage design when the pollution control calculations were undertaken to ensure that there would be no significant impact on the water environment.
 - Lined ditches to be provided over all source protection zones and over aquifers that are sensitive to pollution.
 - Highway drainage would be kept separate from existing land drainage.

- Highway drainage on embankments would generally consist of surface water channels, except where the gradients were very shallow. Then, run-off would drain either into combined kerb and drainage blocks or over the edge into ditches.
- Highway drainage in cuttings would generally consist of combined surface water and groundwater filter drains.
- At the cutting at the Marston Moretaine Junction, a pumping station would be installed, as the levels were too low to allow drainage by gravity.
- Drainage to the Broughton Brook would be attenuated using balancing ponds to a greenfield rate of 4 litres/ sec/ hectare.
- Drainage to the Elstow Brook catchment would be attenuated by balancing ponds (also to 4 litres/ sec/ hectare) except where the receiving water course is already attenuated by the strategic facilities established by the Internal Drainage Board.
- Kerb and gullies or a combined kerb and drainage system would be used where a kerb was required (for example, at bridges, junctions, laybys).
- Subgrade drainage on embankments would consist of fine or narrow filter drains.
- On the high sides of cuttings, cut-off ditches would be built to drain into existing water courses.
- At the toe of embankments ditches would be constructed. Where these would not receive carriageway drainage, they would drain to water courses. Otherwise they would form part of the highway drainage system.
- Spillage containment facilities (to control accidental spillages) would be constructed upstream of balancing ponds or prior to discharge of the highway drainage into the local watercourses.

5.126. The mitigation objective for water set out in the ES was to ensure that water quality within receiving waters (surface and ground) would not be adversely affected, to seek to enhance the quality of receiving waters through the incorporation of pollution control measures and to minimise the risk of the proposed works exacerbating the flood risk of catchments.

Consultation

5.127. The Bedford Borough Council commented that the scheme “*has been overseen by Bedford Internal Drainage Board (IDB) and therefore any evaluation of the local water quality as a result of the improved works can be more thoroughly answered by them. We are not aware of any deterioration in any local water quality as a result of the improvement works*” and that “*The balancing ponds have reduced peak flows in the Elstow Brook*”.

OYA evaluation

5.128. The OYA evaluation confirmed that for most of the scheme, the run-off drained to outfall by gravity, although pumping stations were installed at Marston, Lower Shelton and Berry Farm. Telemetry had been installed on all three stations which would allow an automatic response to pump failure.

5.129. Based on the as-built drawings the OYA report confirmed that the scheme drainage had been constructed as expected. The report confirmed that there were 11 balancing facilities constructed as part of the A421 improvements. Access had generally been provided to all ponds off the local road network where possible. However, in circumstances where access

could not be achieved off the local road network, a maintenance lay-by with an access track to the pond had been provided off the mainline.

- 5.130. The OYA evaluation confirmed that mitigation measures had been implemented as expected and no information had been provided to POPE that would indicate that it was performing other than as expected. It considered that the scheme's overall impact had been neutral, and as expected.

FYA evaluation

- 5.131. Drainage features including ponds and drainage channels were located during the POPE site visits. Despite vegetation maintenance within the scheme being good, drainage channels appeared to not have received the same attention. Ponds appear to have received regular maintenance and were performing as expected (see Figure 5-19 and Figure 5-20).

Figure 5-19 Pond near Vale Farm overbridge



Figure 5-20 Pond north of Manor Road bridleway (OYA view on left, FYA view on the right)



- 5.132. Drainage channels not receiving required maintenance are demonstrated in Figure 5-21. The first view is a channel located near Marston junction showing overgrowth with reeds and reinforced banks not colonising successfully and the second near the drainage pond near Vale Farm overbridge showing a build-up of silt, plant growth and water.

Figure 5-21 Drainage channels not receiving proper maintenance



Sub-Objective	AST	FYA
Water environment	<p>Diversion of Broughton Brook for 700m using flood channel and meandering low flow channel would improve habitat offsetting effects of extra length of culvert. Lengthened culvert for the Elstow Brook and culverting of several of its minor tributaries offset by improved strategic control of flood risk. Balancing ponds provided to ensure no impact on the brooks from the increased rate of runoff from the Scheme and reduce risk of pollution from routine highway runoff. Possible adverse pollution impact from this runoff offset by improved pollution control systems for the M1 and introduction of these systems for the A421.</p>	As expected

Physical fitness

Forecast

AST

- 5.133. The 2007 AST stated that the scheme would provide an improved and extended range of circular walks and linked routes, and the reduction in traffic along the existing A421 would make it more attractive to walk and cycle along, and also cross. It stated that it was not possible to conclude that there would be a significant increase in the use of Public Rights of Way (PRoW).
- 5.134. The AST scored a neutral effect for physical fitness.

Environmental Statement

- 5.135. This sub-objective considered the effects of the scheme on pedestrians, cyclists, equestrians and the local community, in terms of severance. The ES stated that the introduction of the scheme would reduce community severance through safer crossings for PRoW in the network.

- 5.136. The ES stated that the scheme would result in the diversion of some PRoW although, the scheme design would aim to retain the existing network through the provision of overbridges and underpasses (some of which were solely for non-motorised users (NMUs)) and new PRoW diversions. The provision of overbridges and underpasses would provide safe points to cross the new A421 and thus allow users to make safe north south movements, an amenity which did not exist, as many users had to cross the busy existing A421. As the majority of routes were used for leisure purposes only, it was considered that the diversions would contribute to a safer, improved PRoW network. However, for some users, the physical aspects such as bridges and diversions and increased noise levels in the area would make journeys less attractive.
- 5.137. The scheme would deliver an extra 5040m of new PRoW strategically linking certain Rights of Way and forming circular routes. 12 PRoW would be diverted.
- 5.138. The downgrading of the existing A421 to provide local access and the provision of a cycleway and equestrian route would increase the network in the scheme vicinity for cyclists, equestrians and pedestrians.

Consultation

- 5.139. No response to consultation received for physical fitness.

OYA evaluation

- 5.140. The OYA evaluation noted that off-line dualling, coupled with reduced speed limits on the old A421 had improved access along the old A421. New NMU overbridges improved access between the east and west side of the A421.
- 5.141. Several footpaths were upgraded to bridleways, along with a number of diversions to improve safety for non-motorised users. The scheme introduced two new overbridges to accommodate existing bridleways and footpaths.
- 5.142. The Sustrans route between Wood End and Marston was in the A421 scheme. Whilst no specific additional cycleway provision was included, the reduction in traffic on the existing A421 should have improved the cyclists' environment.
- 5.143. It was concluded that the scheme had a neutral impact overall on physical fitness, as expected.

FYA evaluation

- 5.144. During the POPE site visit, various footpaths and bridleways were accessed. Figure 5-22 below shows the re-aligned Sustrans route through the subway at Lower Shelton. This subway was extended as a part of the scheme, including a continuation of artwork within the subway. Pedestrians and cyclists were seen using the subway during the POPE site visit.

