# Transport User Benefits and indicative BCR

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# 1 Introduction

## 1.1 Purpose of the Technical Note

1.1.1 Arcadis has been commissioned by Vale of Glamorgan Council to develop and appraise potential options for improving the strategic transport network encompassing corridors from M4 Junction 34 to the A48 (Five Mile Lane) including the Pendoylan Corridor (or alternative).

1.1.2 For the Stage 2 of the WelTAG Study, two alignments have been considered:

- East Alignment – This alignment passes the village of Pendoylan to the east although utilises a section of existing road at the northern end in order to minimise the impacts on Ancient Woodland;
- West Alignment - This alignment passes the village of Pendoylan to the west although shares the same route at the northern end as the East Alignment.

1.1.3 This technical note sets out the appraisal undertaken for the two options for the M4 Junction 34 – A48 Stage 2. The appraisal of options has been undertaken in accordance with the Welsh Government's latest version of WelTAG (December 2017)[1].

# 2 Economic Appraisal

## 2.1 Introduction

2.1.1 The tools used to arrive at the initial benefit-cost ratio (BCR), based on direct benefits, are:

- The DfT's Transport User Benefits Appraisal Tool version 1.9.9 was used to estimate the direct user and provider benefits in terms of travel time savings and vehicle operating costs.
- The accident benefits have been calculated using DfT's computer program COBALT (COst and Benefit to Accidents-Light Touch) version 2013.2.

## 2.2 Travel time and vehicle operating cost savings

2.2.1 TUBA provides a complete set of default economic parameters in its 'Standard Economics File'. This contains values of time, vehicle operating cost data, tax rates, economic growth rates and a range of other economic parameter values.

2.2.2 The scheme parameters are largely determined by the parameters used in the traffic forecasting model, which are as follows:

- Base year - 2015
- Current Year – 2017
- Scheme Opening – 2023
- Modelled Year – 2036
- Horizon Year – 2082

2.2.3 The 'Horizon Year' has been set at the end of 2082 with the appraisal period taken as 60 years from the scheme opening in line with WebTAG (Unit A1.1 Section 2.3, Appraisal Periods)

2.2.4 Traffic model outputs have been generated for 2036, this diverges from a standard economic appraisal which will be run with a minimum of two modelled years. For this reason, the standard interpolation and extrapolation process in TUBA has been altered to reflect the necessary conditions of the scheme.

[1] https://beta.gov.wales/sites/default/files/publications/2017-12/welsh-transport-appraisal-guidance.pdf

## Interpolation and extrapolation assumptions for TUBA benefits

2.2.5 The standard approach to interpolation and extrapolation in TUBA is set out in Section 9 of the TUBA General Guidance and Advice document. This involves the linear interpolation between two modelled years and the extrapolation of data after the final modelled year following a horizontal line. A graphical representation of TUBA's interpolation and extrapolation process is provided in Figure 2-1.

2.2.6 The TUBA approach to interpolation and extrapolation has not been achievable with the model outputs generated for this scheme. A single modelled year has been provided for the estimation of benefits leading to a necessary change away from the appraisal assumptions that are used in TUBA. As a second model year is not available to interpolate through, it has been assumed that the traffic model outputs for 2036 are extrapolated for all modelled years. This methodology is likely to **overestimate** the benefits but has been taken forward in the absence of a more robust alternative. A graphical example of this alternative methodology is provided in Figure 2-2.

