

Welsh Government

**A40 Llanddewi Velfrey to Penblewin
Improvements**

Economic Assessment Report

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1 The Project

1.1 Context

- 1.1.1 In December 2004, the Welsh Government announced the outcome of the A40 West of St Clears study into the consideration of both single carriageway and dual carriageway improvements to the A40 between

St Clears and Haverfordwest. This study came about as a result of a number of previous reports that all concluded that the A40 needed improvement.

1.1.2 In February 2017, the Welsh Government appointed Carillion, with Arup and RML (the ‘Carillion Team’) as their technical and environmental advisors, to develop the design of the proposed A40 Llanddewi Velfrey to Penblewin Improvements up to publication of draft Orders.

1.1.3 Carillion entered liquidation in January 2018. The Welsh Government subsequently appointed Arup, supported by RML, to continue the development of the design up to publication of draft Orders and to support the Welsh Government through the Statutory process.

1.2 Project history

1.2.1 In December 2004, the Minister announced the publication of his Addendum to the 2002 Trunk Road Forward Programme (TRFP) and this included two major single carriageway improvement schemes for the A40 west of St Clears. The improvements would use the 2+1 configuration allowing overtaking on the two-lane direction, with overtaking prohibited in the one-lane direction and would be delivered in the following phases:

1. A40 Penblewin - Slebech Park
2. A40 Llanddewi Velfrey - Penblewin.

1.2.2 The first of these projects, Penblewin - Slebech Park, was completed in March 2011.

1.2.3 In July 2013, Edwina Hart AM CStJ MBE, Minister for Economy, Science and Transport, published a written statement outlining her priorities for Transport. The statement included the following:

“Improving the A40 has been identified as a priority by the Haven Waterway Enterprise Zone Board and I intend to undertake further development of previously proposed improvements.”

1.2.4 On 12 November 2014, in providing an update on the closure of the Murco Refinery in Milford Haven, the Minister made an oral Statement in Plenary:

“In terms of transport links, I have instructed my officials to accelerate to the fullest extent possible the programme for delivering improvements at Llanddewi Velfrey.”

- 1.2.5 In June 2015, in a written statement on the A40 Improvement Study the Minister noted *“It is my intention to progress delivery of the A40 Llanddewi Velfrey to Penblewin scheme as soon as possible...”*

1.3 The problems

- 1.3.1 Consultation with key stakeholders, including the Local Authority, Welsh Government Departments and the Regional Transport Planner has identified the following problems:
1. The road is substandard and where overtaking provision does exist it is currently not spread along the length of the A40 such as there are long lengths in each direction with no safe overtaking opportunities
 2. Limited overtaking opportunities lead to poor journey time reliability and driver frustration.
 3. Occasional convoys of heavy goods vehicles from the ferry ports and slow moving agricultural vehicles contribute to periods of platooning and journey time unreliability, which is exacerbated with limited overtaking opportunities.
 4. Seasonal spikes in traffic volumes along the A40 especially during the summer months leads to slow moving traffic causing journey time unreliability, which is exacerbated with limited overtaking opportunities.
 5. The community of Llanddewi Velfrey is severed by the A40, which reduces accessibility, increases risks of non-motorised user accidents and results in noise and air pollution.
 6. There are many side road junctions and direct accesses to properties and agricultural fields off the A40, which contributes to operational problems along the road.
 7. A mix of traffic types using the road, contributing to journey time unreliability and driver frustration, risky manoeuvres and collision incidents.
 8. A lack of strategic public transport connectivity in Pembrokeshire generally means there is a dependence on the private car for inter-urban connections.

1.4 Scheme objectives

- 1.4.1 A number of transport planning objectives have been developed iteratively during previous development work and engagement on the A40 project, aiming to address one or more of the identified problems.

During the early stages of Key Stage 3 the problems and objectives were refreshed during a focused workshop event with key stakeholders to take into account the WelTAG 2017 guidance and Well-being of Future Generations (Wales) Act well-being goals. The scheme objectives are:

- O1** To enhance network resilience and improve accessibility along the east-west transport corridor to key employment, community and tourism destinations.
- O2** To improve prosperity and provide better access to the county town of Haverfordwest, the Haven Enterprise Zone and the West Wales ports at Fishguard, Milford Haven and Pembroke Dock.
- O3** To reduce community severance and provide health and amenity benefits.
- O4** To reduce the number and severity of collisions.
- O5** To promote active travel by cycling, horse riding and walking to provide opportunities for healthy lifestyles.
- O6** To deliver a scheme that promotes social inclusion and integrates with the local transport network to better connect local communities to key transport hubs.
- O7** Deliver a project that is sustainable in a globally responsible Wales, taking steps to reduce or offset waste and carbon.
- O8** Give due consideration to the impact of transport on the environment and provide enhancement when practicable.