Figure 5-22 Lower Shelton subway extension and re-alignment (including artwork within the subway)



Figure 5-23 Cyclist using the Lower Shelton subway



- 5.145. A comparison view (Figure 5-24) was taken of the footpath near Marston overbridge to demonstrate growth of screening vegetation and apparent lack of maintenance near the entrance. It is assumed by POPE that maintenance regimes for accesses are seasonal as for the overall scheme.

Figure 5-24 Footpath near Marston overbridge (OYA view on the left, FYA view on the right)



- 5.146. The bridleway between Manor Farm bridleway overbridge and North Common Farm underpass (see Figure 5-25) was found to be blocked by rubble during the POPE site visit. It is unclear to POPE if this access has been blocked to restrict vehicular access or whether it is fly tipping.

Figure 5-25 Bridleway near North Common Farm underpass blocked with rubble



- 5.147. Use of the bridleway east of Vale Farm bridleway 31 overbridge by equestrians was confirmed during the POPE site visit.
- 5.148. Overall, physical fitness is as expected as PROWs are showing signs of use and no issues were raised during consultation.

Sub-Objective	AST	FYA
Physical fitness	The Scheme would provide an improved and extended range of circular walks and linked routes, and the reduction in traffic along the existing A421 would make it more attractive to walk and cycle along, and also cross. However it is not possible to conclude that there would be a significant increase in the use of PRow.	As expected

Journey ambience

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

Forecast

AST

- 5.150. The 2007 AST stated that the scheme would provide enhanced highway design and carrying capacity, separation of NMU facilities and uninterrupted travel along the new A421 which would reduce driver stress and provide improved journey ambience.
- 5.151. The AST scored a large beneficial effect for journey ambience.

Environmental Statement

- 5.152. The ES stated that travellers' views from the existing A421 were generally wide ranging over the predominantly flat agricultural landscape, with a number of settlements, landfill sites and warehouses visible. The existing route was considered to result in high levels of driver stress due to its sub-standard nature.
- 5.153. It was predicted that the overall effect on travellers' views was expected to range from neutral to moderate beneficial (compared to the existing situation) for the majority of the scheme, due to the landscape planting proposed, and the more rural views visible from some of the realigned sections. However the 2.75 km section closest to Bedford would experience a low adverse effect.
- 5.154. Scheme operation would have a beneficial effect on driver stress due to the increased carrying capacity of the carriageway, enhanced highway design, including grade separated junctions, provision of laybys, safer driving conditions, and the separation of NMU facilities from motorists. Overall, driver stress on the new A421 would be low due to the reduction of frustration, fear of potential collisions and route uncertainty, representing a significant beneficial effect.

Consultation

- 5.155. No response to consultation was received.

OYA evaluation

- 5.156. The OYA evaluation concluded that laybys were located along the route; both east and westbound provide a good separation from the main trunk road. This separation allowed for safe access to and from the road.

FYA evaluation

- 5.157. Table 5.6 summarises the FYA evaluation of the various elements of journey ambience and the scheme's impact on this sub-objective regarding the OYA findings.

Table 5-6 Summary of journey ambience evaluation

Traveller factor	Score	OYA evaluation	FYA evaluation
Views	Beneficial	Views out to open countryside for drivers on the bypass are varied, as expected. Open views will become more restricted as new planting matures.	Planting has advanced significantly since OYA and views are mostly restricted as predicted except on embankments.
Stress	Large beneficial	On the new A421 traffic is free flowing with no congestion, which will have reduced driver frustration, the clear signage will mean there is less route uncertainty and overall, driver stress will have benefited as a result of the scheme, as expected.	Restrictions in traffic flows are found at peak hours with remaining flows free flowing. Signage remains clear at FYA.
Care	Large beneficial	The route has numerous laybys which have been designed for ease of access from and back on to the trunk road. Offsite care facilities are available at junctions along the route.	Laybys along the route remain in use at FYA with offsite care facilities in use throughout the day.
Summary score	Large beneficial	As expected	As expected

Key points from environment evaluation

Noise

- Traffic flows along the old and new A421 were in line with POPE expectation allowing an 'as expected' evaluation. Flows have increased since OYA, however they are still in line with forecasts.

Local air quality

- The AST predicted there would be an increase in NO₂ and PM₁₀ concentrations with the scheme. Based on traffic flows, air quality along the new road is likely to be 'as expected'. Along the old road, air quality is generally 'as expected', but may be 'better than expected' at Brogborough due to a reduction in observed traffic flows versus those predicted at this location.

Greenhouse gases

- On the A421 within the scheme there is an additional 4448 tonnes of carbon emissions at FYA. This is lower than the proxy reforecast for the same key links, however isn't directly comparable with the forecast which was forecast for a much larger area.

Landscape and townscape

- Overall, landscape impacts are considered to be slight adverse, as predicted. Mitigation has been implemented as expected with good growth recorded throughout the scheme and it is expected that planting will provide visual screening and integration of the scheme into the local landscape by the design year.

Heritage

- The final archaeology report (2008) was made available and indicated successful archaeological mitigation was undertaken prior to construction. Based on the success of planting within the scheme, the effects on the historic landscape are as expected.

Biodiversity

- New habitats of woodland, scrub, hedgerow and species-rich grassland created as part of the landscaping works are positive and as expected. Mitigation for great crested newts appears successful and will result in a positive effect on the species due to the increase in suitable habitat available. Bat boxes were found to be intact, hibernaculum as expected and vegetation with the Brogborough Lake CWS and adjacent to the Brogborough Spinney is progressing although not at the rate expected.

Water

- The scheme has numerous balancing ponds to accommodate the additional flow of water from the A421. These ponds appear to be performing as expected, with some isolated concerns regarding levels for effective drainage found along the scheme length and maintenance issues with drainage canals. Pollution control measures have been installed and are highly visible to ensure prompt use.

Physical fitness

- Active signs of use for most PROWs demonstrates the success of the scheme in integrating into the existing network. Whilst the A421 remains a dominant feature at FYA, the screening effects of the hedgerows will mitigate this as they mature. Some maintenance issues were noted during the POPE site visit.

Journey ambience

- Impacts on journey ambience are as expected. Reduction in congestion and improved journey times has reduced driver stress. Driver information has been improved, as expected.

6. Accessibility and Integration

- 6.1. The accessibility objective is concerned with how the scheme has affected the ability of people in different locations to reach different types of facility, using any mode of transport. The accessibility objective consists of three sub-objectives. These are:
- Option values.
 - Access to the transport system.
 - Severance.
- 6.2. The integration objective considers how the scheme assists different modes of transport in working together and the ease of people moving between them to make sustainable transport choices. It also looks at how the scheme integrates with land use and wider government policies.
- 6.3. The Integration objective consists of three elements:
- Interchange with other transport modes.
 - Land use policy.
 - Other government policies.

Option values

- 6.4. Option values, as defined in WebTAG, relate to the availability of different transport modes within the study area, even if they are not in use. For example, a car user may value a bus service along their route even if they have never used it because they have the option of another mode should their car become unavailable.

Forecast

- 6.5. The scheme's AST stated that: '*In general, Option Values are not applicable to road schemes*', and gave a neutral assessment score.

