Technical note

Project:	A350 Farmers Roundabout Improvements NPIF bid	**To:**	Peter Binley
Subject:	Modelling and Economics Technical note	**From:**	Pauline Wright
Date:	28/6/17	**cc:**	

1. Purpose of the note

The A350 Farmers Roundabout Improvements NPIF application form, submitted by Wiltshire Council, sets out the primary information supporting this bid for funding. This document, forming an appendix to the NPIF application form provides additional detail on the economic case for the scheme considering:

- The study area
- Options which have been assessed
- Approach to modelling assessment
- Approach to economic assessment
- Assessment of costs
- Estimation of benefits
- Appraisal summary
- Conclusions

This covers both monetised benefits, which are also reported in the AST and non-monetised benefits which are examined more fully in this report.

2. Study area

The A350 Farmers Roundabout in Melksham, Wiltshire, is an unsignalised roundabout with 2/3 circulatory lanes. The signalisation of this roundabout forms the core of the proposed scheme, with additional elements along the A350 through to Semington Roundabout to the south including resurfacing the link road, removal or replacement of existing lighting along this link and improvement to the flare/merge on the northern exit of Semington Roundabout.

Each of these improvements are set out in Figure 1.

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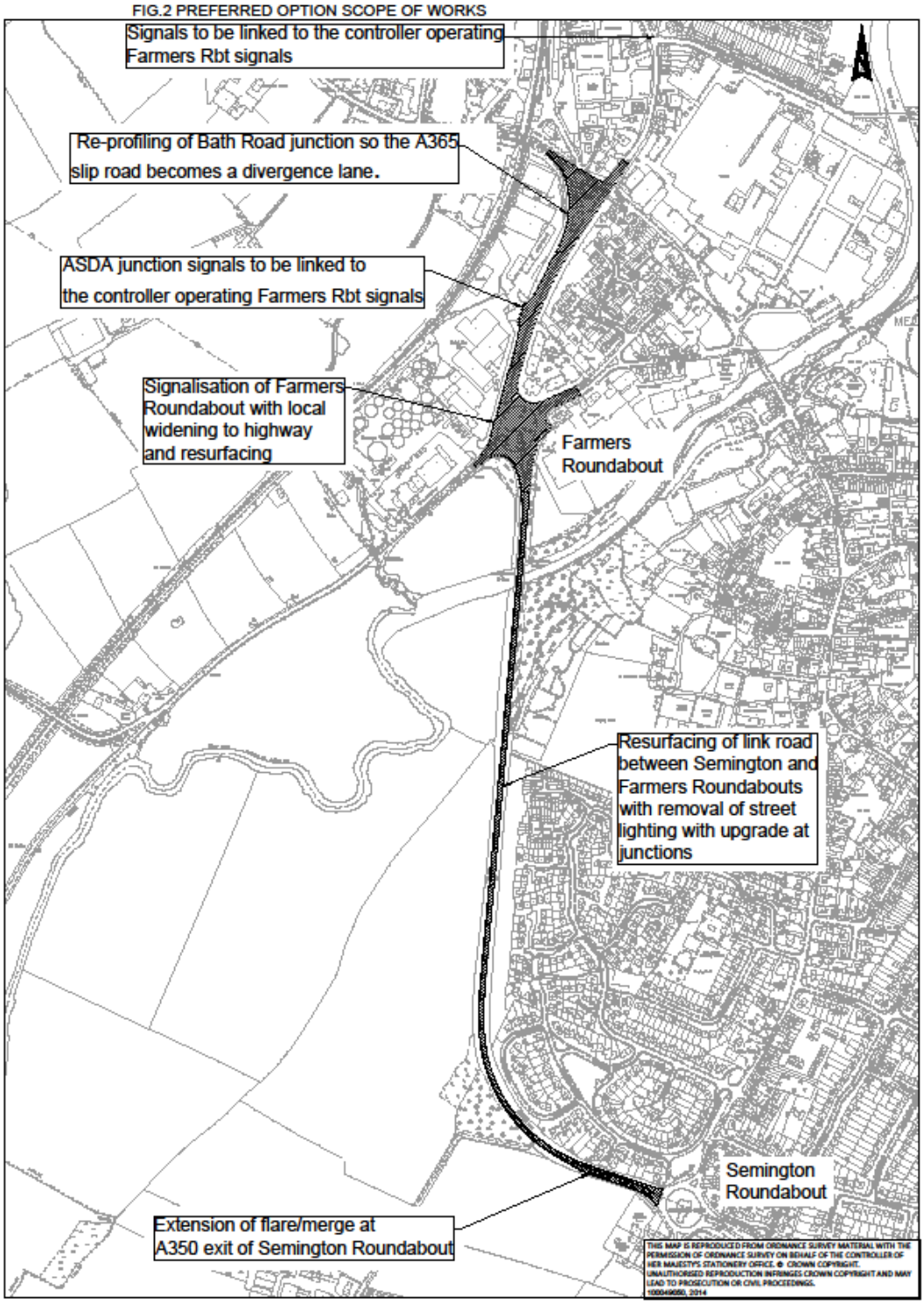
Figure 1 Scheme layout



3. Option assessment

3.1.1. Do minimum

There are currently no schemes either in development or approved for funding in the area of influence of the Farmers Roundabout scheme. The Do-Minimum scenario, for both forecast years is therefore considered to be equivalent to the Do-Nothing scenario.