1.5 Purpose of this Report

- 1.5.1 The purpose of this report is to provide a detailed summary of the economic appraisal undertaken for the proposed A40 Llanddewi Velfrey to Penblewin Improvements. The report outlines the methodology and assumptions adopted in undertaking the economic assessment and presents the results of the appraisal.
- 1.5.2 The economic appraisal of the Scheme provides a quantitative assessment of the costs and benefits of investment. The economic appraisal does not consider any impacts of the Scheme that cannot be monetised and therefore provides only a partial analysis of the case for investment. A broader analysis of the need for the Scheme and its expected economic, social and environmental impact of the Scheme is provided in the WelTAG Stage 3 Report.

1.6 Report Layout

- 1.6.1 Following this introductory chapter, the report is laid out as follows:

- Chapter 2 outlines the approach used for the economic appraisal;
- Chapter 3 presents the results of the economic appraisal; and
- Chapter 4 contains concluding comments.

2 Methodology

2.1 Principles of Economic Appraisal

- 2.1.1 The purpose of the economic appraisal is to consider whether the monetised benefits of a transport scheme justify the costs of investment.
- 2.1.2 Guidance on undertaking economic appraisal for transport schemes is given in WebTAG^{1,2}. The economic appraisal considers the costs and benefits of a transport scheme that are accrued over a 60-year period in monetary terms. In order to ensure consistency, all monetary values are discounted to a common price base to give ‘present values’. The current price base year for economic assessments stipulated by the Guidance is 2010.
- 2.1.3 Benefits relating to the ‘economic efficiency’ of the transport system are presented in the form of a Transport Economic Efficiency (TEE) table. These benefits are made up of the following:
- Journey time savings;
 - Vehicle operating cost savings;
 - User charges, such as tolls; and
 - Additional costs to travellers due to disruption during construction and maintenance works.
- 2.1.4 The TEE table also includes private sector impacts, such as revenue, operating and investment costs and any grants or subsidies.
- 2.1.5 The ‘public accounts’ table relates to the costs faced by Government (either local or central) to implement the Scheme. They include the following:
- Revenue (for example, through the introduction of tolls);
 - Operating costs;
 - Investment costs;
 - Developer and other contributions (not applicable);
 - Grant / subsidy payments (not applicable); and
 - Indirect tax revenues to Central Government through, for example, fuel duty that result from the Scheme.
- 2.1.6 The overall Analysis of Monetised Costs and Benefits table also includes benefits or impacts related to the occurrence of accidents and environmental externalities namely greenhouse gas emissions, air

¹ Transport Analysis Guidance, Cost-Benefit Analysis, TAG Unit A1.1, Department for Transport, May 2018

² Transport Analysis Guidance, User and Provider Impacts, TAG Unit A1.3, Department for Transport, March 2017

quality impacts and noise impacts. These benefits would be negative if the situation were to worsen. Revenues to Government are also included. Such revenues typically relate to changes in tax revenues as a result of the Scheme, which are directly linked to changes in fuel expenditure, this being a function of speed and distance of travel.

- 2.1.7 The total benefits are compared with the ‘Broad Transport Budget’ from the public accounts identified above, in order to determine the value for money of the Scheme. The outputs of the economic assessment are summarised in the Net Present Value (NPV) for the Scheme – the sum of discounted costs and benefits – and the Benefit Cost Ratio (BCR) – the ratio of benefits to costs.

2.2 Economic Appraisal and Scheme Objectives

- 2.2.1 The economic appraisal of a scheme always represents a partial analysis of value for money. It should be noted that the economic appraisal captures costs and benefits that can be feasibly monetised. In practice, transport schemes seek to achieve a wider range of objectives and it is important to place the BCR into this context.
- 2.2.2 A range of other impacts of the Scheme that are not monetised may also be taken into account in assessing the value for money of the Scheme. Table 2.1 considers the extent to which the economic appraisal captures the expected benefits of the Scheme as described by the Scheme Objectives.
- 2.2.3 Table 2.1 demonstrates that many of the objectives of the Scheme are either not captured or only partially captured by the BCR calculation. In particular, benefits to the local population of traffic being diverted away from the Llanddewi Velfrey village and economic benefits associated with providing improved access to West Wales ports are not directly addressed in the economic appraisal and the Welsh Government will need to take this into account when making decisions about the Scheme.