Evaluation

- 6.6. Option values are associated with an individual's attitude to uncertainty and the unexpected use of a transport facility, which has not been built into the forecasts produced by the modelling stage, and would otherwise not appear in the appraisal as a benefit. Since the scheme does not provide or impact any additional modes of transport, the forecast in this instance is deemed correct, and the scheme has had negligible impact on the option values sub-objective.

Severance

- 6.7. The aim of this sub-objective is to reflect both changes in severance and the likely number of users affected. In terms of roads, severance includes the length and ease of pedestrian movements. The primary indicators for roads include footpaths, diversions of rights of way and crossing facilities.

Forecast

- 6.8. The AST scored severance as neutral, and stated:

'Despite a number of PRow diversions, it is considered that these diversions would contribute to a safer, improved PRow network, as there are currently limited safe NMU crossing facilities

along this part of the A421. Furthermore the reduced levels of traffic likely along the existing A421 would facilitate safer crossing opportunities. However, the effects on community severance are not affected significantly because of the existing Lower Shelton Subway, which is being extended.'

Evaluation

- 6.9. Upon completion of the scheme, a non-Motorised User Audit was undertaken. This was carried out in December 2010, and a 'Non-Motorised User Audit Report for the 'scheme completion' stage produced in September 2011.
- 6.10. There are several settlements along the line of the former and new A421 route. The settlements of Brogborough, Lidlington, Marston Moretaine, Lower and Upper Shelton, Wootton Green, Kempston Hardwick and Wootton all lie within approximately 1km of the scheme.
- 6.11. It was considered that the scheme would provide some relief from existing severance within and between the villages on the south eastern side of the new A421 including Brogborough, Lidlington, Marston Moretaine, Stewartby and Kempston Hardwick. This is likely to have been the case, with the reduced volume of traffic on the former A421, meaning that pedestrians and others from these settlements could be encouraged to use the community facilities, recreational and educational centres on the south-eastern side of the old A421.
- 6.12. Consultation with parish councils at FYA reveals that the footpath access to Reynards Wood leading to the private road bridge across the A421 was never completed suggesting some works were not met at OYA.

Figure 6-1 Quiet former A421 route just south of Marston Moretaine



- 6.13. With regard to traffic levels remaining on the old road, the NMU Audit report states:
- 'Whilst carrying out the site visits on 11th / 12th January, frequent gaps of 30 – 90 seconds were noted in the traffic on the old A421. NMUs, including equestrians, will have adequate opportunity to cross the old line without waiting for extended periods'²⁰*
- 6.14. In 2004 and 2006, pre-scheme NMU surveys were undertaken in connection with the Stage 3 Environment Impact Assessment (EIA) to measure the level of usage of the local network by pedestrians, cyclists and equestrians. Survey locations comprised all points along the route

²⁰ NMU audit report – scheme completion, appendix B – general issues raised no. 6.

where the scheme was to intersect PRoW. These surveys indicated that all bridleways and footpaths had light use with the exception of the John Bunyan Trail and Clay Way.

- 6.15. The two trails deemed to be more heavy use – John Bunyan Trail and Clay Way BWs (BW1 and BW2) were deemed to be low to moderately used prior to scheme completion, however further tests were undertaken to reveal these pathways were high use.
- 6.16. These bridleways are close to Manor Farm and are heavily used by pedestrians and equestrians, and dissect a well-used picnic site.
- 6.17. No post opening surveys of NMUs have been undertaken for the purposes of this study.
- 6.18. New facilities for NMUs were provided (not diversions), some 5,040m of new footpath/bridleway, which will have enhanced the local PRoW network.
- 6.19. During the development of the scheme, the provision of NMU facilities were a consideration along with consultation responses from the local councils, statutory bodies, residents and interested parties. Where NMU usage has been moderate, scheme impacts (diversions) have been negligible, and where diversions have been substantial, existing usage was assessed as low.
- 6.20. Some of the diverted routes provided have much improved safety for users, and this on balance, has resulted in an overall 'neutral' impact on the Severance sub-objective, in line with forecast. Adverse impacts have been countered with overall improvements to the local network of PRoW, and several crossing facilities over the new A421 have been provided.
- 6.21. On balance, the scheme is considered to have had a neutral impact on severance as expected, with negative impacts being countered by improvements to the PRoW network and adequate crossings provided for non-motorised users over the new road.

Access to the transport system

- 6.22. Access to the transport system is influenced by access to a private car and proximity to a public transport service.

Forecast

- 6.23. The AST forecast score for access to the transport system was neutral, stating that:

'Junction improvements will improve access to trunk road. The former A421 maintained for local access and could lead to opportunities for re-allocating road space for non-car modes'

Evaluation

- 6.24. New two-level junctions have been provided at Marston Moretaine and at Marsh Leys. In the case of Marsh Leys, the circulatory carriageway was already constructed as part of the Bedford Western Bypass scheme.
- 6.25. M1 junction 13 has been redesigned, with a new bridge carrying the new A421 across the M1, whilst the scheme also uses the existing bridge to the south east for local traffic movements and connection to the Ridgmont Bypass.
- 6.26. These improvements will have eased access for local traffic to the trunk road network. The reduction in traffic along the former route (around 80%) will also have improved opportunities for walking and cycling, as well as the potential for re-allocating road space for non-car modes, however this has not occurred to date.
- 6.27. Local buses in the area are provided by Stagecoach and Grant Palmer and run between Stewartby – Kempston – Bedford (No. 68), Bedford - Kempston - Marston Moretaine – Cranfield

(No. 52) and Bedford - Hillgrounds - Kempston – Wootton (No. 53). By significantly reducing traffic volumes on the former A421, services accessing the route may have noted some benefit, however overall, the scheme's impact on the 'access to the transport system' sub-objective is considered as neutral, as the scheme has not influenced proximity of public transport, or as yet, has not lead to reallocation of road space for non-motorised means of transport.

Transport interchange

Forecast

- 6.28. The AST scored transport interchange as neutral, and stated '*No freight or passenger transport interchanges are included in this proposed improvement*'.

Evaluation

- 6.29. The scheme has had no impact on the provision of public transport interchanges, and therefore it has been evaluated that there has been a neutral impact on transport interchanges in line with the AST.

Land use policy and other government policies

- 6.30. The OYA POPE report documents the scheme in relation to land use policy and government policy, Table 6.1 in the OYA report shows how the scheme aligned with national, regional and local policy. Based on a review of the evidence at FYA, it is considered that the forecast assessment of the scheme on Land Use policy is accurate, and beneficial. In terms of the scheme's impact on Other Government Policies, however, it is considered that the overall score should be 'neutral' rather than the AST's 'beneficial'. This is because positive alignment with some policies, such as reducing community severance, improving safety, and facilitating strategic growth have been countered with other negative outcomes that do not align with policies to reduce car use and protect best and most versatile agricultural land, as the scheme passes through four distinct Landscape Character Areas (LCA). For more detail, please see the OYA report.

