Adran Seilwaith yr Economi
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THE LONDON TO FISHGUARD TRUNK ROAD (A40) (LLANDDEWI VELFREY TO PENBLEWIN IMPROVEMENT AND DE-TRUNKING) ORDER 201-

THE LONDON TO FISHGUARD TRUNK ROAD (A40) (LLANDDEWI VELFREY TO PENBLEWIN IMPROVEMENT) (SIDE ROADS) ORDER 201-

THE WELSH MINISTERS (THE LONDON TO FISHGUARD TRUNK ROAD (A40) (LLANDDEWI VELFREY TO PENBLEWIN IMPROVEMENT)) COMPULSORY PURCHASE ORDER 201-

<u>PROOF OF EVIDENCE</u>

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WELSH GOVERNMENT, TRAFFIC & ECONOMICS

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Contents

1. Author

1.1 My name is Philip Thiele. I am a Senior Engineer within the Transport Consulting sector at Ove Arup and Partners Ltd (Arup), a multi-disciplinary consultancy, where I am responsible for strategic transport modelling and economic appraisal of highway and public transport scheme proposals across the UK.

1.2 In the summer of 2004, I graduated from my Bachelor of Engineering (BEng Hons) course at Swansea University with a first class honours degree in Civil Engineering. I then went on to complete a Master of Research course in Computer Modelling in Engineering at Swansea University in 2006.

1.3 I am a Chartered Engineer and a member of the Institution of Civil Engineers (ICE). I have over 14 years' experience in the field of transport modelling carrying out and leading strategic modelling projects in both the public and private sectors. In 2017 I won the ICE Wales Cymru Paterson Prize for the best written exercise in my ICE professional review and was 'highly commended' for the ICE Wales Cymru Ben Barr Award, which is presented to an engineer who demonstrates exceptional qualities during their professional review to become a chartered engineer.

1.4 I have acted as Project Manager and Technical Modelling Lead across a range of transport modelling projects. Through these roles I have gained significant experience of working with Welsh Government and undertaking traffic modelling in line with Welsh Transport Appraisal Guidance (WelTAG) (Doc. 4.01.11). I have developed and audited strategic transport models throughout the UK and Australia.

1.5 Other than the A40 Llanddewi Velfrey to Penblewin Improvements strategic traffic model I also had key responsibilities in the development of a number of other strategic transport models throughout Wales, which were created in line with WelTAG (Doc. 4.01.11). Recent examples include the M4 Corridor around Newport project and the Severn Crossings Toll model.

1.6 I also regularly work on projects for Highways England. I was recently Work Package Manager and Technical Modelling Lead for the traffic modelling and economic appraisal of three Smart Motorway schemes in the Midlands. The schemes included on this project are the M40/M42 Interchange, Birmingham Box Phase 4 and M1 J19-J23a.

1.7 I have extensive knowledge of applying the UK Department for Transport web-based Transport Analysis Guidance (WebTAG) and was recently Work Package Manager on a project to create a new unit within the guidance (TAG unit M2.2[1]) about the development of base year trip matrices for transport models.

1.8 I have led the development of the strategic traffic model and economic appraisal for the A40 Llanddewi Velfrey to Penblewin Improvements (hereby referred to as the "Scheme") and have been supported by my team of transport modellers. They have worked to my instruction and I adopt their work as my own. The opinions that are expressed in my Proof of Evidence are my own.

1.9 The evidence which I have prepared and provide in this Proof of Evidence has been prepared by me and is given in accordance with the guidance of my professional institution. I confirm that the opinions expressed are my true and professional opinions.

2. Scope and Purpose of this Proof of Evidence

2.1 In this Proof of Evidence, I provide details of key aspects of the traffic data analysis, traffic modelling and economic appraisal that has been undertaken for the Scheme.

[1] Transport Analysis Guidance (TAG) Unit M2.2, Base Year Demand Matrix Development, Department for Transport, Nov 2019

2.2 My evidence is thus presented in the following structure:

a) A summary of existing conditions along the A40;
b) An overview of the strategic traffic model used to assess the impacts of the Scheme;
c) A summary of the development of the base year traffic model;
d) A summary of the traffic forecasting methodology;
e) An outline of the economic appraisal undertaken for the Scheme; and
f) Responses to the traffic related objections to the Scheme received to date.

2.3 Throughout my evidence, I will refer to guidance on transport appraisal provided by both the Welsh Government and the UK Department for Transport. The primary reference document for transport modelling and economic appraisal in the UK is the web-based Transport Analysis Guidance (WebTAG) (Doc. 4.01.69). The Welsh Government's equivalent guidance is the Welsh Transport Appraisal Guidance (WelTAG) (Doc. 4.01.11).

2.4 WelTAG forms the overarching guidance document for the planning and appraisal of transport proposals in Wales. In relation to technical matters of methodology, WelTAG refers appraisers to WebTAG guidance and data sources.

3. Existing Conditions

Overview

3.1 The A40 Trunk Road forms part of the Trans European Road Network (TEN-T) and is critical to the Welsh economy transporting people and goods to homes, industry and employment. It provides access to the ferry port at Fishguard for onward travel to Ireland and serves the Welsh tourism industry. It is therefore a route of significant strategic importance.

3.2 The section of the A40 between St Clears and Haverfordwest is a relatively poor-quality route. In 2002 the Welsh Government published the Trunk Road Forward Programme[2] (Doc. 4.01.44). Within this document the A40 corridor between St Clears and Haverfordwest was described as *"the lowest standard section of the Trans European Road Network in the United Kingdom"*. The St Clears to Haverfordwest section of the A40 connects small villages and as such several sections of the A40 have historically passed through these communities, leading to issues around severance, air and noise concerns and safety problems.

3.3 A description of the existing A40 with reference to design standards is documented in the proof of evidence of Tom Edwards (WG 1.3.2).

3.4 The section of A40 passing through the village of Llanddewi Velfrey is particularly narrow and a speed limit of 40mph applies. There are a number of frontage properties, accesses and side roads including a filling station with mini market and post office facilities. West of the village the A40 re-enters the rural area and the 40mph speed restriction ends, returning to the national speed limit. This section of the A40 has a number of side road, layby accesses and farm accesses. On approach to the A478 roundabout at Penblewin, there is an access to a rest area including parking for heavy goods vehicles (HGVs).

3.5 The proof of evidence of chief witness Mark Dixon (WG 1.1.2) documents the operational problems that were identified along the existing A40 in the WelTAG Stage 3 Report for the Scheme (Doc. 4.03.07). These include the following traffic related issues:

a) Limited and inconsistent overtaking opportunities, which lead to journey time unreliability, driver frustration and associated risky manoeuvres with severe collision incidents;
b) Platooning (when there are convoys of heavy goods vehicles from the ferry ports and slow-moving agricultural vehicle accessing the many side roads and farm accesses along the A40) contributes to journey

[2] Trunk Road Forward Programme, Welsh Assembly Government, Transport Directorate, Mar 2002

time unreliability when combined with the limited overtaking opportunities and mix of local and HGV traffic;

c) The route of the A40 passes through the populated area, creating severance and air and noise pollution problems within the local community at Llanddewi Velfrey; and
d) Slow-moving traffic during the summer months exacerbates the problems, with tourists causing a significant increase in traffic and slow-moving vehicles, including those towing caravans.

3.6 The nearby section of A40 to the west of this section between Robeston Wathen and Slebech Park has already been upgraded to wide single 2+1 road standard (WS2+1). This section was completed in 2011. Llanddewi Velfrey is now the only settlement located directly on the A40 between Carmarthen and Haverfordwest.

3.7 As a result of the upgrade of some sections, there is now significant variation in the standard of road along the A40 between St Clears and Haverfordwest. This results in an inconsistent driver experience along the A40 corridor and a lack of clarity of where the nearest safe overtaking opportunities are provided for those unfamiliar with the road.

3.8 The Initial Traffic and Accident Data Report (Doc. 4.05.01) sets out existing traffic conditions within the study area. The key points are documented in my proof of evidence in the following sections.

Hourly Variation of Traffic

3.9 The hourly traffic flow profile shown in Figure 1 in Appendix A (WG 1.2.3) was observed on the A40 west of Llanddewi Velfrey in June 2017.

3.10 On a typical weekday the morning peak occurs between 8:00 and 9:00 and the evening peak occurs between 17:00 and 18:00. On Fridays the traffic volumes are notably higher compared to other weekdays from 09:00 onwards. On Saturdays and Sundays, the build-up of traffic volumes happens significantly later than on typical weekdays, with the peak flow observed between noon and 13:00 on Saturdays and between 16:00 and 17:00 on Sundays. The highest traffic volumes of any hour of the week are encountered during Friday afternoons between 15:00 and 16:00, when two-way traffic volumes exceed 1,200 vehicles per hour.

Daily Variation of Traffic

3.11 A comparison of traffic volumes by day in June 2017 is shown in Figure 2 in Appendix A (WG 1.2.3). This shows that there is little fluctuation of daily traffic volumes between Mondays and Thursdays. However, traffic volumes on Fridays are 17% higher than the Monday to Friday average. The increased traffic volume on Fridays is likely to be linked to tourism traffic and residents of Pembrokeshire who work in other parts of Wales or the rest of the UK during the week and then return home for the weekend. Traffic volumes on Saturdays and Sundays are 11% and 17% lower than the Monday to Sunday average traffic volume respectively.

Seasonality of Traffic

3.12 A comparison of monthly variation in traffic flows based on data from the nearest available permanent traffic counter located along Whitland Bypass is shown in Figure 3 in Appendix A (WG 1.2.3). This is based on data from the 2016 calendar year. It demonstrates significant seasonal variation in traffic volumes, with a clear trend towards higher traffic volumes during the summer months and lower traffic volumes during the winter months.

3.13 The highest traffic flows were observed during the peak holiday season in August and the lowest in January. Traffic volumes in August were 26% higher than the annual average daily traffic (AADT), whereas volumes in January were 20% lower. When comparing the peak summer traffic in August directly to the quieter winter months, it can be seen that traffic volumes fluctuate by over 50% within the calendar year.

Tidality of Traffic

3.14 Figure 4 in Appendix A (WG 1.2.3) shows the tidality of traffic flows on typical weekdays based on data from June 2017. This illustrates that the westbound traffic is higher in the morning peak than the evening peak, whilst the reverse is the case for the eastbound direction.

Vehicle Type Split

3.15 The vehicle type split by time of day is shown in Figure 5 in Appendix A (WG 1.2.3). This is based on data collected on 4th October 2016. The proportion of light goods vehicles (LGV) and HGVs is highest in the morning and gradually reduces throughout the day. The average vehicle split throughout the surveyed period is 74% cars, 18% LGV and 8% HGV. Less than 1% of total vehicles are made up of a mix of all other vehicle types, including motorcycles, coaches, public service buses, campervans and agricultural vehicles.

Historic Traffic Growth

3.16 Figure 6 in Appendix A (WG 1.2.3) shows the historic growth in traffic volumes based on the nearest permanent traffic counter, which is located on the A40 Whitland Bypass. Data at this location has been recorded since 1999. The AADT data shows that traffic volumes have increased by 20% over the 20-year period analysed. Taking into account compound growth, this equates to an annual average growth of less than 1%. Between 2006 and 2008 annual traffic growth plateaued and then turned negative between 2009 and 2012, which is likely to be linked to the global recession. Following the period of negative growth, the traffic growth rates accelerated to 4% per annum for the subsequent two years. Since 2015 annual traffic growth has fluctuated in the range of 0 to 3%.

Operational Analysis

3.17 In this section I refer to three measures that have been used to describe the operational performance of the A40 through Llanddewi Velfrey. This includes an analysis of operational performance of:

a) Sections of the A40 corridor between junctions;
b) Key junctions (in this case only the Penblewin Roundabout has a significant impact on capacity along the A40); and
c) Journey times along the A40 corridor.

3.18 The Congestion Reference Flow (CRF) of a section of road, as defined in TA46/97[3], is an estimate of the AADT flow at which the carriageway is likely to be 'congested' in the peak periods on an average day. For the purposes of calculating the CRF, 'congestion' is defined as the situation when the hourly traffic demand exceeds the maximum sustainable hourly throughput of the section of road.

3.19 The CRF is used to identify 'stress points' in the existing road network. When traffic volumes reach the level defined by the CRF this is defined as a 'stress factor' of 1.00. The effect is likely to be one or more of the following:

a) flow breaks down with speeds varying considerably;
b) average speeds drop significantly;
c) the sustainable throughput is reduced; and
d) queues are likely to form.