Table 2.1 Scheme Objectives and the BCR

Scheme Objective	Degree to which BCR captures the benefits of achieving this objective
O1 - To enhance network resilience and improve accessibility along the east-west transport corridor to key employment, community and tourism destinations.	<i>Indirectly captured</i> – the economic appraisal does not measure economic outcomes directly although many of these derive from journey time savings which are captured. Access to tourism destinations is affected by seasonal variations in traffic flows which are only partially captured. Improved network resilience is not captured.
O2 - To improve prosperity and provide better access to the county town of Haverfordwest, the Haven Enterprise Zone and the West Wales ports at Fishguard, Milford Haven and Pembroke Dock.	<i>Indirectly captured</i> – the economic appraisal does not measure economic outcomes directly although many of these derive from journey time savings which are captured.
O3 - To reduce community severance and provide health and amenity benefits.	<i>Partially captured</i> – the benefits of reducing severance are not captured by the economic analysis. Health and amenity benefits are only captured in relation to the impact on households of changes in noise levels and air quality.
O4 - To reduce the number and severity of collisions.	<i>Captured</i>
O5 - To promote active travel by cycling, horse riding and walking to provide opportunities for healthy lifestyles.	<i>Not captured</i>
O6 - To deliver a scheme that promotes social inclusion and integrates with the local transport network to better connect local communities to key transport hubs.	<i>Not captured</i>
O7 - Deliver a project that is sustainable in a globally responsible Wales, taking steps to reduce or offset waste and carbon.	<i>Partly captured</i> – vehicular emissions are included although environmental impacts during construction are not assessed.
O8 - Give due consideration to the impact of transport on the environment and provide enhancement when practicable.	<i>Not captured</i>

2.3 Economic Data

2.3.1 WebTAG Guidance³ provides details of the default economic data that should be adopted for the economic appraisal of transport schemes. Transport User Benefits Assessment (TUBA) software, which has been applied in this case, has a standard economics file that contains the default data from WebTAG which includes the following:

- Present value discount rates;
- Values of time and estimated rates of change;
- Tax rates and estimated rates of change;
- Proportion of petrol, diesel and electric vehicles within the vehicle fleet, and estimated rates of change;
- Parameters for fuel consumption (related to travel distances and times);
- Fuel costs and estimated rates of change;
- Rates of change in fuel efficiency;
- Non-fuel vehicle operating cost parameters (related to travel distances and times);
- Trip purpose proportions; and
- Vehicle occupancies.

2.3.2 The economic parameters file also includes default journey purpose splits for each vehicle type. However, as the output from the traffic model was given by journey purpose, this was used in preference to the default values.

2.3.3 The proposed opening year for the Scheme is 2021. It is assumed that construction of the Scheme would commence in 2020. The appraisal covers a 60-year period, starting with the Scheme opening year of 2021, through to 2080.

2.4 Scheme Costs

2.4.1 There are three main elements of the Scheme cost estimate:

- The base cost – the basic costs of constructing the Scheme before allowing for risks;
- Adjustment for risk – which covers all the identified risks as assessed and quantified through a Quantified Risk Assessment, resulting in the risk-adjusted cost estimate; and

³ Transport Analysis Guidance: TAG data book, Department for Transport, May 2018

- Adjustment for optimism bias – to reflect the systematic bias for estimated scheme costs and delivery times to be too low and too short respectively. This adjustment results in an increase in the cost estimate.
- 2.4.2 Cost, risk and optimism bias assumptions have been provided by the Welsh Government.
- 2.4.3 The main components of the investment costs for the Scheme that are input into the TUBA software are:
- **Construction costs**, including main works, ancillary works, statutory undertakings, site supervision and testing;
 - **Land and property costs**, including compensation; and
 - **Preparation and Supervision costs**, including project management, design, public consultation, Public Inquiry, gaining statutory powers, surveys, compensation, supervision and testing.
- 2.4.4 Table 2.2 gives a detailed breakdown of the Scheme cost estimate, including a summary of the input costs to TUBA.

Table 2.2 A40 Llanddewi Velfrey to Penblewin, Scheme Cost Estimate (2018 Prices / Excluding VAT)

Items input to Economic Assessment		Cost
(a)	Key Stage 6 Detailed Design & Construction	£24,351,000
	Statutory Undertakers Costs	£2,140,000
(b)	Key Stage 4 Design	£765,000
(c)	Welsh Government Expenditure	£1,775,110
	Employer's Agent	£1,601,625
(d)	Land Costs	£2,863,000
(e)	Risk Allowance	£2,285,000
(f)	Optimism Bias	£3,701,352
	Sub-Totals:	
	Construction (a)+(e)+(f)	£32,477,352
	Preparation (b)	£765,000
	Supervision (c)	£3,376,735
	Land (d)	£2,863,000
	TOTAL	£39,482,087