Key points from accessibility and integration evaluation

Accessibility

- Despite a number of Public Right of Way diversions, it is considered that the diversions have contributed to a safer, improved Public Right of Way network. Reduced levels of traffic along the existing A421 (some 80%) have facilitated safer crossing opportunities. Some improvements to severance will have been noted to the south and east of the scheme.
- With regard to access to the transport system, the scheme will have improved access to the trunk road network through the junction improvements made at various points along the scheme.
- Due to the reduced traffic along the former route, local access to the road network will have also been made easier.

Integration

- The forecast assessment of the scheme on Land Use policy is accurate, and beneficial. In terms of the scheme's impact on Other Government Policies, however, it is considered that the overall score should be 'neutral' rather than the AST's 'beneficial'. This is because positive alignment to policies such as reducing community severance, improving safety, and facilitating strategic growth have been countered with other negative outcomes that do not align with policies to reduce car use and protect the best and most versatile agricultural land.

7. Conclusions

- 7.1. To conclude this report, this section summarises the scheme’s success in meeting its scheme specific objectives, and assesses the scheme’s impacts against those forecast in Table 8.1 below.

Table 7-1 Success against scheme specific objectives

Objective (source: Public Inquiry Inspectors Report)	Success	
To deliver one of the trunk road improvements identified in the London to South Midlands Multi Modal Study (LSMMMS)	The scheme has improved a major link in the Milton Keynes to Cambridge corridor.	✓
To improve journey time reliability	Journey time reliability has improved in both directions and all time periods for trunk road traffic using the new route compared to the former A421. The biggest improvements have been noted in the northbound AM peak.	✓
To improve safety	At five years after opening, on the old and new A421 combined there has been an annual saving of 0.9 collisions but an increase in collisions of 30.1 for the area used within the appraisal.	Partial
To achieve the above without causing significant adverse environmental impacts	The scheme has incorporated various environmental mitigation measures.	✓

- 7.2. In summary, the results in Table 8.1 show that based on the data available at the FYA stage, the A421 Bedford to M1 junction 13 scheme has fully achieved three of its objectives and has partially achieved its safety objective.

Appendices

Appendix A. Appraisal Summary Table (AST) and Evaluation Summary Table (EST)

Appraisal Summary Table (AST) - December 2007

Scheme Name: A421 Improvements M1 Junction 13 to Bedford	Description: The Scheme comprises a two-lane dual carriageway and is almost entirely off-line, with the exception of the stretch between Marsh Leys Junction and the A6 Junction (at the eastern end of the Scheme), which would be a three-lane dual carriageway. The Scheme includes improvements to the layout of Junction 13 of the M1, and new grade separated junctions at Beancroft Road (near Marston Moretaine, approximately mid-way) and at Marsh Leys. The existing A421 would be detrunked and become a local road, following the opening of the new dual carriageway.		Problems: Existing A421 is largely single carriageway, with substandard geometry, frequent junctions and poor safety records. Serious congestion.	Present Value of Costs to Public Accounts £m Present Value Cost = £136 m
OBJECTIVE	SUB-OBJECTIVE	QUALITATIVE IMPACTS	QUANTITATIVE ASSESSMENT	ASSESSMENT
ENVIRONMENT	Noise	Negligible increase in overall number of people annoyed by noise with the Published Scheme (DS – Do Something) than without the Scheme (DM – Do Minimum). Areas that would experience an overall improvement in noise climate include Brogborough, parts of Marston Moretaine and parts of Lower Shelton. Significant effects from redistributed traffic on existing roads outside the Scheme corridor. For the DM situation, 2351 people would be exposed to noise levels above 69 dB L _{A10,18hr} . For the DS situation, 2093 people would be exposed to similar levels.	Mitigation measures have been implemented as proposed in the ES. The significant reduction in through traffic along the old A421, as a result of the bypass will have benefited residential properties adjacent to the scheme. However, at Lidlington traffic is higher than expected and the benefits of the scheme may be less than expected at this location. The new A421 has introduced a new source of noise into the countryside for the few properties nearer to the route as expected. However, traffic is more than 20% less than forecast and noise due to traffic could be better than expected along the scheme.	Generally as expected on the old A421 and potentially better than expected on the new A421.
	Local Air Quality	Net beneficial impact to the community as a whole. A total of 35,389 properties are located within 200m of the existing A421 and/or Scheme and/or surrounding roads. 61.7% would experience an improvement in PM ₁₀ and 38.3% would experience a worsening. 62.4% would experience an improvement in NO ₂ and 37.6% would experience a worsening. No exceedances of the current air quality objectives are predicted at any affected property with or without the Scheme; the Local Authorities have not declared any AQMAs in the vicinity of the Scheme.	No. of properties where PM ₁₀ concentrations would improve in 2011 due to the Scheme: 21,820 No. of properties where PM ₁₀ concentrations would worsen in 2011 due to the Scheme: 13,569 No. of properties where NO ₂ concentrations would improve in 2011 due to the Scheme: 22,079 No. of properties where NO ₂ concentrations would worsen in 2011 due to the Scheme: 13,310	Assessment value: PM ₁₀ = -388 NO ₂ = -1,438
	Greenhouse Gases	Total emissions of carbon from traffic in the Traffic Model Study Area are predicted (based on total 12 hour weekday flows) to increase by 1% in 2011, with the introduction of the Scheme. This is due to reduced emissions per vehicle kilometre with the Scheme in place, which partially offsets a 2.4% increase in total vehicle kilometres.	Total carbon emissions without Scheme in 2011 = 185,446 T/yr. Total carbon emissions with Scheme in 2011 = 187,528 T/yr. Total carbon emissions without Scheme for 60 yr. appraisal period = 12,831,778 T/yr. Total carbon emissions with Scheme for 60 yr. appraisal period = 12,786,787 T/yr.	Net present value of total change in carbon emissions over 60 yr. appraisal period = £1.14m
	Landscape	While the Scheme introduces an artificial element into an already damaged landscape, extensive woodland, tree and shrub planting has been incorporated into the design. The Scheme is thus better integrated into the landscape, while assisting in meeting the objectives of the Forest of Marston Vale in increasing woodland cover and promoting recreation. It also enhances the landscape quality by the introduction of new landscape features. An Area of Great Landscape Value (AGLV) lies to the south of the Scheme. Whilst the road would not pass through this it would be visible from within the AGLV in the Lidlington/Brogborough area. This is not however considered of enough significance to lead to conflict with the policies in the Bedfordshire Structure Plan.	-	Slight adverse
	Townscape	The Scheme does not directly affect any areas of townscape and townscape has not therefore been assessed.	-	Neutral
	Heritage of Historic Resources	The Scheme would have no direct impact on any Scheduled Ancient Monuments, Historic Parks and Gardens, Historic Battlefields or Conservation Areas. The Scheme would have an adverse impact on some identified archaeological sites. There would be indirect adverse impacts upon three Grade II listed buildings due to noise and visual intrusion.	-	Slight adverse
	Biodiversity	The road passes through a landscape dominated by arable land and improved pastureland, generally of limited value for nature conservation. Landscaping proposed for the new road corridor would, beyond the short-term, provide new areas of species-rich grassland, scrub and woodland; realignment of Broughton Brook would enhance its nature conservation potential. Specific adverse ecological effects would be amenable to mitigation; indeed the mitigation proposed for great crested newt would result in a positive effect on the species overall.		Slight beneficial
	Water Environment	Diversion of Broughton Brook for 700m using flood channel and meandering low flow channel would improve habitat offsetting effects of extra length of culvert. Lengthened culvert for the Elstow Brook and culverting of several of its minor tributaries offset by improved strategic control of flood risk. Balancing ponds provided to ensure no impact on the brooks from the increased rate of runoff from the Scheme and reduce risk of pollution from routine highway runoff. Possible adverse pollution impact from this runoff offset by improved pollution control systems for the M1 and introduction of these systems for the A421.	-	Neutral