3.20 Where the 'stress factor' lies between 0.85 and 1.00, turbulent traffic conditions are likely to be experienced as congestion starts to build up. This is the consequence of having only a low reserve capacity on the road network during peak hours and therefore the effect small incidents

[3] Design Manual for Roads and Bridges, Volume 5 Section 1 Part 3, TA 46/97, Traffic Flow Ranges for Use in the Assessment of New Rural Roads, The Welsh Office, Feb 1997

of vehicles braking can have on other road users when ‘stress factors’ are within this range.

3.21 Results of the CRF analysis are shown in Table 1. The AADT flows quoted in this table are estimates based on the available junction turning count data. The results indicate that the section of the A40 through Llanddewi Velfrey operates at the highest ‘stress factor’, but that conditions are generally uncongested for all periods of an average day under current conditions.

Table 1: Stress analysis of the A40 corridor around Llanddewi Velfrey

Location	AADT	CRF	Stress Factor
A40 Penblewin to Llanddewi Velfrey	11,241	28,000	0.40
A40 through Llanddewi Velfrey	10,820	19,400	0.56
A40 east of Llanddewi Velfrey	10,078	28,000	0.36

3.22 It should be noted that the measure of CRF represents an average as traffic conditions can vary significantly from day to day, by time of year and from location to location. Furthermore, CRF is a measure of the performance of a road link between junctions, which does not consider the effect that junctions have on potential congestion. Junctions are considered separately from paragraph 3.24 onwards.

3.23 The CRF also does not capture the impact of slower moving vehicles on other road users. Journey time data along the corridor was analysed to determine the impact that slow-moving vehicles have on average speeds. This is included in this proof of evidence from paragraph 3.27 onwards.

3.24 Within the study area for the Scheme it is only the A40 / A478 Penblewin Roundabout which potentially limits the capacity for traffic travelling along the A40 to a greater extent than the road sections analysed as part of the CRF analysis. Because the CRF analysis excludes the effect of junctions, the Penblewin Roundabout has been modelled using the

ARCADY software in order to assess its operational performance under existing conditions.

3.25 Outputs from the ARCADY analysis are presented in terms of Ratio of Flow to Capacity (RFC) and Level of Service (LOS). The RFC provides a basis for judging the acceptability of junction designs and typically a ratio of less than 0.85 is considered to indicate satisfactory performance[4]. LOS is a quality measure used in highway capacity analysis to categorise the extent of queuing delay experienced on each approach arm to a junction[5]. Letters designate each LOS category, from A to F, with A representing the best operating conditions and F the worst. The following definition is used for the six LOS categories:

a) A = Free flow;
b) B = Reasonably free flow;
c) C = Stable flow;
d) D = Approaching unstable flow;
e) E = Unstable flow; and
f) F = Forced or breakdown flow.

3.26 The results of the analysis are shown in Table 2. They indicate that Penblewin Roundabout operated well within its theoretical capacity in 2016. The eastern approach arm from Llanddewi Velfrey is closest to approaching capacity. However, at an RFC of 0.50 it still has plenty of reserve capacity.

[4] Junctions 8 User Guide (Issue B), Transport Research Laboratory, Apr 2012
[5] Highway Capacity Manual (HCM 2000), Transportation Research Board, National Research Council

Table 2: Stress analysis of A40 / A478 Penblewin Roundabout

Approach Arm	2016 Morning Peak		2016 Evening Peak	
	Max RFC	Max LOS	Max RFC	Max LOS
A478 (North) from Clynderwen	0.27	A	0.16	A
A40 (East) from Llanddewi Velfrey	0.50	A	0.42	A
A478 (South) from Narberth	0.19	A	0.17	A
A40 (West) from Redstone Cross	0.32	A	0.44	A

3.27 Theoretical measures such as the RFC and LOS reported in the preceding sections should not be analysed in isolation as an indicator for congestion, because there are other factors such as slow-moving vehicles that can impact travel times. An alternative method of identifying the level of congestion experienced by drivers is therefore by analysing journey times. A significant variation in journey times between the peak hours and other hours of the day is a good indicator for the presence of traffic congestion during certain times of day.

3.28 Trafficmaster data is a GPS sourced dataset providing detailed information about vehicle movements and their speeds throughout Great Britain. The data was used to extract average journey times along the A40 for typical weekday conditions (Mondays to Thursdays) between September 2015 and August 2016.

3.29 Data was extracted for a section of the A40 between the access for Flimston Farm west of Redstone Cross and the priority junction approximately 360 metres west of the A40 Whitland Bypass / West Street roundabout. On the basis of the hourly traffic flow profile presented in Figure 1 in Appendix A (WG 1.2.3) the following time periods were defined for this analysis:

a) Morning Peak (08:00-09:00);
b) Evening Peak (17:00-18:00);
c) Inter-peak (10:00-16:00); and
d) Off-peak (22:00-06:00).

3.30 The analysis of journey times during the peaks deliberately focussed on single peak hours in order to establish the ‘worst case’. The timeframe selected for the off-peak period was based on hours, in which the traffic flow was less than 100 vehicles per hour in each direction, in order to capture the ‘best case’ for journey times. Journey times for the inter-peak were also extracted to provide a comparative measure for typical daytime conditions outside of peak hours.

3.31 Table 3 shows that the travel times through the study area along the A40 are similar during the morning peak, evening peak and inter-peak in the eastbound and westbound direction respectively. This indicates that the additional traffic that travels in the morning and evening peaks compared to the inter-peak does not appear to have a notably adverse impact on journey times during these hours.

Table 3: Journey times along the A40 (in minutes and seconds)

Direction	Morning Peak	Evening Peak	Inter-peak	Off-Peak	Congestion Factor
Eastbound	06:44	06:43	06:51	05:54	1.17
Westbound	06:45	06:34	06:44	05:45	1.15

3.32 However, during the off-peak it is evident that journey times are faster than for the rest of the day. This is likely to be linked to the much lower traffic volumes during these hours, which allows traffic to travel freely with a significantly reduced likelihood of getting held up behind other vehicles and without experiencing any junction delay at Penblewin Roundabout. A ‘congestion factor’ has been calculated on the basis of comparing the ‘worst case’ travel time to the ‘best case’. This indicates that congested travel times are on average between 15% and 17% higher than in the off-peak.

3.33 Given that links and junctions along the A40 corridor are shown not to be congested, the increase in travel times during the daytime hours compared to the off-peak is likely to be the result of a combination of slow-moving vehicles and a lack of safe overtaking opportunities.

Accidents

3.34 Personal injury accident data along the A40 corridor, obtained from STATS19 police records, has been reviewed as part of the Scheme appraisal.

3.35 In the 10-year period between 2006 and 2015 there were 9 accidents on the section of A40 in Llanddewi Velfrey with a speed limit of 40mph, of which 1 accident resulted in serious casualties. A further 13 accidents, all leading to slight casualties, were recorded between Llanddewi Velfrey and Penblewin Roundabout. The accident records include several accidents that involved head on collisions or collisions whilst overtaking.

3.36 The A40 between Robeston Wathen and Slebech Park has already been upgraded to the WS2+1 standard proposed for this Scheme. Sections that have been upgraded to WS2+1 standard provide more safe overtaking opportunities than single carriageway roads. This results in a lower accident rate on WS2+1 roads.

3.37 Between Haverfordwest and St Clears the accident rate for WS2+1 roads with 50 / 60mph speed limit is 36% lower than the equivalent accident rate for single carriageway roads with the same speed limit. The accident rate for WS2+1 roads compares even more favourably against single carriageway roads with 30 / 40 mph speed limits. The WS2+1 accident rate is 52% lower in this comparison.

Public Transport

3.38 The only public transport that currently operates along the A40 in the vicinity of Llanddewi Velfrey is bus service 322 between Carmarthen and Haverfordwest. On Mondays to Saturdays it operates 4 buses per day in each direction.

3.39 Bus service 430 operates between Cardigan and Narberth and crosses the A40 corridor at Penblewin Roundabout. On Mondays to Saturdays it operates 3 buses per day in each direction on the section of the route that crosses the A40.

4. Overview of Strategic Traffic Model

Purpose of the Traffic Model

4.1 I will explain how the traffic model was developed and applied as part of the assessment of the likely impacts of the Scheme on transport conditions. In doing so, I will highlight the key aspects including a discussion of induced traffic.

4.2 The traffic model is used to understand firstly, the impact of current traffic flows on the road network around Llanddewi Velfrey, and secondly to provide evidence for the planning of changes to the transport network and to produce traffic forecasts that are used in the detailed economic, social and environmental appraisal of proposed interventions in the transport system. The model represents typical operating conditions on the highway network in terms of average hourly flows and speeds on a normal weekday of operation during a 'neutral period' of the year (defined in paragraph 5.1).

Relevant Guidance

4.3 The Department for Transport publishes guidance, known as WebTAG (Doc. 4.01.69), on good practice for modelling and appraisal of highway schemes. Guidance documents relevant to strategic modelling include the following topics:

a) Principles of modelling and forecasting[6];
b) Data sources and surveys[7];

[6] TAG unit M1, Principles of Modelling and Forecasting, Department for Transport, Jan 2014
[7] TAG unit M1.2, Data Sources and Surveys, Department for Transport, Jan 2014

c) Variable demand modelling[8];
d) Highway assignment modelling[9]; and
e) Forecasting and uncertainty[10];

4.4 The Scheme Traffic Model has been developed in accordance with this guidance and therefore forms a robust basis from which to forecast future year highway network conditions, both with and without the proposed Scheme and other changes to the transport system.

4.5 The Local Model Validation Report (Doc. 4.05.02) sets out the methods and assumptions used in developing the base year traffic model, whilst the Traffic Forecasting Report (Doc. 4.05.03) sets out the development of the future year forecasts. Details of traffic surveys and data collation for the development of the traffic model are given in the Traffic Data Collection Report (Doc. 4.05.04).

Software

4.6 The Scheme Traffic Model uses SATURN (Simulation and Assignment of Traffic to Urban Road Networks) software, which is recognised as an 'industry standard' traffic assignment model that satisfies the requirements for modelling highway networks as set out in WelTAG (Doc. 4.01.11) / WebTAG (Doc. 4.01.69).

Assessment of the Need for Variable Demand Modelling

4.7 Given the relatively small scale of time savings that are expected as a result of the Scheme, the likelihood of traffic switching from alternative routes onto the A40 corridor once the Scheme is completed is negligible. This conclusion was drawn on the basis of analysing existing traffic patterns observed on the A40 and A477 corridors through roadside interview surveys carried out for this study in October 2016. The study

[8] TAG unit M2, Variable Demand Modelling, Department for Transport, Mar 2017
[9] TAG unit M3.1, Highway Assignment Modelling, Department for Transport, Jan 2014
[10] TAG unit M4, Forecasting and Uncertainty, Department for Transport, May 2018

area of the traffic model does therefore not need to extend beyond the A40 corridor between the B4313 Redstone Cross junction and the roundabout to the west of Whitland as shown in Figure 2.2 of the Local Model Validation Report (Doc 4.05.02).

4.8 The traditional methodology for scheme assessment has been to derive forecasts from a traffic model using a ‘fixed trip matrix’ approach. Whilst this approach makes provision for the predicted growth in travel demand in future years, it assumes that this growth would occur whether or not the improvement is implemented.

4.9 Recent years have seen the development of techniques in modelling variable demand for travel, using as its starting point the principle that any change in transport conditions can cause a change in travel demand. This is aimed at considering the extent of suppressed demand in the Do Minimum case (without scheme), as well as the potential for induced traffic in the Do Something case (with scheme). In congested conditions, therefore, an increase in highway capacity can result, in some circumstances, in additional traffic on the network that can add to the congestion, thereby reducing average speeds for all traffic and eroding some of the benefits of the scheme.

4.10 Section 2.2 of WebTAG unit M2 outlines circumstances under which it is appropriate to apply a ‘fixed trip matrix’ approach. The guidance states that it may be acceptable to limit the assessment of a scheme to a fixed demand assessment if the following criteria are satisfied:

a) The Scheme is quite modest either spatially or financially, and is also quite modest in terms of its effects on travel costs; or
b) There is no congestion on the network in the forecast year, in the absence of the Scheme; and
c) The Scheme will have no appreciable effect on travel choices (e.g. mode choice or distribution) in the corridor containing the Scheme.

4.11 Spatially the Scheme is modest, in that it represents a linear improvement to the A40 corridor with little scope for attracting traffic from other routes. Congestion along this route is currently very limited, and this is not expected to change significantly in the future. Time savings associated with the Scheme are also modest. Details of forecast time savings are provided in section 6.19.