3.1.2. Do something option

Options have been developed in two distinct sections.

3.1.2.1. Farmers Roundabout element

Modelling has considered seven potential do-something options, five of which have been progressed to economic appraisal. Each of these options considered variations on the proposed layout of Farmers Roundabout. Table 1 specifies the shortlisted options which are all variants of signalisation.

Table 1 Option specification

	DS1	DS2	DS3	DS4	DS7
Full Signalisation	✓				
Part Signalisation		✓	✓	✓	✓
Resurface Gyratory	✓	✓	✓	✓	✓
Widen Junction Approaches			✓		✓
Widen Circulatory Carriageway				✓	✓

Full specifications and layouts of these options are set out in the appended modelling report.

In addition to the modelling of these options, a range of additional measures have been assessed which fall outside the scope of the existing model.

3.1.2.2. Extended Scheme Options

A range of additional measures has been considered separately from the above range of options for Farmers Roundabout itself and a preferred package of measures has been compiled.

1. A350 Farmers Roundabout to Semington Roundabout resurfacing;
2. Semington junction taper improvement;
3. A350 Farmers Roundabout to Semington Roundabout lighting replacement with LED;
4. A350 Farmers Roundabout to Semington Roundabout lighting removal.

Of these options, items 1, 2 and 4 have been taken forward.

The Farmers Roundabout to Semington Roundabout section of the A350 is in urgent need of resurfacing over its entire length. As a main link road connecting the M4 to Wiltshire and the south, this route is heavily trafficked. This would make a piecemeal approach to repairs economically disproportionate in terms of traffic management costs and the joints created between the existing road sections and patch repairs would be prone to rapid deterioration, introducing the risk of further costs being required due to reworking.

The Semington junction taper improvement involves a 115m merge taper on the A350 northbound exit to Semington roundabout. Currently the roundabout has a 2 lane exit on the circulatory carriageway, which rapidly merges into a single lane, resulting in conflicting traffic. Extending this taper will reduce queues building up back into the roundabout and also reduce risk of accidents.

Lighting along the A350 between Farmers Roundabout and Semington Roundabout has reached the end of its design life and 40 lighting columns need to be removed or replaced. Any replacement is proposed to make use of long lasting, energy efficient LED lamps. It has been considered that lighting is only necessary at junctions and the remainder of this section of the A350 can safely have lighting removed altogether, saving cost of both investment and operation. Both reduction of light columns and use of LED lamps will also reduce light pollution and provide a CO2e reduction.

Each of these three options are therefore taken forward to form part of a package with the preferred option for Farmers Roundabout. The assessment of these options is set out below.

4. Modelling assessment approach

4.1.1. Introduction

A VISSIM model was developed to test the proposed signalisation scheme for the Farmers Roundabout junction by Atkins in February 2017. This NPIF bid is based on a refined version of that model including recommendations and refinements proposed a subsequent independent audit.

The key refinements to the model are as follows:

- Model updated to VISSIM 9.04 & TEMPro 7.2
- Matching AM and PM parameters used in line with best practice
- Link-connector structure at roundabout entries modified

The LinSig model used for Farmers Roundabout project to optimise signal timings given the geometries and junction configuration proposed was also used for this project.

4.1.2. Traffic forecasting

Growth factors to obtain the 2018 and 2028 traffic flows were updated to use the latest version of Trip End Model Presentation Program (TEMPro), TEMPro 7.2.

Trip end growth factors for car drivers were derived and adjusted by NTM dataset AF15 for ‘rural’ area types and ‘principal’ road types to reflect the nature of the A350.

To determine the measures with most potential to improve the Farmers Roundabout junction, several initial options (Table 2) were developed, using the recommendations from the Farmers Roundabout Technical Note as the starting point:

- Partial signalisation
- Provision of additional lanes on approach arms
- Provision of additional arms on the circulatory carriageway

The options were benchmarked against both the Do Nothing scenario and the proposed full signalisation scheme (DS1). To allow a like-for-like comparison, stop line location has been improved and the proposed yellow box removed in all options.