Post Opening Project Evaluation
A421 Scheme M1 J13 to Bedford - Five Years After

	Physical Fitness	The Scheme would provide an improved and extended range of circular walks and linked routes, and the reduction in traffic along the existing A421 would make it more attractive to walk and cycle along, and also cross. However it is not possible to conclude that there would be a significant increase in the use of PRoW.	An extra 5040m of PROW, aside from diversions. 12 PROW would be diverted - average distance of 330m.	Neutral
	Journey Ambience	Enhanced highway design and carrying capacity, separation of NMU facilities and uninterrupted travel along the new A421 would reduce driver stress and provide improved journey ambience.	-	Large Beneficial
SAFETY	Collisions	Upgrading the A421 to a dual 2-lane carriageway is expected to reduce the overall accident levels. Assessment excludes reductions in the number of road collisions and injuries during construction and maintenance.	Savings in Casualty - Fatal: 33 No. Savings in Casualty - Serious: 233 No. Savings in Casualty - Slight: 1591 No. Savings in Personal Injury Collisions 1270 No.	PVB £77.0m
	Security	Lay-bys located with clear sight lines to minimise security risks. No additional security measures proposed.		Neutral
ECONOMY	Public Accounts	The Scheme costs in 2002 prices discounted to 2002 is £129m, and the Indirect Tax Revenues as a result of the Scheme is £24m – these contributed to the PVC. The Scheme is predicted to deliver NPV of £1,043m and BCR of 7.81.	Central Govt PVC: £153m Local Govt PVC: N/A	PVC £153m
	Public Accounts	The Scheme costs in 2002 prices discounted to 2002 is £129m, and the Indirect Tax Revenues as a result of the Scheme is £7.4m – these contributed to the PVC. The Scheme is predicted to deliver NPV of £1,606 m and BCR of 11.77.	Central Govt PVC: £136m Local Govt PVC: N/A	PVC £136m
	Transport Economic Efficiency: Business Users & Transport Providers	The proposed improvement Scheme is expected to deliver substantial travel time and vehicle operating cost benefits to the business users.	Users PVB: £ 658m; Transport Providers PVB: N/A; Other PVB: N/A	PVB £658m
	Transport Economic Efficiency: Consumers	The proposed improvement Scheme is anticipated to bring significant travel time and vehicle operating cost benefits to the consumers.	Users PVB: £ 458m	PVB £458m
	Reliability	The Scheme is predicted to improve journey time reliability for journeys along the upgraded A421. Two sections were assessed to be 'large beneficial' with the third section showing 'moderate beneficial' impact in terms of reliability.	N/A	Moderate to Large beneficial
	Wider Economic Impacts	The A421 Improvement Scheme does not affect a Regeneration Area.	N/A	Neutral
ACCESSIBILITY	Option Values	In general, Option Values are not applicable to road Schemes.	N/A	Neutral
	Severance	Despite a number of PRoW diversions, it is considered that these diversions would contribute to a safer, improved PRoW network, as there are currently limited safe NMU crossing facilities along this part of the A421. Furthermore the reduced levels of traffic likely along the existing A421 would facilitate safer crossing opportunities. However the effects on community severance are not affected significantly because of the existing Lower Shelton Subway, which is being extended.		Neutral
	Access to the Transport System	Junction improvements will improve access to trunk road. Old A421 maintained for local accesses and could lead to opportunities for re-allocating road space for non-car modes.	N/A	Neutral
INTEGRATION	Transport Interchange	No freight or passenger transport interchanges are included in this proposed improvement.	N/A	Neutral
	Land-Use Policy	The Published Scheme is broadly consistent with land use policy at local, county and national level. Where the proposal has adverse environment effects, mitigation measures have been provided. However there are potential conflicts with:- PPG13 regarding greenhouse gas emissions, PPS7 regarding loss of best and most versatile agricultural land, Bedfordshire Structure Plan regarding loss of public open space, and PPG15, Bedfordshire Structure Plan and Mid Beds. Local Plan regarding possible impacts on cultural heritage. Overall, it is considered that the Published Scheme would have a beneficial impact on Land Use policies, as it generally facilitates the achievement of key policy objectives, particularly in respect of this important Strategic Growth Corridor.		Beneficial
	Other Government Policies	The Scheme is considered helpful in respect of most policies, as it would reduce severance for most non-motorised users, facilitate development in this important strategic growth corridor, and contribute to social progress and growth. The Scheme is however considered to hinder policies relating to climate change and protection of best and most versatile agricultural land.		Beneficial

Evaluation Summary Table (AST)