2.5 User Benefits During Operation

- 2.5.1 The calculation of transport user benefits is based on outputs from the A40 Llanddewi Velfrey to Penblewin transport model. A description of the development and validation of the model are given in the Local Model Validation Report⁴, while details of the traffic forecasts produced by the model are provided in the Traffic Forecasting Report⁵.
- 2.5.2 The model represents typical operational conditions on the highway network in terms of average flows and speeds on a normal day of operation. The model does not reflect those occasions when a major incident may have occurred which results in severe reduction in network performance. In such instances, there may be periods of congestion during which journey times significantly increase, imposing additional costs to the travelling public. As a result, benefits of the Scheme that relate to improvements in journey time reliability or network resilience have not been quantified and are excluded from the BCRs presented in this report.
- 2.5.3 TUBA software (version 1.9.11) has been used to undertake the economic assessment for the A40 Llanddewi Velfrey to Penblewin Improvements. This software has been produced by the Department for Transport (DfT) to carry out transport scheme economic appraisal using a ‘willingness to pay’ approach with fixed or variable demand. The economic impacts of a scheme are derived by comparing the future year situation with the Scheme (Do Something scenario) to the situation without the Scheme (Do Minimum).
- 2.5.4 TUBA uses data taken from the traffic model forecasts on the number of trips, average journey times and average distances to calculate the TEE and greenhouse gas impacts in accordance with the WebTAG methodology. The Scheme investment and operating costs are also input to the TUBA software such that an overall comparison of costs and benefits can be made.
- 2.5.5 The TUBA appraisal has taken data from the traffic model forecasts, which have been prepared for 2021, 2036 and 2051. TUBA calculates the benefits for each of the modelled forecast years and then interpolates to calculate the benefits for the intervening years. After the last modelled year, the default TUBA assumption is that there is no change in traffic patterns and so the benefits do not change, but they are discounted back over a longer period of time to the economic base year of 2010.
- 2.5.6 Annualisation factors have been calculated and applied in TUBA to convert impacts from the modelled hourly time periods up to annual values. These factors are based on the ratio of traffic flows

⁴ A40 Llanddewi Velfrey to Penblewin Improvements, Local Model Validation Report, Ove Arup and Partners, October 2017

⁵ A40 Llanddewi Velfrey to Penblewin Improvements, Traffic Forecasting Report, Ove Arup and Partners, November 2018

experienced in each of the modelled time periods to average daily traffic flows.

- 2.5.7 The factors applied for the purposes of the economic appraisal are consistent with the Average Annual Daily Traffic (AADT) factors set out in the Traffic Forecasting Report. As described in the Traffic Forecasting Report, the automatic traffic count (ATC) collected as part of the roadside interview (RSI) along the A40 has been used to derive factors to undertake the conversion from modelled hours to daily flows. The additional conversion from the modelled month of October to annual average traffic conditions was derived from a permanent traffic count on the A40 at Whitland Bypass.
- 2.5.8 The calculation of annualisation factors for the AM (07:00 to 10:00), Interpeak (10:00 to 16:00) and PM (16:00 to 19:00) weekday periods is illustrated in Table 2.3.

Table 2.3 Annualisation Factors (Weekdays 07:00 to 22:00)

Description	Modelled Time Period	Conversion from modelled hour to full peak/inter-peak period (a)	Conversion from October to AADT (b)	Conversion to Full Year (c)	Overall Annualisation Factor = (a)*(b)*(c)
AM peak hour to total annual hours during AM peak	AM Peak Hour	2.556	1.031	253 (working days = 365 less 104 weekend days less 8 bank holidays)	667
Interpeak hour to total annual hours during interpeak	Interpeak Hour	6.000	1.031	253	1565
PM peak hour to total annual hours during PM peak	PM Peak Hour	2.572	1.031	253	671

- 2.5.9 The interpeak model is used as the basis for estimating benefits that accrue during the weekday off-peak (22:00 to 06:00) and weekend and bank holiday periods. The annualisation factors for these periods are based on the ratio of traffic flows during these periods and during the interpeak period. This is illustrated in Table 2.4.