Table 2 Long list of options

Option	Option name	Signalisation	Entry geometry changes	Circulation geometry changes	Yellow box marking	Destination markings
DS1	Full Signalisation	Full Signalisation	None	None	Removal of existing yellow box and new yellow boxes added on A3102, A350 and B3107 Entry	A3102 E no specific lane marking but nearside lane to be used for A350 S and B3107
DS2	Partial Signalisation	B3107 retained as priority control	None	None	Removal of existing yellow box and new yellow boxes added on A3102 and B3107 Entry	A3102 E no specific lane marking but nearside lane to be used for A350 S and B3107
DS3	Partial Signalisation and Entry Changes	B3107 retained as priority control	Short lane added to A350N and A3102 East Entry	None	Removal of existing yellow box and new yellow boxes added on A3102 and B3107 Entry	A3102 E no specific lane marking but nearside short lane to be used for A350 S, middle lane for B3107
DS4	Partial Signalisation and Circulatory Changes	B3107 retained as priority control	None	A fourth lane on the eastern side of the roundabout from the A3102 arm to the A350 South arm	Removal of existing yellow box and new yellow boxes added on A3102 and B3107 Entry	A3102 E no specific lane marking but nearside lane to be used for A350 S and B3107
DS5	Partial Signalisation, entry changes only for A3102 East and Circulatory Changes	B3107 retained as priority control	Short lane added to A3102 East Entry	A fourth lane on the eastern side of the roundabout from the A3102 arm to the A350 South arm	Removal of existing yellow box and new yellow boxes added on A3102 and B3107 Entry	A3102 E no specific lane marking but nearside short lane to be used for A350 S, middle lane for B3107
DS6	Partial Signalisation, entry changes only for A350 North and Circulatory Changes	B3107 retained as priority control	Short lane added to A350 North Entry	A fourth lane on the eastern side of the roundabout from the A3102 arm to the A350 South arm. Additional space taken from north circulatory to provide space for entry of A350 N	Removal of existing yellow box and new yellow boxes added on A3102 and B3107 Entry	A3102 E no specific lane marking but nearside lane to be used for A350 S and B3107
DS7	Partial Signalisation, Entry Changes and Circulatory Changes	B3107 retained as priority control	Short lane added to A350 North and A3102 East Entry	A fourth lane on the eastern side of the roundabout from the A3102 arm to the A350 South arm. Additional space taken from north circulatory to provide space for entry of A350 N	Removal of existing yellow box and new yellow boxes added on A3102 and B3107 Entry	A3102 E no specific lane marking but nearside short lane to be used for A350 S, middle lane for B3107
DS8	Partial Signalisation, Entry Changes and additional Circulatory Changes	B3107 retained as priority control	Short lane added to A350 North and A3102 East Entry	A fourth lane on the eastern side of roundabout from A3102 arm to A350 South arm and additional lane from A350S Entry to A350N. Additional space taken from north circulatory to provide space for entry of A350 N	Removal of existing yellow box and new yellow boxes added on A3102 and B3107 Entry	A3102 E no specific lane marking but nearside short lane to be used for A350 S, middle lane for B3107
DS9	Full Signalisation, Entry Changes and additional Circulatory Changes	Full Signalisation	Short lane added to A350N and A3102 East Entry	A fourth lane on the eastern side of roundabout from A3102 arm to A350 South arm and additional lane from A350S Entry to A350N. Additional space taken from north circulatory to provide space for entry of A350 N	Removal of existing yellow box and new yellow boxes added on A3102, A350 and B3107 Entry	A3102 E no specific lane marking but nearside short lane to be used for A350 S, middle lane for B3107

4.1.3. Sifted options

These long-listed options were tested initially in LinSig, are the following options were rejected:

- DS5 – Entry improvements to the A3102 East only resulted in higher overall delays and a lower Practical Reserve Capacity than entry improvements for both the A350 North and A3102 East (DS7)
- DS6 – Entry improvements to the A350 North only resulted in higher overall delays and a lower Practical Reserve Capacity than entry improvements for both the A350 North and A3102 East (DS7)
- DS8 – Overall delays and Practical Reserve Capacity with a fourth circulatory lane added on the western as well as the eastern side of the roundabout were worse than a fourth circulatory lane on the eastern side only (DS7). In addition, a safety issue was raised given uncontrolled access from the two entry lanes on the B3107 arm to a four-lane circulatory
- DS9 - Overall delays and Practical Reserve Capacity with a fourth circulatory lane added on the western as well as the eastern sides of the roundabout and full signalisation were worse than a fourth circulatory lane on the eastern side only and partial signalisation (DS7)

Options DS1, DS2, DS3, DS4 and DS7 were therefore taken forward for modelling in VISSIM.

Outputs from each VISSIM model were analysed in terms of network performance, journey time on key routes and average and maximum queue lengths at Farmers Roundabout. Data was also extracted for TUBA analysis as part of the NPIF bid.

4.1.4. Option performance

VISSIM produces a range of statistics to measure network performance as well as queueing and delay on individual arms at junctions. These statistics can be used to benchmark the performance of proposed improvements against a Do Nothing scenario.

The following VISSIM statistics provide a good overview of network performance between modelled scenarios, allowing general changes in network congestion to be identified:

- **Average network journey time** – for vehicles travelling though the modelled network in the peak hour in minutes
- **Average network speeds** – average speeds in miles per hour for all vehicles during the peak hour
- **Average delay time** – the difference between the theoretical travel time with no congestion, signals or other stops and the actual travel time per vehicle during the peak hour in minutes.
- **Selected Route Journey Times –** in seconds on important routes across the modelled network

When considering individual junctions, the following performance measures have been used:

- **Average queue -** the mean queue measured by VISSIM over the modelled time period in metres
- **Maximum queue** – the maximum queue measured by VISSIM over the modelled time period in metres

Reporting of the detailed results of the VISSIM modelling is contained in NPIF Modelled Options Report (Document Ref. 5158851 001 Report 2017-06-28) which can be supplied on request.

4.1.5. Conclusion

In terms of overall network performance, Options DS2, DS3, DS4 and DS7 all result in significantly better operation than the DN or DS1 options. Whilst there is relatively little difference between options DS2, DS3, DS4 and DS7 at 2018, DS7 performs better in terms of overall network operation at 2028.

Selected route journey time analysis shows that signalisation of Farmers Roundabout reduces journey times on the A350 in 2018. Journey times are relatively unchanged on the east-west A365-A350-A3102 route, with the exception of DS1 were significantly longer journey times are observed. At 2028, DS1, DS2 and DS3 result in longer journey times when compared with the DN scenario whilst DS4 and DS7 show modest improvements.