**Figure 2-1 - TUBA standard interpolation and extrapolation**

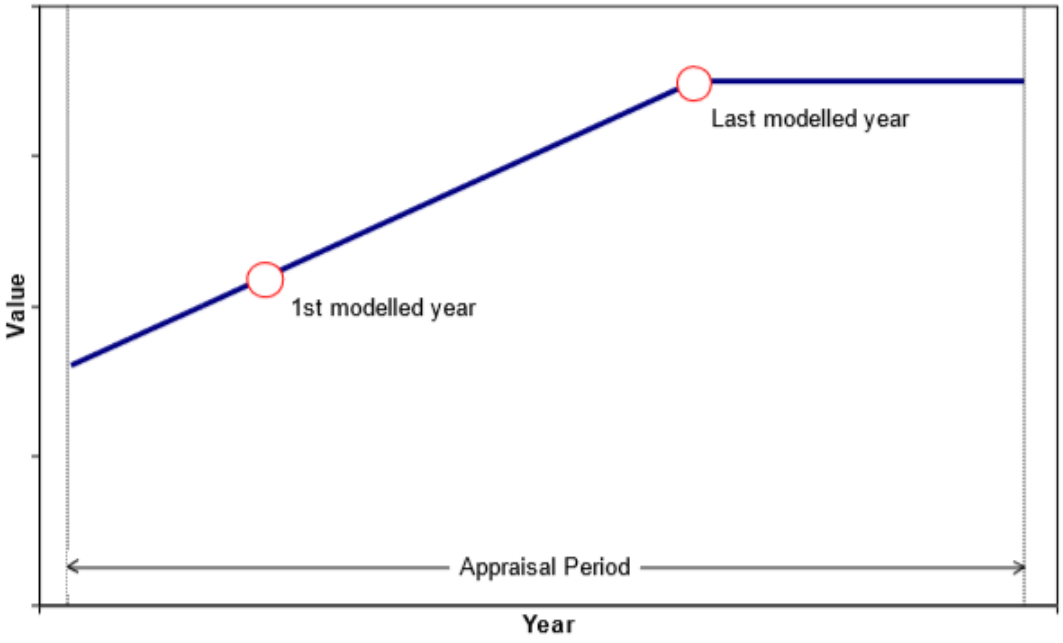
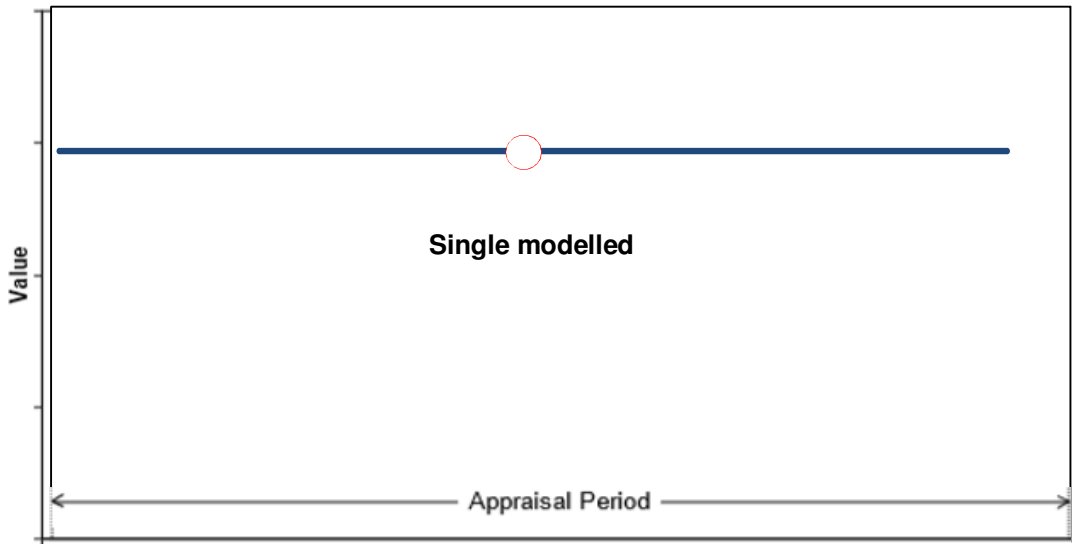



**Figure 2-2 - Interpolation and extrapolation method undertaken for scheme**



### Sensitivity test – factored 2023 trip matrix

2.2.7 A sensitivity test has been undertaken to provide further information regarding the potential overestimation of benefits using a straight-line interpolation/extrapolation technique.

2.2.8 The National Trip End Model (NTEM) forecasts the growth in trip origin/destinations up to 2051. These forecasts are subject to uncertainty, especially when disaggregated to local zones, but could be used to estimate the expected level of reduction in trips in the scheme assessment area for the scheme opening year of 2023.