OBJECTIVE	SUB-OBJECTIVE	QUALITATIVE IMPACTS	QUANTITATIVE ASSESSMENT	ASSESSMENT
ENVIRONMENT	Noise	Mitigation measures have been implemented as proposed in the ES. The significant reduction in through traffic along the old A421, as a result of the bypass will have benefited residential properties adjacent to the scheme. The new A421 has introduced a new source of noise into the countryside for the few properties nearer to the route as expected. However, traffic is within the variation range and is therefore likely to be as forecast impact for noise.	Increase in 168 people annoyed in 2026. NPV £2.49m	Generally as expected
	Local Air Quality	The ES stated that there was a predicted increase in NO ₂ and PM ₁₀ levels by 3.4ug/m ³ and 2.8ug/m ³ respectively at Moretaine Farm as the new alignment passes closer than the existing A421 does. This was expected to result in a moderate adverse impact. The scheme is likely to be as expected for air quality along the old road, while pollutant concentrations are as expected near Marston Moretaine and are likely to be lower than expected close to the M1. At Brogborough traffic flows have been lower than forecast on the old road (by more than 10%), therefore air quality may be better than expected at this location.	Based on difference between forecast and observed traffic flows following the scheme opening	The change with the scheme is likely to be as expected along the old road, and potentially better than expected along the new road close to the M1.
	Greenhouse Gases	The scheme's impact in the A421 corridor has been less than predicted in the ES because traffic volumes have been lower than forecast, and HGVs were underestimated in the Do-Minimum. (Carbon increase in the corridor however has been greater than AST forecast because the AST figure relates to a wide modelled area where traffic was expected to reassign)	Net annual increase of 4,448 tonnes at FYA (based on scheme area only)	Better than expected
	Landscape	The most significant impacts of the scheme are the new overbridges which will remain dominant in the landscape until the planting around them matures. Planting within the scheme has been implemented as expected. Screen planting is in place and should, at design year meet its targets subject to continued successful growth and on-going maintenance.	N/A	Slight adverse (As expected)
	Townscape	Townscape has been scoped out of this assessment	N/A	Not assessed
	Heritage of Historic Resources	The impacts described in the ES and AST are generally considered to be as expected.	N/A	Slight adverse (As expected)
	Biodiversity	New habitats of woodland, scrub, hedgerow and species-rich grassland have been created as part of the works as expected. These will in time increase the biodiversity value of the corridor. Mitigation for great crested newts has been implemented as expected and will result in a positive effect on the species. These enhancements, modification to Broughton Brook, and other new habitat created will benefit reptiles, bats, birds and fish, thus compensating for any detrimental impacts.	N/A	Slight beneficial (As expected)
	Water Environment	The scheme has numerous balancing ponds to accommodate the additional flow of water from the A421. These ponds appear to be performing well, with some isolated concerns regarding levels for effective drainage found along the scheme length. Pollution control measures have been installed and are highly visible to ensure prompt use.	N/A	Neutral (As expected)
	Physical Fitness	An additional 5,040 metres of PROW's has been added as a part of the scheme. The footpaths and bridleways are well signposted and maintained. Active signs of use for most PROW's demonstrate the success of the scheme in integrating the new scheme into the existing network. Whilst the A421 remains a dominant feature, the screening effects of the hedgerows will mitigate this as they mature.	N/A	Neutral (As expected)
SAFETY	Journey Ambience	Impacts on journey ambience are as expected. Reduction in congestion and improved traffic flows have reduced driver stress and improved journey times as expected. Collisions numbers have reduced on the scheme. Lighting and signage have been introduced as expected with traveller care improved as a result of the scheme.	N/A	Large Beneficial (As expected)
	Collisions	Along the new scheme and former A421 only, there has been a saving of 0.9 collisions per annum on average. Within the COBA modelled area, the average number of collisions has increased by 30.1 per annum.	COBA area: average increase of 30.1 collisions per annum New/old road only: average saving of 0.9 collisions per annum	Worse than expected
ECONOMY	Security	The lay-bys installed along the new road are clearly visible, signposted and well used. Along sections of the old A421, footways, cycleways and bridleways have been provided away from the main road, but clearly visible from the road. The footways in the vicinity of the junctions along the old A421 and at Marsh Leys upgraded roundabout scheme are open and exposed, giving users good visibility of their surroundings.	N/A	Neutral (as expected)
	Public Accounts	The scheme's PVC at OYA opening is 5% below the Ministerial Approved Budget issued shortly before construction, however it is higher than the forecast cost given in the scheme's AST. Indirect Tax was forecast to be a positive cost and adds to the scheme's PVC.	PVC = £162m (including indirect tax impact) PVC = £155m (excluding indirect tax impact)	-
	Transport Economic Efficiency	The scheme has produced considerable travel time benefits for users, £896.5m, although these are lower than expected.	Vehicle hr benefits £896.5m	Lower than expected
	Reliability	Journey times have become more reliable in all time periods on the new A421 compared to the former route before the scheme opened. The most notable improvement in reliability has been in the AM peaks.	Journey times have become more reliable in all time periods on the new A421 compared to the former route before the scheme opened.	Moderate Beneficial (as expected)

OBJECTIVE	SUB-OBJECTIVE	QUALITATIVE IMPACTS	QUANTITATIVE ASSESSMENT	ASSESSMENT
	Wider Economic Impacts	The scheme will have helped facilitate economic opportunities, with improved journey reliability, and reduced journey times, is likely to have improved communications across this strategic corridor. This is furthered by the Great Bypass scheme which improved conditions elsewhere on the A421 route. Taken together, it is likely that these schemes have made the whole A421 route more attractive, and a corridor for economic growth.	N/A	Slight beneficial (better than expected)
ACCESSIBILITY	Option Values	The scheme does not provide any additional modes of transport, therefore the scheme has had negligible impact. It could be argued, that the scheme may have made non-motorised forms of transport such as walking and cycling more attractive due to the significantly reduced traffic volumes along the former A421, however this is not considered within WebTAG guidance against this sub-objective, and therefore does not affect the 'neutral' score here.	N/A	Neutral (as expected)
	Severance	The scheme is considered to have had a neutral impact on severance as expected, with negative impacts being countered by improvements to the PROW network and adequate crossings provided for non-motorised users over the new road.	N/A	Neutral (as expected)
	Access to the Transport System	The junction improvements will have eased access for local traffic to the trunk road network. The reduction in traffic along the former route (up to 80%) will also have improved opportunities for walking and cycling, as well as the potential for re-allocating road space for non-car modes, however this has not occurred to date.	N/A	Neutral (as expected)
INTEGRATION	Transport Interchange	The scheme has had no impact on the provision of public transport interchanges.	N/A	Neutral (as expected)
	Land-Use Policy	The scheme has had a beneficial impact on Land Use policies as it generally facilitates the achievement of key policy objectives, particularly in respect of this important Strategic Growth Corridor.	N/A	Beneficial (as expected)
	Other Government Policies	It is considered that the overall score should be 'neutral' rather than the AST's 'beneficial'. This is because positive alignment with some policies, such as reducing community severance, improving safety, and facilitating strategic growth have been countered with other negative outcomes that do not align with policies to reduce carbon emissions, to reduce car use and protect best and most versatile agricultural land, as the scheme passes through four distinct Landscape Character Areas (LCA).	N/A	Neutral (worse than expected)

Appendix B. Environment

B.1. Sources

Standard list of information required to evaluate the environmental sub-objective

Environment Specific Requirements	FYA
Environment Statement (ES) or if not a scheme requirement the latest Scheme Assessment Report (SAR).	Environmental Statement (December 2007) Volumes 1 and 2a, 2b and 3.
AST	AST (2011) provided with inter peak amendments
Any amendments, updates or addendums to the ES/SAR or any relevant further studies or reports. Any significant changes to the scheme since the ES.	Addendum to the Traffic Forecasting Report
As built drawings for landscape/biodiversity/environmental mitigation measures/drainage/ fencing/ earthworks etc.	All drawings requested have been provided
Construction Environment Management Plan (CEMP)	Received – although it was not substantial
Landscape and Ecology Aftercare Plan (LEAP).	Landscape and Ecology Programme supplied
H& S File – environment information	Health and Safety File – Operations and Maintenance manual received
Handover Environmental Management Plan (HEMP).	Not to be issued – EnvIS is being produced in its place
Relevant Contact Names for: the Statutory Consultees (EA, EH and NE); the local authorities (at county and district level); the Parish / Town Councils; Employer’s Agent and Designers or environmental coordinators for scheme; the MAC; and Other relevant specialist consultees.	Contacts provided for designer
Archaeological Reports (popular and academic).	Written Scheme of investigation – field evaluation and mitigation Archaeological Evaluation Report Archaeological Post Excavation evaluation report
The Road Surface Influence (RSI) value of any low noise surface installed	Received