4.12 Because of the strategic nature of the route, most traffic using it travels considerable distances. This, together with the isolated rural nature of the study area means that the Scheme is not expected to have an appreciable effect on variable demand model responses such as mode switch, destination choice, trip frequency changes or trip retiming. As such, a traffic assignment based on a ‘fixed trip matrix’ is appropriate for this Scheme, in other words the Scheme would result in no induced traffic and variable demand modelling is therefore not required.

Traffic Data Collection

4.13 The development of a robust traffic model requires information about traffic volumes, journey times and trip patterns throughout the study area. Figure 2.1 in the Traffic Data Collection Report (Doc. 4.05.04) provides details of all locations where traffic surveys were undertaken. The report also provides further information about each site, such as the type of survey undertaken and the dates when data was collected at each location.

4.14 The majority of traffic data used for this study was collected in autumn 2016. Traffic surveys included a series of 13 manual classified junction turning counts and two roadside interview surveys. Each roadside interview survey was accompanied by a manual classified link count and an automatic traffic count, as is standard practice, in order to collate the necessary data for the expansion of the sample of roadside interviews undertaken to represent the total travel demand.

4.15 Separate to the traffic surveys collected specifically for this project, data from a permanent traffic counter on the A40 Whitland Bypass was obtained from Traffic Wales. It was used primarily to analyse longer-term trends and seasonal variation of traffic flows within the study area, as well as for the derivation of annualisation factors to convert hourly modelled traffic flows to AADT.

4.16 Roadside interview surveys were undertaken in October 2016. This data forms the basis for the travel patterns represented within the trip matrix of the traffic model. All roadside interviews were undertaken over a 12 hour period between 07:00 and 19:00. The sample rate at both roadside interview sites was very high, with both surveys intercepting on average 24% of all traffic passing the survey site in the interviewed eastbound direction.

4.17 Journey times were extracted from Trafficmaster data, which is a GPS-sourced dataset providing detailed information about vehicle movements and their speeds throughout Great Britain. Trafficmaster data representing October 2016 was used to derive observed journey times that align with the month represented in the base year model.

5. Base Year Traffic Model

Time Periods

5.1 The base year traffic model represents October 2016 in line with the 'neutral period' of the year when the majority of surveys were collected. A definition of 'neutral' months can be found in paragraph 3.3.6 of TAG unit M1.2. They are periods of the year when traffic volumes and trip patterns are not affected by school holidays, public holidays or other abnormal events. All Mondays to Thursdays in the month of October are 'neutral' according to this definition.

5.2 The hours represented in this traffic model are 08:00 to 09:00 for the AM peak, an average of the hours between 10:00 and 16:00 for the inter-peak and 17:00 to 18:00 for the PM peak. The modelled hours were derived based on analysis of the traffic counts referred to in Figure 1 in Appendix A of this proof of evidence (WG 1.2.3).

Traveller Types

5.3 Different types of journey are likely to display different characteristics in terms of trip distribution and growth patterns. For this reason, travel demand in the model was split into the following five user classes:

a) Cars – employer's business;
b) Cars – commuting;
c) Cars – other purposes (including leisure, shopping and personal business trips);
d) Light goods vehicles (LGVs); and
e) Heavy goods vehicles (HGVs).

Road Network

5.4 SATURN model networks can comprise either a 'simulation' network, in which the operation of junctions is fully simulated, or a less detailed 'buffer' network, which essentially functions as a more high-level link-based model in which the detailed interactions of vehicles at junctions are ignored. Given the relatively small extent of the model it was possible to represent all of the Scheme Traffic Model as 'simulation' network coding.

5.5 The simulation network includes all junctions along the A40 between the western end of the Whitland Bypass and the B4313 Redstone Cross staggered T-junction. Figure 4.1 of the Local Model Validation Report (Doc. 4.05.02) shows the extent of the base year model network.

5.6 Link lengths were measured using GIS software based on the Integrated Transport Network (ITN) published by Ordnance Survey. Details of junction geometry and layouts were obtained from aerial photography and site visits.

5.7 Network parameters such as saturation flows for turning movements at junctions were based on standard parameter values by junction type. The only exception is the Penblewin Roundabout, for which saturation flows were calculated specifically based on its junction geometry.

Trip Matrices

5.8 Trip matrices contain travel demand data for all origin-destination movements represented within the traffic model. A roadside interview (RSI) survey undertaken on the A40 west of the village of Llanddewi Velfrey was the primary data source used to derive trip patterns within the traffic model. Out of 1,187 interview records collected throughout the day 976 were classed as complete and logical and were carried forward into the trip matrix. Details of the cleaning and checking process applied to the RSI trip records can be found in the Traffic Data Collection Report (Doc. 4.05.04).

5.9 Roadside interview records represent only a sample of the total travel demand and therefore expansion factors are required to rescale the trips to represent the total traffic volume recorded at the survey site. Expansion factors of below 10 are generally targeted in traffic modelling and this has been achieved in all cases. The expansion factors achieved are shown in more detail in Table 4.

5.10 For some time periods and vehicle types the expansion factors are less than 1, which may appear to indicate that the sample of interview records is higher than the total volume of traffic. The explanation for this is that the trip patterns from RSI records from the total peak periods (AM peak: 07:00-10:00, Inter-peak: 10:00-16:00 and PM peak: 16:00-19:00) were used to represent the 1 hour model periods defined in section 5.1, as is standard practice in traffic modelling.

Table 4: Expansion factors calculated in roadside interview processing

Vehicle Type	AM Peak		Inter-peak		PM Peak	
	Interview Direction	Non-Interview	Interview Direction	Non-Interview	Interview Direction	Non-Interview
Car	1.83	2.62	0.78	0.74	3.04	1.93
LGV	1.17	3.67	1.00	0.78	2.41	0.88
HGV	1.13	7.50	1.18	0.88	3.30	1.14

5.11 Some traffic movements relevant to the study area were not captured in the roadside interview survey. Additional seeding of vehicular trips was therefore required for some origin-destination movements. Seeding of unobserved trips was derived based on an analysis of the junction turning counts along the A40 in the study area. The addition of the seeded trips to the expanded RSI site trip matrix produced the 'prior matrix' for input to the model calibration and validation process described from paragraph 5.16 onwards.

Model Convergence

5.12 The traffic model assignment algorithm predicts the routes that drivers will choose and the way in which the traffic demand interacts with the available road capacity. The assignment procedure used for the A40 Llanddewi Velfrey to Penblewin model is referred to as the Wardrop equilibrium assignment for multiple user classes[11]. The principle of this assignment is that traffic arranges itself on the network such that the cost of travel on all routes used between each origin and destination is equal to the minimum cost of travel and all unused routes have equal or greater cost.

5.13 Convergence of the traffic model is required in order to ensure consistent and robust model results. Guidance on the desirable degree

[11] TAG unit M3.1, Highway Assignment Modelling, Department for Transport, Jan 2014 – refer to paragraph 2.7.3

of model convergence is given in WebTAG[12]. The main measure of the convergence of a traffic assignment is the Delta statistic, also referred to as %GAP. This is the difference between the costs along the chosen routes and those along the minimum cost routes, expressed as a percentage of the minimum costs. WebTAG recommends a guideline target for the %GAP value of 0.1% or less.

5.14 In addition, WebTAG recommends that the proportion of links in which the changes in traffic volumes is less than 1% should be at least 98% for four consecutive iterations of the traffic assignment before convergence is reached.

5.15 The model convergence statistics presented in Table 6.2 of the Local Model Validation Report (Doc. 4.05.02) show that the model achieves a convergence level that is significantly better than the recommended target in WebTAG.

Model Calibration

5.16 The first stage of model calibration was to assign the 'prior matrix' onto the road network and to review the resulting warning and error messages produced by the SATURN software. Any issues identified in the network coding or trip matrix were rectified at this stage.

5.17 In addition, a number of separate specific checks were carried out, including:

a) A review of link lengths, speeds and connectivity;
b) A review of junction coding, including junction types, capacities and lane allocations;
c) The checking of the minimum-cost routes through the network for selected traffic movements;

[12] TAG unit M3.1, Highway Assignment Modelling, Department for Transport, Jan 2014 – refer to paragraph 3.3.5 onwards

d) Select link analyses of the origin-destination pattern of trips using key links to identify any implausible movements; and
e) A review of assignment attributes to identify locations of poor convergence, long delays and high volume-to-capacity ratios.

5.18 This checking process provided a high level of assurance that the SATURN network is an accurate representation of the physical layouts and operation of the highway network within the study area.

Matrix Estimation

5.19 The second stage of model calibration was to undertake a process known as 'matrix estimation'. Matrix estimation is a modelling technique that has become a standard feature of the calibration process in most strategic traffic models. Essentially, its purpose is to produce a trip matrix that provides a best fit against available traffic count data.

5.20 The process uses an iterative procedure to find a set of balancing factors for the origin-destination movements on each road link where traffic count data exists, to ensure that the assigned flows match the counts within certain user-defined limits.

5.21 The process of model validation is described in section 5.27 onwards within this proof of evidence. In order to robustly validate the traffic model, it is important that the traffic counts used for validation are not also used in the process of developing the trip matrices. The count data selected for matrix estimation, therefore, has not been used for the validation of the traffic model.

5.22 WebTAG suggests a set of benchmark criteria to be used to review the extent of changes resulting from the matrix estimation process[13] in order to ensure that observed trip patterns are not skewed significantly compared to the 'prior matrix' within the process. The criteria include

[13] Tag unit M3.1, Highway Assignment Modelling, Department for Transport, Jan 2014 – refer to paragraph 8.3.13 onwards

checks of trip end totals and zonal cell values. Table 7.2 of the Local Model Validation Report (Doc. 4.05.02) shows that the majority of statistics fall within the ranges recommended in guidance.

5.23 A few statistics do however fall slightly short of the suggested benchmarks. A likely cause for this is that the matrix estimation process can make changes to small travel demand values that produce relatively large percentage differences when comparing back to the 'prior matrix', even where the absolute change is insignificant. Given the lack of route choice available in the model network, these changes are not considered to have a material impact on distorting observed trip patterns.

5.24 The changes in trip length distribution that result from matrix estimation are shown in Table 7.3 of the Local Model Validation Report (Doc. 4.05.02). The level of change meets the suggested WebTAG benchmarks for all user classes except for HGVs. For HGVs it is relatively commonplace for it to be difficult to achieve good validation without allowing matrix estimation to distort average trip lengths by slightly more than the amount recommended in guidance. This tends to be the consequence of having a relatively low sample for HGVs as a result of the difficulty of stopping and interviewing these large vehicles at roadside interview survey sites. A detailed review of HGV trip patterns was therefore undertaken to provide further assurance that HGV patterns within the base model are realistic.

Traffic Flow Calibration

5.25 A standard method for checking model calibration and validation is to compare observed against modelled traffic flows. Acceptability guidelines on 'goodness of fit' are given in WebTAG[14]. These are presented in terms of percentage or absolute difference in modelled flows and GEH. The GEH statistic is a standard metric used in the

[14] Tag unit M3.1, Highway Assignment Modelling, Department for Transport, Jan 2014 – refer to paragraph 3.2.7 onwards

comparison of modelled and observed flows. Further background about the GEH statistic and guidelines used in comparing modelled and observed traffic volumes is given in section 7.3 of the Local Model Validation Report (Doc. 4.05.02).

5.26 Traffic flow calibration results for the AM peak, inter-peak and PM peak are shown in Tables 7.5 to 7.7 in the Local Model Validation Report (Doc. 4.05.02). The target set out within guidance is that at least 85% of all calibration sites should pass the traffic flow acceptability criteria set out in WebTAG. In the AM peak 47 out of 48 calibration sites (98%) pass the acceptability guidelines. In the other two modelled time period all sites pass the acceptability guidelines. Therefore, the 'goodness of fit' significantly exceeds the standard expected within WebTAG.

Traffic Flow Validation

5.27 Validation is the process of demonstrating the quality of the model by comparing the model output with observed data, which should be independent of data used for model development. Traffic flow validation was carried out on seven links along the A40.

5.28 Tables 8.1 to 8.3 in the Local Model Validation Report (Doc. 4.05.02) provide a comparison between modelled and observed flows at the validation sites, for both total flows and separately for HGVs.

5.29 The results show that every validation link achieved a 100% pass rate against the acceptability guidelines in each time period, both for total traffic volumes and for HGVs. The results therefore indicate that the modelled traffic flows fully satisfy the WebTAG validation criteria in all time periods.