2.2.9 This can provide an alternative view of the potential level of benefits in 2023 and allow for the WebTAG standard interpolation and extrapolation methodology to be undertaken as in Figure 2-1.

2.2.10 A trip matrix reduction factor of 0.05 has been applied based NTEM trip end forecasts. This has been compared with close by local authorities to ensure it is of a comparable magnitude. Table 2-1 provides an overview of the NTEM forecasts.

**Table 2-1 NTEM Trip end growth (Origin + Destination for all time periods)**

| Origin and Destination Trip-ends (all time periods | Bridgend | Rhonda Cynon Taff | Vale of Glamorgan |
|---|---|---|---|
| 2023 | 424,835 | 623,340 | 352,075 |
| 2036 | 448,477 | 651,814 | 370,351 |
| % change 2036-2023 | -5.27% | -4.37% | -4.98% |

2.2.11 This factor has been applied to the 2036 trip matrices to approximate the expected level of trips in 2023 for TUBA. It is important to note that all distance and time skims have been kept at the 2036 level as it has not been possible to run the factored trip matrix through the transport model.

2.2.12 This sensitivity should be regarded as an alternative view of the potential magnitude of benefits using more conservative assumptions and not as a substitute for actual transport model outputs.

## 2.3 Estimation of costs

2.3.1 For the Stage 2 of the WelTAG Study, 2 alignments have been considered and cost estimates produced:

- East Alignment - This alignment passes the village of Pendoylan to the east although utilises a section of existing road towards the north of the project
- West Alignment - This alignment passes the village of Pendoylan to the west although utilises a section of existing road towards the north of the project

2.3.2 Cost estimates have been produced following WebTAG guidelines for both alignments. A detailed explanation is provided in a technical note produced by the costing team.[2]

2.3.3 The cost estimates, in undiscounted 2017 market prices, are as follows (£000's):

- East Alignment - £81,028
- West Alignment - £58,666

2.3.4 For appraisal purposes, these costs need to be converted into 2010 prices and discounted to 2010. The following process was undertaken to achieve this:

- The costs were factored back to rebase them to 2010 calendar year values using the GDP deflators from the December 2017 WebTAG Data book.
- The cost estimates were discounted from 2017 to 2010 using the discount rate of 3.5%.

2.3.5 The final cost estimates in 2010 prices and discounted to 2010 are as follows:

- East Alignment - £56,810

[2] Cost estimates provided in 10013270-ARC-XX-XX-RP-HE-0001 – M4 J34 – A48 WelTAG Study Stage 2

- West Alignment - £41,132

## 2.4 Accident Cost Savings

2.4.1 DfT's program COBALT (COst and Benefit to Accidents-Light Touch) has been used to undertake the analysis of the impacts on accidents as part of the economic appraisal of the road scheme. The accident impact assessment has been performed using the method set out in the COBALT Manual[3]. It is used to forecast changes in the number of accidents and casualties and estimate the monetary value of these impacts.

2.4.2 The latest COBALT scheme parameter file used for the assessment is 2017.1 in conjunction with the COBALT software version 2013.2.

2.4.3 The COBALT model estimates the number of accidents by summing the product of accident rates and forecast annual flows for each link using the relationships built into the COBALT software. Standard valuations for fatal, serious and slight accidents are applied within the program to calculate the cost of accidents in both 'without' and 'with' scheme scenarios and the difference between them. These savings (or costs) are then annualised and interpolated and extrapolated over the 60- year appraisal period and discounted to produce a 2010 present value of accident benefits in 2010 prices.

### Interpolation and extrapolation assumptions for COBALT

2.4.4 Traffic flow data was provided for the Base year (2015), and for Do-Minimum and Do-Something for 2036. COBALT requires traffic flow data for a minimum of two forecast years to be able to do the linear interpolation between the two modelled forecast years, and extrapolate to the Horizon year, to estimate benefits over the 60-year appraisal period.