Environment Specific Requirements	FYA
The insulation performance properties of any noise barriers installed (The BS EN 1794-2 result provided by the noise barrier manufacturer)	Received
List of properties eligible for noise insulation.	Information received
List of Part 1 Claims regarding noise/air quality/lighting (will be obtained from HA national part 1 team by POPE team).	Information received
Reports for any pre/post opening survey and monitoring work e.g. for noise, biodiversity, water quality).	Annual Ecological Monitoring Reports (2007 – 2015) provided. Landscape audit reports up to 2015
Animal mortality data	Not received
Post opening Non-motorised User (NMU) Audit or Vulnerable User Survey	Received at OYA
Any information regarding environmental enhancements to streetscape/townscape for bypassed settlements.	N/A
Employers Requirements Works Information – environment section	Received

Appendix C. Glossary

Glossary of terms used in this report

Term	Abbreviation	Description where appropriate
Annual Average Daily Traffic	AADT	Average of 24 hour flows, seven days a week, for all days within the year.
Accessibility	-	Accessibility can be defined as 'ease of reaching'. The accessibility objective is concerned with increasing the ability with which people in different locations, and with differing availability of transport, can reach different types of facility.
AM	-	Denoting the morning peak period
Appraisal Summary Table	AST	This records the impacts of the scheme according to the Government's five key objects for transport, as defined in DfT guidance contained on its Transport Analysis Guidance web pages, WebTAG
Automatic Traffic Count	ATC	An automated method of recording the volume (and sometimes classification) of vehicles passing a particular point on a road.
Average Weekday Traffic	AWT	Average of Monday to Friday 24 hour flows over a particular period.
Average Daily Traffic	ADT	Average of Monday to Sunday 24 hour flows over a particular period.
Benefit Cost Ratio	BCR	The ratio between the monetised benefits and costs of a scheme, used as a measure of value for money in economic terms.
Billion vehicle kilometres	bvkm	Billion Vehicle Kilometres
Capacity	-	The maximum hourly lane throughput
Capitalisation	-	The process of extrapolating benefits over the appraisal life of a scheme.
Chi-square	-	A statistical test to determine whether the observed values of a variable are significantly different from those expected on the basis of a null hypothesis. Variables are categorised to determine whether a distribution of scores is due to chance or experimental factors and tests whether one variable is independent of another.
Congestion Reference Flow	CRF	An AADT flow estimate at which a road is likely to be congested in the peak periods on an average day.
County Wildlife Site	CWS	
Department for Transport	DfT	A Government department whose objective is to oversee the delivery of a reliable, safe and secure transport system that responds efficiently to the needs of individuals and business whilst safeguarding our environment.

Term	Abbreviation	Description where appropriate
Discounting	-	A technique used to compare costs and benefits that occur in different time periods and is the process of adjusting future cash flows to their present values to reflect the time value of money, e.g. £1 worth of benefits now is worth more than £1 in the future. A standard base year needs to be used which is 2002 for the appraisal used in this report.
Design Manual for Roads and Bridges	DMRB	A comprehensive manual system which sets out current standards, Advice Notes and other published documents relating to Trunk Road works.
Do-minimum	DM	In scheme modelling, this is the scenario which comprises the existing road network plus improvement schemes that have already been committed.
Do-something	DS	In scheme modelling, this is the scenario detailing the planned scheme.
Environment Agency	EA	An Executive Non-departmental Public Body responsible to the Secretary of State for Environment, Food and Rural Affairs. Its principal aims are to protect and improve the environment, and to promote sustainable development.
English Nature	EN	EN was the United Kingdom government agency that promoted the conservation of wildlife, geology and wild places throughout England between 1990 and 2006. It was a non-departmental public body funded by the Department for Environment, Food and Rural Affairs (DEFRA) and gave statutory advice, grants and licences. It was integrated with parts of both the Rural Development Service and the Countryside Agency from 1 October 2006, to form a new body called Natural England .
Environmental Statement	ES	This must be submitted with the initial planning application and covers all potential significant impacts that the road project may have.
Evaluation Summary Table	EST	In POPE studies, this is a summary of the evaluations of the WebTAG objectives using a similar format to the forecasts in the AST .
Five Years After	FYA	Relating to a POPE evaluation Five Years After scheme opening
Heavy Goods Vehicle	HGV	Goods-carrying vehicle over 3,500kg unladen weight.
Handover Environmental Management Plan	HEMP	Once construction is complete, the management documents and other environmental information passed to those responsible for operating the Project.
Highways England	-	Responsible for operating, maintaining and improving the strategic road network in England.
Inter Peak	IP	The time between the AM and PM peaks
Killed or Seriously Injured	KSI	A term used to describe the number of people killed or seriously injured as a result of PICs .

Term	Abbreviation	Description where appropriate
Local Transport Plan	LTP	Strategic transport authorities (county councils, unitary authorities, passenger transport authorities and London Borough councils), are expected to prepare LTPs as forward-looking plans covering a number of years (typically five years), and present them to the DfT .
Managing Agent Contractor	MAC	Highways England maintenance areas, combining the roles previously undertaken by separate Managing Agent and Term Maintenance Contractors.
Major Schemes programme	-	Programme of investment in improvements to the Trunk road and Motorway road network comprised of a number of major schemes each costing more than £5m. Formerly known as TPI .
Million vehicle kilometres	mvkm	Million vehicle kilometres
Natural England	NE	The government's advisor on the natural environment, whose remit is to ensure sustainable stewardship of the land and sea so that people and nature can thrive.
New Approach To Appraisal	NATA	A framework to appraise and inform the prioritisation of new trunk road investment proposals. The approach includes identification and assessment of problems, as well as the identification of options. Used since 1998.
Non-motorised User	NMU	A term used to describe pedestrians, cyclists and equestrians.
Non-Technical Summary	NTS	This document describes the proposed scheme and summarises the ES in non-technical language.
National Road Traffic Forecast.	NRTF	This document defines the latest forecasts produced by the Department of the Environment, Transport and the Regions of the growth in the volume of motor traffic. The most recent one is NRTF'07 and the one previous was NRTF'97 , and this document makes particular reference to the one used for the scheme's appraisal – NRTF '89 .
One Year After	OYA	Relating to a POPE study One Year After scheme opening.
Project Appraisal Report	PAR	The Highways England process and report produced for the appraisal of small and large Local Network Management Schemes (LNMS).
Part 1 Claims	-	Claims for compensation under Part 1 of the Land Compensation Act 1973, relating to homeowners affected by road schemes.
Personal Injury Collision	PIC	A term commonly used to refer to road collisions.
Personal Injury Collisions per million Vehicle kilometres	PIC/mvkm	A term used to express collision rates for a link on a road, i.e. the number of collisions per million vehicle kilometres travelled.
PM	-	Evening peak period