At Farmers Roundabout, all DS options reduce the long average and maximum queue lengths on the A350 South (2018 and 2028 AM Peak) and B3107 (2018 and 2028 PM Peak) than the DN scenario. DS2, DS3, DS4 and DS7 however have significant shorter queue lengths than DS1 across the junction as a whole in all time periods. Whilst the results vary, DS7 typically has the shortest average queue lengths across all arms in each peak period.

5. Economic assessment approach

5.1.1. Purpose of the economic assessment

As explained in TAG Unit A1.1, an economic assessment is undertaken to facilitate the quantification and monetisation of scheme costs and benefits. Overall, schemes are assessed against relevant government objectives, which include:

- providing good value for money in relation to impacts on public accounts;
- improving transport economic efficiency for business users and transport providers;
- improving transport economic efficiency for consumer users; and
- improving reliability.

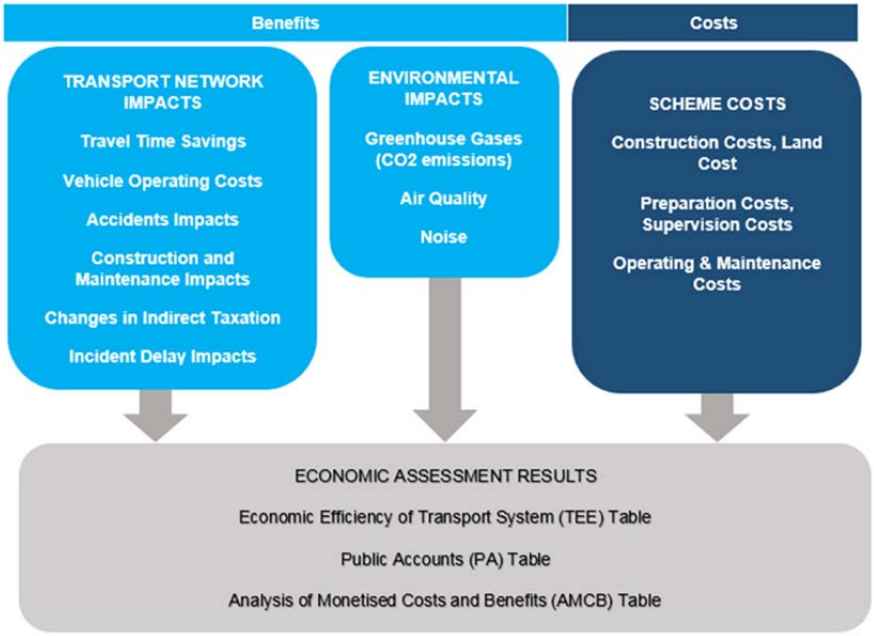
An economic assessment is undertaken over a period reflecting the design life of the scheme in accordance with the requirement of TAG Unit A1.1. Economic assessment results are presented in the form of Transport Economic Efficiency (TEE), Public Accounts (PA), and Analysis of Monetised Costs and Benefits (AMCB) tables. The results are also input to an Appraisal Summary Table (AST).

5.1.2. Economic assessment approach

The Economic Assessment has been carried out using standard procedures and economic parameters as defined by TAG Unit A1- Cost Benefit Analysis with efforts made to quantify and monetise costs and other impacts where appropriate. The key components that make up the assessment and feed into the TEE, PA, AMCB and supporting unmonetised analysis are shown in Figure 2.

All present values shown are in 2010 prices, discounted over a 30-year appraisal period to 2010 and are quoted in the market price unit of account unless otherwise stated.

Figure 2 Economic assessment components



The following elements of the economic assessment have been monetised:

- road user journey time savings
- road user vehicle operating costs
- indirect tax revenue – due to changes in the amount of fuel and other direct vehicle
- operating costs purchased and changes in expenditure on transport offsetting changes in expenditure elsewhere in the economy
- Greenhouse gas, noise and air quality impacts

The following elements have not been monetised, due to the requirements for their assessment being disproportionate the overall scheme assessment, but have instead been considered qualitatively:

- road user safety impacts – due to changes in the future number and/or severity of accidents
- public transport (bus) journey time impacts – due to changes in travel time
- construction impacts– impacts on road user travel time and vehicle operating costs during scheme construction
- incident delay impacts – due to changes in journey time related to incidents

5.1.3. DfT's Value for Money (VfM) process and categories

The Value for Money (VfM) assessment is carried out as a staged process to ensure that a complete and robust analysis is undertaken. The Appraisal Summary Table (AST) helps to summarise all the monetised, qualitative and quantitative impacts of the scheme and present as a coherent package. This has been included as a separate appendix.

A Value for Money statement is produced using the information within the AST to provide a summary of the conclusions from the Value for Money assessment. The VfM categories and their relationship with benefit-cost ratios (BCRs) generated through cost-benefit analysis, is presented in Table 3.

Table 3 DfT value for money categories

DfT Value for Money Categories	
BCR	**Low**
Less than 1.0	Poor
1.0 to 1.5	Low
1.5 to 2.0	Medium
2.0 to 4.0	High
Greater than 4.0	Very High

6. Estimation of scheme costs

6.1.1. Overview

Part of the economic analysis process is to derive the costs associated with the scheme, predominantly construction, land, preparation and supervision costs. The preparation of each shortlisted option costs for the Scheme has been carried out following the principles set out in TAG Unit A1.2 'Scheme Costs'.