5.30 For ease of reference Appendix B of this proof of evidence (WG 1.2.3) includes a copy of Figure 8.1 from the Local Model Validation Report (Doc. 4.05.02), which illustrates modelled traffic volumes on various sections of the A40 representing the AM peak hour, inter-peak hour, PM peak hour and AADT flow. This demonstrates that traffic flows along the existing A40 between Llanddewi Velfrey and Penblewin show little variation, highlighting the fact that most of the traffic on this road is strategic through traffic that passes all sections of A40 within the study area. Two-way traffic volumes east of Penblewin Roundabout peak at around 1,000 vehicles per hour, with inter-peak volumes lower at around 750 vehicles per hour. AADT flows reach levels of around 11,500 vehicles per day.

Journey Time Validation

5.31 The purpose of journey time validation is to show that the model is correctly replicating journey times on key routes. The WebTAG criterion for journey time comparisons[15] is that the modelled journey times should be within 15% of the observed time (or 1 minute if higher) on at least 85% of routes surveyed.

5.32 Given the limited extent of the study area journey time validation was undertaken on a single eastbound and westbound route along the A40. Table 8.4 of the Local Model Validation Report (Doc. 4.05.02) shows the results of the journey time validation. The journey time routes pass the criterion set out in WebTAG in all three time periods. In most cases the modelled journey times are marginally longer than the observed journey times by up to around 30 seconds or 7.6% of the total journey time, but the discrepancy between modelled and observed is well within the acceptable limits defined in the preceding paragraph 5.31.

Fitness for Purpose

5.33 In summary, this section demonstrates that the Scheme Traffic Model provides a robust representation of observed traffic conditions in the base year and is therefore fit for purpose for the preparation of future year traffic forecasts in order to appraise the proposed Scheme.

[15] Tag unit M3.1, Highway Assignment Modelling, Department for Transport, Jan 2014 – refer to paragraph 3.2.10 onwards

6. Traffic Forecasting

Overview of Methodology

6.1 The projected economic and environmental impacts of the Scheme are based on future year runs of the traffic model. The traffic impact of the Scheme is the difference between two forecasts, the Do Minimum (without the Scheme) and the Do Something (with the Scheme).

6.2 Outputs from the forecast traffic model also form a key input into the environmental appraisal and the Scheme design.

6.3 The Do Minimum scenario consists of the future year traffic conditions in the absence of the proposed section of A40 to the north of Llanddewi Velfrey. In the Do Minimum scenario the speed limits along the A40 are assumed to remain the same as in the existing situation, which is 40mph through Llanddewi Velfrey and 60mph between Llanddewi Velfrey and Penblewin. The only difference between the Do Minimum and the Do Something is that the latter includes the proposed Scheme.

6.4 Three future years have been defined for the traffic model, namely the assumed year of Scheme opening, 2021, a design year which is defined in TA46/97 as the fifteenth year after Scheme opening[16], in this case 2036, and a 'horizon year' of 2051. The 'horizon year' was chosen as 2051 on the basis that no data is available in the Department for Transport's National Trip End Model (NTEM) beyond this year.

6.5 Forecast results are presented for a 'Core Scenario', which represents the most likely central growth forecasts. The forecasts that are described in the Traffic Forecasting Report (Doc. 4.05.03) are fully compliant with WebTAG guidance. They informed the Welsh Government decision to proceed to publication of draft Orders for the Scheme.

[16] Design Manual for Roads and Bridges, Volume 5 Section 1 Part 3, TA 46/97, Traffic Flow Ranges for Use in the Assessment of New Rural Roads, The Welsh Office, Feb 1997 – refer to Chapter 3, Section 3.2

6.6 Sensitivity tests were undertaken on alternative low and high growth future scenarios, to check how alternative growth assumptions impact on traffic volumes and congestion in the future. The impact of low and high growth assumptions on forecast traffic volumes is described in the Traffic Forecasting Report (Doc. 4.05.03). The low and high growth scenarios provide a range around central growth that is large enough to cover local uncertainty such as uncertainty around passenger and freight demand at ferry port in Fishguard or growth in the level of tourism within Pembrokeshire.

6.7 Demand growth over time for car drivers was derived from the National Trip End Model (NTEM) dataset through the Trip End Model Programme (TEMPro) software that presents the NTEM dataset (version 7.2). The NTEM has been developed by the Department for Transport and provides a set of predictions for growth in travel demand at trip end level for a range of different travel modes. The NTEM datasets are long-term forecasts – they represent the Department's estimate of the long-term response to demographic and economic trends.

6.8 Due to the application of a fixed demand approach additional adjustment factors must be applied to the forecast demand matrices to take account of two further considerations which change over time, specifically income and fuel prices as described in WebTAG[17]. These adjustment factors have been extracted from the TAG databook[18].

6.9 The NTEM does not produce growth factors for trips made by goods vehicles, and TAG Unit M4 advises that for modelling vehicle types other than cars in highway models, growth factors derived from the Road Traffic Forecasts (RTF18)[19] should be used. This incorporates the Great Britain Freight Model which expands base HGV data by modelling the effects of macroeconomic variables and changes in generalised cost,

[17] WebTAG unit M4, Forecasting and Uncertainty, Department for Transport, Jan 2014 – refer to paragraph 7.4.13
[18] TAG databook v1.10.1, Department for Transport, Jun 2018
[19] Road Traffic Forecasts (RTF18), Department for Transport, 2018

while LGV traffic is projected using a separate time series model related to changes in the Gross Domestic Product and fuel price.

6.10 The current Local Development Plan published by Pembrokeshire County Council was adopted in February 2013 and covers the period up to 2021(Doc. 4.01.58). The Plan lists only one potential development site within the study area: Housing Allocation ‘HSG/057/LDP/01’ in the village of Llanddewi Velfrey, with potential for 12 new houses.

6.11 In view of the small size of this development, and in line with standard modelling practice, it was considered appropriate not to include it in the traffic model for the purpose of growth in traffic. Trips from the Llanddewi Velfrey zone are therefore assumed to grow in line with the rest of Pembrokeshire. Accordingly, because no specific developments were included in the traffic forecasts, traffic growth factors derived from NTEM and RTF18 were applied directly to the base year travel demand to create the forecast trip matrices.

Traffic Growth

6.12 The Traffic Forecasting Report (Doc. 4.05.03) provides information about the level of growth extracted from NTEM and RTF18 as part of the demand forecasting in Sections 4.2 and 4.3 respectively.

6.13 The resulting forecast trip matrix totals compared against the trip totals within the base year demand matrix are shown in Table 5 below. The traffic growth data shows that relative to 2016 traffic levels are expected to be broadly 7% higher by 2021, 22% higher by 2036 and 34 to 35% higher by 2051. Growth in LGV trips is significantly higher than car growth, whilst growth in HGV trips is significantly lower.

Table 5: Forecast trip matrix totals (in passenger car units)

User Class	2016	2021		2036		2051	
	Trips	Trips	% Growth from 2016	Trips	% Growth from 2016	Trips	% Growth from 2016
AM Peak							
Car, Business	145	155	+7.2%	175	+20.4%	194	+33.8%
Car, Commuting	555	596	+7.3%	666	+20.1%	737	+32.9%
Car, Other	615	658	+7.0%	742	+20.7%	807	+31.1%
LGV	286	317	+10.8%	396	+38.4%	466	+62.9%
HGV	220	223	+1.4%	237	+7.6%	254	+15.3%
Total	**1,821**	**1,949**	**+7.0%**	**2,216**	**+21.7%**	**2,457**	**+34.9%**
Inter-peak							
Car, Business	169	182	+7.5%	203	+20.4%	224	+32.6%
Car, Commuting	151	161	+6.8%	179	+18.8%	196	+29.6%
Car, Other	631	674	+6.9%	764	+21.0%	824	+30.5%
LGV	203	225	+10.8%	281	+38.5%	331	+63.0%
HGV	176	178	+1.3%	189	+7.5%	203	+15.1%
Total	**1,331**	**1,421**	**+6.7%**	**1,617**	**+21.5%**	**1,777**	**+33.5%**
PM Peak							
Car, Business	179	192	+7.2%	215	+20.2%	237	+32.6%
Car, Commuting	415	443	+6.7%	493	+18.9%	540	+30.2%
Car, Other	708	755	+6.6%	851	+20.3%	922	+30.2%
LGV	205	227	+10.6%	283	+38.1%	334	+62.7%
HGV	89	91	+1.8%	96	+8.1%	103	+15.9%
Total	**1,595**	**1,707**	**+7.0%**	**1,939**	**+21.6%**	**2,136**	**+33.9%**

Model Convergence

6.14 As already outlined in the context of the base model in paragraph 5.13 of this proof of evidence, convergence is an important consideration in the traffic model to ensure that outputs are robust.

6.15 In the context of forecasting, there needs to be confidence that any differences reported by the model between a Do Minimum scenario and a Do Something scenario are realistic and the direct result of the proposal, rather than relating to poor levels or differing degrees of model convergence between scenarios (referred to as ‘model noise’).

6.16 The model convergence statistics presented in Table 5.1 and Table 5.2 of the Traffic Forecasting Report (Doc. 4.05.03) show that the model achieves a convergence level that is significantly better than the recommended target in WebTAG[20] in all forecast years and time periods for the Do Minimum and Do Something scenario respectively.

Forecast Traffic Flows

6.17 For ease of reference the forecast Do Minimum and Do Something traffic flows for all three forecast years based on central traffic growth projections are presented in Appendix C of this proof of evidence (WG 1.2.3). They are also included in Appendix A of the Traffic Forecasting Report (Doc. 4.05.03). The equivalent figures for the low and high growth scenarios are included in Appendix B and C of the Traffic Forecasting Report (Doc. 4.05.03).

6.18 The figures show that the Scheme would result in a significant reduction in traffic volumes along the existing A40 through Llanddewi Velfrey as a consequence of all through traffic switching to the proposed section of A40 to the north of the village. For example, in the design year (2036) the amount of AADT passing through Llanddewi Velfrey is forecast to reduce by 96% from an 13,780 to 520 vehicles as shown in in Appendix C (WG 1.2.3).

[20] TAG unit M3.1, Highway Assignment Modelling, Department for Transport, Jan 2014 – refer to paragraph 3.3.5 onwards

Journey Time Savings

6.19 Car journey time savings resulting from the Scheme would be in the order of approximately 20 seconds in the eastbound direction and approximately 10 seconds in the westbound direction. Details by time period and forecast year are given in Table 6.

6.20 HGV journey times would be slightly longer as these are affected by a reduced national speed limit of 50mph, which applies to goods vehicles over 7.5 tonnes on single carriageway roads. However, as this restriction impacts both the Do Minimum and Do Something the journey time savings for HGVs are very similar to those presented for cars.

6.21 Whilst the Scheme is marginally longer than the existing route through Llanddewi Velfrey, the speed limit would be higher on the proposed road and the sections of WS2+1 standard would provide more opportunity to overtake slower moving vehicles. Travel time savings are reduced slightly by new junction delays associated with the proposed roundabout at the Llanddewi Velfrey East junction, the eastern tie-in point of the Scheme with the existing A40. Further discussion of the specific junction arrangement at the eastern tie-in point of the Scheme, its impact on time savings and therefore the economic benefits of the Scheme, is included in paragraph 7.67 of this proof of evidence.

Table 6: Forecast car journey times along A40 (minutes and seconds)

Direction	Year / Scenario	AM Peak	Inter-peak	PM Peak
Eastbound	**2021**			
	Do Minimum	7:22	7:15	7:22
	Core Scenario	7:04	6:58	7:03
	Time Saving	0:18	0:17	0:19
	2036			
	Do Minimum	7:31	7:22	7:31
	Core Scenario	7:12	7:04	7:11
	Time Saving	0:19	0:18	0:20
	2051			
	Do Minimum	7:40	7:29	7:29
	Core Scenario	7:20	7:11	7:11
	Time Saving	0:20	0:18	0:18
Westbound	**2021**			
	Do Minimum	7:20	7:00	7:11
	Core Scenario	7:12	6:55	7:02
	Time Saving	0:08	0:05	0:09
	2036			
	Do Minimum	7:32	7:05	7:19
	Core Scenario	7:23	7:00	7:10
	Time Saving	0:09	0:05	0:09
	2051			
	Do Minimum	7:44	7:11	7:11
	Core Scenario	7:33	7:03	7:03
	Time Saving	0:11	0:08	0:08

Operational Analysis

6.22 The Congestion Reference Flow (CRF) of a link and the term ‘stress factor’ are defined in paragraphs 3.18 to 3.20 of my proof of evidence.

6.23 Results of the ‘stress analysis’ in all three modelled forecast years are shown in Table 7. The AADT flows quoted in this table have been derived from forecast model outputs using annualisation factors derived from traffic counts as described in section 2.5 of the Traffic Forecasting Report (Doc. 4.05.03). The slight variations in CRF values by year and scenario are the result of fluctuations in the percentage of heavy vehicles and the directional split of traffic.