Term	Abbreviation	Description where appropriate
Post Opening Project Evaluation	POPE	Before & after monitoring of all major highway schemes in England.
Public Right of Way	PROW	Highways that allow the public right of passage, of which England has about 190,000 km.
Present Value of Benefits	PVB	The value of the scheme's estimated benefits discounted back to a common base year.
Present Value of Costs	PVC	The value of the scheme's estimated costs discounted back to a common base year.
Retail Price Index	RPI	A measure of inflation published monthly by the Office for National Statistics. It measures the change in the cost of retail goods and services.
Road Surface Influence	RSI	An internationally agreed standard for measuring the influence of road surfaces on traffic noise levels.
'Route Stress'	Stress	Ratio of the AADT flow to the CRF. When the traffic flow on a particular link reaches the CRF it is considered to be at 100% Stress.
Screenline	-	An imaginary line intersecting routes on a map to allow easier analysis of vehicular movement across a corridor.
Security	-	In terms of the NATA sub-objective relating to the likelihood of crime or perception of likely crime.
Severance	-	Community severance is the separation of adjacent areas by road or heavy traffic, causing negative impact on non-motorised users, particularly pedestrians.
STATS19	-	A database of injury collision statistics recorded by police officers attending collisions
Transport Analysis Guidance	TAG	Transport Analysis Guidance - as defined in WebTAG .
Transport Statistics Bulletin	-	Produced by the DfT presenting information on Traffic in Great Britain
Trip End Model Program	TEMPO	A program which provides access to the DfT's national Trip End Model projections of growth in travel demand, and the underlying car ownership and planning data projections.
Targeted Programme of Improvements.	TPI	The Highways England's programme of investment in improvements to the Trunk road and Motorway road network comprised of a number of major schemes each costing more than £10m. Now called Major Schemes .
Traffic Database	TRADs (now WebTRIS)	Traffic count database developed by Highways England, to hold data from monitoring sites in England.
Vehicle Operating Cost	VOC	Reflects fuel and other operating costs calculated from total distance travelled on affected links, also taking into account vehicle speeds.

Term	Abbreviation	Description where appropriate
Value of Time	VOT	A monetary value placed on the benefits accrued by a road scheme in terms of vehicle hours.
webTAG	-	The DfT's website for guidance on the conduct of transport studies at http://www.webtag.org.uk/

Appendix D. Tables and Figures in this Report

Tables

Table 1-1	Nearby schemes	13
Table 2-1	Change in million vehicle kilometres (mvkm)	17
Table 2-2	Change in two-way traffic volumes	21
Table 2-3	Screenline 1 AWT	24
Table 2-4	Screenline 2 AWT	24
Table 2-5	Accuracy of Do Minimum forecasts	25
Table 2-6	Accuracy of Do Something forecasts	25
Table 2-7	Forecast and observed changes in volumes	26
Table 2-8	Road schemes	27
Table 2-9	Volume and proportion of HGVs on a typical weekday	28
Table 2-10	Journey times and savings (mm:ss) by time period and direction	30
Table 3-1	Observed collision numbers in COBA area	37
Table 3-2	Observed casualties in COBA area	38
Table 3-3	Observed collisions in scheme section	42
Table 3-4	Observed casualties in scheme section	42
Table 3-5	Collisions involving NMUs within the COBA modelled area	43
Table 3-6	Collision rate before and after compared to the national average	44
Table 3-7	Chi-square tests for the scheme	45
Table 3-8	Forecast vs. observed collision savings	45
Table 4-1	Economic benefits of scheme (2002 prices and values)	50
Table 4-2	Vehicle hour savings at FYA and calculation of vehicle hour benefits	51
Table 4-3	Present value benefits £m, in 2002 prices and values	54
Table 4-4	Costs in 2002 prices, £million	54
Table 4-5	PVC for A421 improvements M1 junction 13 to Bedford scheme	55
Table 4-6	Benefit Cost Ratio	55
Table 5-1	Summary of environmental consultation responses	59
Table 5-2	Traffic flows: FYA observed versus forecast	61
Table 5-3	Evaluation summary: noise	64
Table 5-4	Evaluation summary: local air quality	65
Table 5.5	Revised forecast and outturn impact on annual emissions (tonnes of carbon) at OYA and FYA	67
Table 5-6	Summary of journey ambience evaluation	90
Table 7-1	Success against scheme specific objectives	97

Figures

Figure 1-1	Location of scheme	7
Figure 1-2	Figure 1-2 Scheme Detail	9
Figure 1-3	Key events in the scheme's development	12
Figure 1-4	Nearby completed schemes	14
Figure 2-1	Local and regional trends in million vehicle kilometres (mvkm)	17

Figure 2-2 Long term trends northbound and southbound on A421, north of the scheme	19
Figure 2-3 Average weekday traffic (AWT)	22
Figure 2-4 Traffic screenlines	24
Figure 2-5 Journey Time Route	29
Figure 2-6 Journey time reliability, northbound	32
Figure 2-7 Journey time reliability, southbound	32
Figure 3-1 Background trends in collision numbers	36
Figure 3-2 Study area for collision analysis	37
Figure 3-3 Location of collisions – pre-scheme	39
Figure 3-4 Location of collisions – post-scheme	40
Figure 3-5 Scheme section	41
Figure 3-6 NMU collision locations by casualty type	44
Figure 3-7 A lay-by in use on the A421 © 2017 Google (September 2016 image)	47
Figure 3-8 Footpath alongside the old road © 2017 Google (September 2010 image)	47
Figure 3-9 Footpath at Woburn Road junction © 2017 Google (September 2016 image)	47
Figure 5-1 Development east of Fields Road overbridge – under construction (OYA view) and nearing completion (FYA view)	63
Figure 5-2 Noise barrier east of Marston Junction	63
Figure 5-3 Gap in noise barrier east of Marston junction	64
Figure 5-4 Woodland planting and species rich grassland showing good growth and establishment	70
Figure 5-5 Bulb planting north of Marston junction	71
Figure 5-6 Planting near Fields Road overbridge	72
Figure 5-7 Comparison views of planting between the old A421 and existing A421 at Fields Road junction (OYA view on the left, FYA view on the right)	72
Figure 5-8 Southern approach to Manor Road Bridleway (OYA view on left, FYA view on right)	72
Figure 5-9 Mammal tunnel entrance south east of North Common Farm underpass (left) and an example of badger proof fencing (right)	78
Figure 5-10 Badger tunnel near Wootton (OYA view on the left, FYA on the right)	78
Figure 5-11 Bat boxes installed near Vale Farm bridleway overbridge	79
Figure 5-12 GCN mitigation pond (OYA view below, with FYA view below that)	79
Figure 5-13 Planting within the Brogborough Lake CWS	80
Figure 5-14 Extension of Brogborough Spinney adjacent to North Common Farm	81
Figure 5-15 Species rich grassland along the A421 north of the M1 junction 13	81
Figure 5-16 Example of amphibian-proof fencing located along the A421	81
Figure 5-17 Log pile near Vale Farm overbridge	82
Figure 5-18 GCN hibernaculum near Vale Farm overbridge	82
Figure 5-19 Pond near Vale Farm overbridge	85
Figure 5-20 Pond north of Manor Road bridleway (OYA view on left, FYA view on the right)	85
Figure 5-21 Drainage channels not receiving proper maintenance	86
Figure 5-22 Lower Shelton subway extension and re-alignment (including artwork within the subway)	87
Figure 5-23 Cyclist using the Lower Shelton subway	88
Figure 5-24 Footpath near Marston overbridge (OYA view on the left, FYA view on the right)	88
Figure 5-25 Bridleway near North Common Farm underpass blocked with rubble	88
Figure 6-1 Quiet former A421 route just south of Marston Moretaine	93