6.1.2. Construction costs and profile

Table 5.1 summarises the value of the construction cost with expenditure profile. It also shows total discounted costs in 2010 market price unit of account (Present Value of Costs, 2010 prices, discounted to 2010) for the scheme options.

These costs include all elements of the proposed schemes, i.e.:

- Signalisation of Farmers Roundabout
- A350 Farmers Roundabout to Semington Roundabout resurfacing
- Semington junction taper improvement
- A350 Farmers Roundabout to Semington Roundabout lighting removal

Table 4 Scheme costs – Investment, 2015 Q1 prices, £million

	DS1	DS2	DS3	DS4	DS7
Preparation	0.134	0.134	0.134	0.134	0.134
Supervision	0.181	0.181	0.181	0.181	0.181
Works	2.178	2.323	2.353	2.393	2.413
Land	0	0	0	0	0
Evaluation and monitoring	0.100	0.100	0.100	0.100	0.100
Total	**2.397**	**2.523**	**2.549**	**2.584**	**2.602**

Costs set out for all options include optimism bias uplifts of 5%, having undergone detailed assessment of preliminary design and costing exercises. Being mostly surface works, on council owned land, with little scope for disputes or significant environmental impacts, much of the usual optimism bias allowance added to the cost of road schemes is not applicable. Therefore, this reduced uplift has been considered more appropriate. These uplifts are included in the values presented in Table 4

The timing of costs will be dependent on the timing of any funding provision from NPIF, but the local authority contribution has already been arranged and detailed design could begin immediately,

so it has been assumed that costs will fall during 2018/19. However, if DfT funding were to become available later a delayed start date could also be supported.

Although the preferred option does involve a small amount of increased land use for the Semington taper improvement, this land is already owned by the local authority. Being part of the existing highway verge, no opportunity cost is being lost through the use of this land and therefore no land cost has been included for its use as part of the scheme.

Table 5.2 sets out for clarity how the costs above translate into the cost presented for funding in the NPIF application form. These costs allow for inflation up to the point of expenditure based on Tender Prices Indices forecast by BCIS and include an allowance for risk which is discussed in detail below.

This cost calculation does not inform the PVC but is used for funding purposes only. Being costs for funding, optimism bias is not included.

Table 5 Outturn costs – Investment, including risk adjustment, 2018/19 prices, £million

	DS1	DS2	DS3	DS4	DS7
Total	**2.750**	**2.900**	**2.931**	**2.973**	**2.993**

6.1.3. Quantified Risk Assessment

A quantified risk assessment (QRA) has been undertaken to capture the likely impacts of risk over and above the central cost forecast. A single QRA has been carried out which is considered relevant to all options.

The key items which were identified in the risk register are set out in Table 6, indicating the range of values and probability of occurrence attributed to each.

Table 6 Risk assessment

Risk	Low Cost P(10)	Expected Cost P(50)	High Cost P(90)	Probability of Occurrence	P(50) x Probability
Unforeseen costs of delay in start of works associated with utility diversions or with conflict with holiday season traffic	-£42k	£63k	£188k	100%*	£63k
Unexpected ground conditions or buried services	£0	£50k	£100k	50%	£25k
Changes to design after construction has commenced	£0	£103k	£205k	50%	£51k
Market forces, inflation impacts on costs of materials	-£96k	£0	£96k	100%*	£0
Total					**£133k****

* Delay and inflation treated as a continuous, rather than discrete, events

** The total value of risk is not equal to the sum of the individual items, as the overall risk has been assessed using a Monte Carlo combined probability distribution analysis.

It should be noted that elements of cost have been included in the central cost forecast in relation to some of these items, so the additional allowance included as “risk” is only the value over and above that central forecast. It has been ensured that no double counting or exclusion has occurred. For example, in the case of inflation risk, while uncertainty exists, the central estimate is based on BCIS TPI forecasts of inflation, so the risk pivots around this central point.

Similarly, a negative value in relation to delay occurs in the QRA, allowing for the chance of delays being less than anticipated.

6.1.3.1. Risk management

An overall risk management strategy has been provided in a separate appendix whilst Table 7 only considers the management of specific risks picked up by the QRA itself and mitigation measures put in place for each.

Table 7 Risk mitigation

Risk	Mitigation Measure
Unforeseen costs of delay in start of works associated with utility diversions or with conflict with holiday season traffic	Early investigation into requirement for utility diversions to be carried out to understand what delay these may entail prior to commencing works.
Unexpected ground conditions or buried services	Establish communication with service companies at an early stage.
Changes to design after construction has commenced	Effective project management. Peer review at critical stages.
Market forces, inflation impacts on costs of materials	While these risks cannot be specifically prevented, they can be reduced by early appointment of contractors, which will be possible with the planned 2018 start of construction. Contracts will be agreed to optimise transfer of risk in this area. Ensure latest cost forecasts and availability of funds is monitored.

6.1.4. Operational and Maintenance costs

Operational and maintenance costs have not been assessed in detail, as their impact is considered to be low relative to the cost of implementation. Cost savings are forecast to outweigh additional costs incurred, but a detailed assessment of cost savings is not possible as the maintenance spend in the do-minimum scenario would be highly dependent on the availability of alternative funding packages.

Maintenance Costs

The primary variation in operational and maintenance costs between the do-minimum scenario and the preferred option will be the reduced requirement for ongoing maintenance on the A350 Farmers Roundabout to Semington Roundabout link, once the resurfacing has been completed.