Table 2.4 Annualisation Factors (Off-peak, weekends and bank holidays)

Description	Modelled Time Period	Ratio of off-peak/weekend traffic to average hourly interpeak traffic (a)	Conversion from October to AADT (b)	Conversion to Full Year (c)	Overall Annualisation Factor =(a)*(b)*(c)
Interpeak hour to total annual hours during weekends and bank holidays	Interpeak hour	25	1.031	56 (52 weekends plus 8/2 bank holidays)	1,440
Interpeak hour to total annual off-peak hours	Interpeak Hour	2	1.031	253	609

2.6 User Benefits During Construction

- 2.6.1 Traffic management works during construction can result in increased journey times and vehicle operating costs, producing economic disbenefits.
- 2.6.2 In the case of the A40 Llanddewi Velfrey to Penblewin Improvements, most of the Scheme will be constructed offline, so that the only impact of construction works on traffic movements will take place at the tie-in points. It is assumed that the works associated with the tie-in points will take place overnight or at weekends in order to minimise disruption at these points. There is a short section of online works through the Ffynnon Area. This will be dealt with in a similar manner to that of the tie in works.
- 2.6.3 In view of the relatively minimal level of disruption, the impact of construction works on user benefits has not been included in this economic assessment.

2.7 User Benefits During Maintenance

- 2.7.1 As with construction works, traffic management works during maintenance programmes can result in increased journey times and vehicle operating costs, producing economic disbenefits.
- 2.7.2 In general, the maintenance disbenefits associated with an improvement scheme are likely to be lower than in the Do Minimum situation, because maintenance works on the improvement Scheme are likely to have a smaller impact on traffic. The net effect, therefore, would be a positive benefit produced by the improvement Scheme.
- 2.7.3 The A40 Llanddewi Velfrey to Penblewin Improvements would be expected to produce a net positive benefit associated with maintenance works. However, as the effect is likely to be small, maintenance benefits have not been assessed as part of this economic assessment.

2.8 Safety Benefits

- 2.8.1 The safety impacts of the Llanddewi Velfrey to Penblewin Improvements have been assessed quantitatively and monetised to be incorporated into the overall economic assessment for the Scheme.
- 2.8.2 TUBA does not calculate accident benefits, and so this assessment has been carried out using the DfT's COBALT software, using information on link length and traffic flows extracted from the traffic model forecasts for the Do Minimum and Do Something scenarios.
- 2.8.3 The assessment compares the cost of accidents that are predicted to occur in the Do Minimum and Do Something scenarios. The economic costs of accidents costs are given in the WebTAG Databook⁶ and built into the COBALT software. Average accident costs are based on the average casualty split for different types of link. In addition to the casualty costs, the total costs include components associated with damage to property, insurance administration, police time, together with an allowance for damage-only accidents.
- 2.8.4 WebTAG also provides default accident rates (average accidents per million vehicle kilometres) for a range of different carriageway types. The Llanddewi Velfrey to Penblewin Improvements include a significant proportion of '2+1' links, that is, three-lane single carriageway links, comprising two lanes in one direction and one in the opposite direction, in order to facilitate overtaking, thereby increasing journey time reliability and reducing driver stress. This type of link, however, is not distinguished from the standard two-lane single carriageway in the default accident rates provided in the WebTAG Databook.
- 2.8.5 Accordingly, accident rates for the COBALT assessment were derived from observed accident data for sections of the A40 between St Clears and Haverfordwest. To derive observed accident rates, the existing A40 was divided into a number of sections which were categorised by carriageway type. Accident rates were then calculated for each carriageway type, namely: Single 2-lane carriageway (30/40 mph) sections, single 2-lane carriageway (50/60 mph) and Single 2+1 carriageway (50/60 mph).
- 2.8.6 Using observed accident rates has the advantage that the rates applied are likely to be more reflective of local conditions with the disadvantage that the sample size upon which the analysis is based will be lower than that used to derive the WebTAG rates. In order to maximise the sample size for this analysis, the decision was taken to apply accident rates for the full length of the A40 from St Clears to Haverfordwest (rather than Llanddewi Velfrey to Penblewin specifically) using on accident and traffic flow data for the period between 2006 and 2015. The resulting average accident rates are shown in Table 2.5.

⁶ WebTAG Databook release v1.10.1, Department for Transport, May 2018

Table 2.5 Observed Accident Rates, A40 St Clears-Haverfordwest, 2006-2015⁷

Link Type	Accidents per Million Vehicle Km	
	Llanddewi Velfrey to Penblewin	St Clears-Haverfordwest
Single 2-lane carriageway, 30/40mph speed limit	0.157	0.201
Single 2-lane carriageway, 50/60mph speed limit	0.144	0.147
Single 2+1 carriageway, 50/60mph speed limit	0.087	0.097