2.4.5 As mentioned above, the traffic modelled data has been provided for only one forecast year (2036), therefore to estimate flows for the opening year (2023) for Do-Min and Do-Some, a few assumptions have been made to be able to estimate the accident benefits of the scheme. The assumptions made to calculate the flows are as follows:

- Flows for Do-Min for opening year 2023 - Traffic flows data has been linearly interpolated between the Base year and the DM 2036, to get the flows for DM 2023;
- Flows for Do-Some for opening year 2023 - The percentage change in flows between DM 2036 and DS 2036 has been calculated for each link and applied to the DM 2023 flows calculated above to find out the flows for DS 2023.

2.4.6 This methodology is likely to **underestimate** the benefits as the interpolation is used from the Base year which is 2015, but these assumptions are considered to be the best way to estimate flows for a second forecast year.

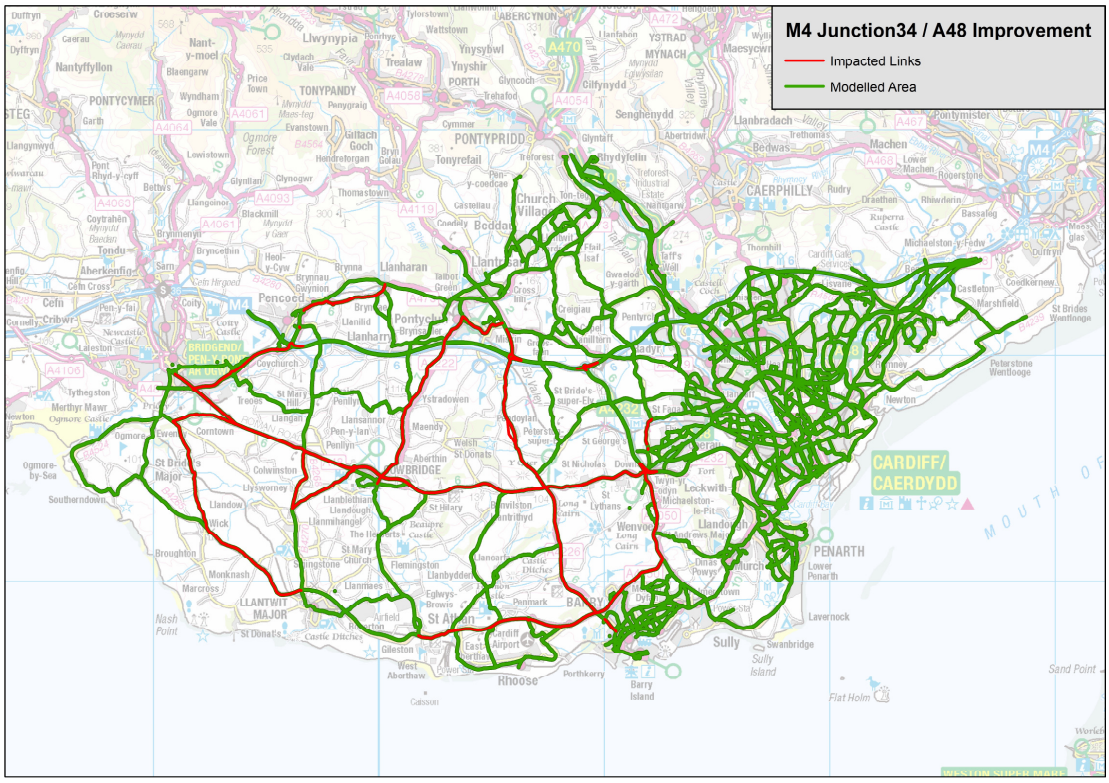
### Impacted links (Study Area)

2.4.7 The impacted links were identified by finding the change in AADT (Annual Average Daily Flows) as a result of the scheme and using the standard criteria of finding the links where the change in flows is 5% or more with a flow change of +/- 500 AADT for 2036.

2.4.8 COBALT uses traffic flows and accident rates attributed for each link type, and within the link types, the accident rates are split by speed limit. As COBALT results are only affected by a change in flows or change in link type, it was decided to undertake the accident benefit assessment for the impacted links only instead of a cordon area. Figure 2-3 shows the impacted links in the modelled area.