The section of the A350 between Semington Roundabout and Farmers Roundabout is in urgent need of resurfacing works over its entire length. Without this resurfacing and without alternative funding, maintenance is likely to carried out on an ad-hoc basis which will be costly and result in extended delays to traffic.

As a main link road connecting the M4 to Wiltshire and the south, this route is heavily trafficked. This would make a piecemeal approach to repairs economically disproportionate in terms of traffic

management costs and the joints created between the existing road sections and patch repairs would be prone to rapid deterioration, introducing the risk of further costs being required due to reworking.

Maintenance cost increases generated by the scheme relate to:

- the slight increase in maintenance costs due to widening of the Farmers Roundabout circulatory system; and
- maintenance for the widened Semington junction taper.

These increases are considered relatively minor when compared to the cost savings described above.

One element of renewal cost which does form an appreciable value of ongoing cost in all options and which can be reliably assessed is the cost of renewals for the new signals at Farmers Roundabout. These have a design life of 15 years and will have a replacement cost of £240,000 for the full signalisation option (DS1) or £225,000 for the partial signalisation options (DS2, DS3, DS4 or DS7) in 2015 Q1 prices. This cost would fall in 2033 and leave no residual value at the end of the 30 year appraisal period.

Operational Costs

Operational costs relating to street lighting will also result in a saving, with 40 columns being removed and the remaining columns at junctions having existing lamps replaced by LEDs.

Operational cost increases generated by the scheme relate to the operation of signals at Farmers Roundabout.

The net impact of operational costs will form a low proportion of the overall operating and maintenance cost of the scheme, leaving an overall cost saving during the operational period.

6.1.5. Calculation of PVC

Table 8 shows the conversion of costs from base estimates to PVCs. The stages of this conversion for capital costs, carried out in line with WebTAG unit A1-2, involved:

1. Inclusion of risk (from Table 6)
2. Conversion to 2010 prices
3. Application of real growth up to 2018
4. Conversion from factor costs to market prices
5. Discounting from 2018 to 2010

A similar process has been applied for renewal costs, but with inflation and discounting applied to/from 2033, rather than 2018.

Table 8 Discounted scheme costs – Investment, PV, £million

	DS1	DS2	DS3	DS4	DS7
Preparation	0.117	0.117	0.117	0.117	0.117
Supervision	0.158	0.158	0.158	0.158	0.158
Works	2.008	2.134	2.161	2.195	2.213
Land	0	0	0	0	0
Risk	0.123	0.123	0.123	0.123	0.123
Renewals	0.145	0.136	0.136	0.136	0.136
Total, PVC	**2.458**	**2.575**	**2.601**	**2.636**	**2.653**

As has been described, the cost savings associated with maintenance and operating costs have not been monetised. These savings would result in a reduction to the PVC. It is not possible to reliably estimate the value of this reduction, but it is not expected to substantially impact on the economic performance of the scheme.

7. Estimation of scheme benefits

7.1.1. Model scenarios

As set out previously modelling has focussed on five potential do-something options, each considering variations on the proposed layout of Farmers Roundabout.

In addition to the modelling of these options, a range of additional measures have been assessed which fall outside the scope of the existing model and so the benefits of these options have been assessed qualitatively.

7.1.2. Model inputs and scheme parameters

A VISSIM model representing the AM and PM peak hours has been prepared to assess the impacts of each of these options, based on forecast years of 2018 and 2028.

Using outputs from this VISSIM model, a TUBA assessment has been prepared to measure the economic benefits. An appraisal period of 30 years has been used, based on the design life of the Farmer's Roundabout improvements, with scheme opening in 2018.

Benefits have been annualised to reflect 3 hour AM and PM peak period flows, based on 2017 count data around the site. No benefits have been assumed outside of the peak periods or at weekends, as flows are significantly lower and levels of queuing cannot be expected to be represented by those seen in the models.

7.1.2.1. Annualisation factors

To efficiently appraise the benefits of the scheme, the annualisation factor is used to convert from benefits per time slice to annual benefits. The model covers 0745-0845 in AM peak, and 1630-1730 in PM peak and results from the model will give benefits for these two peak hours. The benefits in each time slice are multiplied by annualisation factors, one for AM peak and one for PM peak, and then summed to give annual benefits.

The annualisation factor was calculated based on the Manual Classified Counts (MCC) data which covers the 0600-0900 and 1600-1900 in 15-minute time slices. The ratio of flow was calculated to represent the full AM peak period using traffic modelling of only the 0745-0845 time slice. A similar process was used for the PM peak.

This provided peak hour to peak period factors of 2.25 for the AM peak and 2.62 in the PM peak. Each of these factors was multiplied 253 (working weekdays, excluding bank holidays in a year) to convert from daily to annual factors.

7.1.2.2. User classes

Only four user classes are modelled for this scheme, Car, LGV, HGV and Bus. Bus has not been included in the appraisal, as the model does not capture numbers of passengers, only numbers of vehicles. Therefore, buses are used in the VISSIM model only to capture the delay and congestion impact for other user classes. In the economic assessment, a fixed purpose split for each user class has been applied, with car users split based on default parameters in the TUBA economics file.

7.1.3. Travel time and vehicle operating costs

The impacts of the options on travel times and vehicle operating costs for trips using the junction after scheme opening were assessed using the DfT's TUBA program (version 1.9.8).