Table 7: Forecast stress analysis of A40 corridor around Llanddewi Velfrey

Location	Do Minimum			Do Something		
	AADT	CRF	Stress Factor	AADT	CRF	Stress Factor
Opening Year: 2021						
A40 Penblewin to Llanddewi Velfrey	12,000	28,900	0.41	12,100	28,900	0.42
A40 through Llanddewi Velfrey	11,800	20,900	0.56	400	15,800	0.03
A40 east of Llanddewi Velfrey	11,800	30,300	0.39	11,800	30,300	0.39
A40 Llanddewi Velfrey bypass	-	-	-	11,400	30,000	0.38
Design Year: 2036						
A40 Penblewin to Llanddewi Velfrey	13,900	28,900	0.48	14,100	28,900	0.49
A40 through Llanddewi Velfrey	13,800	21,000	0.66	500	16,000	0.03
A40 east of Llanddewi Velfrey	13,800	30,400	0.45	13,800	30,400	0.45
A40 Llanddewi Velfrey bypass	-	-	-	13,300	29,900	0.44
Traffic Model Horizon Year: 2051						
A40 Penblewin to Llanddewi Velfrey	15,600	28,700	0.54	15,800	30,200	0.52
A40 through Llanddewi Velfrey	15,500	20,800	0.74	600	17,000	0.03
A40 east of Llanddewi Velfrey	15,500	30,300	0.51	15,500	31,800	0.49
A40 Llanddewi Velfrey bypass	-	-	-	14,900	31,600	0.47

6.24 The results in the table show that all sections of the A40 within the study area operate below the point at which congestion would be expected to start occurring over an average hour. Based on this, the road would be expected to operate under free-flow conditions and journey time reliability issues would be expected to be marginal. The highest 'stress factor' is shown on the stretch of A40 through Llanddewi Velfrey, which reaches a value of 0.74 by 2051.

6.25 However, the CRF analysis does not capture the impact of slow-moving HGVs, agricultural vehicles, campervans or towing vehicles on other road users. Observations in the base year confirm that road users are, at times, held up behind slow-moving vehicles and the occurrence of this would become more frequent as travel demand rises in forecast years.

Public Transport

6.26 Section 3.38 onwards of my proof of evidence refers to the existing public transport services in the study area.

6.27 Bus route 322, which currently serves Llanddewi Velfrey, would continue to do so in forecast years. Eastbound services would access the village by turning right from the proposed A40 onto the existing A40 at the Llanddewi Velfrey West Junction. In turning right from the proposed A40 buses would need to cross traffic travelling along the proposed A40 in the westbound direction. Average delays associated with this turning movement are in the order of less than 10 seconds in the peak hours in the design year (2036). Average delays for traffic re-joining the A40 at the Llanddewi Velfrey East Junction are around 20 seconds.

6.28 In the westbound direction bus service 322 would encounter around 10 seconds delay at the Llanddewi Velfrey East Junction when turning left to access the existing A40 and a further 10 seconds when turning left to re-join the proposed A40 at the Llanddewi Velfrey West Junction.

6.29 However, bus services on route 322 would also benefit from the significant reduction in traffic through the village of Llanddewi Velfrey, which would bring some journey time savings, for example in situations where buses have to wait for a gap in traffic to pull off from a bus bay in the village. This would offset some of the journey time impacts on bus service 322.

6.30 Bus route 430 travels along the A478 and crosses the A40 corridor at Penblewin Roundabout. An upgrade of the existing Penblewin Roundabout is proposed as part of the Scheme. However, turn delays from the northern and southern approach arms used by bus route 430 would be largely unaffected by the Scheme.

7. Economic Appraisal

Overview

7.1 This section of my proof of evidence summarises the principles and results of the cost benefit analysis. The Economic Assessment Report (Doc. 4.05.05) provides further details.

Relevant Guidance

7.2 The economic appraisal of the Scheme is based on a cost benefit analysis. The cost benefit analysis has been undertaken in accordance with WelTAG guidance (Doc. 4.01.11). In relation to technical matters, WelTAG refers the appraiser to WebTAG guidance and data (Doc. 4.01.69). Therefore, in practice, WebTAG is the primary reference document for the cost benefit analysis.

7.3 The WebTAG units relating to the cost benefit analysis are TAG Unit A1.1 (Cost-Benefit Analysis)[21], TAG Unit A1.2 (Scheme Costs)[22] and TAG Unit A1.3 (User and Provider Impacts)[23]. WebTAG also incorporates economic data and parameters which are applied in the cost benefit analysis (referred to as the TAG databook).

Principles of the Economic Appraisal

7.4 The main purpose of the economic appraisal is to provide a measure of the value for money of a transport proposal. The economic appraisal uses ‘cost benefit analysis’ to establish whether the value of the benefits of a scheme justifies its cost.

7.5 Cost benefit analysis is a quantitative assessment of scheme impacts and value for money. It only considers costs and benefits that can be quantified in monetary terms. Comparing the costs and benefits of a

[21] TAG unit A1.1, Cost-Benefit Analysis, Department for Transport, May 2018
[22] TAG unit A1.2, Scheme Costs, Department for Transport, Jul 2017
[23] TAG unit A1.3, User and Provider Impacts, Department for Transport, Mar 2017

scheme allows decision makers to consider whether a scheme is likely to deliver value for money for the taxpayer.

7.6 The value of some impacts or resources can be quantified based on the market price paid for goods and services. For example, changes in fuel costs can be measured directly on the basis of the prices (or forecast prices) faced by users (drivers) per litre of fuel. However, cost benefit analysis also attempts to place a value on impacts which are not associated with a financial transaction and for which markets do not provide prices. In such cases, values are derived from research. The value of journey time savings is the most important example of this. The value of journey time savings is captured irrespective of whether the saving is associated with a financial transaction or financial cost saving, the value of travel time savings experienced by those on leisure trips being a key example of this principle. As such, the economic appraisal is primarily concerned with the change in societal welfare (or 'well-being') as a result of a scheme[24].

7.7 Because the economic appraisal is a quantitative assessment the analysis is focussed on, but not limited to, impacts on the economic efficiency of the transport sector. There may be other costs and benefits that cannot be quantified in monetary terms, such as improvements in journey quality, community severance within Llanddewi Velfrey or health and amenity benefits. Therefore, the economic appraisal is only one aspect of the overall case for investment and needs to be balanced against other environmental and social costs and benefits and should be considered in the context of the overall scheme objectives.

7.8 The cost benefit analysis compares costs and benefits of a situation with the Scheme (the Do Something scenario) against a situation without the Scheme (the Do Minimum scenario).

[24] "Welfare" or "social welfare" is the total well-being of society. It reflects the "utility" of people within society. Although the level of welfare is impossible to measure, it is possible to assess changes resulting of a project or policy.

7.9 The analysis compares costs and benefits that occur over time during the operational phase of the Scheme. An appraisal period is defined for this purpose. The appraisal period is intended to cover the useful life of the asset. In practice, a road construction scheme – so long as maintenance and renewal activity is continued – has an indefinite life. To ensure consistency between projects, a standard appraisal period is defined in WebTAG[25], which extends from the current year (in this case 2018) to a point in time 60 years after the opening of the Scheme (in this case 2080).

7.10 In order to compare streams of costs and benefits that occur at different points in time, values are converted or 'discounted' to a 'present value'. Discounting costs and benefits that occur in the future reflects the fact that, generally, society prefers to receive goods and services sooner rather than later. In other words, people and societies place a greater weight on impacts that occur now rather than in the future. It should be noted that discounting is a separate concept to inflation (changes in the price of goods and services over time).

7.11 The discount rate which is used to convert all costs and benefits to a consistent base year is the HM Treasury Green Book discount rate (also known as the social time preference rate)[26]. This rate is applied in the appraisal of projects across all areas of public policy in the UK. In accordance with WebTAG, all values are converted to 2010 values[27]. The choice of the year 2010 is largely arbitrary. It is set by the Department for Transport and ensures consistency with other transport investments in the UK.

7.12 Given that the cost benefit analysis compares costs and benefits that accrue at different points in time, it is also necessary to account for the

[25] TAG unit A1.1, Cost-Benefit Analysis, Department for Transport, May 2018 – refer to paragraph 2.3.3
[26] The Green Book, Central Government Guidance on Appraisal and Evaluation, HM Treasury, 2018 – refer to Table 8
[27] TAG unit A1.1, Cost-Benefit Analysis, Department for Transport, May 2018 – refer to paragraph 2.7.6

effects of inflation. The effect of inflation is to increase the price of goods and services over time. To account for changes in price levels, all values are expressed in real terms by converting to a consistent price base. In accordance with WebTAG, all monetary values are expressed in 2010 prices[28]. The purpose of using a defined price base is to ensure consistency across the assessment of different transport schemes, but the choice of the base year has a neutral impact on the relativity between costs and benefits.

7.13 A further adjustment to the monetary values is applied to ensure that all costs and benefits are compared on a consistent basis. This adjustment ensures that all values are expressed in the same 'unit of account'. Such an adjustment is required because indirect taxation (taxes and subsidies levied on goods and services rather than on incomes or profits) creates two possible units of account: market prices (values including or gross of indirect tax) and factor cost (values excluding or net of indirect tax). Whether costs and benefits are expressed in market prices or in factor cost has no material impact on the economic appraisal, but it is necessary to use a consistent unit of account for all costs and benefits.

7.14 As set out in WebTAG it is customary in transport appraisal to express all values in the market prices unit of account[29]. To achieve this, values which are measured net of tax (i.e. in factor cost) are converted to market prices by applying the 'indirect tax correction factor' which is given in WebTAG[30]. This factor is the average rate of indirect taxation in the economy, which is currently 1.19.

[28] TAG unit A1.1, Cost-Benefit Analysis, Department for Transport, May 2018 – refer to paragraph 2.6.3
[29] TAG unit A1.1, Cost-Benefit Analysis, Department for Transport, May 2018 – refer to paragraph 3.1.1
[30] TAG databook v1.10.1, Department for Transport, Jun 2018

Primary Outputs of the Economic Appraisal

7.15 As noted, the purpose of the economic appraisal is to quantify a range of impacts of the Scheme such that the costs and benefits of the investment can be compared. The present value of benefits (PVB) of the Scheme is the total of all discounted benefits over the appraisal period. The present value of costs (PVC) of the Scheme is the total of all discounted costs of the Scheme over the appraisal period.

7.16 Two key measures are used to summarise the results of the cost benefit analysis. Firstly, the Net Present Value (NPV) is the difference between the PVB and the PVC. In essence, the NPV is the sum of all costs and benefits. If the NPV is a positive number, this indicates that the benefits of the Scheme outweigh its costs.

7.17 The benefit-to-cost ratio (BCR) is calculated as the benefits divided by costs. If this is in excess of 1 it indicates that the benefits of the Scheme outweigh its costs. The higher the BCR, the more efficient the transport investment and the greater the value for money.

7.18 There are no precise rules for assessing the extent to which the value of the BCR indicates that the Scheme offers good value for money for the taxpayer, although there is a clear distinction between schemes for which the BCR is substantially less than 1 and schemes for which the BCR is substantially in excess of 1.

7.19 As noted, not all costs and benefits of the Scheme can be quantified and monetised. Therefore, the BCR should be interpreted on the basis of the impacts that are captured within it.

7.20 Benefits relating to the 'economic efficiency' of the transport system are presented in the form of a Transport Economic Efficiency (TEE) table This is included as Table D.1 in Appendix D of this proof of evidence (WG 1.2.3). The term 'benefits' is applied to a specific set of impacts and is applied consistently whether such impacts are positive or negative (i.e. dis-benefits). These benefits are made up of the following:

a) User benefits;
b) Journey time savings;
c) Vehicle operating cost savings;
d) User charges, such as tolls (not applicable for this Scheme);
e) Additional costs to travellers due to disruption during construction and maintenance works (not applicable for this Scheme – see paragraph 7.40 onwards).

7.21 Costs faced by Government (either local or central) to implement the Scheme are presented in the Public Accounts (PA) table. This is included as Table D.2 in Appendix D of this proof of evidence (WG 1.2.3). They include the following:

a) Operating costs;
b) Investment costs (or maintenance costs);
c) Revenue (not applicable for this Scheme);
d) Developer and other contributions (not applicable for this Scheme); and
e) Grant/subsidy payments (not applicable for this Scheme).