- 2.8.7 The equivalent WebTAG default rates to the rates given in Table 2.5 are 0.671 (2015) for a Single 2-lane carriageway (30/40mph) and 0.185 for a Single 2-lane carriageway (50/60mph)⁸. As noted, no equivalent WebTAG rates are available for a Single 2+1 carriageway.
- 2.8.8 Under the Do Minimum scenario, for the section of the road which passes through the village, forecasts for the number of accidents were calculated by applying the observed rate for Single 2-lane carriageway (30/40mph). Sections of the A40 either side of the village either side of the village we apply observed rates for single 2-lane (50/60mph) and Single 2+1.
- 2.8.9 Under the Do Something scenario, the new highway is assumed to have an accident rate equivalent to the observed rate for a Single 2+1 carriageway (50/60mph) with the exception of approaches to bypass junction which attract a rate equivalent to a Single 2-lane carriageway (50/60mph).
- 2.8.10 The total cost of accidents for each year between 2021 and 2080 was calculated by COBALT for the Do Minimum and Do Something scenarios and then discounted to the base year of 2010. The discounted cost of accidents was then summed over the 60-year period for each scenario, and the resulting benefits were then added to the main TUBA assessment.

⁷ Accident rates shown in Table 2.5 for the Llanddewi Velfrey to Penblewin Section differ from those provided in the Initial Traffic Data and Accident Data Report (March 2017).

⁸ The observed accident rate for Single 2-lane carriageway sections of the A40 is substantially lower than the default rate provided in the WebTAG Databook. The default rate will incorporate a high proportion of urban routes with a greater incidence of vehicle conflicts at junctions that will not be comparable to the linear route through small villages that occur on this part of the A40. This further reinforces the advantage of using observed rather than default rates to inform the economic appraisal.

2.9 Monetised Environmental Impacts

Greenhouse Gas Emissions

- 2.9.1 Greenhouse gas emissions were monetised in accordance with WebTAG Unit A.3, employing the latest available version of the Greenhouse Gases Workbook to provide monetised estimates of the impacts of changes in emissions. Vehicular emissions were calculated based on outputs from the traffic model in respect of traffic volumes and speeds within a defined study area. The assessment considers only vehicular emissions and does not include any ‘embodied carbon’ resulting from the construction of the Scheme. This is considered a proportionate approach given that many of the sources of greenhouse gas emissions during the construction phase are covered by the European Emissions Trading Scheme.
- 2.9.2 The Scheme generates an increase in emissions due to an increase in traffic speeds as well as a very slight increase in the distance that through traffic on the A40 incurs as a result of the bypass.

Air Quality Impacts

- 2.9.3 The assessment of air quality impacts employs the methodology set out in Unit A.3 and the Air Quality Valuation Workbook. Further information regarding the approach to modelling air quality impacts will be provided in the Environmental Statement for the Scheme.
- 2.9.4 Under the WebTAG approach, two aspects of air quality are considered:
- Changes in NO_x emissions; and
 - Changes in particulate (PM₁₀) emissions.
- 2.9.5 The effect of the Scheme is to reduce particulate emissions currently affecting households in close proximity to the current alignment of the A40 and therefore the value derived for particulate emissions is positive. However, the Scheme results in an overall increase in NO_x emissions.
- 2.9.6 At the time of the air quality assessment, WebTAG guidance from March 2017 was used. The overall balance of these two impacts is positive. This result has been included in the ‘central case’ economic appraisal.
- 2.9.7 A sensitivity test was also used to account for updates to WebTAG NO_x damage cost guidance that was announced in March 2017 and published in May 2018. This new guidance accounted for new evidence on the health impacts of exposure to NO_x. The result of the change is an updated set of NO_x ‘damage costs’ which is significantly higher than for previous versions on WebTAG.
- 2.9.8 The analysis using updated NO_x damage costs is presented in this report as a sensitivity test. Employing the values from the sensitivity

test changes the balance of monetised particulate and NO_x emissions such that the overall impact of the Scheme becomes negative.

Noise Impacts

- 2.9.9 WebTAG provides a framework for monetising the benefits of reducing noise exposure to traffic for households. A model has been constructed to simulate changes in noise levels as a result of the Scheme and this will be described in the Environmental Statement for the Scheme. The value of noise impacts has been quantified using the most recently published WebTAG Noise Assessment Workbook. The quantified assessment captures impacts on households in respect of sleep disturbance, amenity and health impacts.
- 2.9.10 The overall effect of the Scheme is positive because the bypass reduces the exposure to noise of households in close proximity to the alignment of the existing A40.