TUBA is a software package developed on behalf of the DfT to estimate the impacts of transport schemes in terms of the costs and benefits experienced by users and providers of the transport system, and the associated indirect taxation impacts. All impacts are considered in monetary terms.

TUBA estimates costs and benefits experienced by users and providers of the transport system by comparing transport conditions in a Do-something scenario against conditions in a Do-minimum scenario. To this end, for highway schemes such as Farmer's Roundabout, TUBA uses information from the transport models to:

- Calculate user benefits by vehicle type and for each element of journey cost (i.e. travel time and vehicle operating costs - fuel and non-fuel)
- Calculate the changes in the indirect tax income received by the government (for highway schemes this primarily reflects the levels of indirect taxation incurred on fuel cost)
- Calculate the changes in the greenhouse gases emissions

For the scheme assessments, the user and provider related costs and benefits in each year produced by TUBA are combined with estimates of costs and discounted to 2010 values (using a discount rate of 3.5% for the first 30 years from the appraisal year and 3.0% thereafter, in line with WebTAG). In this case cost calculations have been performed externally to TUBA but using an identical approach.

8. Economic appraisal summary

8.1.1. Overview

This section examines the findings of the analysis of both monetised and non-monetised benefits and brings these together with the assessed costs.

All monetised impacts have been reported in a consistent unit of account to enable direct comparison, both with each other and with other DfT funded schemes.

8.1.2. Headline economic appraisal results

Table 9 presents a summary of the Present Value of Benefits (PVB), Present Value of Costs (PVC) and Benefit to Cost Ratio (BCR) for each of the scheme options.

Table 9 Headline economic indicators

Scheme Option	PVB, £million	PVC, £million	BCR
DS1	-1.6	2.5	**-0.7**
DS2	13.0	2.6	**5.1**
DS3	11.6	2.6	**4.5**
DS4	14.5	2.6	**5.5**
DS7	17.9	2.7	**6.8**

The total benefits, as shown in the PVB column above, include the following items:

- Travel times, assessed using TUBA
- Vehicle Operating Costs (VOC), assessed using TUBA
- Indirect tax, assessed using TUBA
- Greenhouse gas (CO2) emissions using TUBA

8.1.3. Non-Monetised benefits

While the table above summarises the economic impacts assessed through VISSIM and TUBA, the impacts on reliability, safety, air quality, noise, and delay during construction have not been monetised.

Neither have any of the impacts described relating to the resurfacing of the A350 between Farmers Roundabout and Semington Roundabout, the removal of lighting along this stretch or the Semington taper improvement, though costs of these elements are included in the PVCs.

8.1.3.1. Reliability

Journey time reliability is the largest of the economic benefits which has not been monetised. Reductions in queuing will generate more predictable journey times. This is particularly the case on the A350 South in the AM peak where the largest queues exist in the do-minimum scenario and are reduced by around 80% by options DS2-DS7. During the PM peak flows are more spread over the peak period and queuing is less extreme in the 2018 modelled year, however by 2028 queues on the B3107 West are forecast to reach similar lengths as queues seen during the AM peak. Again, the proposed schemes are expected to reduce the lengths of these queues by over 80%.

8.1.3.2. Safety

Safety impacts have not been possible to monetise, as the junction alterations proposed are of too detailed a nature to apply existing software such as COBALT for forecasting changes in accident numbers or severities. However, the signalisation at Farmers Roundabout will result in reduced conflict between flows, as will the improved taper on Semington Roundabout and the resurfacing of the A350 between Farmers and Semington Roundabouts will remove the need for running repairs as the existing surface continues to deteriorate. These factors will contribute to improved safety with reductions in accidents and this in turn will contribute further to improved reliability.

8.1.3.3. Air Quality and Noise

Although journey times are improved, this is a result of reduced congestion at junctions rather than increased speed on links and while the scheme results in reduced congestion, it is not expected to generate any significant increases in traffic flow, due to limited options for rerouting. As a result, air quality in the vicinity of the junction will see slight improvements in air quality.

The introduction of signals at Farmers Roundabout may result in a change in the pattern of vehicle speed on the approach to the junction, there are no sensitive receptors within 200m of the scheme. Therefore, no significant noise impacts are forecast.

8.1.3.4. Delays during construction

The proposed scheme will include positive as well as negative elements of impact on delay during construction. The signalisation of Farmers Roundabout will require disruption to road users during implementation, as will the improved taper at Semington Roundabout. The resurfacing works between roundabouts is likely to generate a positive impact on road user disruption relative to the do-minimum scenario, as the entire project works could be carried out at once, according to a

planned timetable, rather than requiring numerous interventions as different sections need repairs at different times.

8.1.4. Overall monetised and non-monetised benefits

The non-monetised benefits are very similar for all options, leaving DS7 as a clear strongest performer of the options assessed, with a BCR of 6.8 which represents very high value for money according to DfT's categorisation (as set out in Table 3).

Detailed outputs from the economic assessment in terms of TEE, PA and AMCB tables for the preferred option of the scheme are presented in the following section.

8.1.5. Breakdown of monetised benefits

A detailed breakdown of outputs from the TUBA analysis for each of the options is presented in Table 10. This indicates that, in all options (with the exception of DS1 which results in increased delays compared to the do-minimum scenario) the vast majority of benefits are derived from time savings brought about by congestion relief. These benefits are fairly evenly spread between business and non-business trips.