7.22 The overall cost benefit analysis is presented in the Analysis of Monetised Costs and Benefits (AMCB) table. This is included as Table D.3 in Appendix D of this proof of evidence (WG 1.2.3). The AMCB table also includes benefits or impacts due to changes in greenhouse gas emissions, and changes in the rate of accidents.

7.23 Impacts on wider public finances are also included in the AMCB table and are included as a benefit of the Scheme. This relates to changes in tax revenues as a result of the Scheme. Changes in tax revenues are directly linked to changes in fuel expenditure, which is a function of speed and distance of travel.

7.24 The economic appraisal for the Scheme excludes consideration of any wider economic benefits, termed 'Wider Impacts' in WebTAG guidance[31]. Such impacts can occur as an 'indirect' result of the Scheme and are additional to the 'direct' transport user benefits captured in the Transport Economic Efficiency analysis. Given the relatively limited extent of travel time savings projected by the Scheme it was judged that Wider Impacts would be negligible and therefore not worthwhile quantifying as part of the economic appraisal.

Benefits during Operation

7.25 User benefits during operation are comprised of journey time savings, vehicle operating costs and (where relevant) user charges.

7.26 The calculation of user benefits has been undertaken using TUBA (Transport User Benefit Appraisal) software. TUBA software has been produced by the Department for Transport to carry out economic appraisals specifically for transport schemes. The software uses data taken from the Scheme Traffic Model forecasts on the number of trips, average journey times and average distances for each origin-destination movement represented within the model to calculate journey time and vehicle operating cost savings.

7.27 TUBA software (version 1.9.12) has been used to undertake the economic appraisal of the Scheme. This version of the TUBA software is based on economic data and parameters included in the TAG databook (version 1.11.1) published in December 2018. Inputs to the TUBA economic appraisal were prepared in accordance with the TUBA Manual[32].

[31] TAG unit A2.1, Wider Economic Impacts Appraisal, Department for Transport, May 2018
[32] Transport User Benefits Appraisal (TUBA), User Manual, Version 1.9.12, Department for Transport, Jan 2019

7.28 Demand, journey time and trip distances were extracted from the Scheme Traffic Model for each of the five user classes which are represented in the traffic assignments as defined in section 5.3.

7.29 As identified in section 5.1, the traffic model is based on three modelled periods: AM peak hour (08:00 to 09:00), PM peak hour (17:00 to 18:00) and Interpeak hour (an average hour representing the period from 10:00 to 16:00). It is necessary to apply factors to convert the traffic model outputs from the modelled time periods to represent daily and annual values. Such factors are termed annualisation factors and are derived from traffic count data along the A40 within the study area. Traffic model outputs from the single hour AM and PM peak models have been expanded to represent the full three hour AM and PM peak periods (07:00 to 10:00 and 16:00 to 19:00 respectively) based on the ratio of traffic volumes in the full peak period to traffic volumes in the modelled hour. A similar process has been applied to convert Interpeak model outputs to represent off-peak and weekend periods.

7.30 Traffic forecasts have been prepared for the years 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. The year 2051 is the last year for which traffic growth factors are published by the Department for Transport within TEMPro. From 2051 onwards, it is assumed that there is no change in traffic patterns or volumes and so the impact of the Scheme on travel times and distances are fixed. Assuming fixed demand and benefits after 2051 is a simplifying assumption which may result in the long-term benefits of the Scheme being slightly underestimated.

7.31 Travel costs for road users comprise both the financial costs in relation to fuel costs and other vehicle operating costs, and the opportunity cost of lost time spent in transit[33].

7.32 Vehicle operating costs are made up of two elements:

a) Fuel costs; and
b) Non-fuel vehicle operating costs.

7.33 Fuel consumption rates are a function of both distance travelled and average speeds. Fuel consumption rates are defined for cars (petrol, diesel or electric), LGVs (petrol, diesel or electric), OGV1 and OGV2 and provided in the WebTAG databook. The proportion of cars and LGVs assumed to be using petrol fuel, diesel fuel or electric propulsion are also defined within WebTAG and these proportions are forecast to change over time. Adjustments are made to fuel consumption rates in each year of the appraisal up to 2050 to account for forecast vehicle fuel efficiency improvements. From 2050 onwards, no further data is provided in the WebTAG databook, therefore fuel consumption rates are held constant for the remainder of the appraisal period. Fuel and electricity prices are also defined within TUBA and are based on the WebTAG databook.

7.34 Non-fuel vehicle operating costs comprise vehicle wear and tear including oil, tyres, maintenance and depreciation. Non-fuel vehicle operating costs are calculated for each user class based on both distance travelled and time spent travelling using a formula contained within the TUBA software. Non-fuel vehicle operating cost parameters are similarly based on the WebTAG databook.

[33] Opportunity cost refers to a benefit that a person could have received, but gave up, to take another course of action. In this context, the opportunity cost of the time spent travelling is the benefit that an individual or business would have enjoyed had that time been spent doing something else.

7.35 Time related journey costs are calculated by applying standard values of travel time saving (referred to as values of time) which are published in the TAG databook. WebTAG values of time are provided for work (employer's business and freight) and non-work journey purposes (commute and other, such as leisure, shopping or personal business trips).

7.36 Values of time in WebTAG are per person values. TUBA includes assumptions on vehicle occupancy rates by user class which are used to convert the vehicle-hours extracted from the assignment model to person-hours.

7.37 TUBA calculates user benefits on the basis of the theory of consumer surplus and the concept of 'willingness to pay'. The consumer surplus is defined as the benefit that the consumer (in this case the transport user) enjoys, in excess of the costs which he or she perceives (in relation to financial and time costs). At a given level of travel cost, there is a difference between what users would be willing to pay (in practical terms, the costs that users would be willing to incur) and what they actually pay.

7.38 In overall terms, the effect of the Scheme is to reduce the costs of travel, primarily as a result of lower travel times. For existing users, the change in consumer surplus is equal to the change in the costs of travel between a particular origin and destination. For new users, the change in consumer surplus would be the difference between the costs they would be willing to pay and the costs that they actually incur following the improvement. However, as discussed in paragraphs 4.11 and 4.12, the extent of time savings provided by the Scheme is small and consequently there would be no new users (referred to as induced traffic) resulting from the Scheme.

7.39 The Scheme Traffic 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 incidents may have occurred, which may result in severe reduction in network performance. In such instances, the improved network resilience and capacity offered by the Scheme would minimise the disruption caused by the incident and reduce the additional costs imposed on the travelling public, resulting in a net economic benefit. Such benefits are not included in the quantified economic appraisal of the Scheme.

Impacts during Construction and Maintenance

7.40 Traffic management during construction and maintenance works tend to result in changes in journey times and vehicle operating costs. These impacts should be considered in the economic appraisal for a scheme if they are judged to be material.

7.41 Most of the Scheme would be constructed offline, so that the only impact of construction works on traffic movements would take place at the tie-in points east of Llanddewi Velfrey and at Penblewin Roundabout. The traffic management associated with the construction of these tie-ins would be relatively minor and would take place largely in the off-peak period when traffic volumes are low. There is also a short section of online works through the Ffynnon Area. This would be dealt with in a similar manner to that of the tie-in works. Construction works would therefore result in negligible dis-benefits to traffic travelling on this section of the highway network, which is the rationale for excluding impacts during construction from the economic appraisal.

7.42 In addition to the construction phase, the economic appraisal should consider the disruption during maintenance of both the proposed road and the existing road during the 60-year appraisal period if this is judged to be material.

7.43 Maintenance impacts typically lead to positive net benefits because in the Do Something scenario the existing road can be used a diversionary route during maintenance works on the proposed road and vice versa. In the Do Minimum scenario maintenance works, such as resurfacing, would be more disruptive due to the lack of nearby diversionary routes. However, the scale of these additional benefits resulting from an analysis of future maintenance cycles would be small and the extent of analysis required to quantify these would be disproportionate to their overall contribution of the economic case. Maintenance benefits have therefore been omitted from the economic appraisal for this Scheme.

Safety Impacts

7.44 The safety impacts of the Scheme have been assessed quantitatively and monetised to be incorporated into the overall economic appraisal for the Scheme. Accident saving benefits have been calculated using COBA-LT (Cost and Benefit to Accidents – Light Touch[34]), a software tool developed by the Department for Transport to undertake the analysis of the impacts on accidents as part of the economic appraisal of road schemes.

7.45 COBA-LT compares accidents by severity and associated injury and damage costs across the network in the Do Minimum scenario with those in the Do Something scenario, using details of link and junction characteristics and forecast traffic volumes. The assessment covers the same 60-year operational phase of the Scheme as used in the calculation of operational benefits. Monetised impacts are calculated based on the average costs of accidents by severity and road class. In addition to the casualty costs, the total costs of accidents include components associated with damage to property, insurance administration, police time, together with an allowance for damage-only accidents.

7.46 WebTAG also provides default national accident rates (average accidents per million vehicle kilometres) for a range of different carriageway types. The Llanddewi Velfrey to Penblewin Improvements

[34] COBA-LT User Guide, Version 2013.02, Department for Transport, Nov 2015

include a significant proportion of WS2+1 sections of road, that is, three-lane single carriageway links, comprising two lanes in one direction and one in the opposite direction. These sections facilitate safe overtaking, thereby increasing journey time reliability, reducing driver stress and reducing the likelihood of head-on collisions, which tend to result in high severity of casualties due to the high speed nature of these accidents. This type of road, however, is not distinguished from the standard two-lane single carriageway in the default national accident rates provided in the WebTAG databook.

7.47 Accordingly, accident rates for the COBA-LT assessment were derived from observed local 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 by road type, namely: Single 2-lane carriageway (30/40 mph) sections, Single 2-lane carriageway (50/60 mph) and WS2+1 carriageway (50/60 mph).

7.48 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 national default accident 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 only Llanddewi Velfrey to Penblewin) using accident and traffic flow data for the 10-year period between 2006 and 2015. One of the key drivers for this was the requirement to obtain a representative accident rate for the WS2+1 road standard. The resulting average accident rates are shown in Table 2.5 of the Economic Assessment Report (Doc. 4.05.05).

7.49 Under central growth assumptions the accident analysis forecasts a saving of 41 personal injury accidents resulting in 51 fewer casualties over the 60-year appraisal period. The total monetised accident savings amount to £1.39m.

Indirect Taxation

7.50 The appraisal captures indirect tax revenues to Central Government through, for example, changes in fuel duty that result from the Scheme. In accordance with standard practice, impacts on indirect tax revenue are included as part of the overall Scheme benefits.

Greenhouse Gases

7.51 The social cost of changes in greenhouse gas emissions are included in the economic appraisal. Greenhouse gas emissions were monetised in accordance with WebTAG[35], employing 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 the study area defined for the traffic model. This is referred to as user greenhouse gas emissions impacts within the proof of evidence of Tom Edwards (WG 1.3.2). Further information regarding the approach to modelling greenhouse gas emission impacts is provided in Chapter 18 of the Environmental Statement (Doc. 3.18.01).

7.52 The economic appraisal considers only user greenhouse gas emissions and does not include any greenhouse gas emissions during the construction phase or operational greenhouse gas emissions, which includes the impacts of maintenance and street lighting. This is considered a proportionate approach in the context of the economic appraisal given that many of the sources of greenhouse gas emissions during the construction phase are covered by the European Emissions Trading Scheme.

[35] TAG unit A.3, Environmental Impact Appraisal, Department for Transport, Dec 2015 – refer to Chapter 4

7.53 The Scheme generates an increase in emissions due to an increase in traffic speeds, as well as a small increase in the distance that through traffic on the A40 has to travel as a result of the bypass.

Air Quality Impacts

7.54 The assessment of air quality impacts employs the methodology set out in WebTAG[36] and the Air Quality Valuation Workbook. Further information regarding the approach to modelling air quality impacts is provided in Chapter 13 of the Environmental Statement (Doc. 3.13.01) and in the proof of evidence of Andrew Sumner (WG 1.4.2).

7.55 The effect of the Scheme is to reduce particulate (PM10) 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 NOx emissions. The overall balance of these two impacts is positive.

Noise Impacts

7.56 WebTAG provides a framework for monetising the benefits of reducing noise exposure to traffic for households[37]. A model has been constructed to simulate changes in noise levels as a result of the Scheme and is described in Chapter 14 of the Environmental Statement (Doc. 3.14.01). More information is included in the proof of evidence of David Hiller (Doc. 1.6.2).

7.57 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.