**Figure 2-3: Impacted links for the accident assessment**

[3] https://www.gov.uk/government/publications/cobalt-software-and-user-manuals




### Other Assumptions for COBALT

2.4.9 The combined link and junction analysis has been used, as this scheme does not require analysing links and junctions separately to estimate the accident benefits.

2.4.10 The accident rates used for this assessment are the default accident rates (national average) provided in the Tag Databook[4], which has a base year 2009.

# 3 Economic appraisal results

## 3.1 User and provider benefits

3.1.1 The Transport User Benefits Appraisal (TUBA) tool which calculates transport user benefits and indirect taxation has been used to estimate direct economic benefits for the scheme. As only one year of modelled data has been provided, 2036 modelled data has been extrapolated for every other year in the appraisal. For this reason, 2036 model data has also been set at 2035 providing a horizonal appraisal profile as demonstrated in Figure 2-2.

3.1.2 The user and provider benefits for the scheme are reported in the TEE tables. Table 3-1 presents these benefits and distinguishes between benefits to business users and consumers.

**Table 3-1 : User and provider benefits (£000's PVB 2010 prices discounted to 2010)**

| £m PVB 2010 prices | | Scheme Benefits |
|---|---|---|

[4] https://www.gov.uk/government/publications/webtag-tag-data-book-december-2017

| | | |
|---|---|---|
| **Commuting** | **Travel Time** | 34,807 |
| | **VOC** | 1,223 |
| **Other consumers** | **Travel Time** | 48,319 |
| | **VOC** | 1,529 |
| **Business** | **Travel Time** | 49,099 |
| | **VOC** | 3,184 |
| **Total** | | 138,161 |
| **Business benefits as % of total** | | 38% |

VOC = vehicle operating cost

3.1.3 The current scheme user and provider benefits have been estimated at £138 million. It should be noted that this is likely to be an overestimation of benefits due to the extrapolation technique required for a single modelled year.

## 3.2 Public accounts

3.2.1 Table 3-2 shows the effects of the options on public finances, taking into account the impact on the broad transport budget after allowing for changes in revenues. It also includes changes in the broader indirect tax revenues which accrue to the government.

**Table 3-2 : Public accounts (PVC £000's 2010 prices discounted to 2010)**

| Scheme costs | East Alignment | West Alignment |
|---|---|---|
| **Investment Costs** | 56,810 | 41,132 |
| **Operator Costs** | - | - |
| **Revenue** | - | - |
| **Indirect Tax Revenue** | -2,460 | -2,460 |

3.2.2 The net impact on the transport budget is estimated at £81 million for the East route alignment and £59 million for the West route alignment.

3.2.3 The indirect tax revenue values shown are increase in revenue to the wider public finances and, in accordance with WebTAG guidance, are included in the calculation of the Present Value of Benefits (PVB). The sign of the value in the PA table is therefore reversed in the AMCB table because the PA table presents costs to the public accounts as positive values.

3.2.4 The AMCB tables combine the results from the TEE tables and the PA tables supplemented by information on accidents and environmental effects. The results from the appraisal of the impact on accidents. The results from the appraisal of accidents is set out below.

## 3.3 Accident cost savings

3.3.1 Table 3-3 outlines the accident cost savings for the impacted links, which are based on the COBALT run outputs, using default accident rates (national averages). These are for the 60-year assessment period (2023-2082). The savings are discounted to 2010 prices.

**Table 3-3: Accident Benefits summary (Cost in £000's discounted to 2010)**

| | | Without Scheme | With Scheme | Total Savings (diff. of with and without scheme) |
|---|---|---|---|---|
| **Accident cost** | Total (£000) | 226,573 | 209,981 | 16,591 |
| **Accident Summary** | Total | 4,963 | 4,517 | 446 |

| | | | | |
|---|---|---|---|---|
| **Casualty Summary** | Total | 6,749 | 6,184 | 566 |
| | Fatal | 51 | 51 | 1 |
| | Serious | 649 | 602 | 47 |
| | Slight | 6,049 | 5,530 | 518 |

3.3.2 The results show positive scheme benefits with a reduction in accident cost of 16.6m, over the 60-year period in 2010 prices. The table also shows that the scheme will reduce 446 accidents, which is a significant reduction considering that the improvement is to a small part of the network.