The reduced congestion also results in a lower level of user benefit in the form of reduced vehicle operating costs, related mainly to fuel consumption. This reduced fuel consumption also results in a greenhouse gas emissions benefit, but has a negative impact on indirect tax revenues.

Table 10 Transport benefits, £000s (PV)

Option	DS1	DS2	DS3	DS4	DS7
Business					
Time Savings	- 752	6,745	6,018	7,507	9,384
Operating Costs	- 93	219	185	248	343
Subtotal	- 845	6,964	6,203	7,755	9,727
Non-Business					
Time Savings	- 755	5,651	5,041	6,311	7,672
Operating Costs	- 106	471	385	549	653
Subtotal	- 861	6,122	5,426	6,860	8,325
Indirect Tax	116	- 114	- 84	- 130	- 213
Greenhouse Gases	- 37	33	24	39	65
PVB	**- 1,627**	**13,005**	**11,569**	**14,524**	**17,904**

8.1.6. Transport economic efficiency (TEE), Public accounts (PA) and Analysis of monetised costs and benefits (AMCB)

Set out in Table 11 to Table 13 are the TEE, PA and AMCB economic summary tables for option DS7. An AST has been provided as a separate appendix, setting out further detail of economic performance for this option and performance against objectives.

Table 11 Transport Economic Efficiency (TEE)

Consumer Benefits (£000's, 2010 PVs)					
	Type	**All Modes**	**Road, Private Cars and LGVs**		**Coach/Bus Passenger**
Commuting User Benefits	Travel Time	5,376	5,376		
	Vehicle Operating Costs	159	159		
	User Charges	0	0		
	During Construction & Maintenance	0	0		
	Net Benefits	**5,535**	**5,535**		
Other User Benefits	Travel Time	4,008	4,008		
	Vehicle Operating Costs	184	184		
	User Charges	0	0		
	During Construction & Maintenance	0	0		
	Net Benefits	**4,192**	**4,192**		
Business	**Type**	**All Modes**	**Goods Vehicles**	**Business Cars & LGVs**	**Coach/Bus Passengers**
	Travel Time	7,672	2,589	5,083	
	Vehicle Operating Costs	653	412	241	
	User Charges	0	0	0	
	During Construction & Maintenance	0	0	0	
	Net Benefits	**8,325**	**3,001**	**5,324**	
Present Value of Transport Efficiency (TEE)		**18,052**			
Note: Benefits appear as positive, with costs negative. All entries are discounted present values, 2010 prices and values					

Table 12 Public Accounts (PA)

Public Accounts (£000's, 2010 PVs)			
Local Government Funding	All modes	Road	Bus
Revenue	0	0	
Operating Costs	0	0	
Investment Costs	661	661	
Developer Contributions	0	0	
Grant/Subsidy Payments	0	0	
NET IMPACT			
Central Government Funding - Transport	All modes	Road	Bus
Revenue	0	0	
Operating costs	0	0	
Investment costs	1,993	1,993	
Developer Contributions	0	0	
Grant/Subsidy Payments	0	0	
NET IMPACT			
Central Government Funding- Non Transport			
Indirect Tax Revenues	213	213	
TOTALS			
Broad Transport Budget	**2,653**		
Wider Public Finances	**213**		
Note: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers. All entries are discounted present values in 2010 prices and values.			

Table 13 Analysis of Monetised Benefits (AMCB)

Analysis of Monetised Benefits (£000's, 2010 PVs)	
Noise	N/A
Local Air Quality	N/A
Greenhouse Gases	65
Accidents	N/A
Economic Efficiency: Consumer Users (Commuting)	5,535
Economic Efficiency: Consumer Users (Other)	4,192
Economic Efficiency: Business Users and Providers	8,325
Wider Public Finances (Indirect Taxation Revenues)	-213
Present Value of Benefits (PVB)	**17,904**
Broad Transport Budget	2,653
Present Value of Costs (PVC)	**2,653**
OVERALL IMPACTS	
Net Present Value (NPV)	**15,251**
Benefit to Cost Ratio (BCR)	**6.8**
Note: This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.	

9. Summary and conclusions

Of the options considered, DS1 relieves queuing for certain movements but this in turn creates delays for other movements, with the overall impact on the AM peak being detrimental and outweighing the positive impacts the option has during the PM peak.

All other options generate benefits during both modelled periods, with a split of around 35% during the AM peak and 65% during the PM peak, though specific movements affected vary by option. Full details of this range of impacts is set out in the modelling report.

With the exception of DS1, all shortlisted options are forecast to return very high value for money, with BCRs above 4, for an investment of between £2.5m to £2.6m (PVC).

The preferred option, DS7, returns a BCR of 6.8, with a PVC of £2.6m, which represents an outturn cost of £3.0m. Of this total, local funding of £0.5m will be provided and has already been made available for use in this scheme.

In addition to the monetised benefits, each option will also generate a range of benefits and cost savings which have been assessed qualitatively, being a proportionate approach to the impact of each on overall scheme performance. These factors include journey time reliability, road safety, reduced maintenance costs and air quality and noise benefits. This range of positive factors will be partially offset by the disbenefit to users generated by delays during the construction period.

Detailed design can begin immediately if the requested NPIF contribution can be provided during 2018/19, which will enable opening of the scheme within that year.