[36] TAG unit A.3, Environmental Impact Appraisal, Department for Transport, Dec 2015 – refer to Chapter 3
[37] TAG unit A.3, Environmental Impact Appraisal, Department for Transport, Dec 2015 – refer to Chapter 2

Calculation of Scheme Costs

7.58 Scheme costs used in the economic appraisal are set out in Table 8. Scheme costs are adjusted for risk of cost overrun based on a Quantified Cost Risk Assessment (QCRA). The purpose of the QCRA is to adjust the cost estimate for the identifiable factors that could result in an overspend relative to the base cost estimate. The QCRA is an extension of the Risk Register for the Scheme. For each identified risk, an assessment has been made of the impact of the risk on the Scheme costs and the likelihood of the risk occurring. The product of these assessments is the expected value of risk for the Scheme.

7.59 A further adjustment to the Scheme costs is made to allow for Optimism Bias. Optimism Bias is required to be applied to public sector project scheme cost estimates to adjust for a systematic historical tendency to underestimate project costs. Optimism Bias can be interpreted as an allowance for risks that cannot be reasonably predicted and are therefore not necessarily captured by the QCRA.

7.60 WebTAG[38] provides default Optimism Bias uplift factors based on empirical evidence on the difference between estimated scheme costs and outturn costs for past highways schemes in the UK. The uplift applied to a scheme is based on empirical evidence and the specific characteristics of the scheme in question. Such characteristics include the type of project and the degree of complexity, the stage of development of the scheme, the quality of the risk assessment and the degree to which the likelihood of Optimism Bias has been mitigated. The process for determining the appropriate uplift factor for a scheme is set out in Supplementary Green Book Guidance: Optimism Bias[39]. Based on this methodology an Optimism Bias of 15.2% was calculated.

[38] TAG Unit A1.2, Scheme Costs, Department for Transport, Jul 2017
[39] Supplementary Green Book Guidance: Optimism Bias, HM Treasury, Apr 2013

7.61 In 2018 prices, the total Scheme cost applied in the cost benefit analysis is £39.5m as shown in Table 8. Costs associated with VAT are excluded because the proposal is a public sector scheme, so that the VAT which is payable is regarded as an internal Government transfer and has a neutral impact in respect of economic efficiency.

7.62 Costs are assumed to be incurred during the period 2018 to 2022, based on the predicted expenditure profile for the Scheme. Most of the expenditure (around 88% of construction costs) is incurred in the years 2020 and 2021.

Table 8: Scheme costs (2018 prices excluding VAT)

	Elements of the Scheme Costs	**Cost (£000s)**
(a)	Key Stage 6 Detailed Design & Construction Statutory Undertakers Costs	£24,351 £2,140
(b)	Key Stage 4 Design	£765
(c)	Welsh Government Expenditure Employer's Agent	£1,775 £1,602
(d)	Land Costs	£2,863
(e)	Risk Allowance	£2,285
(f)	Optimism Bias	£3,701
	Sub-Totals: **Construction** (a)+(e)+(f) **Preparation** (b) **Supervision** (c) **Land** (d)	 £32,477 £765 £3,377 £2,863
	TOTAL	**£39,482**

Economic Appraisal Results

7.63 The results of the economic appraisal are presented in Table 9. The total discounted costs (PVC) of the Scheme are £29m (in 2010 prices and values). The total discounted benefits (PVB) of the Scheme are £3.7m (in 2010 prices and values). The difference between benefits and costs (the NPV for the Scheme) is -£25.2m resulting in a BCR for the Scheme of 0.13. Whilst this indicates a poor economic case, there are a number of benefits that cannot be quantified as part of the economic appraisal as described from paragraph 7.74 onwards.

Table 9: Summary of economic appraisal (central growth)

Components of the Economic Appraisal		**Results (£000s) (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		**£3,742**
Present Value of Costs, PVC		**£28,957**
Net Present Value, NPV		**-£25,215**
Benefit-to-Cost Ratio, BCR		**0.13**

Sensitivity Analysis

7.64 In addition to the central traffic growth forecasts, sensitivity tests were carried out for low and high growth scenarios. The derivation of these forecasts is detailed in section 6 of this evidence. The results of the economic appraisal for these forecasts based on alternative growth assumptions are summarised in Table 10.

7.65 Under a low traffic growth scenario, the benefits of the Scheme are reduced such that the BCR for the Scheme reduces to 0.10. Under the high growth scenario the BCR for the Scheme increases to 0.16.

Table 10: Summary of economic appraisal (low and high growth)

		Results (£000s) (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		**£2,916**	**£4,729**
Present Value of Costs, PVC		**£28,957**	**£28,957**
Net Present Value, NPV		**-£26,041**	**-£24,228**
Benefit-to-Cost Ratio, BCR		**0.10**	**0.16**

7.66 Aside from the sensitivity tests related to the traffic growth, two further sensitivity tests were undertaken in order to assess the impact of possible alternative future road network configurations.

7.67 The first additional sensitivity test was undertaken to assess the impact of an alternative scheme design. The proposed Scheme includes a roundabout at the Llanddewi Velfrey East Junction. This has a negative impact on travel time savings as it introduces additional delay to through traffic travelling along the A40 compared to a staggered T-junction in its place.

7.68 Whilst a staggered T-junction is compliant with design standards in the DMRB, a roundabout was instead adopted in the Core Scenario on the basis of the levels of support for it following public engagement as documented in the proof of evidence of Tom Edwards (WG 1.3.2). His proof of evidence also highlights the benefits of a roundabout. An additional benefit of the roundabout in traffic operational terms is that it facilitates easier movements of traffic from Llanddewi Velfrey turning right onto the eastbound A40, because vehicles making this manoeuvre only need to give way to traffic travelling westbound along the A40.

7.69 The economic appraisal results of this alternative scheme option show that user benefits would be around 3 times as high as the Core Scenario, indicating that the BCR would be in the order of 0.4. This illustrates that the BCR is very sensitive to relatively small changes in the Scheme design.

7.70 A second sensitivity test was undertaken with the impact of traffic on local communities in mind. Feedback received from local residents at public engagement events has been that they consider that traffic has a negative impact on their quality of life and that there are safety issues with the road as it stands.

7.71 In the absence of the Scheme, a possible alternative measure to improve safety would be to reduce traffic speeds through Llanddewi Velfrey and between the village and Penblewin, although no such proposal has currently been put forward by the Welsh Government. Lower traffic speeds would improve safety at the Penblewin rest area junction and within the village of Llanddewi Velfrey, but would do little to address severance as the volume of traffic passing through the village would not be affected. It should be noted that this is not being put forward as an alternative to the Scheme, but rather as a measure that may have to be implemented if the Scheme does not go ahead and therefore would affect the assumptions applicable in the Do Minimum scenario.

7.72 We have therefore tested an alternative Do Minimum scenario in which the speed limit is reduced to 50mph between Penblewin and Llanddewi Velfrey and to 30mph through the village. Under the Do Something scenario we have assumed that the speed limit on the proposed section of road would remain at 60mph as the highway would be built to modern standards and the traffic would not be passing through the village.

7.73 When we compare the Scheme against this alternative Do Minimum it results in a significantly better economic case for the Scheme. This is because journey time savings would be significantly improved by more than 60 seconds as a result of the lower speeds in the alternative Do Minimum. The result of this would be broadly a fivefold increase in benefits and a BCR of around 0.6, illustrating the sensitivity of the economic case to the speed limit.

Overview of Other Non-Monetised Impacts

7.74 As noted, in paragraph 7.7 the economic appraisal can only include 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 in the following sections.

Journey Time Reliability

7.75 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 or accidents. It is distinct from the predictable variation relating to varying levels of demand by time of day or 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 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.

7.76 The section of A40 around Llanddewi Velfrey is prone to unreliable journey times due to the limited overtaking opportunities on this section. The speed of slow-moving vehicles can vary considerably between agricultural vehicles, HGVs and vehicles towing caravans. Slow-moving vehicles can have a particularly strong impact on journey time variability on the section between Llanddewi Velfrey and Penblewin, due to the low speed of slow-moving vehicles relative to the 60mph speed limit.

Detailed Impact of Additional Overtaking Opportunities

7.77 TD70/08[40] includes reference to the traffic modelling and economic appraisal process recommended specifically for WS2+1 roads.

7.78 Traditional traffic assignment models are often referred to as “macroscopic”, reflecting that they operate on the principle of average hourly traffic flows and speed / flow relationships. Macroscopic models, such as the SATURN traffic model developed for this Scheme, capture the broad time savings expected to result from an upgrade to WS2+1. However, they are not well suited to simulate the detailed build up and dispersal of vehicle platoons, which is an important consideration in the economic appraisal of WS2+1 roads.

7.79 Microsimulation models are an alternative type of traffic model that represent the detail of individual vehicles and therefore improve the granularity compared to strategic models. Microsimulation modelling is therefore able to provide an accurate representation of platoon formation on the approaches to WS2+1 roads. It also better captures the interaction between faster and slower-moving vehicles during overtaking manoeuvres and the formation of new platoons downstream of the dedicated overtaking section.

7.80 In the context of WS2+1 roads, the PEARS (Program for the Economic Assessment of Road Schemes) software has been developed by Transport Scotland and is currently only approved for use in Scotland. Its application elsewhere in the UK is subject to the approval of the appropriate Overseeing Organisation and the Department for Transport. Microsimulation modelling and a PEARS assessment was therefore not undertaken for the Scheme.

[40] Design Manual for Roads and Bridges, Volume 6, Section 1, Part 4, Chapter 7, TD70/08, Design of Wide Single 2+1 Roads, Dec 2010

7.81 The method outlined in this section would be likely to capture additional benefits related to platooning and overtaking manoeuvres that are not fully captured in the SATURN traffic model.

Seasonality and Periods of High Traffic Demand

7.82 The Initial Traffic and Accident Data Report (Doc. 4.05.01) outlines the monthly variations in traffic volumes. The month of August typically experiences the highest traffic volumes, some 23% higher than the AADT.

7.83 For limited periods of time or parts of the year, this may result in a reduction in traffic speeds. Concerns about poor journey time reliability during summer months were highlighted by businesses that responded to a business survey undertaken in 2015. This is described in the 'Economic Activity and Location Impact' (EALI) study undertaken by Peter Brett Associates on behalf of the Welsh Government[41] (Doc. 4.02.11).

7.84 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 Stress and Frustration

7.85 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.

[41] A40 St Clears to Haverfordwest, Economic Activity & Location Impacts (EALI) Study, Peter Brett, Jun 2015 – refer to paragraph 5.9.3

Freight

7.86 As described in paragraph 3.1 the A40 corridor is critical to the Welsh economy in facilitating freight movements connecting to the ferry port at Fishguard. Whilst the impact of the Scheme on goods vehicles and their drivers is captured in the appraisal undertaken, any related benefits resulting from faster movement of freight have not been captured because they were considered to be small.

Wider Economic Benefits

7.87 The EALI (Doc. 4.02.11) referred to in paragraph 7.83 identified a number of mechanisms through which improvements to the A40 could deliver economic benefits. These were as follows:

a) Widening the labour market;
b) Population retention and immigration;
c) Improved business performance;
d) Scheduling benefits;
e) Perceptions of remoteness;
f) Inward investment;
g) Enhanced prospects for the Enterprise Zone;
h) Increased residential development;
i) Increased trade; and
j) Improved strategic rail access.

7.88 In respect of any potential 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 Pembrokeshire or Wales but do not represent a benefit to the UK economy overall.

7.89 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 businesses. Agglomeration effects are essentially an urban phenomenon. Given the rural nature of the A40, undertaking an assessment of agglomeration effects was not considered to be appropriate. In my judgement the inclusion of wider impact would have only had a small impact on the overall scale of benefits resulting from the Scheme.

Other Environmental and Social Impacts

7.90 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 vehicular 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. These include improvements in journey quality, community severance within Llanddewi Velfrey and associated health and amenity benefits.

8. Responses to Objections

8.1 Individuals and organisations have submitted objections to the draft Orders in accordance with the statutory process.

8.2 Whilst the Welsh Government and its project team has considered all of the responses, I address only the general objections that are relevant to traffic and economic issues in this section of my proof of evidence.

Induced Traffic

8.3 A point of objection raised by Mr Thomas Wheeler (R0015) is that the Scheme would induce traffic. He also states that the traffic induced by the Scheme could increase congestion further east along the A40, A48 and M4.

8.4 I have explained in paragraphs 4.11 and 4.12 of my proof of evidence that the Scheme would not induce any traffic and I have provided a rationale for this assumption.

8.5 At the time of writing my evidence, Mr Thomas Wheeler was maintaining this point of objection.

Impacts on Modal Shift

8.6 A further point of objection raised by Mr Thomas Wheeler (R0015) is that the Scheme would disadvantage rail and bus relative to cars due to the improvements to car journey times as a result of the Scheme.