2.10 Non-Monetised Impacts

- 2.10.1 As noted, in Section 2.2 the economic appraisal includes those impacts – positive or negative – which can be feasibly monetised. There are a range of impacts which are not included in the economic appraisal. A non-exhaustive list of these impacts is set out here:
- **Journey Time Reliability** – The term journey time reliability refers to variation in journey times that individuals are unable to predict. Such variation can come from recurring congestion at the same period each day or from non-recurring events, such as incidents. It is distinct from the predictable variation relating to varying levels of demand by time of day, day of week, which travellers are assumed to be aware of. The Scheme is expected to deliver some improvement in reliability by improving operational performance and by reducing the frequency of traffic incidents due to accidents. WebTAG guidance does not provide a methodology for the assessment of reliability benefits for rural, single carriageway roads and therefore such benefits are not included in the economic appraisal.
 - **Seasonality and Periods of High Traffic Demand** – The Initial Traffic and Accident Data Report outlines the monthly variations in traffic volumes. The month of August typically experiences the highest traffic volumes, some 23% higher than the AADT. For limited periods of time, this may result in a reduction in traffic speeds. Because the economic appraisal has been undertaken based on a traffic model which simulates average conditions, the benefits of the Scheme during periods of very high demand, are not captured in the appraisal.
 - **Driver Frustration** – although challenging to quantify, one of the perceived issues with unimproved sections of the A40 is

the lack of overtaking opportunities and the platooning of cars behind slow moving vehicles. Such issues will add to the stress and frustration that drivers experience and therefore the potential benefit of providing overtaking opportunities. If levels of driver frustration on the A40 are higher than average, then it may be argued that the values applied to travel time savings are conservative.

- Wider Economic Benefits – An ‘Economic Activity and Location Impact’ study undertaken by Peter Brett Associates on behalf of the Welsh Government in 2015⁹ identified a number of mechanisms through which improvements to the A40 could deliver economic benefits. These were as follows:
 - Widening the labour market;
 - Population retention and immigration;
 - Improved business performance
 - Scheduling benefits
 - Perceptions of remoteness
 - Inward investment
 - Enhanced prospects for the Enterprise Zone
 - Increased residential development
 - Increased trade
 - Improved strategic rail access

2.10.2 In respect of any potentially monetisation of wider economic benefits, two factors need to be taken into account. Firstly, the economic appraisal is undertaken at a UK level and therefore captures only those economic benefits which are additional at a UK level. Many of the impacts listed above (for example, inward investment) represent a transfer of economic activity from one part of the UK to another. Hence, the impacts may be additional to Wales but do not represent a benefit to the UK economy overall.

2.10.3 Secondly, and related to this, WebTAG guidance on the quantification of wider economic benefits is not well suited to the expected economic benefits of the Scheme. The ‘Wider Impacts’ methodology in WebTAG is focussed on ‘agglomeration effects’ – the benefits of improving access between firms. Agglomeration effects are essentially an urban phenomenon. Given the rural nature of the A40, undertaking an assessment of agglomeration effects is not considered to be appropriate and, in any case, any such assessment would be unlikely to substantially influence the BCR for the Scheme.

⁹ A40 St Clears to Haverfordwest Economic Activity & Location Impacts (EALI) Study. June 2015.

- 2.10.4 Other environmental and social impacts – As noted, the economic appraisal captures some aspects of the environmental impact of the Scheme in relation to noise impacts on households, air quality impacts and changes in greenhouse gas emissions. There are a range of other environmental and social impacts of the Scheme that have a bearing on quality of life and also need to be taken into account in decision making.

3 Results of Economic Assessment

3.1 Central Growth

- 3.1.1 As described in Section 2.1, the Analysis of Monetised Costs and Benefits compares the present value of benefits (PVB) and the present value of costs (PVC) to give the Net Present Value (NPV) and Benefit to Cost Ratio (BCR) for the Scheme. The NPV is calculated by subtracting the present value of costs (PVC) from the total present value of benefits (PVB). The BCR is calculated by dividing the PVB by the PVC.
- 3.1.2 A positive NPV and a BCR greater than unity indicate that the benefits due to the Scheme outweigh its costs and so it is positive in economic terms. The higher the NPV and BCR, the better the value for money of the Scheme.
- 3.1.3 A summary of the economic assessment results for the Scheme is shown in Table 3.1. The results show that the Scheme costs outweigh the benefits, producing a very low BCR of 0.13.
- 3.1.4 A BCR of 0.13 indicates that the costs of the Scheme outweigh the quantifiable benefits. However, the BCR is not the only indicator of value for money, particularly for smaller scale schemes which achieve a broad range of objectives which is the case here. It should also be considered that the Llanddewi Velfrey to Penblewin Improvements need to be seen in the context of the overall A40 corridor improvement, of which it forms an integral component. As noted, the need for the Scheme and the broader case for investment is set out in the WelTAG Stage 3 Report.