## 3.4 AMCB tables

3.4.1 The AMCB tables combine results from the TEE tables and the PA tables supplemented by information on accidents. A summary of the results for the scheme appraisal is set out in Table 3-4.

**Table 3-4 - AMCB summary table (prices in £000, discounted to 2010)**

| | Scheme costs | East Alignment | West Alignment |
|---|---|---|---|
| **A** | **Accidents** | 16,591 | 16,591 |
| **B** | **Economic efficiency: Commuting** | 36,030 | 36,030 |
| **C** | **Economic efficiency: Other** | 49,848 | 49,848 |
| **D** | **Economic efficiency: Business** | 52,306 | 52,306 |
| **E** | **Wider Public Finances (ITR)** | -2,460 | -2,460 |
| **F** | **PVB** (A+B+C+D+E) | 152,315 | 152,315 |
| **G** | **PVC** | 56,810 | 41,132 |
| **H** | **NPV** (F-G) | 95,505 | 111,183 |
| **I** | **BCR** (F/G) | 2.68 | 3.70 |

## 3.5 Sensitivity test – factored 2023 trip matrix

3.5.1 A sensitivity test was undertaken to provide further information regarding the impact of the straight-line interpolation/extrapolation methodology undertaken due to a lack of transport model data. This sensitivity used an NTEM derived trip reduction factor to estimate the impact a reduced level of traffic in 2023 would have on the scheme benefits. Table 3-5 demonstrates the impact of a reduced 2023 trip matrix on the PVBs and BCRs.

**Table 3-5 - AMCB summary table for sensitivity test (prices in £000's, discounted to 2010)**

| | Scheme costs | East Alignment | West Alignment |
|---|---|---|---|
| **A** | **Accidents** | 16,591 | 16,591 |
| **B** | **Economic efficiency: Commuting** | 35,745 | 35,745 |
| **C** | **Economic efficiency: Other** | 49,471 | 49,471 |
| **D** | **Economic efficiency: Business** | 52,020 | 52,020 |
| **E** | **Wider Public Finances (ITR)** | -2,532 | -2,532 |
| **F** | **PVB** (A+B+C+D+E) | 151,295 | 151,295 |
| **G** | **PVC** | 56,810 | 41,132 |
| **H** | **NPV** (F-G) | 94,485 | 110,163 |

| | | | |
|---|---|---|---|
| **I** | **BCR** (F/G) | 2.66 | 3.68 |

3.5.2 Introduction of the factored 2023 trip matrix has led to a decrease in benefits of around 0.5%. There has been a minimal impact on the PVBs and BCRs of the scheme, this is likely due to the following reasons:

- Only 15-years of the 60-year appraisal have been impacted by the change in trips (2023-2036)
- For this 15-year period, the interpolation methodology further reduces the impact of the change in trips up to 2036.

3.5.3 This sensitivity test has helped to inform the core analysis and suggests that the current approach to calculating benefits is a robust methodology given the modelling outputs provided.

# 4 Summary and Conclusions

## 4.1 Summary of economic appraisal

4.1.1 Total benefits for the East and West Alignment have been assumed to be the same with the only difference being introduced with the costs.

4.1.2 The methodology used to undertake the transport user benefits using TUBA will likely lead to an overestimation of benefits, whereas in case of accident benefits using COBALT, there might be an underestimation of the benefits. However, given the context specific data provided, it has been deemed as the most robust approach.

4.1.3 The West Alignment route has a higher BCR of 3.7 and NPV of £111.0m than the East Alignment route which has a BCR of 2.7 and NPV of £96m. This is due to providing the lowest cost estimate of around £41 million for the West Alignment.

4.1.4 On the basis of greatest economic advantage, the West Alignment route is best performing option, although it is recognised that economic performance is only one of the elements which must be taken into account in decision making.