8.7 I have provided information about the projected forecast journey time savings in Table 6. This shows that the maximum forecast journey time saving, experienced by eastbound traffic, would be 20 seconds. Such a small scale of change in journey times would have a negligible impact on modal shift.

8.8 At the time of writing my evidence, Mr Thomas Wheeler was maintaining this point of objection.

Impacts on Bus Delays

8.9 A further point of objection raised by Mr Thomas Wheeler (R0015) is that the Scheme may impact on bus journey time reliability. He refers specifically to the example of eastbound buses having to cross westbound traffic along the A40 to access Llanddewi Velfrey at the Llanddewi Velfrey West Junction.

8.10 I have provided information about how bus journey times would be impacted as a result of the Scheme in paragraphs 6.26 to 6.30. These sections show that, even during the peaks in the design year of the Scheme (2036), average delays for the specific turning movement referred to in the objection would be less than 10 seconds. Delays of this scale would not have a detrimental impact on journey time reliability.

8.11 Mr Wheeler also refers to his personal experience of bus delays of over 10 minutes for buses turning right onto the A40.

8.12 The only new right turn onto the A40 would apply to bus service 322 leaving Llanddewi Velfrey in an eastbound direction. This right turn would be carried out at the roundabout at the Llanddewi Velfrey East Junction. Even during the peaks in the design year of the Scheme (2036), average delays for this turning movement would not exceed 20 seconds. This is an average value and there will be some small fluctuation around the average, but any concerns about delays in the order of 10 minutes are unfounded in this context.

8.13 At the time of writing my evidence, Mr Thomas Wheeler was maintaining these points of objection.

Safety Issues

8.14 In his objection Mr Thomas Wheeler (R0015) states that there do not appear to be any significant safety issues on this section of A40, except on the section through Llanddewi Velfrey. The same concerns are highlighted in a separate objection by Pembrokeshire Friends of the Earth (R0040).

8.15 I have provided information about the recent accident record in paragraphs 3.34 to 3.37. Between 2006 and 2015 there were 22 accidents that occurred on the stretch of A40 that would be bypassed by the Scheme. The number of accidents that occurred between Llanddewi Velfrey and Penblewin (13) was higher than the number of accidents that occurred within the 40mph speed limit in Llanddewi Velfrey (9).

8.16 At the time of writing my evidence, Mr Thomas Wheeler and Pembrokeshire Friends of the Earth were maintaining this point of objection.

8.17 In a separate objection related to safety issues Mr Jeff Jenkins (R0016) highlights the fact that the road has had no fatalities.

8.18 Whilst this statement is factually correct when examining accident data over the last decade, any accident that can be avoided, whether it leads to damage only, or slight, severe or fatal injuries, has to be given due consideration in the accident analysis.

8.19 WS2+1 roads are shown to be safer than standard single carriageway roads. Therefore, the COBA-LT analysis shows that the number of accidents with the Scheme in place would reduce by 41 and the number of casualties would reduce by 51 over the 60-year appraisal period with the Scheme. This is explained in paragraphs 7.45 to 7.49.

8.20 At the time of writing my evidence, Mr Jeff Jenkins was maintaining this point of objection.

8.21 Mrs Moira Rowlands (R0060) has also submitted an objection to the Scheme highlighting concerns about the safety record of WS2+1 roads, with specific reference to the recent nearby A477 improvements.

8.22 My response to these concerns is covered by paragraph 8.19.

8.23 At the time of writing my evidence, Mrs Moira Rowlands was maintaining this point of objection.

Loss of Trade

8.24 In his objection Mr Jeff Jenkins (R0016) states that the Scheme would have a detrimental impact on Preseli Service Station due to the loss of passing trade. He comments that he would have no option but to close his business. Related objections concerning loss of trade to Preseli Service station have been submitted by Mr John & Mrs Linda Smith (R0028) and by Mrs Sally Amoore (R0069).

8.25 Preseli Service Station is located within the village of Llanddewi Velfrey with direct access off the A40 trunk road. The proposals for the A40 Llanddewi Velfrey to Penblewin Improvements include a northern bypass of the village of Llanddewi Velfrey. Therefore, if the Scheme was to proceed, the Preseli Service Station would be bypassed by the proposals and would no longer have direct access to the A40 trunk road.

8.26 Should the Scheme proceed, access to Llanddewi Velfrey from the A40 trunk road would be retained for both the local community and other motorists who wish to use local facilities by the provision of the following:

a) a roundabout at the eastern end of the village;
b) a major/minor priority junction at the western end of the village.

8.27 The loss of passing trade would be mitigated by an appropriate signage strategy. More information on the signage strategy is provided in the proof of evidence of Tom Edwards (WG 1.3.2).

8.28 Whilst I am unable to comment on whether the business would remain viable, it may benefit from the reduced traffic levels that would improve accessibility for those within the local community.

8.29 There is also a nearby similar example to refer to as a point of reference. The improvements to the section of A40 between Robeston Wathen and Slebech opened in 2011 and resulted in a significant reduction in traffic volumes passing through the village of Robeston Wathen. The consequence of this was less passing trade for the petrol station in Robeston Wathen. Signage was put in place to alert drivers on the A40 of the availability of local services including the filling station. The petrol station in Robeston Wathen continues to trade nine years after the improvements scheme was opened.

8.30 At the time of writing my evidence, Mr Jeff Jenkins, Mr John & Mrs Linda Smith and Mrs Sally Amoore were maintaining this point of objection.

Poor Value for Money

8.31 In his objection Mr Jeff Jenkins (R0016) states that the Scheme would be a waste of taxpayers' money. John & Linda Smith (R0028) also object to the Scheme on the grounds of poor value for money.

8.32 I have provided information about the economic appraisal results in paragraph 7.63 and Table 9. Whilst the BCR of 0.13 indicates a poor economic case, I have also highlighted that there are a number of non-monetised benefits which are referred to in more detail in paragraphs 7.74 to 7.90. If monetisation of some of these benefits was possible, then the BCR would increase. With that in mind the BCR should be regarded as a conservative value.

8.33 Sensitivity tests described in paragraphs 7.64 to 7.74 also highlight that the BCR is very sensitive to certain input assumptions, such as the junction configurations that form part of the Scheme or the speed limit that would apply through the village of Llanddewi Velfrey in the future in the absence of the Scheme.

8.34 Importantly, the economic appraisal is only one aspect of the overall case for investment and needs to be balanced against other environmental and social costs and benefits. These should be considered in the context of the overall Scheme objectives.

8.35 At the time of writing my evidence, Mr Jeff Jenkins and John & Linda Smith were maintaining this point of objection.

The Need for the Scheme

8.36 In his objection Mr Jeff Jenkins (R0016) implies that the existing A40 does not experience congestion. Mrs Janine Perkins (R0089) also challenges the need for the Scheme in a more general context in her objection.

8.37 In section 3 of my proof of evidence I describe the existing conditions on the A40. This highlights the operational problems that are experienced on the A40. They are related to the standard of the existing road, the mix of traffic that uses the road and the frequency of property accesses onto the road.

8.38 Paragraphs 3.27 to 3.33 highlight that journey times along the A40 are between 15 and 17% higher during daytime hours than during night time hours. A key contributory factor to this increase in journey times during daytime hours are slow-moving vehicles and a lack of safe overtaking opportunities.

8.39 The number of accidents that occurred on the section on A40 that would be bypassed is quoted in paragraph 8.15. The Scheme would also lead to a reduction in the number of accidents and resulting casualties as highlighted in paragraph 8.19.

8.40 Further rationale for the Need for the Scheme and an explanation of how the Scheme meets the objectives is included in the proof of evidence of chief witness Mark Dixon (WG 1.1.2).

8.41 At the time of writing my evidence, Mr Jeff Jenkins and Janine Perkins were maintaining this point of objection.

9. Conclusion

Traffic Modelling and Economic Appraisal

9.1 The traffic modelling and economic appraisal for this Scheme has been undertaken in compliance with the relevant guidance set out in WelTAG (Doc. 4.01.11) and WebTAG (Doc. 4.01.69). The base year traffic model provides a good match against observed traffic volumes and journey times.

Impact of Slow-Moving Vehicles

9.2 Analysis of observed journey times demonstrates that vehicles take between 15 and 17% longer to travel along the A40 during daytime hours than during night time hours. This indicates the extent to which slow-moving vehicles, the frequency of junctions and direct property accesses onto the A40 are currently impacting on vehicle speeds.

Impact of Traffic Growth

9.3 Traffic growth projections show that traffic volumes relative to the base year of 2016 are likely to increase by broadly 22% by the design year (2036) and 34 to 35% by the traffic modelling horizon year (2051).

9.4 Whilst the A40 corridor has generally got sufficient capacity to accommodate the forecast levels of traffic growth, existing operational problems related to lack of overtaking opportunities (especially of slow-moving HGVs, campervans, towing vehicles or agricultural vehicles), platooning of traffic and in particular community severance would be exacerbated by the projected increase in traffic volumes.

9.5 The Scheme would address these operational issues and would make the section of A40 around Llanddewi Velfrey consistent with the WS2+1 standard of road that has already been implemented on nearby sections of the A40 and A477.

9.6 Traffic growth would exacerbate existing safety concerns voiced by local residents at public engagement events. It can be argued that the Do Minimum scenario should include provision for a reduction in the speed limit through Llanddewi Velfrey and between the village and Penblewin Roundabout. Such an alternative Do Minimum scenario would have a significant positive impact on the economic case for the Scheme due to the increase in time savings resulting from the Scheme relative to it as described in paragraphs 7.70 to 7.73.

Impact of Removal of Traffic from Llanddewi Velfrey

9.7 In 2036, the Scheme is forecast to remove 96% of traffic from the existing A40 through Llanddewi Velfrey. This would result in improvements in quality of life, for example through the enhancement of journey quality, significant reduction of community severance within Llanddewi Velfrey and associated health and amenity benefits that would arise from this.

Impact on Road Safety

9.8 The proposed WS2+1 road would be safer than the existing A40 and would therefore result in a reduction in the number of accidents. Under central growth assumptions the accident analysis forecasts a saving of 41 personal injury accidents resulting in 51 fewer casualties over the 60-year appraisal period. The total monetised accident savings amount to £1.39m in benefits.

The Economic Case

9.9 Whilst the BCR of 0.13 indicates a poor economic case, there are a number of benefits that either cannot be quantified or have not been quantified, on the basis that the analysis required would be disproportionate to the scale of likely benefits. These include:

a) Journey time reliability;

b) Detailed impacts of the overtaking sections (in terms of the detailed build up and dispersion of platoons);
c) Seasonality and other periods of high demand;
d) Driver stress and frustration;
e) Freight;
f) Wider economic impacts; and
g) Other environmental and social impacts aside from GHG, air quality and noise impacts.

9.10 The benefits of the Scheme are also shown to be very sensitive to small changes, such as a change to the junction configuration at the eastern tie-in point of the Scheme or the speed limit that applies through Llanddewi Velfrey without the Scheme in place as described in paragraph 9.6.

9.11 It is important to note that the economic appraisal is only one aspect of the overall case for investment and that it needs to be balanced against other environmental and social costs and benefits. The BCR should therefore be considered in the context of the overall Scheme objectives. The proof of evidence of chief witness Mark Dixon (WG 1.1.2) provides further context of how the Scheme would address the objectives.

Final Remarks

9.12 The Scheme is one part of a wider set of improvements along the A40 Trunk Road between St Clears and Haverfordwest, which forms part of the Trans European Road Network (TEN-T). It would remove 96% of traffic from Llanddewi Velfrey, which would bring safety, health and amenity benefits to the community as a result of reduced severance.

9.13 Strategic traffic travelling along the A40 would benefit from faster journey times, better journey time reliability and safer journeys. Additional overtaking opportunities would provide a more consistent driver experience along the A40. The Scheme would therefore improve journey quality and reduce driver frustration and stress.

9.14 The economic case for the Scheme indicates poor value for money. However, I regard this as a conservative estimate on the basis that a number of additional benefits that would be likely to arise are not captured. A key consideration is that the economic appraisal is only one aspect of the overall case for investment, which is why it needs to be balanced against other environmental and social costs and benefits. The economic case should therefore be considered in the context of the overall scheme objectives.

9.15 Taking everything into consideration there is, in my view, on balance a good overall case for the Scheme.

10. Appendices (Separate Volume – WG 1.2.3)

Appendix A – Existing Conditions Figures

Appendix B – Base Year Traffic Flow Figures

Appendix C – Forecast Year Traffic Flow Figures

Appendix D – Economic Appraisal Outputs