Table 3.1 Summary of Economic Assessment (Central Growth)

		Results (£000)
		(2010 prices, discounted to 2010)
User Benefits	Consumers	2,036
	Business	699
Accident Benefits		1,390
Greenhouse Gas Impacts		-1,175
Air Quality Impacts		30
Noise Impacts		344
Indirect Tax Revenues		418
Present Value of Benefits, PVB (£000)		3,742
Present Value of Costs, PVC (£000)		28,957
Net Present Value, NPV (£000)		-25,215
Benefit-to-Cost Ratio, BCR		0.13

3.2 Sensitivity Tests

Traffic Growth

- 3.2.1 Low and high growth scenarios were developed to test the impact of uncertainty in projections of demographic data (population, households and employment), GDP growth and fuel price trends. As recommended in TAG Unit M4¹⁰, in order to create the low growth scenario, a proportion of the base demand was subtracted from the forecast demand from the Core Scenario. For the high growth scenario, a proportion of base demand was added. The proportion of base year demand that was used to adjust the Core Scenario to create low and high growth scenarios is shown in Table 3.2.
- 3.2.2 The traffic growth sensitivity test has been applied to impacts related to user benefits, accidents, and indirect tax only. In practice the environmental benefits would also be affected by the variation in traffic volumes in the low and high growth scenarios. However, the scale of variation would be expected to be small and therefore the environmental impacts have only been assessed based on the central case.

Table 3.2 Adjustment of Core Scenario to create Low and High Growth Scenarios

Year	Low Growth	High Growth
2021	-5.6 % of base demand	+5.6 % of base demand
2036	-11.2 % of base demand	+11.2 % of base demand
2051	-14.8 % of base demand	+14.8 % of base demand

¹⁰ Transport Analysis Guidance Unit M4, Forecasting and Uncertainty, Department for Transport, May 2018

3.2.3 A summary of the economic assessment results for the Scheme under the low and high growth scenarios is shown in Table 3.3.

Table 3.3 Summary of Economic Assessment (Low and High Growth)

		Results (£000)	
		(2010 prices, discounted to 2010)	
		Low Growth	High Growth
User Benefits	Consumers	1,592	2,579
	Business	472	993
Accident Benefits		1,263	1,516
Greenhouse Gas Impacts		-1,175	-1,175
Air Quality Impacts		30	30
Noise Impacts		344	344
Indirect Tax Revenues		390	442
Present Value of Benefits, PVB (£000)		2,916	4,729
Present Value of Costs, PVC (£000)		28,957	28,957
Net Present Value, NPV (£000)		-26,041	-24,228
Benefit-to-Cost Ratio, BCR		0.10	0.16

Air Quality Valuation

3.2.4 Updated NO_x damage costs have been calculated by Defra as part of their updated guidance on valuing changes in emissions of NO_x. These values have been published in WebTAG in 2018.

3.2.5 A sensitivity test has been carried out using the updated values. The results are shown in Table 3.4. The sensitivity test demonstrates that the adoption of the updated values results in a significantly higher weight being applied to NO_x emissions such that the BCR for the Scheme is slightly reduced.

Table 3.4 Change in Air Quality Valuation

Scenario	Air Quality Benefits		Benefit-to-Cost Ratio with Proposed Valuation
	Current Valuation	Proposed Valuation	
Central Growth	30	-259	0.12
Low Growth			0.09
High Growth			0.15

4 Conclusions

- 4.1.1 The purpose of the economic appraisal is to consider whether the quantifiable benefits of a transport scheme justify the costs of investment. The economic appraisal compares the costs and benefits of a transport scheme that would accrue over a 60-year period in monetary terms. The results of the economic appraisal are summarised in the Benefit-Cost Ratio (BCR).
- 4.1.2 Under the central case, the BCR for the Scheme is 0.13 which indicates that the costs of the Scheme outweigh the quantifiable benefits. Sensitivity testing which employs low and high traffic growth forecasts show the BCR to be in the range 0.10 to 0.16. A further sensitivity test has been undertaken which reflects recently published updated NOx damage costs. With the updated treatment of NOx damage costs, the range of the BCR falls slightly to 0.09 to 0.15.
- 4.1.3 Whilst the BCR for the Scheme is substantially below 1, it should be considered that the economic appraisal is only a partial assessment of value for money. It considers only those impacts which can be monetised. There are a range of other considerations that the Welsh Government will take into account in its decision-making process. The WelTAG Stage 3 Report¹¹ describes how the Scheme contributes to the Welsh Government's objectives from a broader perspective, taking into account quantitative and qualitative evidence.

¹¹ A40 Llanddewi Velfrey to Penblewin Improvements, WelTAG Stage 3 Report